THE PRINCIPAL CONCEPTS FOR A LONG-TERM MAPPING PROGRAM IN THE MARITIME PROVINCES

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PREFACE

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THE PRINCIPAL CONCEPTS FOR A LONG-TERM MAPPING PROGRAM IN THE MARITIME PROVINCES

A Report

by

The Department of Surveying Engineering

University of New Brunswick

for

The Land Registration and Information Service

Council fo Maritime Premiers

December, 1976

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Preface and Acknowlegments

This study is one of a series of background studies undertaken for the Council of Maritime Premiers by the Department of Surveying Engineering at the request of the Land Registration and Information Service.

Mr. R.H. Castonguay of the L.R.I.S. staff collaborated in the preparation of the report, however the responsibility for the contents rests with me.

Brig. L.J. Harris collaborated on the study as a consultant. His long experience in cartography has been extremely valuable in the investigation related to the traditional mapping practice and the computer-assisted technology.

The study team is grateful to all the map users who responded to the long questionnaire on the regional and local mapping needs in the Maritime Provinces.

A.C. Hamilton.

December, 1976

PROGRESS UPDATE

In the fall of 1977, an Ad Hoc Committee was formed to review the study on "The Principal Concepts for a Long-term Mapping Program in the Maritime Provinces".

The Committee had representatives from the provinces of New Brunswick, Nova Scotia and Prince Edward Island, the Provincial Associations of Land Surveyors and Professional Engineers,consulting, surveying, mapping and engineering firms, the Land Registration and Information Service and the study team.

The Committee met twice. The report was reviewed and the recommendations were discussed, modified and restructured. A list of recommendations, as finally adopted by the Committee, is enclosed.

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RECOMMENDATIONS FROM LONG TERM MAPPING MEETINGS

Recommendations Regarding General Mapping Program of the Maritime Provinces

--Digital map files for high density urban areas be compiled at a content and quality level consistent with 1:1 000 standard map scale.

--Digital map files for lower density cities, suburbs, towns, villages and urbanized rural communities be compiled at the content and quality level consistent with 1:2 000 standard map scale.

--A series of seminars and workshops be held with concerned groups before adapting specifications on 'quality level' of regional digital map files. The two quality level choices are the equivalent to the 1:10 000 and 1:20 000 standard map scales.

--The planes of the provincial plane coordinate systems be adopted as the map projection planes within the Maritime provinces.

--The reference grid representing the provincial plane coordinate system be the predominant grid in all medium and large scale maps.

Recommendations Regarding the Cartographic Framework and Identifiers

--The decimal degree be adopted for geo-packaging in the Maritime provinces.

--The Universal Transverse Mercator plane coordinate system and the ellipsoidal coordinate system be subsidiary referencing systems.

--All large scale maps be provided with a predominant reference grid spacing corresponding to a ground distance of 100 metres.

--All medium scale maps be provided with a predominant reference grid spacing corresponding to a ground distance of 1000 metres.

--A serial identifier and a serial name be adopted for every public map series (those offered for sale to the public).

Recommendations Regarding Revision

--The medium scale photo base be revised on a nominal 10-year revision cycle with a long term goal of a true 10-year revision cycle.

--The large scale map revision be revised on a nominal 5 year revision cycle with a medium term goal of a true 5 year revision cycle and a long term goal of continuous revision.

--A graphical revision procedure for the existing large scale map series be developed as soon as possible. The resultant maps should be at least as accurate as the original map.

Recommendations Regarding Coordination and Responsibility

--Production of new maps and digital files remain the responsibility of a centralized unit.

--The revision of the medium scale map series provided by LRIS remain centralized.

--The standard specifications not require data from field completion but include field inspection.

--Whenever large scale maps of a municipality are being produced or revised, the municipality be given the opportunity to provide data by field completion.

--In order to achieve revision requirements, serious consideration be given to regional map revision strategy keeping in mind the maintenance of standard quality maps.

--The design of the digital files corresponding to the medium scale maps should try to provide for the flow of data to and from the various federal map series and other digital data.

--It is anticipated that if data from one specific project mapping will be of significant value to the regional mapping program, a cooperative or joint venture be considered.

PRINCIPAL CONCEPTS FOR A LONG-TERM
MAPPING PROJECT IN THE MARITIME PROVINCES

APPENDICES

A. THE PREPARATION, DISTRIBUTION, MONITORING AND PROCESSING OF THE QUESTIONNAIRE ON MAPPING NEEDS IN THE MARITIME PROVINCES

B. ANALYSIS OF THE REGIONAL QUESTIONNAIRE

C. ANALYSIS OF THE LOCAL QUESTIONNAIRE

D. URBAN TERRITORY PROJECT MARITIME PROVINCES-- 256 CITIES, TOWNS AND VILLAGES

E. THE PLACE OF MINIATURIZATION IN MAP PRODUCTION

PART A

1 INTRODUCTION

The large and medium scale map series presently being produced in the three Maritime Provinces were initiated prior to the formation of LRIS, consequently, there are differences between the provinces in the scales, in the numbering system, in the sheet boundary system, in the map surrounds and in map content. Because of these differences the full cost savings possible from the unification of the production facilities under LRIS cannot be realized.

Only some ten years ago computer-assisted (digital) map production was possible but it was practical only for military agencies; now in addition to military agencies, large civilian organizations have computer-assisted map production programs. In view of this the time has come for medium-sized agencies, such as the LRIS, to explore the potential for this new technology. The decision to embark on a digital mapping program should not be taken lightly; the equipment and the skilled resources needed are so costly that without extensive and careful planning the program will not be cost effective. There is also another important aspect to consider. This is the fact that plotting accuracy by automated methods is appreciably higher than by manual methods. The implication of this is that the specifications for all stages of map production will need to be revised. Thus in view of the need to resolve the differences between map series noted above and of the prospect of the introduction of digital mapping methods the necessity of identifying the principal concepts for a long-term mapping program in the Maritimes was recognized.

Map requirements vary widely from country to country; they are dependent, for example, on the state of development of a country, on the level of economic activity, on the land registration system, on the assesment method and on the traditions of the society with respect to map use; in other words, it is a complex question. In view of this

In mapping jargon the scale of a map is the ratio of distance on the map sheet to the true distance. Maps of cities may be at scales 1:1000, 1:1200 or 1:2000, these are large scales; maps showing an entire province or country may be at scales ranging from 1:250 000 to 1:5 000 000, these are small scales. This is because the fraction 1:5 000 000 is much smaller than 1:1000.

complexity, it would be surprising if the first series of maps proposed for a region were to meet the need ideally or for all time. Similarly due to differences of climate, terrain, culture, industry, or population density, it is highly unlikely that a mapping program that has proven suitable in one country or in one region can be transferred to a different type of country or region without considerable adaptation. Even in those countries which have a long history of production and of usage of large scale maps, it is the practice to review their programs periodically and to adapt to the changing technology and to changing requirements.

This study has, as a consequence, the following objectives:

i. to examine the long-term mapping needs of the region;

ii. to examine alternative methods to achieve these needs in light of the new technology; and then,

iii. to develop the principal concepts and preliminary specifications for a long-term mapping program in the Maritime Provinces in light of changing requirements, new technology, and other national and regional developments.

Map-making is both an art and a science; many of the earliest maps had very little science but a large element of artistic creativity. Some modern maps have a large component of science, some have a large art component. Some are strong in both art and science; others are deficient in both. In the Middle Ages maps were used primarily for exploration and navigation. Early explorers, such as Champlain, were also map makers. Champlain's work is interesting as an example of a dichotomy in mapping of which one can see remnants to this day. Champlain had detailed drawings of his encampments showing the location of fences, buildings, barricades, etc., at a scale of approximately 100 feet to one inch (1:1200); at the other extreme, he made small-scale maps depicting on one sheet the entire eastern coastline of North America as it was known at that time. He made maps, or plans, at very large scales and exploration maps at small scales, but it was obviously beyond his resources or his immediate needs to make maps at the intermediate scales. Our society in the Maritime Provinces appears to be becoming more and more a series of encampments surrounded by developing hinterlands. To an increasing degree, there is a need to know the location of every element of our environment and spatial referencing is the only method by which a quick and effective correlation can be made of all the elements - environmental or geographical in our complex civilization.

Although maps have been made for many thousands of years, it is only in the last two to three hundred years that national governments have initiated systematic national survey and mapping programs and created organizations to undertake this work. Previously, surveys were carried out for roads, for example, by specialists, as in the days of the Roman Empire; and the surveys of properties were undertaken by individual surveyors. The needs of science, military defence, and taxation combined to accelerate the establishment of national governmental organizations and the execution of systematic national programs of surveys and mapping. Thus, in Great Britain and France, scientific reasons motivated the joint effort to undertake the trigonometrical survey to join the Paris observatory to Greenwich in the early 1780's, while the defence of the realm against France caused the extension of this triangulation along the south of England with some mapping under the direction of the Honorable Board of Ordnance in 1791. Ever since the Army had prepared a military sketch map for the building of roads in the Scottish Highlands after the 1745 up-rising, the idea of creating a national mapping organization had been in the minds of many in Great Britain. The efforts of William Roy, who had been engaged on the Scottish Survey as a young officer, resulted in the establishing of a national trigonometrical survey organization in 1791. The production of the one inch to one mile map of England and Wales (1801-1824) resulted from the desires of landowners, industrialists, and even of recreation (fox hunting). The enlargement of the scale to six inches to one mile for the Survey of Ireland (1824-1849) was intended to meet the requirements of land administration and taxation. In time, the trigonometrical survey came to be called the "Ordnance Survey" from the Board which directed its operations. The uniqueness of of the British organization is the centralization of production of all mapping scales in one organization from the large or cadastral scales (1:1250 and 1:2500) through the topographical scales (1:10 000 to 1:250 000) to the geographical and atlas scales. In France, similar influences played their part, but organizationally the responsibility for topographical surveying was separated from cadastral surveying and remains so. Topographical surveying from Napoléon's time was vested in the Service Geographique de l'Armée, (in which Napoléon served for a time), until it was renamed the Institut Géographique National in May 1940 by Marshal Pétain just before the fall of France. Large scale and cadastral surveying is carried out by a separate governmental organization and by private géomètres.

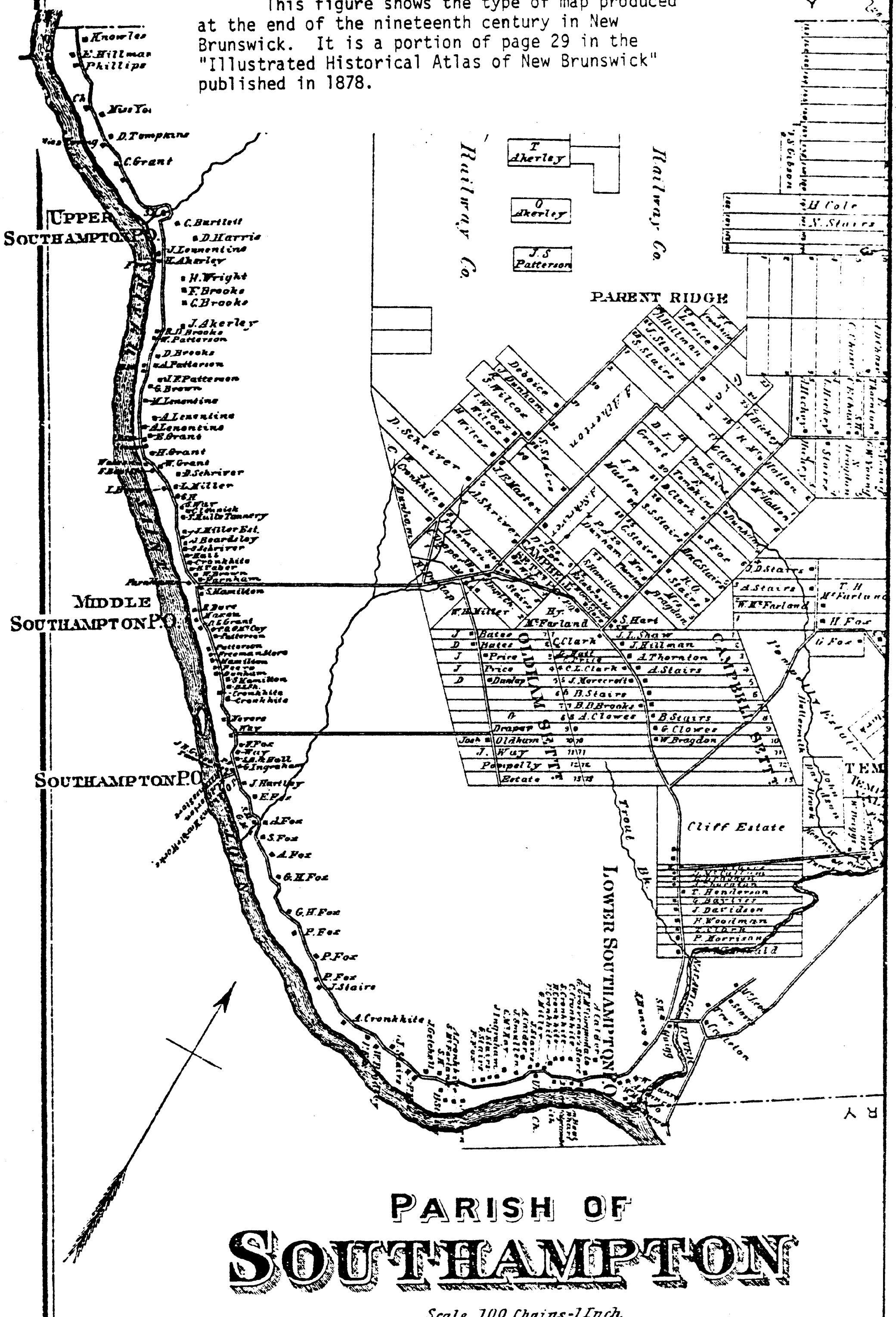
In North America apart from coastal and exploratory surveys, the priority of early governments was to divide the land into lots so that settlers could occupy it as quickly as possible. For this purpose, a map depicting the lots as delineated on the ground was compiled; these became known as Crown grant maps. Having done this, the government of the day was satisfied that it had no further responsibility for large or medium scale mapping. These Crown grant maps, made nearly 200 years ago, continued to be the only large scale maps in existence for many regions until well into this century. A portion of one of these maps is reproduced in Figure 1-0-1.*

By comparison, land in Europe was not in such plentiful supply and had long been considered a precious commodity. The need for information about the land was recognized for military purposes, taxation, and, more recently, for planning and management. From this need, distinctive cartographic appreciation, cultures and programs have evolved.

*Figure 1-0-1
- 1 — Figure #1 of
- 0 — main section #0
- 1 — chapter #1

Figure 1-0-1

This figure shows the type of map produced at the end of the nineteenth century in New Brunswick. It is a portion of page 29 in the "Illustrated Historical Atlas of New Brunswick" published in 1878.



In the Maritimes as in the rest of North America, mapping received little impetus from either the military or the civil areas of government prior to World War II. There was no military impetus because the defence of the Maritimes depended on command of the seas which was the responsibility of the Royal Navy. Nor was there any impetus from the civil administration, because land taxes were not a source of revenue for either the national or the provincial government. Where property taxes existed, they were levied and collected at the local municipal level and for this purpose an annotated copy of the Crown grant map sufficed.

The absence of a long tradition of mapping in the Maritimes has economic, educational and cultural effects on the mapping program. Each of these will be discussed briefly:

i. The economic effect— The most significant economic effect is the pattern of project mapping or ad hoc mapping that prevails in Canada. In the absence of suitable region-wide medium-scale and urban large-scale map series, many agencies and industries have been forced to do project-oriented mapping. In some instances, this is justifiable and economical; more ofter, however, several project requirements partially overlap and project mapping of some areas may be done three, four or five times where one multi-purpose map would have served for all the projects and for general users. In such cases, project-mapping is an uneconomic approach.

ii. The educational effect— Because there was no demand for the skilled people to make maps, there were until recently, no educational facilities either at the professional or technical personnel for map making.

iii. The cultural effect — For the most part the Canadian public are cartographically illiterate. To many Canadians, map usage is limited to a map obtained at a gasoline station. On the other hand, to residents of the British Isles and of most European countries, maps have a wider appeal, and are used for hiking, for cycling, and for many other pursuits.

The net effect of the absence of a long tradition of mapping in the Maritimes is that, until World War II, there was no equivalent here of the official governmental large scale mapping programs undertaken in European countries. The medium scale mapping at one mile to one inch (1:63 360) was initiated in the 1930's and completed (as 1:50 000) in 1953.

In New Brunswick a series of planimetric maps at the scale of 20 chains to one inch (1:15 840) was initiated in 1945 and completed approximately ten years later; in Nova Scotia a similar series was initiated in 1955 (see Figure 1-0-2). It should be noted too that each city has long had some type of large-scale map — usually for assessment purposes. Following World War II, most cities contracted for a large-scale planimetric or topographic map of the territory within the city boundaries; usually, however, there was no large scale mapping of the area surrounding a city.

In 1968, under the Atlantic Provinces Surveying and Mapping Program (APSAMP), a vigorous program of mapping at both medium and large scales was undertaken. A summary of the work done under APSAMP and its successor, LRIS, is presented in Figure 1-0-2 along with a list of the previous series. This summary also shows the diversity of scales, map projections, sheet lines and map numbering systems in the three provinces.

Under normal circumstances, there would not be a critical deadline for a new program to be defined, but there are other deadlines which have a critical effect on the timing of any major change in the mapping program. These are "metric conversion" and "geodetic readjustment". The Metric Commission has given wide publicity to the metrication program and published a schedule in which January 1, 1978 is recommended as M-Day for the "Realty and Survey" sector of the economy. A program to readjust the North American geodetic networks is under way and, at the request of the provinces, the Federal Government has agreed that readjusted coordinates can be introduced simultaneously with the introduction of metric units.

	Province	Scale	Series	Sheet Line	Projection	Grid	Numbering System	Sheet Quantity	Period
Prior to APSAMP & LRIS (mainly)	N.S.	1"=100' to 1"=300'	City Atlas of Halifax	Variable	Unknown	None	None	85 pages	Published 1878
	N.B.		Atlas	Village & Parish	Unknown	None	None	85 pages	Published 1875
	N.S.	1"=4 chains to 1"=50 chains	Atlas of Pictou County	Aristocrates & Land Ownership to 1879	Unknown	None	None	95 pages	Published 1879
	N.S.	1:63 360	County Series	County	Unknown	None	County Name	18	Published 1864
	P.E.I.	Variable	Meachems Atlas	Aristocrats Lot of 1767	Unknown	None	Lot 1 to 67	162 pages	Published 1880
	P.E.I.	Variable	Cummins Atlas	Aristocrats Lots of 1767	Unknown	None	Lot 1 to 67	140 pages	Published 1927, 1947
	N.B.	1:15 840	Planimetric	Graticule	Polyconic	None	1 A Z Matrix 32	455	1945 to 1976
	N.B.	1:15 840	Crown Land Forest type	Graticule	Polyconic	None		455	
	N.B.	1:15 840	Geology	Graticule	Polyconic	None		134	
	N.B.	1:31 680	Planimetric	Graticule	Polyconic	None	1 to 167	167	
	N.B.	1:31 680	Original Crown Grant	Graticule	Polyconic	None	1 to 167	167	
	N.B.	1:25 000	Aeromagnetic	Graticule	Unknown	None	NTS	60	1975
	N.S.	1:15 840	Series (a) Forest type	Graticule	UTM	3°TM	1 A 45 V Matrix and 1 to 125 for Cape Breton	543	1957 to 1976
	N.S.	1:15 840	Series (b) Original Grant	Graticule	UTM	3°TM		72	
	N.S.	1:15 840	Series (c) Crown Land	Graticule	UTM	3°TM		206	
	N.S.	1:15 840	Series (d) Planimetric	Graticule	UTM	3°TM		543	
	N.S.	1:15 840	Forest type	Graticule	UTM	None		545	1954 - 1957
	N.S.	1:31 680	Original Crown Grant Index Sheet	Modified Graticule	UTM	None	Excluding 134 2 to 140	138	1938 - 1958
	N.B.	1:15 840 & Larger Scales	Assessement Series	Variable	Polyconic	None	Variable	4809	1969 to present
	N.B.	1:480	St. John City Cadastral	Street Block	Unknown	None	1 to 106	106	1923 to APSMP
	N.S.	1:4800	Topographic	Variable	Local	None	1 & up on urban Community bases	372	1950 to APSMP
	N.S.	1:2400	Topographic	Variable	Local	None		186	1950 to APSMP
	N.S.	1:1200	Topographic	Variable	Local	None		22	1950 to APSMP
	N.S.	1:480	Halifax City Topographic	Grid	UTM & Local	Yes		143	1959 to 1960
	P.E.I.	1:2400	Topographic	Variable	Unknown	None	Sheet 1 to 72	72	Early 1960 to APSMP
APSAMP & LRIS	N.B.	1:1200	Planimetric & Topographic & Cadastral	Grid	Stereographic	Stereo-graphic (feet)	32 1 A Y	748	Late 1960 to 1976
	N.B.	1:2400		Grid	Stereographic	"		590	
	N.B.	1:4800		Grid	Stereographic	"		533	
	N.B.	1:10 000		Graticule	Stereographic	"	Expanded NTS numbers	517	
	N.S.	1:1000	Planimetric & Topographic & Cadastral	Grid	3°TM	3°TM (metres)	Metric Coordinate	232	
	N.S.	1:1200		Grid	3°TM	3°TM (feet)	1 A R Zone Identifier 20	1004	
	N.S.	1:2400		Grid	3°TM	3°TM (feet)		34	
	N.S.	1:4800		Grid	3°TM	3°TM (feet)		107	
	N.S.	1:5000		Grid	3°TM	3°TM (metres)	Expanded NTS number	37	
	N.S.	1:10 000		Graticule	3°TM	3°TM (feet)	Expanded NTS number	138	
	P.E.I.	1:1250	Planimetric & Topographic & Cadastral	Graticule	Stereographic	Stereo-graphic (metres)	Expanded NTS number	199	
	P.E.I.	1:2500		Graticule	"	"	"	92	
	P.E.I.	1:5000		Graticule	"	"	"	1456	
	P.E.I.	1:10 000	Planimetric & Topographic	Graticule	"	"	"	117	

Figure 1-0-2

Logically, any proposed changes in map projections, map scales, map sheet neat lines or any other major item in map specifications should be timed to coincide with the introduction of metric units and of the readjusted coordinates. It follows that the specifications for a long-term mapping program should also be ready by January 1, 1978.

From a cursory review of mapping programmes in many countries it is apparent that in some countries the mapping programmes have evolved to a "steady state" whereas in others, such as Canada, the mapping programmes are still in an evolutionary stage. A summary of the programmes in two of the countries (Great Britain and Sweden) in which a "steady state" was achieved some decades ago is presented in the next chapter as examples of what we have termed "traditional mapping practice".

In a concurrent study, one of the investigators (Hamilton) reviewed progress on several applications of computer technology to mapping and information systems. A summary of this review presented in chapter 3 serves as an introduction to a discussion on how it is anticipated that the general pattern of mapping practice will be modified by the new technology. The potential impact of this new technology is itself sufficient to warrant a re-examination of traditional mapping programs. As there is no documented analysis of mapping requirements in the Maritime Provinces, the investigators of this study decided to make a survey by questionnaire to identify as closely as possible the needs for mapping in the Maritime Provinces. The development of this questionnaire is described in Appendix A and recommendations based on an analysis of the responses are given in Chapter 4.

2 TRADITIONAL MAPPING PRACTICE

2.1 BASIC CONCEPTS

2.1.1 The Principle of the Basic or Parent Scale

The topographic map on a national level provides a synthesized record of the visible features of the environment to the extent that the scale of a map permits. The largest scale of map produced for an area is the basic, or parent scale from which all the smaller scales may be derived. The traditional ideal is illustrated in Figure 2-1-1 and the Maritime-Federal practice is illustrated in Figure 2-1-2. The resulting family of scales, in its turn, supports a theoretically limitless range of thematic maps. The choice of parent scale is dependent on the value or potential value of the land,on the size of the task, and on the available resources. Currently in Canada, the largest planned nation-wide parent scale is the 1:50 000 National Topographic Series (NTS) mapping.

Within each region, depending on the type of environment, a parent scale is selected. The parent scale should be dependent on the density of features to be shown. Because the "built environment" contains more information to be recorded than the rural environment, it follows that the parent scale for cities and towns should be larger than the parent scale for an agricultural region. The scales in use in Great Britain were chosen after a number of parliamentary debates, commissions, and committees covering a period of over one hundred and fifty years. The British story (Section 2.2.1) illustrates the importance which should be attached to the choice of the basic scales.

The concept outlined above by which all smaller scales are derived from the basic or parent scale is an ideal which is honoured more in word than in deed. This is because it is desirable when going to the expense of recompiling and reprinting a map sheet to have the information as complete and up-to-date as possible. To achieve this in making a smaller scale map, from a larger scale map, it is necessary that all the map sheets at the larger scale be up-to-date. Except for a brief period immediately following the completion of revised mapping at the larger scale, these large scale maps are not up-to-date. Futhermore, the number of map sheets required

TRADITIONAL IDEAL

HINTERLAND	RURAL	URBAN	SCALE RANGE
SECOND DERIVED SCALE	THIRD DERIVED SCALE	FOURTH DERIVED SCALE	ATLAS
FIRST DERIVED SCALE	SECOND DERIVED SCALE	THIRD DERIVED SCALE	1:1 000 000 to 1: 250 000
PARENT SCALE	FIRST DERIVED SCALE	SECOND DERIVED SCALE	1: 250 000 to 1: 50 000
--	PARENT SCALE	FIRST DERIVED SCALE	1: 50 000 to 1: 4 800
--	--	PARENT OR BASIC SCALE	1: 4800 to 1: 1000

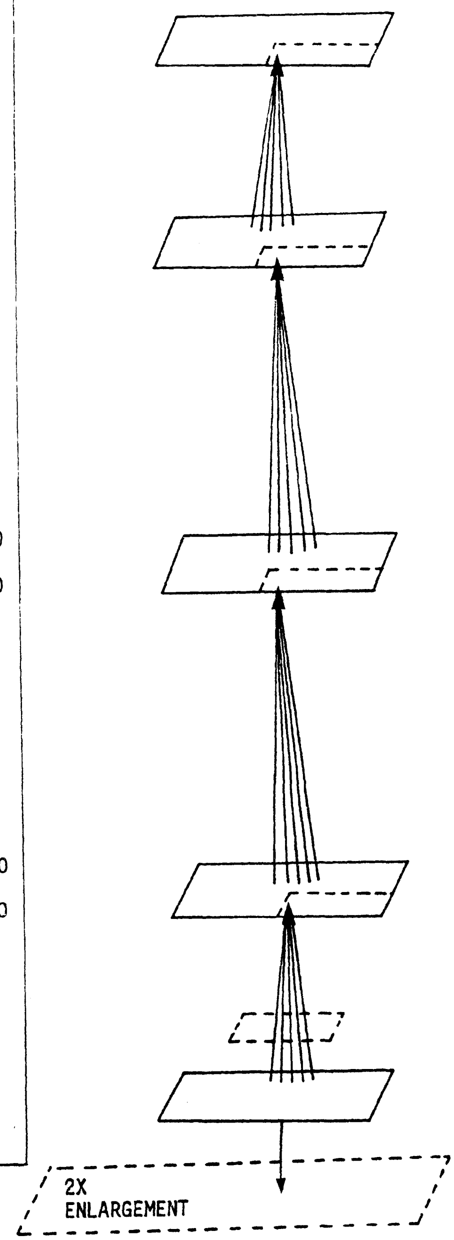


Figure 2-1-1 - In the traditional ideal, data collected to meet the requirements of the parent scale map is used to "derive" all smaller scales. Note that the area represented by a whole map sheet at scale 1:1000 is represented by a square approximately 0.5 mm by 0.5mm at scale 1:1 000 000.

MARITIME-FEDERAL PRACTICE

Coverage	Production Technique
Whole country	Derived
Whole country	Derived
Populated area of the country	Parent scale
Whole Province	Derived
Cities only	Compiled
Whole Province	Parent scale in N.B. Retrace in N.S.
Southern counties in N.B. Whole Province in P.E.I.	Compiled in N.B. Compiled in N.S. Reduced in PEI
	Compiled
Rural areas	Compiled in N.B. Compiled in N.S.
Villages and towns	Compiled
Villages and small towns	Compiled in N.B. Compiled in N.S.
Cities	Compiled
Cities and larger towns	Compiled in N.B. Compiled in N.S.
	Enlarged

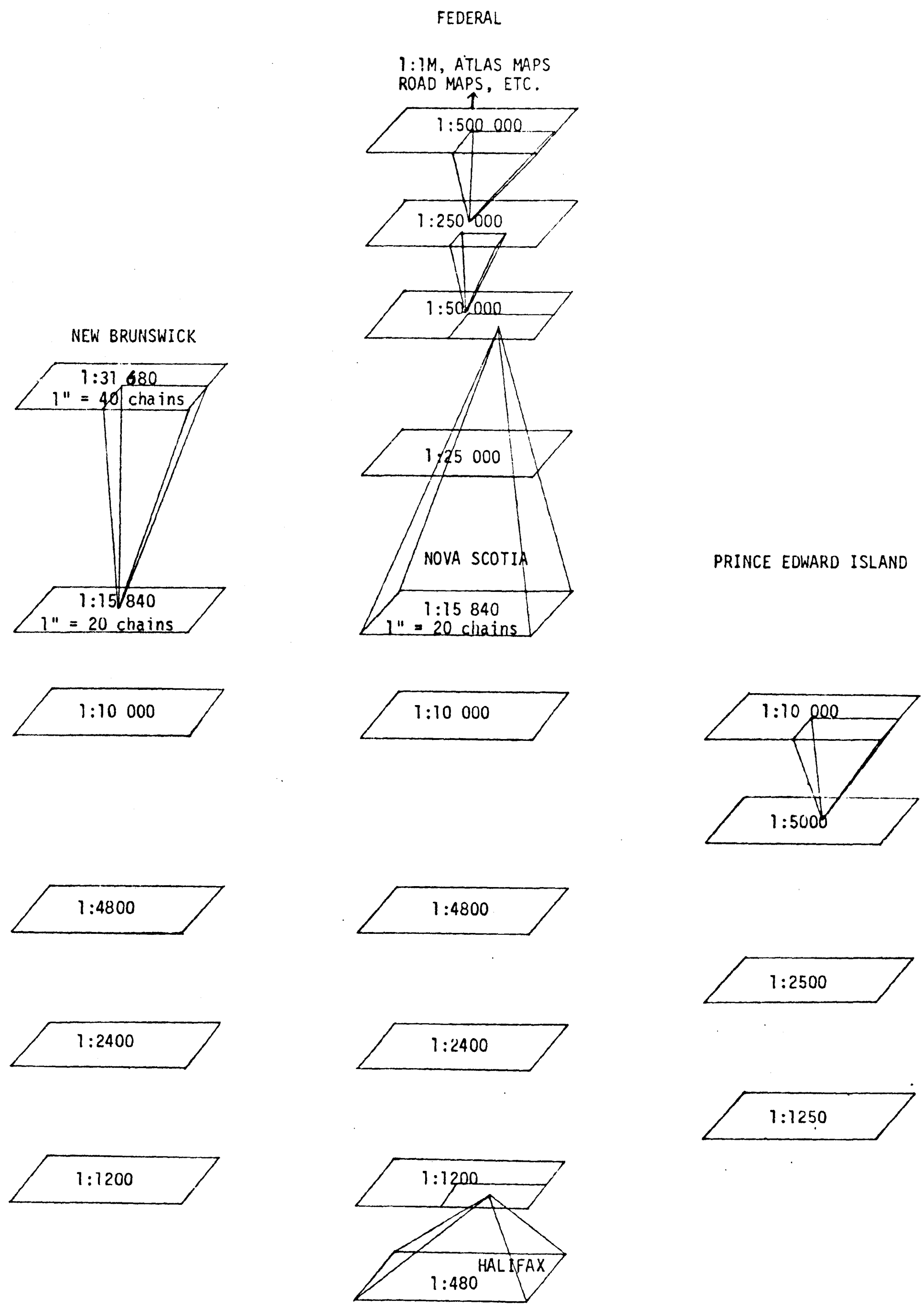


Figure 2-1-2 The principle of a parent scale from which smaller scales are derived has been followed only for the production of the 1:500 000 series. The 1:250 000 series (from the 1:50 000), and the 1:31 780 series (from the 1:15 840) in New Brunswick. Photographic reduction was used in the production of the 1:10 000 photomaps (from the 1:5000) in Prince Edward Island. Photographic enlargement was used for the production of the 1:480 (from the 1:1200) series in Halifax. The 1:15 840 series in Nova Scotia was a special compilation using the 1:50 000 series as a base.

to derive a smaller scale map from a large-scale map can be quite large; for example for the compilation of a 1:50 000 sheet— some 100 sheets at scale 1:2000 would be required. From this it becomes apparent that in many cases the ideal must remain just that— an ideal only.

In practice two or three parent scales are needed. The choice of the basic or parent scale for a country-wide or region-wide mapping programme is affected by the size of the country and region, and the resources available. Great Britain, a country of small geographical extent, chose successively, as it grew richer, basic scales of mapping of one inch to one mile (1800); six inches to one mile (1824); 1:2500 (1855) for the developed areas; and 1:1250 for the major towns (1937). Canada, a vast country with limited mapping resources initiated a one inch to one mile series early in this century; shortly after World War II this series was superceded by the 1:50 000 series. This series is a parent scale for revision of the 1:250 000 series and the 1:250 000 is, in turn, used to revise the 1:500 000 and 1:1 000 000 series.

At the larger scales the parent scale principle has, until now, rarely been followed. This is because the economics of photogrammetric compilation have been such that in general it has been more economical to compile medium scale maps directly by photogrammetric methods than to collect and generalize large scale maps. There are indications however that digital mapping technology may lead to simplifications in the generalizing procedure and this in turn will lead to economy. This will be discussed in more detail subsequently.

2.1.2 Map Reproduction - Multi-color and Monochrome Map

The use of color greatly enhances any graphic communication; in particular it permits much more information to be presented while still maintaining good accuracy and readibility. Consequently, color is introduced into maps as the map-scale grows smaller but it is usually unnecessary in the large scale plans and maps where data are plotted to scale and the content is not cluttered. Color, then, is added to improve the readability of the map and to accentuate features but for three main reasons should not be added unless necessary.

i. Experience has proven that a long period of time is required for the production of color maps. For example in a U. S. Government study entitled "Report of the Federal Task Force on Mapping, Charting, Geodesy and Surveying" published in 1973, it is stated that about five years elapses from the date the decision is taken to procure photography until the map is on sale to the public.

ii. Printing presses are designed for and are only practical for mass production; it is prohibitively expensive to set up a printing run for a small number of copies.

iii. At the present state of the art of map reproduction, it is many times more costly to produce a multi-color map than to produce a map in one color (monochrome). The reason that multi-color maps are so costly is that the lithography is a complex process.

In the printing of a multi-color map, a separate printing plate is required for every solid color printed on the map or used in combinations to make other colors. Sometimes, there may be two plates for one color, e.g., one for the culture (black plate) and one for the names (also a black plate). A separate drawing (overlay) is also required for every plate. Traditionally, it is at the drafting or scribing* stage that the map data is separated. The separations for the 1:50 000 NTS multi-color maps are shown in Figure 2-1-3. Having these separations enables various versions of a map to be produced by omitting one or more overlays. An example of this technique as applied in Sweden is discussed in section 2.2.2. For some purposes, such as for adding geological information it is sometimes desirable to omit contours. It must be emphasized that detail cannot be omitted from a particular overlay. For example, selected contours in the contour overlay or minor streams from the hydrography overlay cannot be omitted except by preparing special masks of the deletions or by manual retouching of the production material, i.e., by a manual drafting-type procedure.

* Scribing is similar to drafting except that: it gives higher quality line work; and a negative instead of a positive is produced.

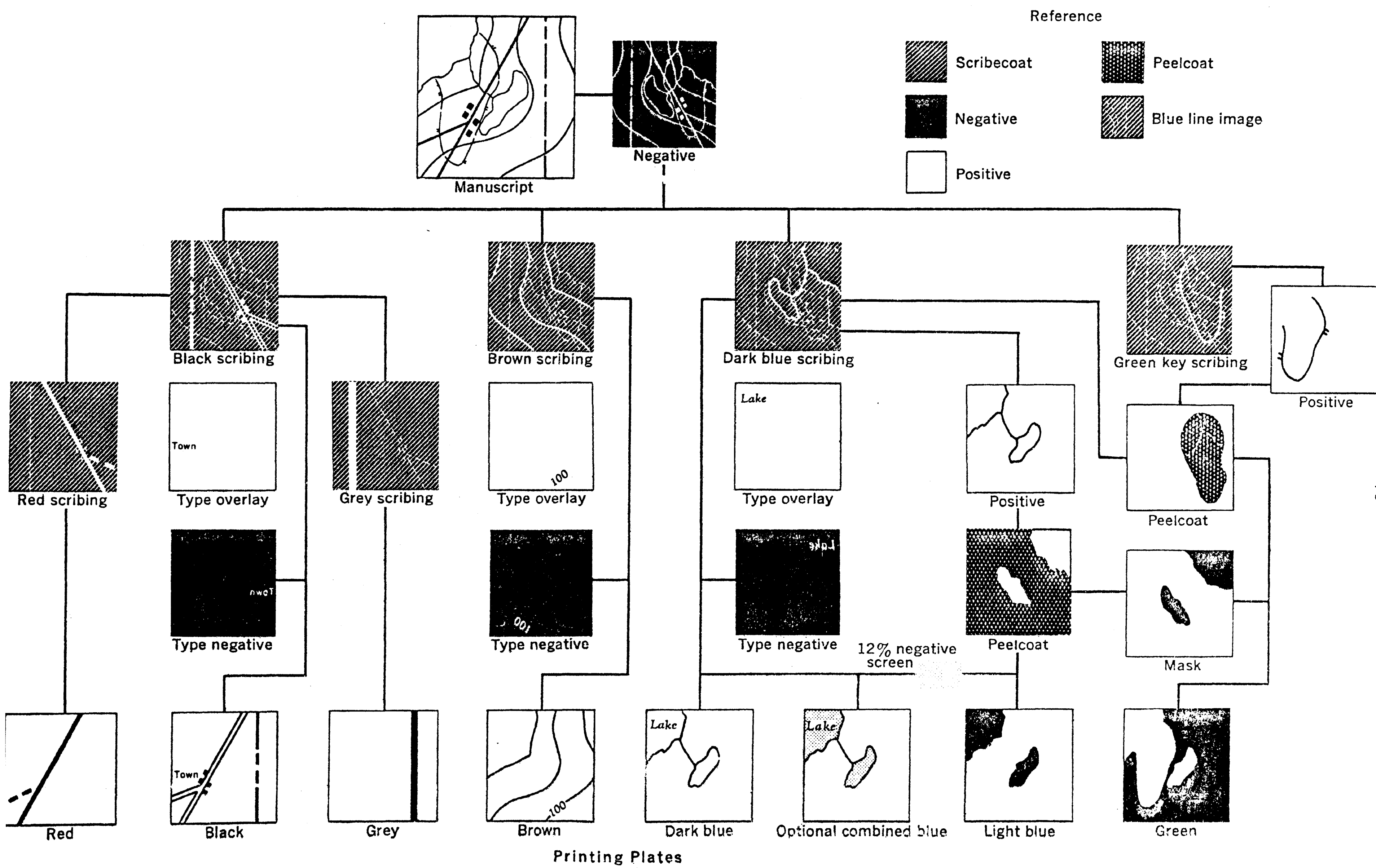


Figure 2-1-3

Flow diagram of multi-color map production

Baldock, E.D., Manual of Map Reproduction Techniques, Surveys and Mapping Branch, Ottawa

Where there is no intention of producing a multi-color map from a manuscript, separate scribe sheets are not required and problems of registration of the different overlays are thus avoided. This is currently done when monochrome processes such as diazo are used for printing. However, if it is anticipated that copies of the map may be required without certain classes of features, such as vegetation, omitted the class of features to be omitted can be scribed on a separate scribe sheet in the original production. (Each separate scribe costs approximately $40.00.) This overlay can then be combined with the other scribe sheets, photographically, to prepare the combined negative for printing. This procedure is depected in Figure 2-1-4. The procedure currrently followed in LRIS is shown in Figure 2-1-5 for the orthophoto mapping and in Figure 2-1-6 for the line mapping program.

The decision to produce monochromatic or color maps has a large impact on the design of the map, on the symbolization and on the amount of content that can be presented. However, by appropriate symbolization, monochrome maps can be made increasingly readable — a challenge in itself. Should a multi-color map be desired in the future, the adaptation of properly designed monochrome maps will be easily modified for multi-color processing — but the converse is not true. It must also be emphasized that the monochrome maps are the most adaptable to processing and usage in the current era of digital mapping and TV type display screens.

The over-riding factors with regard to multi-color maps are the high cost of multi-color printing and the long production time. This last factor also rules out the possibility of up-dating multi-color maps frequently. A breakthrough in color technology would, of course, change this situation dramatically. For the present, the above limitations dictate that mapping programs at large scale should be planned for monochrome reproduction.

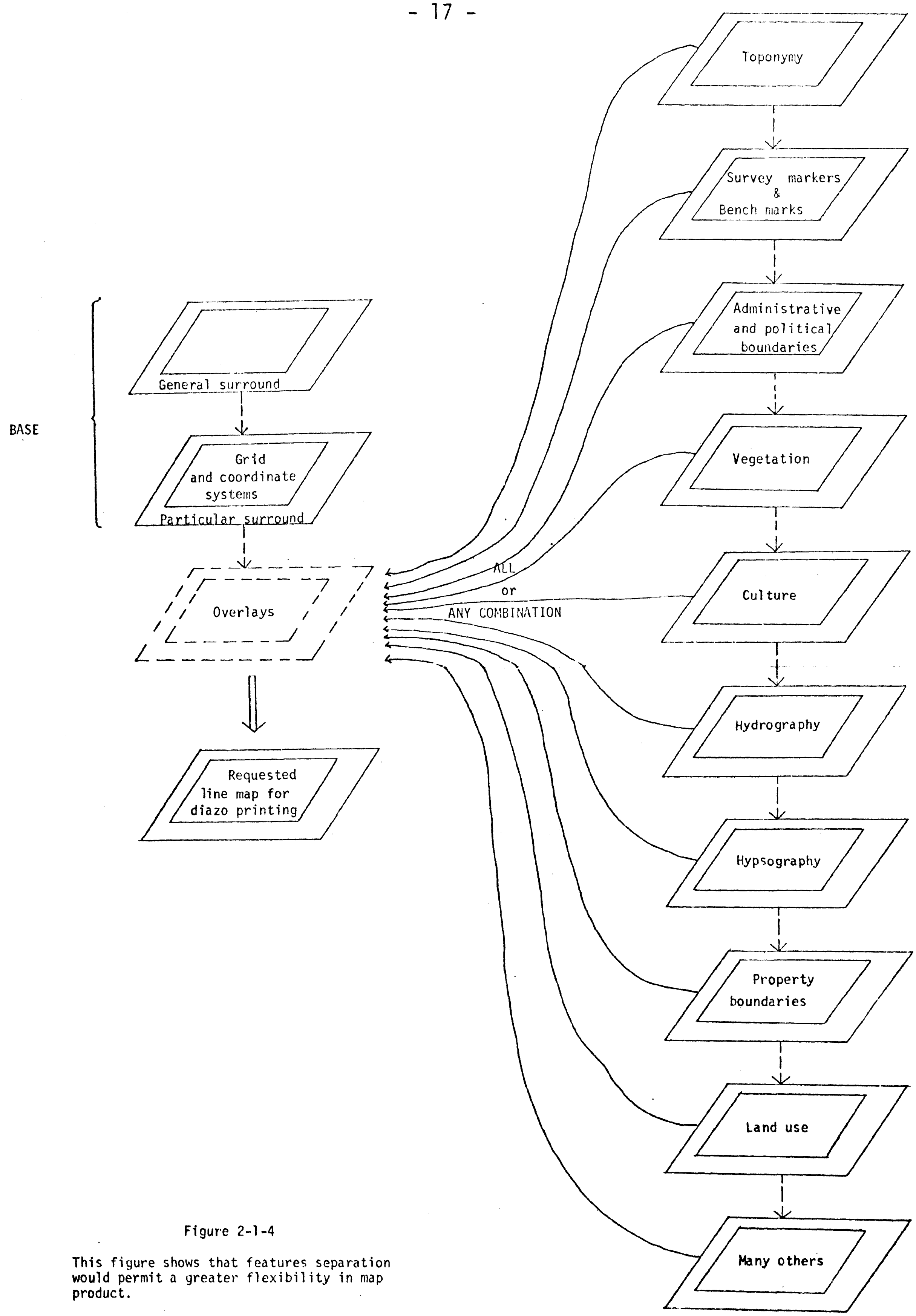
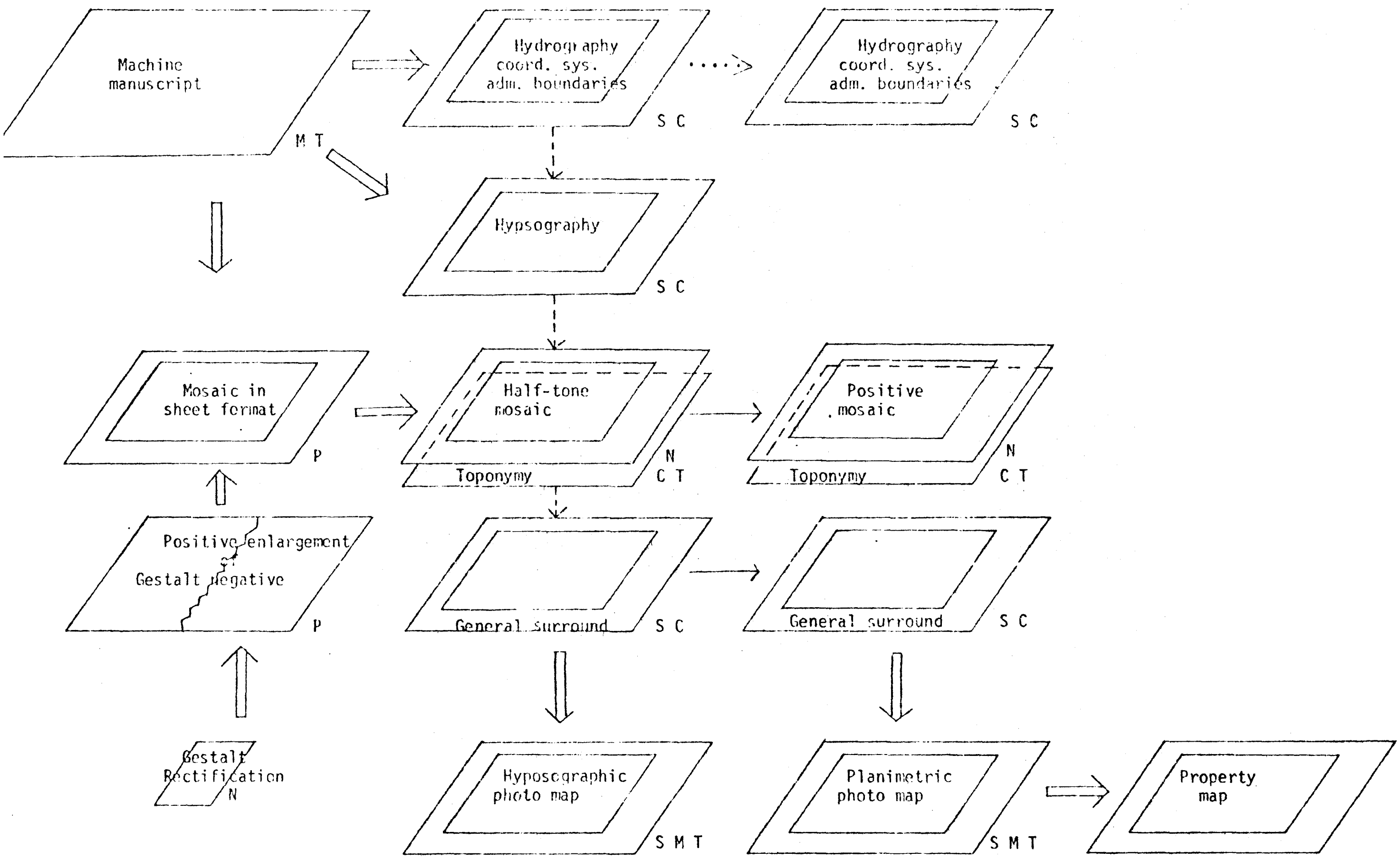


Figure 2-1-4

This figure shows that features separation would permit a greater flexibility in map product.

LRIS PHOTO MAP ASSEMBLY



Material Used

N	Negative film
P	Positive film
M T	Mat transparency
S C	Scribe coat
C T	Clear transparency
S M T	Sensitize mat transparency

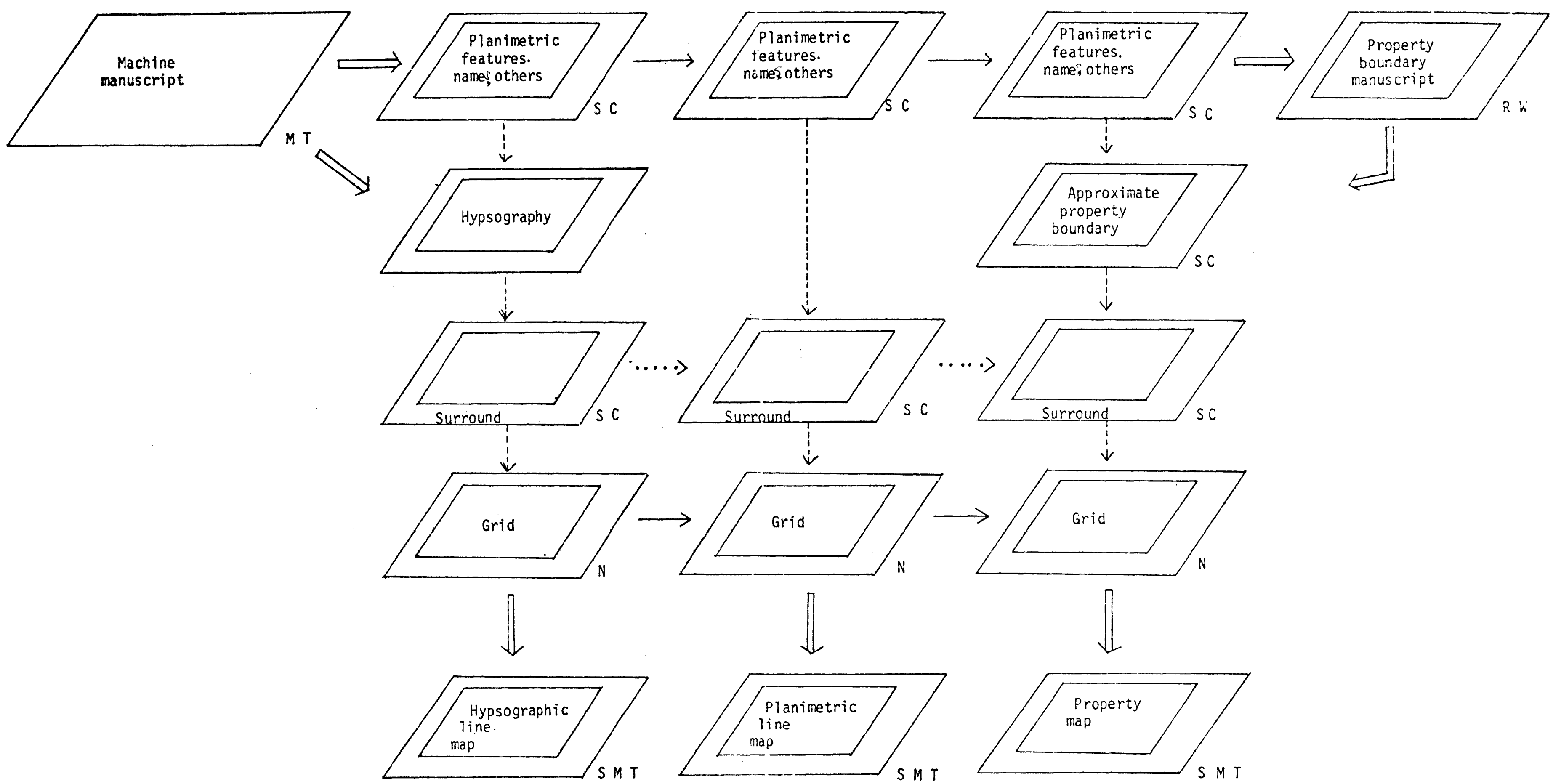
Activities

····>	minor change
---–>	multi-exposures i.e. vacuum frame (require registration)
——>	same material
⇨	used to produce

Figure 2-1-5 Flowchart showing the sequence of steps in preparing material for printing LRIS photomaps. Three public series are produced:

(1) Planimetric map (no contour)
(2) Hypsographic map (planimetric map with contour)
(3) Property map (no contour)

LRIS LINE MAP ASSEMBLY



Material Used

N Film negative
M T Matte transparency
S C Scribe coat
S M T Sensitized matte transparency (used for printing diazo paper or transparent copy)
R W Red wash (red sensitized matte transparency)

Activities

····> minor change
----> multi-exposures i.e. vacuum frame (require registration)
⟶ same material
⟹ used to produce

Figure 2-1-6 Flowchart showing the sequence of steps in preparing material for printing LRIS monochrome maps. In this sequence three map products are produced: line map with contours, planimetric map (no contours); property map (planimetric plus property boundaries).

2.2 MAPPING PROGRAMS AND PRACTICES IN GREAT BRITAIN AND SWEDEN

2.2.1 Great Britain

In Great Britain virtually all official mapping and a large part of the surveying is done by one agency — The Ordnance Survey. The basic scales of mapping, based on Lord Davidson's committee Recommendations of 1937, are as follows:

1:1250 of the major towns totalling about 50 000 map sheets each 500 m x 500 m;

1:2500 of the minor towns and rural areas totalling about 200 000 map sheets each 1 km x 1 km; and

1:10 000 of the mountainous areas totalling about 10 000 map sheets each 5 km x 5 km.

From these basic scales, smaller scales of maps are derived to produce the family of national map series. These are:

1:25 000; 1:50 000; 1:100 000; 1:250 000; 1:625 000; and 1:1 Million.

Except for the 1:1 Million map which is on IMW (International Map of the World System) graticule sheetlines, all of these maps are on grid sheetlines.

A single projection, the Transverse Mercator on a central meridian at two degrees West longitude, has been adopted. As the maximum width of Great Britain is less than 8 degrees of longitude, the maximum scale error due to projection is never greater than 1:2500. A national rectangular spatial referencing system, the national grid, has been superimposed on all maps of the scale of 1:625 000 and larger, in order to provide one reference system for all map series in the national family of maps as recommended by Lord Davidson's Committe. The international metre is the unit on which the grid is based.

From the middle of the 19th Century up to the time when the Davidson recommendations were implemented, the largest scale of general mapping was the 1:2500 scale of the county plan; these were drawn on the Cassini projection with local origins. During this period the Ordnance Survey also undertook the survey of a few city plans at scales varying from 1:480 to about 1:1200. These independent city plans were abandoned with the introduction of the major town program at 1:1250 scale recommended by the Davidson Committee.

The major British tasks since World War II have been the production of the two largest scales. The 1:1250 resurvey has been completed. For reasons of economy, the 1:2500 maps have been produced (the programme is to be completed by 1980) by the less rigorous "overhaul" procedure, in which the previous 1:2500 plans on the Cassini projection are being cast on the grid sheet lines of the National Transverse Mercator projection calculated on the Airy-Hotine spheroid, and the detail is graphically adjusted to this projection and revised. Compared with the resurveyed 1:1250 maps, the accuracy is much lower and internal errors of up to 1 mm occasionally occur (see OS Professional Paper New Series No. 25).

The Ordnance Survey's long experience in mapping at the 1:2500 scale—since 1855—adds significance to the present specifications, in particular the content and symbolisation of their large scale maps. The following points are worthy of mention :

i. In 1853 at a statistical conference in Brussels, ALL the delegates from the principal states of Europe voted in favor of the scale of 1:2500.

ii. The 1:1250 and 1:2500 maps are printed in one color. Miniaturised reproduction material and electrostatic prints are obtainable.

iii. The ground line and not the roof line of buildings is surveyed and shown on the maps. Photogrammetric information must conform to this rule. The additional information, such as a ground line which is not visible in an air photograph, is obtained by field survey methods.

iv. The acreages of all parcels of land are shown on the 1:2500 maps.

v. Height information is shown by Bench Marks, and not by contours on the 1:1250 and 1:2500 maps.

Some production details taken from "Map Production in the Ordnance Survey" (Derrick Heald in The Penrose Annual, Vol. 52, 1958) are also of interest and are attached at the end of this section.

There has been considerable activity in Great Britain in computerising urban data, e.g., the Greater London Council and Leeds. Concurrently, the Department of the Environment Road Research Laboratory is engaged in computerising road data, and also accommodating the software clearinghouse of the International Segment Oriented Referencing System Asssociation. These activities influence the current activity at the Ordnance Survey in digital mapping. Digitising was initiated at the 1:1250 scale and 1:2500 scale, but experiments in the production of derived maps at 1:10 000 and 1:25 000 have since been successful. The segmentation of linear features and the numbering of each segment in the digitising of the 1:1250 plans reflect the requirements of other authorities and users concerned with data management and analysis.

The UK situation is of particular interest because of the complete integration of the national family of maps from the largest to the smallest scales; the use of the larger scales of maps for land registration; and the adoption of one unique national rectangular coordinate reference system - the National Grid.

Map Production in the Ordnance Survey

Derrick Heald

Since the early days of the Ordnance Survey, when the sheets of the 1 in. map first edition were being published, there has been a continuous process of development of its map series. In this development it is apparent that three requirements have exerted much influence. Firstly, that the map should be surveyed and published at a scale large enough to satisfy any user's needs in any area of country. This scale is usually called the basic or parent scale of survey-parent because the smaller scale maps can be derived from it. Secondly, that the map should be kept as up to date as is economically possible. And thirdly, that the map should be easy to read and pleasing to the eye.

In the description which follows of some of the techniques now employed in the Ordnance Survey, this interdependence of the surveyor, the cartographer, and the printer will be readily apparent. For example the production of the 50 in. to one mile (1:1250) scale plans illustrates the need, with the increased scale of survey, to pay greater attention to maintaining the size of all the documents used in the process.

The final stage of the survey in the field at the scale of 50 in. to one mile is to survey in detail the topographical features and to record them in a graphical manner on a "field document". To avoid distortion and to ensure agreement at the edge of the plan with the adjacent plan, aluminium plates 20 cm square and 0.0625 in. thick are used as the surveyor's drawing medium in the field Figure 2-2-1. These plates are assembled in a sketching case by butting together in groups of four to form the drawing surface. The edges of these "butt joint plates" are accurately machined so that they fit together tightly. When they are photographed the junction line between them forms a grid line of the plan. The same precautions against distortion are maintained in all the subsequent processes until the final paper copy is printed, all the work being done on non-distorting media: metal, glass, or plastic.

The first stage is to produce a glass negative by the photography of the "butt joint plates" mounted in sets of four on the vacuum copy-holder of a fixed focus camera. To keep the glass negative in the same plane and so avoid distortion it is held in position in the negative holder by suction. From this glass negative a blue drawing key is printed photo-mechanically on a white enamelled aluminium plate (Figure 2-2-2). On this enamelled plate the draftsman completes the fair drawing of the plan (Figure 2-2-3). Subsequently the fair drawn enamelled plate is photographed in a fixed focus camera to produce the final negative from which the lithographic printing plate is made. It will be seen that at no stage is paper or any other material liable to distortion used in the process.

Similar procedure is adopted for the production of the 25 in. to one mile plans, except that the field document is a plastic sheet and the plan may be scribed as an alternative to being drawn. As there will be about 180 000 plans at this scale even small savings in the production cost of one plan will be well worthwhile. Scribing has been recently introduced and promises such a saving.

In a modern industrialized and densely populated country such as Great Britain the task of keeping the plans up to date is immense, for the survey must keep pace with the rate of building and engineering construction which increases with advancing civilization. To this end a system thought to be unique in the world has been developed by the Ordnance Survey whereby a new edition of any plan is placed under "continuous revision" as soon as it is published. The system ensures that changes are surveyed as they arise. The decision to republish in a later edition is decided by a flexible yardstick which depends on the age of the existing edition and the extent of the change of topographical features on the ground. Immediately the yardstick is reached in any particular plan the publication of a revised edition is authorized. The use of such a yardstick ensures that plans of rapidly developing areas will be republished at more frequent intervals than plans of areas where development is slow.

RESURVEY 1:1250

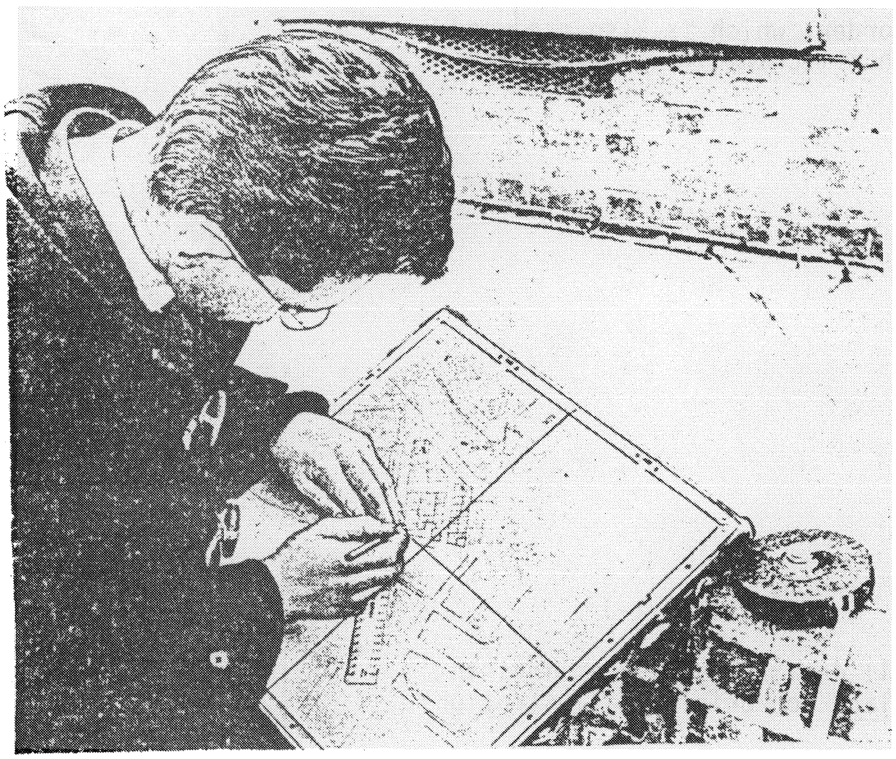


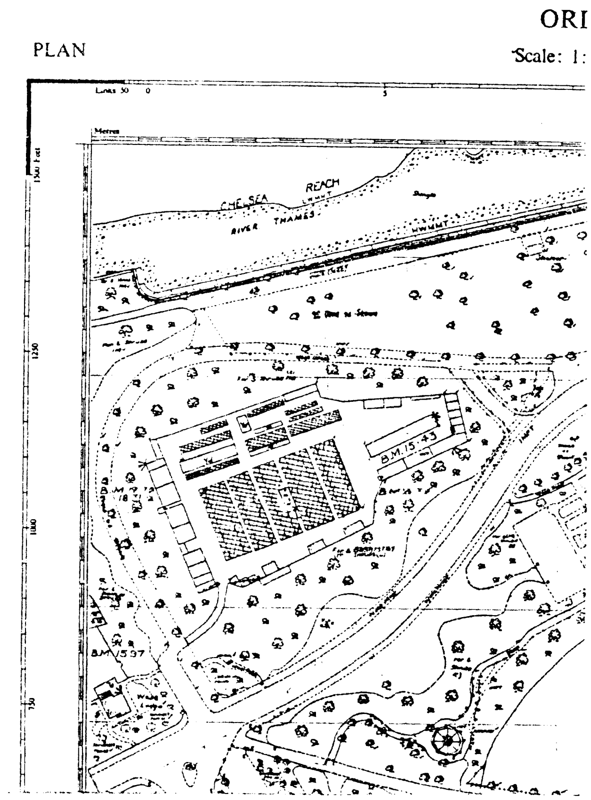
Figure 2-2-1

Surveyor at work on butt joint plates held in special sketching case.

Figure 2-2-2

All detail inside neatlines in <u>blue</u> (on original illustration).

The negative made from the butt joint plates is used to produce a ferro prussiate blue key on the white enamel plate, within a black standard grid and border, which is also produced photomechanically.

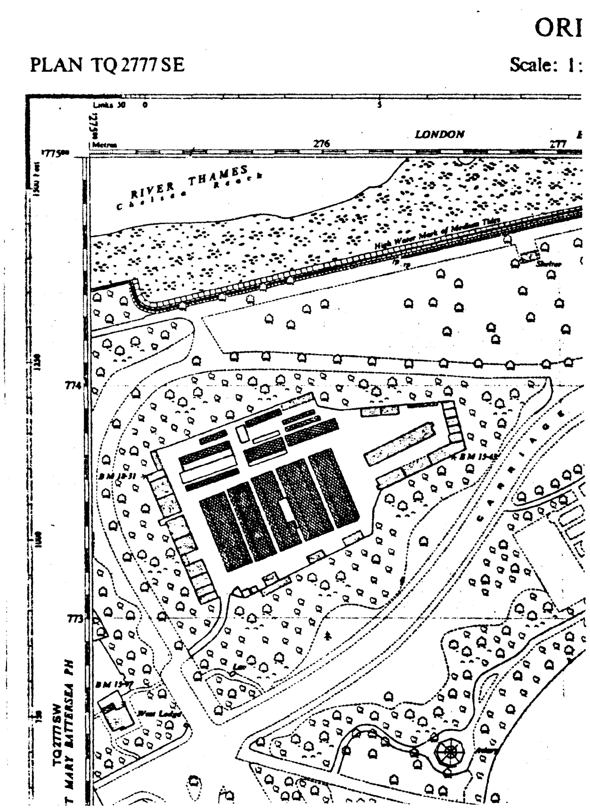


Resurvey drawing enamel plate.

Figure 2-2-3

All detail inside neatlines in <u>black</u> (on original illustration).

The draughtsman has now fair drawn the work of the Field Surveyor, using the ferro prussiate blue shown in Fig. above as a drawing guide. The Plan number and grid information has also been added to the standard grid and border.



Resurvey fair drawn enamel plate.

NOTE: The sections of large plans are reduced in size approximately two and a half times.

The detailed stages in the continuous revision system are as follows. When any particular edition of a plan is being printed, either a first or a later edition, a ferro-prussiate blue impression of the plan is made on a transparent plastic sheet (Figure 2-2-4). This is sent to the surveyor responsible for the particular area. As development takes place he will survey all new development and draw the result on the plastic sheet in opaque coloured inks, using the blue detail of the previous edition as a guide. It is the aim of the surveyor to ensure that the detail on the sheet is never more than a few days behind development on the ground. When the yardstick has been reached for a new edition to be published the plastic sheet showing all the additional detail is despatched to the Large Scales Division of the Ordnance Survey at Southampton where the subsequent processes are carried out. At the same time the surveyor provides a tracing on paper to show all the detail which needs to be omitted from the current edition of the plan (Figure 2-2-5).

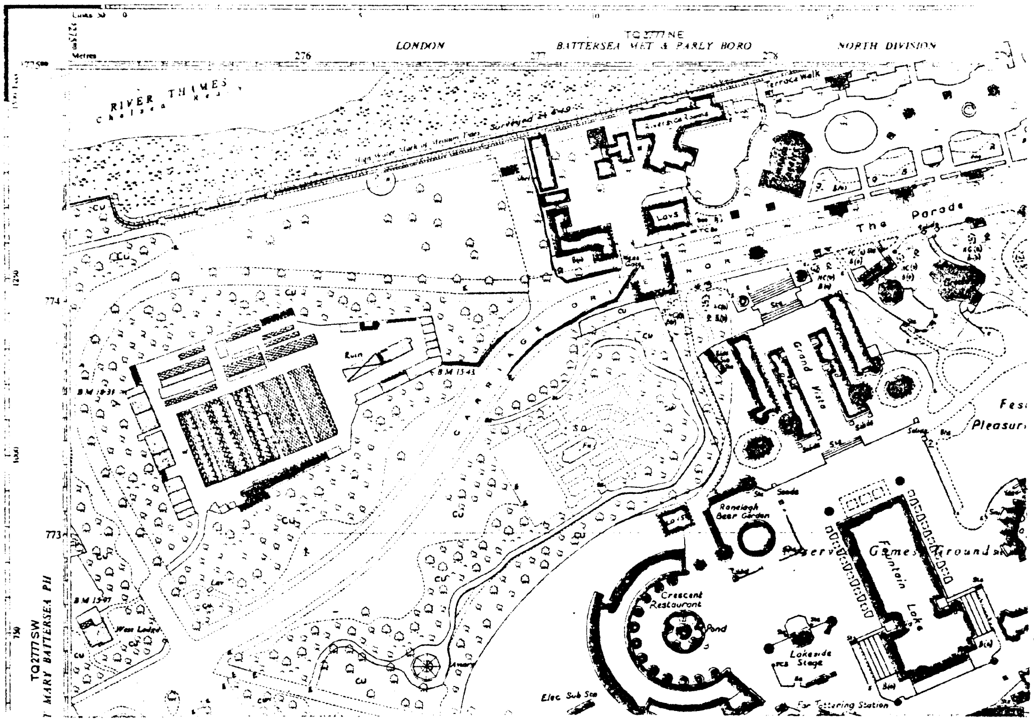
CONTINUOUS REVISION 1:1250

ORDNANCE SURVEY

PLAN TQ2777SE

Scale: 1:1250 or 50·688 inches to 1 Mile

Figure 2-2-4



Continuous revision plastic field document.

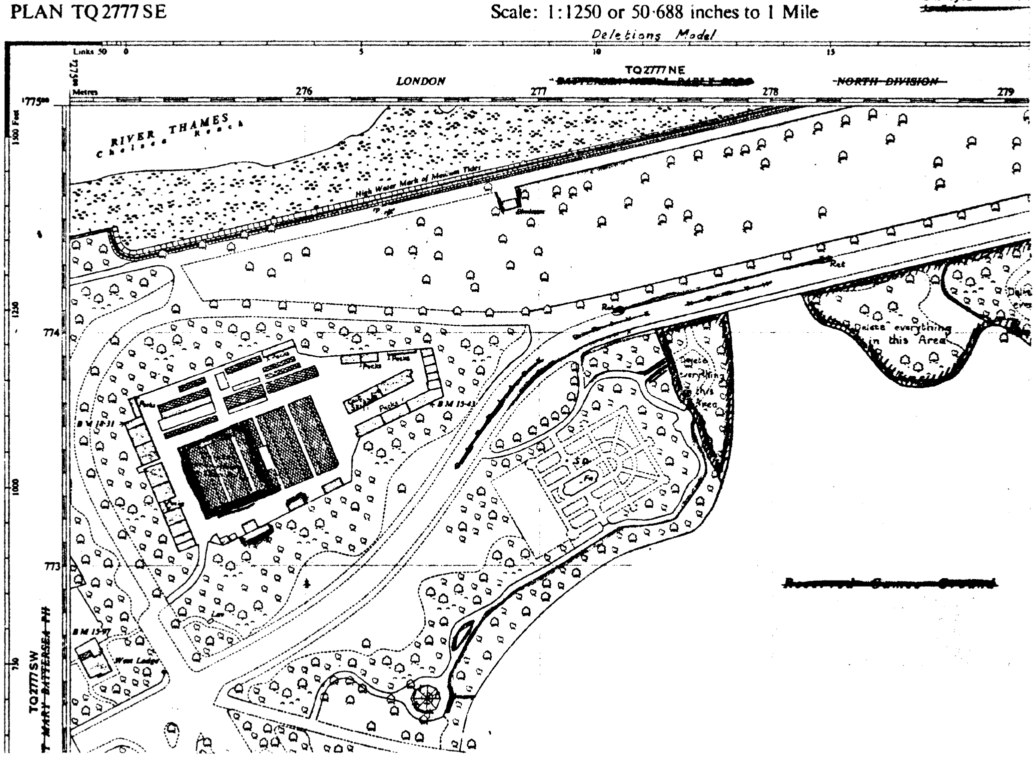
The work of the previous edition is shown in blue (on original) and the new detail in black.

ORDNANCE SURVEY

PLAN TQ2777SE

Scale: 1:1250 or 50·688 inches to 1 Mile

Figure 2-2-5



Deletion trace

Detail to be removed for the new edition is marked in red (on the original).

2.2.2 Sweden

The information that follows has been mainly extracted from a monograph entitled "Urban Mapping in Sweden" with limited editing.

In Sweden, the responsibility for map production — as well as for establishing the geodetic control framework — is divided between State (The Geographical Survey Office) and Local municipal (CSO - City Survey Office) authorities. The State, in principle, provides maps at the scales 1:10 000 and smaller, whereas mapping at the scales larger than 1:10 000 is a municipal responsibility. This is because the principal use of large-scale maps is in municipal planning and development.

The Geographical Survey Office's main responsibility is to produce the official maps of Sweden. The modern series of these maps includes the following:

The Economic Map (General Land Use Map) 1:10 000

The Topographic Map 1:50 000 (1:100 000 in parts of Northern Sweden)

The Comprehensive Map 1:250 000

The General Map 1:1 000 000

The Coastal Nautical Charts

The Gauss Conformal Projection (the 1938 Datum Grid) has been adopted for all of Sweden's official maps. The central meridian of this system is 2^{c}, 5 W. (2^{c}15' W of the old Stockholm observatory), X co-ordinates are positive, with the Equator as the origin; Y co-ordinates are counted as positive increasing towards east, 1:500 000 metres has been added to the central meridian to avoid negative values. The topographic map sheets are furthermore fitted with the UTM grid.

The sheet edges for both the Economic and Topographic Map sheets are directly related to the co-ordinate system, being parallel with the X and Y axes. The division into separate sheets begins in the south with an X value of 6 100 000 metres and in the west with a Y value of 1 200 000. The map sheets normally have a 50 x 50 cm format: thus an Economic Map sheet at a scale of 1:10 000 covers an area of 5 x 5 square kilometres whereas a 1:50 000 Topographic Map sheet which is made up of 25 Economic Map sheets covers an area of 25 x 25 square kilometres. An Economic Map at a scale of 1:20 000 covers an area of 10 x 10 square kilometres and a 1:100 000 Topographic Map sheet 50 x 50 square kilometres i.e. the area covered by 25 1:20 000 Economic Map sheets. Certain Topographic Map sheets covering coastal regions and areas along Sweden'a international boundaries have a 50 x 75 cm rectangular format. By altering the standard format in this way it is possible to avoid publishing sheets which show very limited land areas.

The economic map sheets 1:10 000 (1:20 000 in an older series) covering nearly all of the populated portions of Sweden, constitute a most valuable tool in all comprehensive planning. Production began in 1937, and so far nearly 12 000 sheets covering about half of Sweden have been published. These Economic Maps are printed in four colours by offset methods. The detail shown in black includes administrative divisions, property sub-divisions, plan detail, the limits of and the notation referring to different land-use types, hydrographic detail, lettering and the map surrounds. Contour lines are shown in brown, arable land in yellow and the photographic reproduction of the geographical background in green.

The orthophoto map, at scale 1:10 000 is produced from aerial photos flown at a standard altitude of 4600 metres. Originally, it constituted the basic support in compiling the economic map sheets, but in recent years it is available as a separate product, and as such is widely used in planning. Even other orthophoto maps, specially produced from low altitude aerial photographs, are finding their way into ever-increasing municipal planning use.

As mentioned above, mapping at scales larger than 1:10 000 is a municipal responsibility. These maps, at scales from 1:5000 downwards, display a much greater variety than the State map series. Sheet size and sheet divisions, and even the principal map scales have been independently decided upon by the various CSO's (City Survey Officers) at different times, following the various mapping needs and the varying development pace of the separate communities. Mapping is a costly and time-consuming enterprise and a system once introduced is adhered to for decades. It is quite difficult to alter or to re-shape a mapping system, although strong demands for general nation-wide conformity have recently been raised. The most frequently applied map sheet size in municipal maps is 80 x 50 and 80 x 60 centimetres, the latter enabling diagonal check measure of 1 metre to be made easily.

In the case of maps and geodetic control at scales larger than 1:10 000, the National Grid is insufficient because of the considerable east to west extension of the Swedish territory. If one single projection plane were to be applied throughout the whole country, unacceptable projection errors would ensue. To avoid this, Sweden is divided into six narrow meridional bands, each featuring its own projection plane to prevent the map image from deteriorating towards the outer edges of the altogether too wide National Grid.

Large-scale maps: 1:400, 1:500, 1:1000: — The municipal master map or primary map is designed to provide a basic source in the preparation and compilation of a vast array of specific maps needed in the municipal planning and projects-designing activities. To make the map as useful and versatile as possible, its image content is often split up into a number of separate sub-sheets, which enables different versions of map image to be assembled as composite prints. The method is adapted from the preparation of the separate plates needed for printing maps in multi-color editions. The following is an example of the division of map content into sub-sheets and the ensuing possibilities of creating different versions of the master map:

1	Buildings, boundaries, hydrography
2	Texts (street and block names, property titles, etc.)
3	Planning Regulations Lines (valid town plans)
4	Control points and benchmarks
5	Level contour lines
1+2	Property Version
1+2+3	Planning Version
1+2+3+4	Project Support Version
1+2+3+4+5	Formal Plan Support Map Version

A great variety of systems using similar techniques is practiced by the City Survey Officers (CSO's). Revisions and updating are generally carried out on the respective sub-sheets, but it is convenient to enter slight alterations even in the various composite versions to avoid the rather costly assembly printmaking too frequently. Technically, the master maps are often subdivided into original sheets (on which the actual plotting and the careful image construction is performed) and usage sheets, i.e. ink drawn, scribed or photomechanically derived map sheets allowing convenient day-to-day printing and assembling use. At many CSO's, even separate original sheets are kept for map image of different accuracy, e.g. differentiating sharp numerical plotting from photogrammetrically captured detail.

Town Planning Support Maps 1:1000, 1:2000: — Support maps provide the officially regulated basic mapping image to various types of formal town plans. As such they are divided into four different quality standard classes pertaining to varying accuracy and to image content requirements. The choice of quality standards depends upon items such as land value, the intended land use, property structure, nature of terrain and surroundings, the objective of the proposed plan and its possible legal effects:

Quality Class I	Town Plans relating to the re-development of densely clustered districts with high land value and a high grade of exploitation, i.e. central urban districts.

Quality Class II	Town Planning for the development of new, permanent, year-round housing or other permanent building.
Quality Class III	Planning for development of areas for recreational housing use where joint water supply and sewage is intended.
Quality Class IV	Planning in areas of low land value and uncomplicated property conditions, the intention of planning being merely a modest regulation of recreational housing conditions.

For the most part, the CSO's are exclusively dealing with support maps of Class I and Class II quality.

The Registry Map 1:2000, 1:1000: — In urban areas, the registry map, showing the current property configuration, is formally a part of the Property Registry, officially regulated as to its contents and is continuously updated. The keeping of a registry map is included in the City Surveyor's formal duties as a Property Registration Authority.

Control Network Maps 1:4000 - 1:50 000: — Maps intended to comprise the current state of control networks, triangulation, traverse and height controls of various orders.

Project Support Maps 1:400, 1:500, 1:1000: — In meeting the demands of mapping support for the designing of various projects, the CSO encounters the most advanced utilization of the master map's image content, its overall accuracy and correctness here being put to the severest test. The project support maps, i.e. carefully prepared prints from master map sheets, constitute the base for detailed drawings of projected buildings, streets, utility lines and similar technical constructions.

Building Permit Support Map 1:400, 1:500: — The Building Permit Support Map is a formalized version of Project Support Maps, in providing the base for all projects subject to examination and formal building permit granting by the municipal building and planning authorities. A building permit map has its content and features regulated as to topography, valid property boundary lines, town planning regulation lines, heights data for street and utilities connection, economic data for street building costs, etc. This type of map is very frequent in CSO work and constitutes a fairly important CSO product.

Block Disposition Plan 1:400, 1:500: — The Block Disposition Plan is an official map prepared by the CSO delineating the proposed detailed property structure within a city block (i.e. the area bounded by streets). It constitutes the step in Town Planning procedure immediately succeeding the final ratification of a town plan, and provides the formal foundations for further property formation measures.

Formal Property Formation Maps 1:400, 1:500, 1:1000: — Property Formation maps (Deed Maps) are established to depict the outcome of official Property Formation proceedings and they form a part in the formal documentation thereof. Previous boundaries and the newly created boundaries, areas, lengths, boundary markings and property unit titles are recorded on these maps.

Address Maps, City Maps, Tourist Maps 1:4000, 1:5000, 1:10 000: — Maps of this type, intended for sale to the public at large, are often printed in four to six colors and published in large editions. Their main content is street, block and town district names, address numbering, buildings of public interest, traffic thoroughfares, etc. Although often referred to as mere "tourist maps", this type of map is of great importance and of vast use even inside the municipal administration. It is a very sought-after product, and requires active CSO participation in its preparation and editing.

Utilities' Networks Maps 1:400, 1:500, 1:1000, 1:2000: — In the municipal-sphere, there is a constant need for map series depicting the various urban utility networks such as electricity lines, water, gas, remote heating and sewage pipelines and manholes, telephone cables, etc. To be sure, the CSO's have, through the years, been providing the respective Utility Departments with suitable mapping support, but a unified approach to the problem has hitherto been somewhat neglected by most municipal authorities. In recent years, the need for a comprehensive and rational solution has been more urgently felt. The solution will probably entail the application of some system of sub-sheets or composite map sheets with part of the image revised by the special Utilities' Department and the other part delivered by the CSO. At suitable intervals, both separately revised images would be amalgamated into fresh composite-assembly prints. In the 1970's, such development of unified systems for utility network map series will be a central task for many CSO's.

2.3 SUMMARY OF RELEVANT FACTORS AND CONCLUSIONS FROM THIS REVIEW OF TRADITIONAL MAPPING PRACTICE

i. There are so many differences — historical, cultural and geographical — between the Maritime Provinces and the older European countries that it cannot be assumed without further investigation that programs similar to theirs should be adopted in the Maritimes. On the basis of this conclusion, a questionnaire to map users in the Maritime Provinces was initiated. This is discussed in Chapter 4.

ii. In the normal course of events, many years are required to complete the coverage of a region.

iii. The ideal of collecting map data once and only once at a chosen scale and of selecting from this collected data as required has been achieved in practice over a small range of scales, but has never been followed over the whole range of an extensive national family of map scales. Nevertheless, it remains a worthy objective which digital mapping may help to achieve.

iv. Because conventional mapping is compiled graphically, there is very little "source" data behind the map. That is, except for the toponymy file, the file of survey markers and perhaps some data on administrative boundaries, the map itself is the only "file" of its contents.

This review of current mapping programs, when considered in conjunction with the review of technology and methodology in the recently completed study "Infrastructure Information Requirements in the Maritime Provinces: An Analysis",* leads to the conclusion that there is a need for a rationalization of the handling of position information in the Maritime Provinces. This is taken up in the next chapter.

* Hamilton, A.C., MacNaughton, N., Chrzanowski, A., Infrastructure Information Requirements in the Maritime Provinces: An Analysis, U.N.B. Department of Surveying Engineering for the Land Registration and Information Service (Fredericton, 1976). Hereafter referred to as the "Infrastructure Study"

3 RATIONALIZATION OF MAPPING AND THE CONCEPT OF AN INFORMATION CLEARINGHOUSE.

3.1 A MODEL FOR THE RATIONALIZATION OF THE MAPPING PROGRAM.

Several attempts to develop a model to serve as a basis for the rationalization of mapping in the Maritime Provinces culminated in the one called "the family of maps and their component themes" shown in Figure 3-1-1. In this model, themes are the building blocks for assembling maps. In this context, a theme is the narrowest classification into which it is meaningful to sub-divide map content.

How does this model differ from what has always been done? In traditional practice it was assumed that there was one map base — the planimetric map — which would serve as a "base map" for all other themes. The separations were made as a necessary step in the production of multi-color maps. In the model shown in Figure 3-1-1, the themes are identified separately so that they can be used in various map series as required. It is assumed that much more flexibility is needed and that it can be achieved by more "separations". Thus, the basic planimetric map would be considered as made up of several themes such as roads, buildings, etc. These theme units can then be selected individually in compiling special purpose maps. It should be recognized that this is an idealized model.

By looking at this model showing all the maps and their component themes, we can see:

i. in how many maps one component (theme) appears;
ii. at what scale each component first appears; and
iii. which smaller scale themes can possibly be obtained by derivation.

This approach will increase the flexibility of a purely graphical system and becomes essential in planning the optimum utilization of a digital system.

A few examples will illustrate these points:

i. If theme T_1L (theme #1 at large scale) is used in L_1 (public series #1 at large scale), L_2, L_3, L_4, L_5 and L_6, it could also be used to derive T_1M (theme 1 at medium scale) which in turn is used in M_1, (public series #1 at medium scale) M_2, M_3, and M_4 it follows that the investment in compiling Theme #1 at the large scale is sound and that additional effort to keep it up to date and in a format that is readily useful for all subsequent uses is justified.

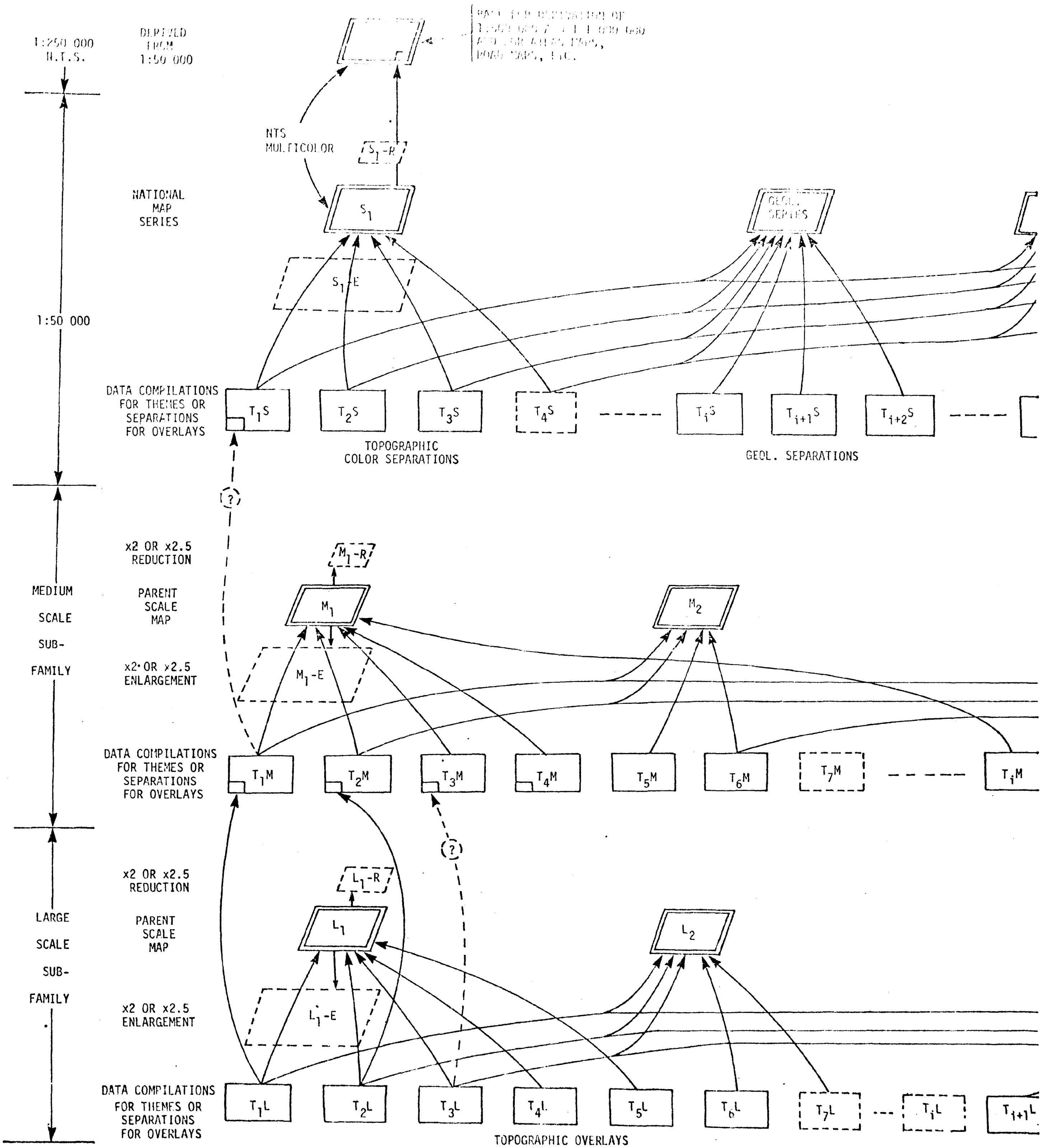
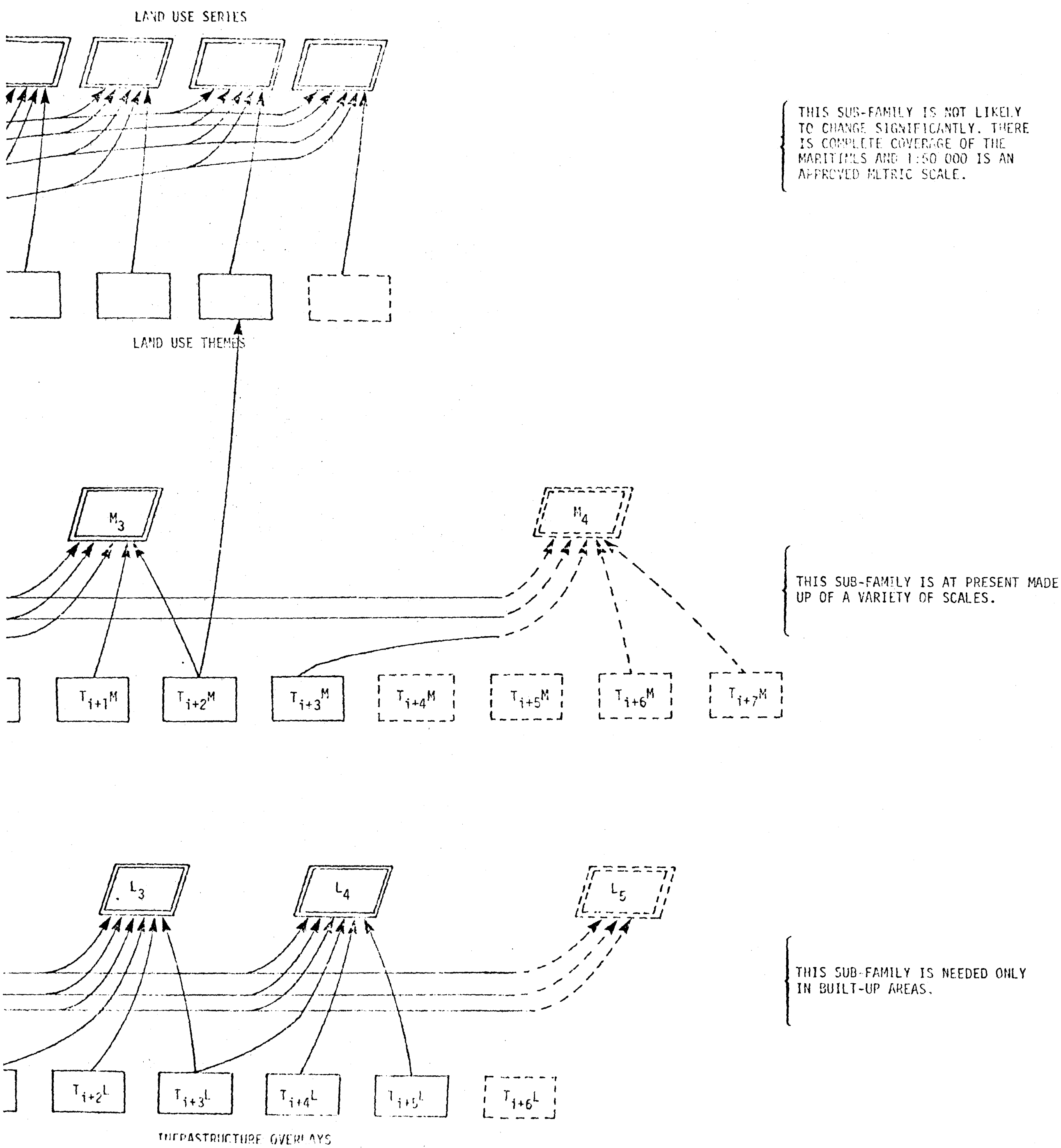


Figure 3-1-1: THE FAMILY OF MAPS AND THEIR COMPONENT THEMES.

▱ - SIGNIFIES A MAP SERIES THAT IS DISTRIBUTED TO THE PUBLIC

☐ SIGNIFIES AN OVERLAY THAT IS USED IN ASSEMBLING A MAP

NOTE: THIS IS NOT A DEFINITE PLAN INSOFAR AS THE NUMBER OF MAPS OR OVERLAYS. ITS PURPOSE IS TO ILLUSTRATE THE INTER-RELATIONSHIPS AMONG THE MAP COMPILATIONS AND MAP SERIES OF A REGION.


LAND USE SERIES
LAND USE THEMES
THIS SUB-FAMILY IS NOT LIKELY TO CHANGE SIGNIFICANTLY. THERE IS COMPLETE COVERAGE OF THE MARITIMES AND 1:50 000 IS AN APPROVED METRIC SCALE.
M3
M4
Ti+1M
Ti+2M
Ti+3M
Ti+4M
Ti+5M
Ti+6M
Ti+7M
THIS SUB-FAMILY IS AT PRESENT MADE UP OF A VARIETY OF SCALES.
L3
L4
L5
Ti+2L
Ti+3L
Ti+4L
Ti+5L
Ti+6L
THIS SUB-FAMILY IS NEEDED ONLY IN BUILT-UP AREAS.
INFRASTRUCTURE OVERLAYS

ii. If the merits of digitizing two themes are being compared and one theme is used as in (i) above and the other only once, then it follows that much more benefit will be obtained by digitizing the theme that is being used the most.

iii. If all the themes in one sub-family, say the large scale sub-family, are compiled at one scale and on one sheet line system, the problems in assembling maps will be minimized.

iv. As indicated by L_1-E (public series #1 at large scale-enlarged) and by L_1-R (public series #1 at large scale-reduced) a photographic enlargement or reduction by a factor of 2.0 or 2.5 is feasible.

3.2 DIGITAL TECHNOLOGY AND METHODOLOGY

The technology to collect, store and plot map information digitally has been in use for several years and is improving rapidly. Many mapping agencies now are routinely storing map information on magnetic tape simultaneously with the graphic compilation. There is much discussion and considerable uncertainty on how best to use this new technology. Initially it was thought of as a labor-saving method and hence was warranted on economic grounds. This has rarely been confirmed. Nevertheless digital mapping, (computer-assisted mapping, or automated cartography) has arrived and it is merely a matter of time till it becomes an integral part of any sizeable map production system. In this study of the concepts for a long-term mapping program, the investigrators would be remiss if they did not develop a rationale for decisions on where and when to introduce digital methods to the mapping program at LRIS. For this purpose three criteria can be identified:

i. The first is that there be a requirement for the digital data other than simply for mapping. An example of this criterion is discussed at considerable length in the Infrastructure Study. In that study, the need by a power commission (N.B. Power) for several themes in digital mode as part of an on-line operational management system is discussed.

ii. The second criterion emerges from a close study of Figure 3-1-1. Some themes such as the main elements of the transportation network appear on virtually every map; if these were in digital form (and a suitable plotter were available) it would be a relatively simple matter to plot this theme at the required scale, the required level (trunk, arterial, feeder) and at the required line width. Once changes in the transportation network were made and corresponding changes were made to the digital master file, all other subsequent output would be up to date.

iii. The third criterion is the ease with which the digital file can be compiled. Clearly when data is already in alphanumeric form, it should be relatively easy to compile a digital file for plotting purposes. The survey control file (benchmarks and survey stations) is an example of this type; the coordinates for each survey marker are the result of computer processing of survey observations.

One important point with regard to digital data was identified in the above-mentioned study. It is essential to obtain the theme content throughout an entire region in digital format within a relatively short time because patches or bits and pieces of digital data are of negligible value. There is thus a strong argument in favor of a theme by theme approach to digitization.

The introduction of digital technology will be a slow process, if for no other reason than that the education and training of people to use it is a slow process. On the other hand, there are some cases where it should be introduced without delay. It is apparent that we will have a hybrid digital-graphic positional information system as far into the future as we can see at this time.

Again referring to Figure 3-1-1, it is apparent that the sheet lines (map sheet boundaries) of all theme maps should form a consistent pattern. They should be identical at any one scale and the larger scales should fit into the smaller ones without any fractioning.

Similarly, and in particular when a digital format is being considered, the desirability of having a consistent system of coordinates throughout the map family is apparent. In coding (coding is the assigning of a unique label or identifier to a feature) in the digital mode, the need to have a standardized code for every feature cannot be over-emphasized. Thus a road of certain class must be given the same code regardless of what agency does the actual coding.

3.3 AN INTEGRATED POSITION INFORMATION EXCHANGE: A MODEL

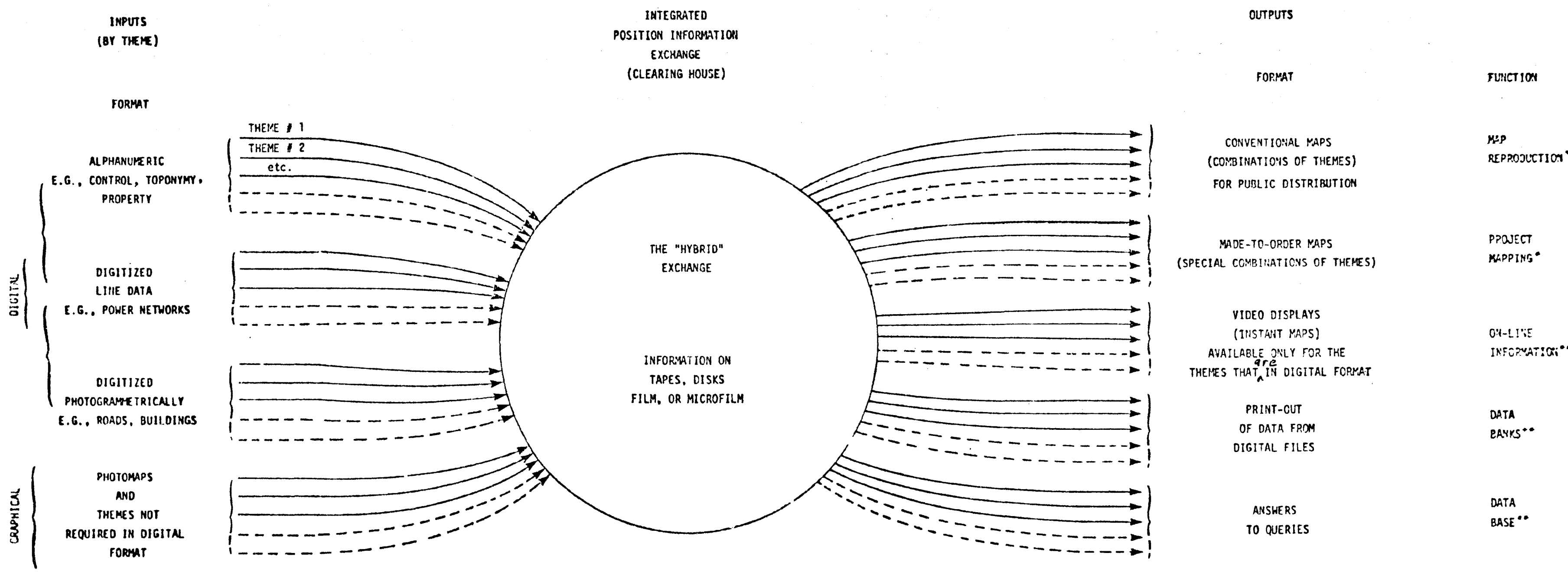
The rationalization of traditional mapping (as illustrated in Figure 3-1-1) in conjunction with the potential of modern technology (as described in Chapter 2 of "Infrastructure Information Requirements in the Maritime Provinces: An Analysis") leads to the concept of an integrated position information exchange. (Figure 3-3-1)

The input to the exchange includes all possible themes of positional information. The only constraint in the input themes is that the features of a theme must have a fixed position in space; they may be tangible (roads) or intangible (boundaries) or this may be statistical (people, goods).

The format for each input may be graphic or it may be digital; if it is digital it may have been taken from an alphanumeric file such as a toponymy file or a survey station file or it may have been collected by digitizing from line data or directly from a stereographic plotter. Graphic formats will include photomaps, transparencies of theme data, microfilm or microfiche.

The output from the exchange will normally consist of a group of themes (as in a conventional map). As mentioned previously in this study, the word "theme" denotes what is sometimes described as a class of features; for example, hydrogrpahy could be one theme. This, of course, does not preclude the output of one theme by itself. In a primitive sense, the exchange is, in effect, functioning at present. The grouping of themes to form a topographical maps is an example of the function of the exchange.

The output may be in the format of conventional maps, or it may be designed for special purposes, video displays, numerical print-outs, or analysis of data in the exchange. Conventional maps would represent traditional theme groupings as in topography, geology, utilities, land use, etc. Special purpose maps may include themes not normally grouped together; for example a geological theme and a utilities theme. These two types of output format may combine themes having graphical input with themes having digital input. The remaining output formats are restricted to themes having digital inputs. Video displays could be "casual" searches for information in the digital files or they could be "on-line" systems for operations and management purposes. The data bank format will provide print-outs of selected information from the



* MAY BE FROM GRAPHIC INPUT, DIGITAL INPUT OR A COMBINATION OF BOTH.

** RESTRICTED TO THOSE THEMES IN WHICH THE INPUT WAS IN DIGITAL FORMAT

Figure 3-3-1

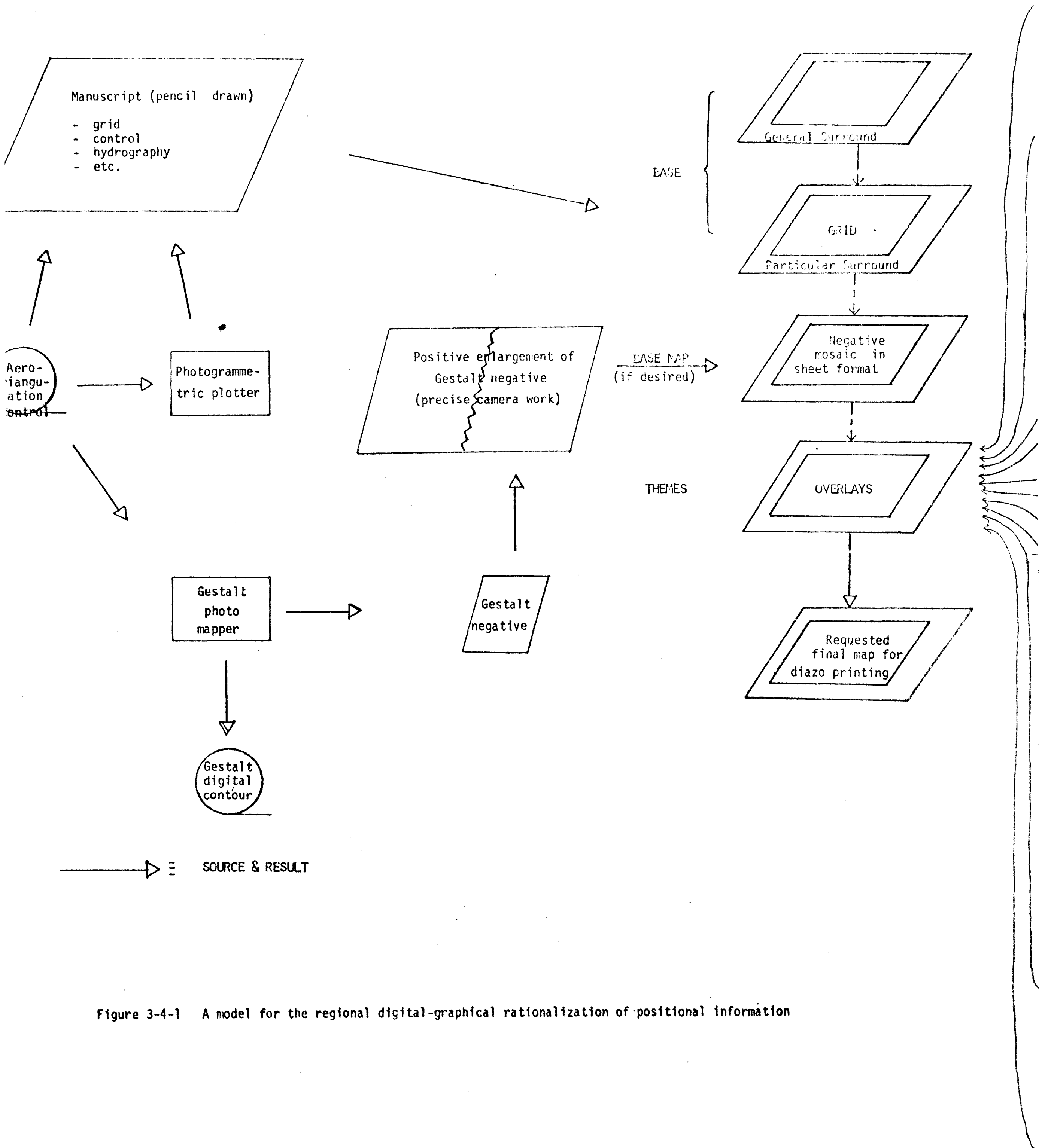


Figure 3-4-1 A model for the regional digital-graphical rationalization of positional information

NON-PHOTOGRAMMETRIC OVERLAYS	SOURCE	REVISION TECHNIQUE AND RESPONSIBILITY	HYBRID EXCHANGE
Toponymy	BOOKS	Revision: Continuous revision in digital form and as required in graphical form. Responsibility: A permanent toponymist (LRIS) and a Maritime committee on geographical names.	Name, location and attributes + Parent scale overlay
Horizontal and Vertical control	Field observations	Revision: Continuous revision in digital form and as required in graphical form. Responsibility: LRIS	Station number, co-ordinates and attributes + Parent scale overlay
Property boundaries	co-ordinate table of survey plan + Deeds and plans	Revision: Continuous revision in both graphical and digital form. Responsibility: LRIS	Parcel coordinate file + Parent scale overlay
Administrative and political boundaries	BOOKS	Revision: Continuous revision (once a month say) in digital form and as required in graphical form. Responsibility: LRIS	Boundary type and location + Parent scale overlay
Photogrammetric overlays			
Hypsography	Gestalt digital terrain model	Revision: Same time as the photo base in in both graphical and digital form. Responsibility: LRIS	Gestalt digital contour + Parent scale overlay
Hydrography	Digitized from graphical media or directly from photogrammetric instruments.	Revision: Hydrography is generally a static overlay. Only minor revisions are required.	Hydrographic features, Names? Attributes? + Parent scale overlay
		NON - LRIS ACTIVITIES	
Regional infrastructure	?	Revision: Continuous revision on digital files and cyclic or as required revision on graphical files. Responsibility: Utilities Agencies	+ Parent scale overlay
Agriculture land use	?	Revision: As needed by the user - producer. Responsibility: Agriculture	+ Parent scale overlay
Forest Classification	Photographic interpretation and field surveys.	Revision: As needed by the user - producer. Responsibility: Forestry	Type of forest, boundary type, budworm kill, burnt, cutover planted. + Parent scale overlay
Geology aeromagnetic etc.	?	Revision: Minor in many cases. Responsibility: Geology	+ Parent scale overlays

digital files as requested by a user. The data base format will provide output in print or in graphic format representing answers to rather complex questions. It should be stressed that this calls for quite sophisticated software but its development is likely to be a continuing process at a rapidly increasing pace.

The basic rationale for this exchange concept is the need to live with both graphic and digital files for an indefinite period. Graphic technology is cumbersome but it is here and it does work. Digital technology is capable of doing the job and it can provide some services, such as video displays and data banks, that are not feasible using graphic technology. But right now digital technology is costly and it will take at least a generation to solve the "people problems" connected with its introduction. Its potential is attracting many disciples in all the developed countries, and the opportunities for lowering costs of equipment, accelerating data capture, and training production personnel to be more effective are being pursued.

When only graphic technology was in use, the function of the information exchange was partially achieved by the passing of manuscript transparencies from one unit of graphic activity to another. Differences in scales and in symbolism made this primitive exchange inefficient but not totally inoperative. Digital technology is much less forgiving. Unless there is consistency on many factors the exchange process will fail. When we recognize that hybrid (graphical and digital) systems are inevitable, the need for formal recognition of the exchange concept to merge digital and graphical data becomes indispensible.

If the integrated position information exchange concept as outlined in this section is accepted, then it leads to a number of conclusions.

3.4 CONCLUSIONS

i. A much more extensive definition of the exchange model should be made — a preliminary regional digital-graphical exchange model is shown in Figure 3-4-1.

ii. Existing graphical procedures should be reviewed for compatibility with the model.

iii. New developments should be planned as integral components of the Exchange. This is particularly applicable to digital mapping projects.

iv. In order to achieve the potential of the Exchange, a Centre should be created with the task of developing and testing the concepts for a fully integrated position information system.

v. There is a need for standardization of the cartographic framework and for cartographic specifications and standards. These are discussed in Part B of the report.

3.5 RECOMMENDATION

It is recommended that a Centre be created with the task of developing and testing the concepts for a fully integrated position information system. It is expected that this Centre would be located close to or at a University where a nucleus of expertise in handling position information already exists.

4 Mapping Needs in the Maritime Provinces

4.1 QUESTIONNAIRE ON MAPPING REQUIREMENTS

The mapping needs of a region are a function of many social, cultural, political and economic factors. The weighting of these factors determine the mapping need. On the one hand one may say that the need should depend on the present level of activity; on the other hand there is evidence that mapping is a prerequisite for development and hence that the mapping need should be related to the potential or the desired level of development.

In Chapter II the mapping programs and mapping practice in Great Britain and in Sweden were summmarized and it has been assumed that the programs generally meet the needs of these countries. One method of establishing the need for mapping in the Maritimes would be to assume that its need would be similar to that of Great Britain or Sweden and hence that a similar program should be followed. In view of the fact that the social, cultural, political and economic history of the Maritimes is distinctly different from that of the examples cited above, it was decided that this method was not justified and that an inquiry of considerable depth was needed.

For this purpose a questionnaire was prepared, tested and sent to a carefully screened list of some 400 "economic users" of maps. An economic user is defined as one who requires a map in connection with his or her work; with few exceptions, economic users are working with or for industry or for a government agency. A copy of the questionnaire, the mailing list of those to whom it was sent and notes on the preparation, distribution and processing of it, are contained in Appendix A. Two versions of the questionnaire were prepared. One had some questions specifically directed to regional users and the other had some questions specifically for local users. In this context "local users" are people such as municipal officials whose main interest is confined to limited parts of the Maritimes; "regional users" are people such as foresters and water management personnel.

The responses to the questionnaire were key-punched and processed using a program package called SPSS (Statistical Package for Social Sciences). The results of the regional questionnaire are included in Appendix B and those of the local questionnaire are included in Appendix C.

4.2 ANALYSIS OF THE RESPONSES

The quantity of data which is available in both the regional and local questionnaire is rather large. Any attempt to fully tabulate the data would create an enormous quantity of output. Consequently only the histograms of the complete set of data is presented together with some selected cross-tabulations. Should more tabulation and analysis be desired, the data is on computer cards in a form that can quickly respond to further analysis by other investigators.

The graphics presented in Appendix B and C are not interpreted, however they are labeled in such a way that the reader can make his own interpretation. A sample showing how to read and interpret the data is presented in Appendix B-3 and Appendix C-3.

The SPSS (Statistical Package for Social Sciences) version 5.01 has been mainly used for compiling the histograms and for making the cross-tabulations. Version 6.02 is a new version of SPSS having additional analytical capability. Only a few cards need to be changed to process the data with version 6.02. No matter which version is used, the documentation or labelling is sufficent to read and interpret the results.

4.3 CONCLUSIONS FROM THE ANALYSIS OF THE RESPONSES TO THE QUESTIONNAIRE

The main thrust in the analysis of the questionnaire has been in the field of map scale, resolution, content and accuracy. This has revealed an inconsistency with regard to map accuracies. Many respondents who say they want a map at a certain scale also say they want accuracies many times higher than can be attained from the scale they have requested. This indicates

i. that they should have requested a larger scale

ii. that the accuracy requested is not needed, or

iii. that there is a lack of understanding of the quality of maps.

The cost of mapping escalates rapidly as the scale increases and as accuracy requirements increase. Thus a decision on the scale and accuracy of a map can have a manifold effect on the cost of a mapping program. In view of the fact that this decision over the long term is so significant and in view of the inconsistencies revealed in the questionnaire, there is a a need for further discussion with all those who responded to the questionnaire.

This is not a "cop-out" on the part of the investigators; it is a recognition of the fact that the respondents to the questionnaire gave it a lot of time and thought and consequently are entitled to participate directly in the formulation of the main conclusions from it. (It is assumed that the conclusions will have a significant impact on the long-term Maritime mapping program.) For those whose requirements cannot be met, it would give a good understanding of why they could not be met.

4.4 RECOMMENDATION:

It is recommended that a seminar or workshop be organized as a follow-up to the questionnaire. The objective would be to develop a consensus and quality (scale, content, accuracy) of regional mapping needed for the Maritimes.

5 A Mapping Program for the Maritime Provinces

5.1 THE PARENT SCALE PRINCIPLE AND THE DIGITAL DATA BASE

In Chapter 2 the principle of the parent scale in mapping is discussed at some length and in Chapter 3, on new technology, the digital data base is shown to be the logical successor to the graphical cartographic manuscript.

In this chapter the broad outlines for a mapping program that is consistent with the parent scale principle and adaptable to the digital data base concept will be outlined. The concept is shown in Figure 5-2-1.

5.2 LARGE SCALE REQUIREMENTS

In the spectrum of mapping scales, large scales include all maps below 1:5000. All map scales above 1:5000 are medium or small scale, while 1:5000 maps may fall in either group depending on how the map is made. If the map is made by enlarging a parent scale of say 1:10 000 (or by selecting data from the medium scale data base), it would still be a medium scale map because its content, accuracy and resolution, would be the same as that of its medium scale parent. On the other hand if the map is made by reducing a parent scale, of 1:2000 for instance (or from the large scale map data base), it could be considered large scale because the quality of its data would be that of a large scale map.

The requirements for large scale mapping vary widely depending on the territory. For uninhabited forest territory there is no need for any large scale mapping. In agricultural areas there might be some need for large scale mapping. In urbanized areas there is always a need for large scale mapping - the type of mapping depending primarily on population density. In general, for mapping purposes urbanized areas can be considered as falling in two categories:

(i) high density cities and

(ii) low density cities, suburbs, towns, villages and rural communities.

As the requirements for each of these differ appreciably further discussion on this topic will be under two sub-headings.

5.2.1 Requirements in High Density Cities

The large cities have a complex infrastructure system and hence a greater need for an infrastructure information system than smaller cities and towns. In the infrastructure study, recommendations on urban infrastructure information are given along with an overview of the subject (Chapter 5, pp. 72-90).

Basic (or base) mapping is an indispensible first step towards an infrastructure information system. The requirements for basic mapping in high-density urban regions were explored in considerable detail in the above-mentioned study. Also, as infrastructure information is the most demanding of all the requirements for basic mapping, it can be accepted that if basic mapping meets the infrastructure requirements, it will meet all other requirements. An extract from Section 5.7.4 (p. 87) of the infrastructure study sums up the mapping requirements. "Scales at 1:500 or larger are required for urban (infrastructure) information mapping..... Enlargements from the city maps at the scale 1:1000 are adequate for infrastructure systems. However, one has to remember to take into consideration thickness of lines and symbols of the basic maps." In view of the fact that the 1:1000 is among the accepted Canadian metric scales, it can be accepted as the "parent scale" map of high density urban areas. By careful design and adequate control this parent scale can meet the needs for infrastructure (utilities) maps and smaller scales such as 1:2000 or even 1:5000 can be derived from it as needed.

No attempt has been made in this study to delineate the area that warrants mapping at this scale. If the suggestion made in the infrastructure study that cities collaborate with LRIS on large scale mapping materializes, then the area would be delineated by discussion between LRIS and the cities interested. In the delineated area, cities would supplement the cost of the mapping and assist with up-dating.

5.2.2 Requirements in Low Density Cities, Suburbs, Towns, Villages and Rural Communities.

Much of the activity creating change in our landscape occurs in the suburbs, in low density cities and in towns, villages and in urbanized rural communities. It is in these areas that much of the debate over zoning and planning takes place. Utilities and other constructions are not packed as tightly as in the high density cities. Thus the need for accurate positioning and for large scale mapping is not as great. In most of the comparable regions of other countries, mapping is done at the scale of 1:2000, 1:2400, or 1:2500. As 1:2000 is the only "metric scale" in this range, it is recommended here. With a parent scale of 1:2000, enlargement to 1:1000 is practical and, of course, reduction to 1:5000 could be done by photomechanical methods or by editing and recompiling (Figure 5-2-1).

A project to prepare an index map showing the boundaries of cities, towns and villages in the Maritimes was defined during this study. It is included as Appendix D. As the information in this index will be essential at the planning and budgeting stage of this mapping program, it is recommended that this index be compiled as soon as possible.

Prior to the evolution of photogrammetry, mapping was done by survyeors in the field; since World War II most topographic maps have been compiled from air photos. The reason for using photogrammetry is economic: it is much, much cheaper than having surveyors locate every feature. Its only disadvantage is that some features are either not visible at all or not identifiable on the photographs. The map-maker must then either omit certain features or send a surveyor to identify and verify and in some cases locate features. This is called "field completion". It improves the quality of a map but also adds appreciably to its cost. As noted above, unless there is an identified need for field completion it is omitted for economic reasons. As some communities undoubtedly need field completed maps, it is recommended that LRIS develop a cooperative program whereby municipalities have the option of accepting the standard "economy model" or of doing the field completion and receiving a higher quality product.

The main advantage to this approach is that it allows the major users of a particular group of map sheets to participate in the decision on the content and quality of the sheets.

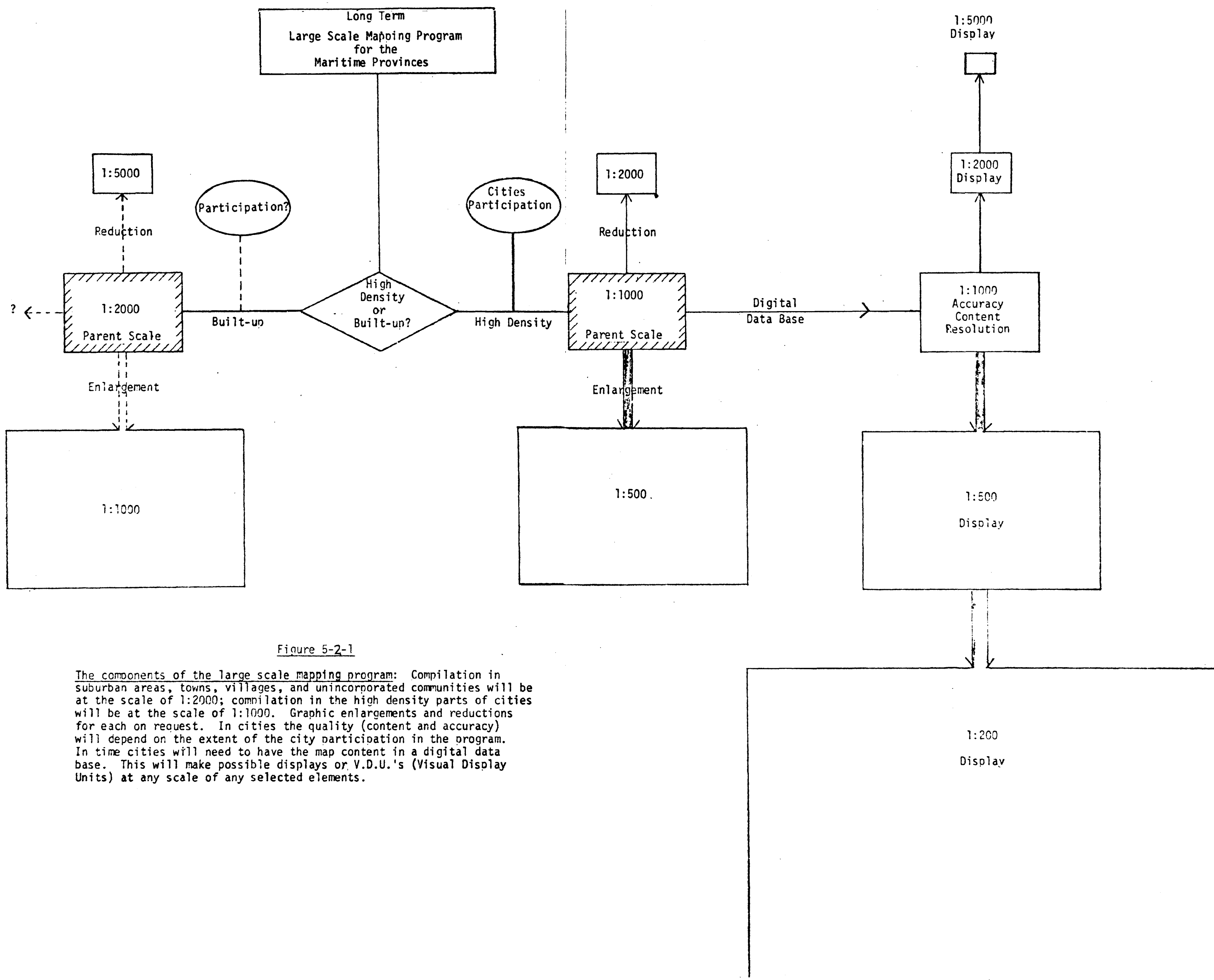


Figure 5-2-1

<u>The components of the large scale mapping program</u>: Compilation in suburban areas, towns, villages, and unincorporated communities will be at the scale of 1:2000; compilation in the high density parts of cities will be at the scale of 1:1000. Graphic enlargements and reductions for each on request. In cities the quality (content and accuracy) will depend on the extent of the city participation in the program. In time cities will need to have the map content in a digital data base. This will make possible displays or V.D.U.'s (Visual Display Units) at any scale of any selected elements.

There are several side benefits to this approach:

i. The feeling of alienation at the local level against "big government" will be reduced.

ii. Those at the local level who participate in the field completion will have a tendency to identify the map products as "theirs" and hence will tend to utilize them and to promote their use as much as possible.

iii. Discussions on field completion between local and central agency representatives will lead to better communication on other aspects of "information flow". This, in turn, could lead to a more responsive attitude at the central agency and to an increased interest in innovative technology at the local level.

The 1:2000 series will be a new one for the Maritimes. Thus it presents the opportunity to design a completely new product. Here, again, conceptual questions arise. Should we, at this stage, design maps in the conventional sense knowing that a digital data base will be evolving or should we design a digital data base recognizing that one of the immediate application will be for the compilation of a new map series? The answer to this question must await the results of the analysis of the family of themes as recommended in Chapter 3.

Thus, in concluding this sub-section we recommend that for low density urbanized areas the basic map data be compiled at a quality level equivalent to that required for a 1:2000 map series. It is also recommended that a cooperative program be developed whereby local governments have an opportunity to get a better-than-standard product by contributing to the data compilation.

5.2.3 Project Mapping Requirements

As discussed in Chapter I (Economic effects, p. 6) until recently much of the large scale mapping in Canada was done on a project or ad hoc basis. It was also noted that the effect of this type of mapping is that in many cases there is unnecessary duplication and expense; the development of a systematic map series as outlined in this chapter should eliminate much of the duplication. This does not mean however that project mapping can or should be abandoned entirely. There is still a place for project mapping and in this section an attempt will be made to define some criteria under which project mapping should be undertaken.

It should be clear from the discussion in the preceding chapters that if one of the planned map series will meet the requirements for a project then every effort should be made to juggle priorities so that the mapping for the project is done in time for the project. This aspect of the problem will diminish in significance as progress is made on the completion of the respective series. Thus, under normal circumstances, the only time that the question of project mapping will arise is when the requirements for the project mapping will not be met by an existing or a scheduled map series.

There are still two situations that may arise:

i. Part of the data collected for the project mapping may be of value to the LRIS cartographic data file.

In this situation it is recommended that LRIS collaborate with the project agency on some shared-cost basis. This can be beneficial to both parties. The benefit to LRIS would be that the data would be collected to standards and in a format compatible with the LRIS information system. The benefit to the project agency would be twofold: the mapping expertise of LRIS will be available to it; and, by sharing the cost with LRIS, the net cost to the agency should be reduced.

ii. None of the data collected is likely to have any lasting value.

This eventuality should be considered quite apart from the long-term cartographic program. It depends on whether or not LRIS has a role as a contractor or as a contract manager in providing "services". This question is beyond the scope of this study.

5.2.4 Requirements in Agricultural Areas

There are no well established precedents on suitable scales for rural mapping. If intensive agricultural practices involving, say, irrigation are being followed then mapping at large scale (1:2000) may be indicated. If the land is used mainly for pasture and cereal crops, it is likely that the regional resource mapping will be adequate.

It is suggested that the requirements for rural mapping be left open for the present. If the Resource Mapping Workshop as proposed in Chapter 4 is held, a definitive answer should be forthcoming; if it is not held, then a more critical assessment of the questionnaire responses is suggested as the next step.

5.3 MEDIUM SCALE (REGIONAL) REQUIREMENTS

The scales ranging from 1:5000 to 1:31680 are considered to be medium scale. The examples cited in Section 2.2 confirm that medium scale maps are essential members of the family of maps for any territory. Based on precedent here and elsehwere and confirmed by the responses to the questionnaire we can at this time, without hesitation, make a basic recommendation:

Mapping for the entire territory of the Maritime Provinces at one medium scale is needed.

There is good reason to expect that these maps would, when complete, become by far the most widely used maps in the Maritimes.

It was apparent from the discussion in the previous chapters that mapping is a complex subject, and that much more than the question of scale needs to be specified to define a map series; for the 1:10 000 map of the British Isles , for example, there are 120 pages of specifications.

There are countless items that concern the quality, and hence the value and the cost of a map. Scale and hence horizontal accuracy is one of the items; contour interval and hence vertical accuracy is another; monochrome or multi-colour production is another; there are many more.

No specific recommendations are being made on the medium parent scale that should be adopted for the Maritimes. This is mainly because further consultation with the users is required. The decision related to parent scale map characteristics is so important that the recommendations should not only be sound but they should be arrived at with the concurrence of a wide spectrum of concerned map users. Nevertheless map economics on one hand and response to the regional questionnaire on the other lead us to believe that a concensus will be reached on either the 1:10 000 or the 1:20 000. Figure 5-3-1 shows that in the long term with the digital data base basically the same resulting data display is achieved with either parent scale. The difference between the two choices is level (higher or lower) of accuracy, resolution, content, production cost, and revision cost. In the infrastructure study, the concept of a digital data base for regional infrastructure information is outlined. Many of the features (road networks, hydrography, buildings, etc.) needed as background for the display of infrastructure information are features normally shown on a planimetric map. The possibility of establishing one digital base to serve both the infrastructure agencies (e.g. power, telecommunications) and medium scale mapping is explored in Chapter 6 (pp. 91-115) of the above-mentioned study and will not be repeated here.

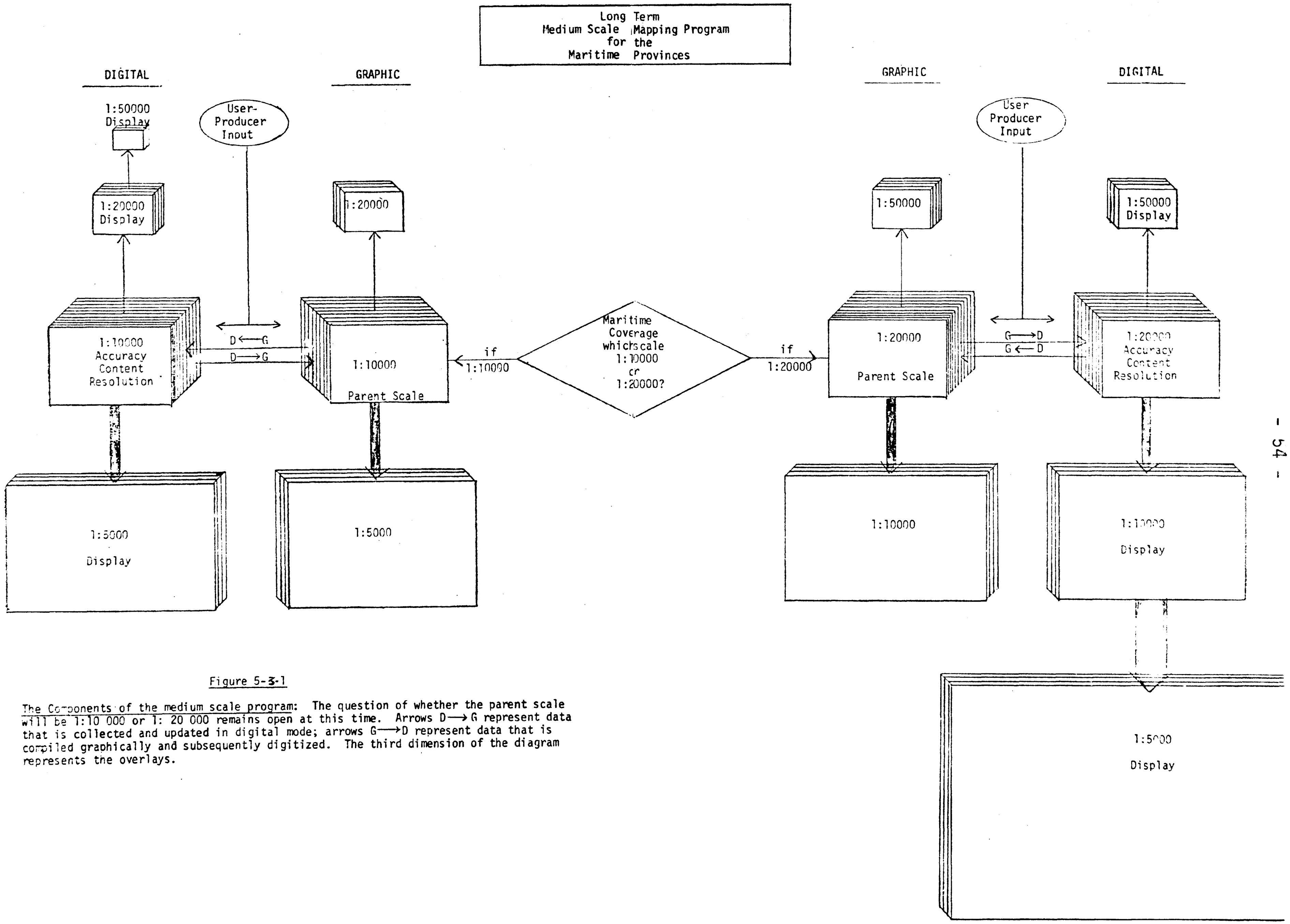


Figure 5-3-1

The Components of the medium scale program: The question of whether the parent scale will be 1:10 000 or 1: 20 000 remains open at this time. Arrows D⟶G represent data that is collected and updated in digital mode; arrows G⟶D represent data that is compiled graphically and subsequently digitized. The third dimension of the diagram represents the overlays.

5.4 MEDIUM/SMALL SCALE REQUIREMENTS: THE NTS 1:50 000 MAPPING

The Maritimes have been fortunate in that there has been complete coverage of the region at 1:50 000 scale in the National Topographic Series for many years. It is not surprising that in the questionnaire a great many users indicate that they are familiar with these maps and use them regularly.

It is clearly not within the scope of this study to suggest changes to the NTS maps. They are available, they cover the entire area, they are attractive in appearance, they are rich in content. Being multi-coloured, information is readily readable even when it is quite compact. The NTS maps are obviously invaluable.

Inevitably, they have limitations. They are never up to date; this is because there is a time lapse of up to four years from photography to release. They cannot be revised frequently; this is primarily because of the cost of multi-colour reproduction. There are limitations in content; this is primarily because of the cost of field completion.

In addition, there are limitations imposed by the scale itself. When we bear in mind that features are reduced 50 000 times, we can see that many features are reduced to microscopic size; thus many features are represented by a symbol which bears little relationship to the actual size of the feature. If we accept 0.2 mm as the smallest dot, then the smallest feature that can be represented in its true proprotion is a feature that is 10 000 mm (10 m) in diameter. The size of objects smaller than 10 m have to be exaggerated if they are to be shown. The point of this discussion is that there is a limit to what can realistically be expected from a 1:50 000 map. This, incidentally, explains why information on a small scale map is rarely of value in compiling a larger scale map. In theory the converse is not true; in practice there are limitations this way also. The limitations are not matters of accuracy or of content but simply of "housekeeping" and of standardization of the infromation. In practice it is more economical to start with uniform photography and compile a 1:50 000 map independently than it is to start with say, 25 maps at 1:10 000 and condense and edit the information from the 25 maps. This explains why, under present practice, the 1:50 000 series is an independently compiled parent scale (Fig. 2-1-2).

If all the data needed for the compilation of the 1:50 000 series could be obtained photogrammetrically there would be no need to discuss the series any further in this study. However, as for the larger scale maps, there are several "themes" that do not show up on aerial photographs and as discussed previously the "field completion" necessary to collect the data for these themes is costly. Thus, if provision for the flow of this data from the medium scale data base to the NTS data base can be built into the design there should be significant economies and improvements in the quality of the data shown on the 1:50 000 maps.

5.5 RECOMMENDATIONS

i. For high density urban areas it is recommended that the basic map data be compiled at a quality level equivalent to that of 1:1000 scale maps.

ii. For low density cities, suburbs, towns, villages and urbanized rural communities it is recommended that the basic map data be compiled at a quality level equivalent to that of 1:2000 scale maps. Further, as an essentital step in the planning and budgetting for this series, it is recommended that an index (see Appendix D) showing the boundaries of cities, towns and villages be compiled.

iii. For both of the above series it is recommended that the"LRIS standard" not include "field completion" data. It is further recommended that a program be introduced whereby local governments have an opportunity to provide field completion data and in return receive a map that is "tailored" to their particular needs.

iv. Project mapping: If there is a likelihood that the data compiled during project mapping will be of value in the LRIS data base then a co-operative or joint venture with the project agency is recommended. If it is anticipated that the data will be of negligible value to the LRIS data base it falls outside the terms of reference of this study.

v. For agricultural areas: As the requirements vary depending on the type of agriculture it is suggested that agricultural requirements be included in a proposed Resource Mapping Workshop (See vi below)

vi. Regional requirements: There is a definite need for a medium scale map (and map data base) covering the whole of the Maritimes. It is recommended that a Resource Mapping Workshop be held before a firm recommendation as to scale (quality level) and content be made.

vii. Regional requirements at medium/small scale: The 1:50 000 NTS map series meet this requirement very well. The design of the regional cartographic information system should provide for the flow of certain theme data from the medium and large scale data base to the NTS data base.

Viii. Compilation of a digital cartographic data base: On the assumption that in the long term (20 to 30 years), the data base for all map products will be in digital form, it is recommended that a theme-by-theme (Figure 3-1-1) approach to digitization be followed. It is further recommended that an in-depth analysis of the family of mapping themes be made in order to establish the sequence in which the themes should be digitized.

PART B

6 THE CARTOGRAPHIC FRAMEWORK

6.1 DEFINITION, REQUIREMENTS, EXTERNAL FACTORS, CONSTRAINTS AND ASSUMPTIONS

6.1.1 Definition and Requirements

In Chapter 3 the family of maps and their component themes were illustrated symbolically (Figure 3-1-1) and in Figure 3-3-1 the concept of an integrated position information exchange was illustrated. It is implied but not stated specifically in Chapter 3 that all the "theme" sheets (T_1L, T_2L, etc. in Figure 3-1-1) should be consistent with each other so that they may be readily superimposed. Similarly it was implied that the digital data files in Figure 3-3-1 should be structured such that they can be readily correlated with the graphical theme sheets.

In this study the cartographic framework is defined as the composite of all the elements that will facilitate:

i. The development of coherent graphical map series, at all scales, printed from a combination of themes;

ii. The creation of a homogeneous digital file system (over the next 20 years) on the theme-by-theme concept; and finally

iii. The integration of digital and graphical data via a one-to-one correspondence between the graphical and digital source files.

In a different perspective the cartographic framework is a broad set of specifications that should be adopted and not be subject to change.

The first cartographic framework element is the map projection plane. This is a vital requirement because the compilation of data on maps cannot be initiated before the map projection plane is selected. The factors to be considered in selecting a map projection plane are discussed in section 6.2.

The second cartographic framework element is the coordinate system(s). In most of our day-to-day activities we can ignore the fact that the surface of the earth is curved (quite apart from local topographical features). This enables us to create a multitude of rectangular designs (buildings, lots, subdivisions) within which we can use plane trigonometry. Thus, on the assumption that society in general cannot be converted to the general use of ellipsoidal coordinates some type of plane coordinate system is necessary. It is then a question of which plane coordinate system, or systems, should be used. This is discussed in section 6.3.

The third cartographic framework element is the referencing system. The referencing system is the mechanism which establishes the linkage between the maps and the land. There may be many coordinate systems in use. Referencing systems are printed on maps to enable users to relate their own coordinate system with the features on the earth's surface. This is discussed in section 6.4.

The fourth cartographic framework element is the packaging. This is a new term which is introduced in order to convey the concept that the selection of map sheet boundaries in map production and its digital counterpart in digital form is independent of the map projection plane, of the coordinate systems and of the referencing systems. A rational system for numbering the map sheets, and the corresponding digital entity, is a vital part of the packaging system. The packaging choice has far-reaching consequences hence it deserves an extensive analysis. This is discussed in section 6.5.

6.1.2 External Factors and Constraints

Within the cartographic framework there are constraints and external factors which must be taken into account. These are:

i. The National Topographic Series (NTS) of maps at scales 1:1 000 000, 1:500 000, 1:250 000 and 1:50 000 are complete though not always up-to-date. Their packaging is based on the ellipsoidal coordinates; they are compiled on the Universal Transverse Mercator (UTM) map projection plane; the predominant reference grid, representing the UTM plane coordinate system, is printed on the 1:50 000 and the 1:250 000 series together with the graticule (parallels of latitude and meridians of longitude) as a subsidiary referencing system.

ii. In Nova Scotia the 3° Transverse Mercator (3°TM) projection in two zones is used as the map projection plane for large scale map sheet boundaries and as the basis for the plane coordinate system. In New Brunswick the stereographic projection is used as the map projection plane for large scale map sheet boundaries and as the basis for the plane coordinate system. In Prince Edward Island the stereographic projcction is used as the map projection plane and as the basis for the plane coordinate system.

iii. For provincial use, specifically for land surveying and engineering surveys, a plane coordinate system having distortions no greater than 1:10 000 is required.

6.1.3 Assumptions

i. Some form of integrated position information exchange along the general lines discussed in Chapter 3 will be evolving as the number of digital themes increases.

ii. The cartographic framework of the 1:50 000 NTS maps will not change significantly.

iii. The resolution of digital data (place-related data in digital form) corresponding to large and medium scale maps is many times finer than the resolution of the digital data corresponding to the small scale maps. Consequently the amount of data at the regional level will be many times larger than the amount shown on NTS maps.

iv. Sub-division plans will be used as a base for data for several of the more important themes of the information exchange.

6.2 MAP PROJECTION PLANE

In Section 6.1 it was stipulated that a map projection plane is an element of the cartographic framework. This is because the shape of the earth is ellipsoidal whereas the paper on which we portray our maps is flat. Thus, not having some type of convex paper, we must have some type of map projection plane by which we can "project" the ellipsoidal surface of the earth onto a plane. This implies that:

i. For mapping, the ellipsoidal coordinates must be transformed to some type of plane coordinate (Figure 6-2-1).

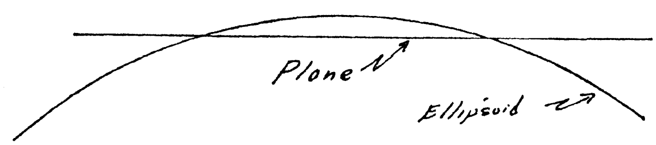
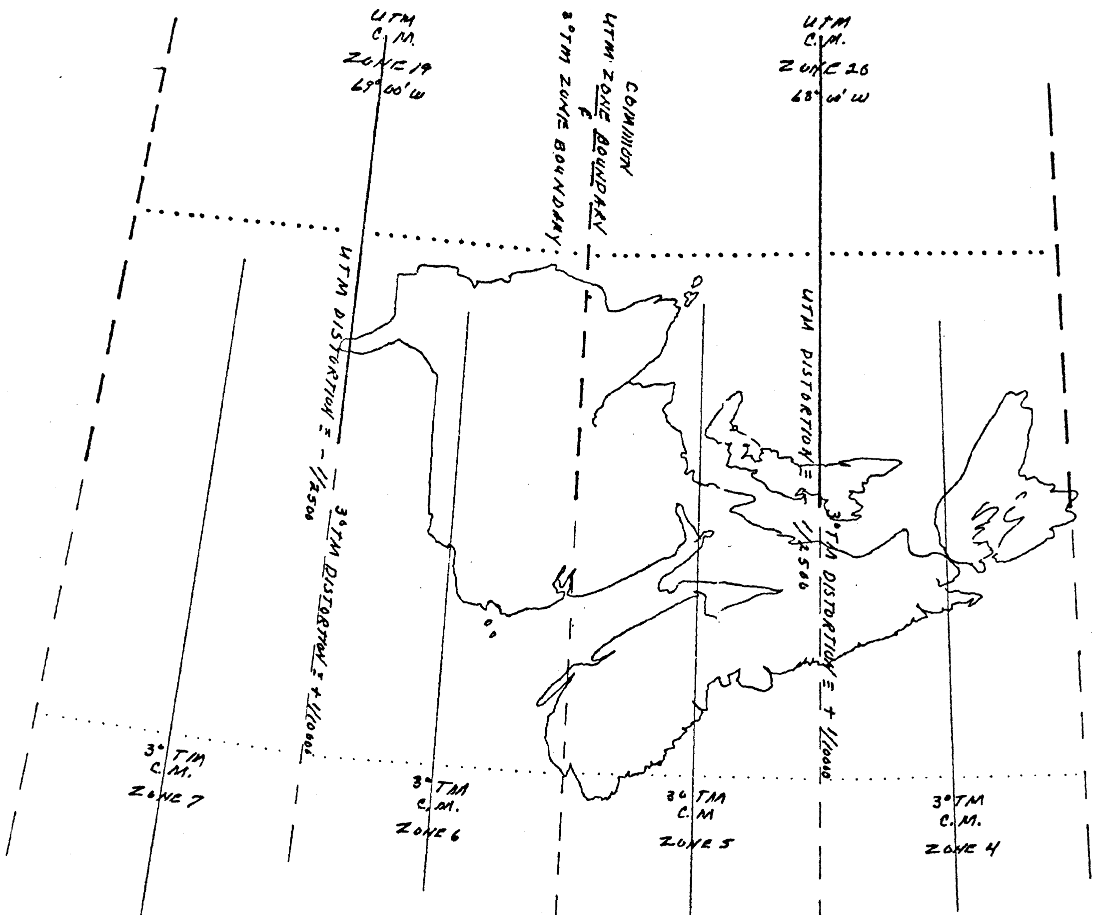


Figure 6-2-1

ii. Every point on the ellipsoid must have a corresponding point on the map projection plane. In this discussion we will limit the use of the term "map projection plane" to the case of a plane which is used for mapping. Thus the discussion will be appreciably simplified and the controversial question of survey accuracy requirements will be discussed under "coordinate systems". Here it will be necessary to discuss only the accuracies of the relevant map projection planes and their implications.

The accuracies of the three projections under consideration in the Maritime Provinces were analysed thoroughly in "A Critical Review of Existing and Proposed Map Projection Systems for the Maritime Provinces".*

* Hamilton, A.C., Chrzanowski, A., Vanicek, P., Castonguay, R.H.: A Critical Review of Existing and Possible Map Projection Systems for the Maritime Provinces, U.N.B. Department of Surveying Engineering for the Land Registration and Information Service, (Fredericton, 1975), hereafter referred to as the "Projection Study".



C.M = Central Meridian

FIGURE 6-2-2

The maximum linear distortions were as follows:

UTM - 1:2500

3°TM - 1:10 000

Stereographic (N.B.) - 1:10 000

Stereographic (P.E.I.)- 1:25 000

In the Projection Study it was concluded that, from a purely graphical point of view, the UTM map projection plane is sufficiently accurate. If, however, as will be discussed subsequently, the 3°TM or the stereographic plane coordinate system is to be used for land and engineering surveys there is not merit in introducing the UTM map projection plane. The 3°TM and stereographic reference grid would have to be plotted on the UTM map projection plane and would be slightly distorted along with all the other map features. The difference of scale between the UTM reference grid and the provincial reference grid would be 1/2000 along the 69°W and 63°W meridian (Figure 6-2-2); the UTM reference grid being smaller than the provincial reference grid (+1/10 000 - 1/2500 = 1/2000). Assuming the change along the meridian is constant (this is very close to reality at medium and large scale), the difference in the mapped length of the two reference grids, on a sheet 75 cm wide, is as follows: 3°TM - UTM = 0.015 inches = 375 micrometres; this is a significant difference. This difference is the average accuracy of a manually drawn line and is readily detectable by the unaided human eye. In computer-assisted cartography the drafting is much more accurate (±0.001 inch i.e. ± 25 micrometres).

If a map is compiled on the UTM map projection plane, the provincial reference grid will be in error by as much as 0.015 inch. Similarly, when compiling on the provincial map projection plane, the UTM reference grid is in error by 0.015 inch. If we superimpose either the UTM reference grid or the provincial reference grid on the other, there are two ways to minimize the error:

i. One can distribute the difference centrally on a sheet so that the error is reduced to 0.0075 inch in the worst case. (6.2 ft @ 1:10 000 scale).

ii. One can enlarge or reduce one reference grid slightly (0.25%) in order to make one fit the other. The above enlargement or reduction is the largest that occurs in the Maritimes. It is different with every sheet.

It should be noted that both of these alternatives would be difficult to execute manually but could be done with relative ease by computer-assisted methods.

From a digital perspective the introduction of the UTM as the Maritimes map projection plane would mean that some user-producer could collect, store, and display data on the UTM map projection plane while others could collect, store, and display on the provincial map projection plane. In order for the majority of agencies to exchange theme data and for the agencies' themes to be overlaid readily in either graphical mode, digital mode or both, it is highly desirable that everyone including LRIS use the same map projection plane. The situation where half the data would be on the UTM map projection plane and the other half on the provincial projection plane appears to be the worst situation possible because it would create the maximum amount of data transformation. It could also jeopardize the exchange of data between various users. The ideal situation is to have only one system. But accepting that the ideal might not be achieved, the next best alternative is to have most of the information in one system. Since the largest quantity of information is at the local and regional level and since only a very small fraction of that information is required at the national level, the best way to minimize the number of transformations is to keep all the information in the provincial map projection plane.

If the provincial plane coordinate systems and map projection plane were based on the same projection system, most of the regional and local users would then be collecting and displaying data on the UTM map projection plane, however, since those users would need an accuracy less than 1:2500, the data when overlaid on the provincial map projection plane would be in error by 1:2000 at the most. One can assume that if 1:2500 is sufficiently accurate 1:2000 would not create any significant problem. Also the medium and large scale data, collected or projected on the provincial map projection plane would carry insignificant error when reduced to 1:50 000 to overlay on maps projected on the UTM mapping plane. Conversely, when enlarging and overlaying 1:50 000 data on the larger scale maps the distortions due to the map projection plane will be negligible in comparison to the inherent accuracy of the 1:50 000 data.

In summary the choice of the map projection plane should be made so as:

i. To minimize the problems in map production. Problems in map production will be minimized when the map projection plane is made consistent with the predominant reference grid; this is the reference grid which will be used most.

ii. To prevent foreseeable problems in the graphical and digital interface, i.e. in the interface between the themes that are filed graphically and those that are filed digitally.

In light of the above considerations *it is recommended that the map projection plane be consistant with the predominant reference grid.*

On the basis of the recommendation in section 6.4 that the predominant reference grid be the grid of the provincial coordinate system *it is recommended that the planes of the provincial plane coordinate systems be adopted as the map projection planes within the Maritime Provinces.*

6.3 COORDINATE SYSTEMS

6.3.1 Review of the Coordinate Systems in the Maritime Provinces

Approximately fifteen years ago New Brunswick, Prince Edward Island and Nova Scotia adopted the plane coordinate concept for surveying, mapping and engineering activities. Due partly to the shapes of the individual provinces and partly to their individual administrations, three different plane coordinate systems emerged. These systems are based on two different map projection planes. New Brunswick and Prince Edward Island plane coordinate systems are based on the stereographic map projection and the Nova Scotia one is based on the 3° Transverse Mercator map projection (two zones). The coordinates are all expressed in feet. The UTM plane coordinate system and the ellipsoidal coordinate system (latitude and longitude) are also being used. This means that there are five coordinate systems in use. To add to this diversity two variants of these coordinate systems are appearing. In these variants the coordinates of points are being expressed in metres on an ad hoc basis. This is due to pressure to produce metric plans to accommodate the construction industry which is scheduled to go metric on January 1, 1978. The confusion ensuing from the introduction of these ad hoc systems will not be significant if the new fully metric systems become available soon. However, if it would turn out that the regional readjustment of the second order control network, which is scheduled to be completed by the end of 1978, were delayed then there would inevitably be a delay in the establishment of a fully metric system and the confusion introduced by these ad hoc systems would continue for many years.

6.3.2 Plane Coordinate Systems Needs

Coordinates are a language through which surveyors, mappers, engineers, and a number of other professions are communicating more and more. They can be used to define elements related to land, air or sea. They specify where elements are located in space and how they are related with respect to each other. Depending on how the coordinates are grouped, they can inform the users as to the location, shape, size, volume and orientation of the element under consideration. In another perspective the coordinate systems are working tools which have increased in importance in the last fifteen years. This is due to the necessity for improving our survey practice which in turn reflects the increasing attention that society is giving to land and its utilization.

The specific needs of the engineering and land surveying professions were examined in the Projection Study referred to previously; the conclusion of that study was that a provincial plane coordinate system with a maximum distortion not greater than 1:10 000 was necessary to meet engineering and land surveying requirements. The plane coordinate systems capable of meeting these requirements are the stereographic and the 3° Transverse Mercator systems.

The zone boundary problem was discussed briefly in the Projection Study and several examples of problems that zone boundaries cause are presented subsequently (section 6.5). From this it is apparent that plane coordinate systems should be selected such that zone boundaries do not fall in or near any significant development centre.

At this stage then we conclude that:

i. Zone boundaries are unacceptable in any "active" area such as a city or its region of influence;

ii. The choice of plane coordinate system(s) for the Maritimes is limited to the stereographic projection and the 3° Transverse Mercator projection.

6.4 REFERENCING SYSTEMS

In general, referencing is the process of measuring the horizontal distance and direction from a land mark to an object of interest. In cartography, referencing is the process of establishing the relationship between the recorded elements of the earth's surface, in graphical or digital form, and the coordinate systems which permit the elements to be located on the ground.

In digital cartography the referencing is the mechanism which permits one to establish the relationship between the coordinates of the elements stored in the computer and the coordinate system in which the users wish to work on the ground; it may be to locate a physical element on the earth's surface or to store a collected element in a digital computer.

In graphical cartography the referencing is the mechanism which permits one to establish the relationship between the elements plotted on maps and a coordinate system. Given a coordinate system, the element can be plotted directly on the map; or given element on a map, its physical location on the ground can be directly determined and located. Consequently the referencing systems permit the users and producers to go back and forth between the maps and the earth's surfaces. In order to achieve this there must be at least one graphical referencing system on maps. However there can be more than one. It is important to note that there are two main types of graphical referencing systems:

i. Grid type: this is two sets of parallel lines intersecting at right angle and forming squares or rectangles. On a map they represent a plane coordinate system.

ii. Graticule type: this is a network of lines representing the earth's parallels of latitude and the meridians of longitude.

In the first case the graphical referencing system is a reference grid. There can be many reference grids on a map. One can be representing the provincial plane coordinate system; another can be representing the national plane coordinate system; and finally there can be reference grids representing other plane coordinate systems. Ideally there should be only one reference grid. In the second case the graphical referencing systems is a reference graticule. There could be more than one reference graticule but it is unlikely to happen. One reference graticule can represent the sexagesimal degree systems and another one can represent the decimal degree system. Traditionally the reference graticule (sexagesimal degree) was not fully drawn. However the border of the map was constructed in such a way that the full reference graticule could be completed if desired (Figure 6-5-11).

If more than one graphical referencing system is to be printed on a map, care must be taken to minimize confusion. This can be done by designating one system as the predominant referencing system and the others as subsidiary referencing systems. The predominant reference system should be shown by clear, relatively heavy lines; the subsidiary reference systems should be shown by either:

i. Very light lines or

ii. By marks at the package boundaries or

iii. By just enough information somewhere at the package boundary or in the surround to enable the users to construct the subsidiary reference systems himself if he requires them.

The representation of the latitude and longitude drawn along the perimeter of the 1:50 000 national topographical series (Figure 6-5-3) is a variant of a subsidiary reference system.

Which graphical referencing system is needed on the Maritimes' maps? The responses to question 11 in the regional map users' questionnaire compiled in Appendix B, section B-4, page 15 indicates that:

71 (32.7%) use the latitude and longitude coordinates

47 (25.0%) use the Universal Transverse Mercator coordinates

70 (32.2%) use the provincial plane coordinates

Similarly the local map users' questionnaire Appendix C, section C-4, page 10 indicates that:

19 (18.3%) use the latitude and longitude coordinates

21 (20.2%) use the Universal Transverse Mercator coordinates

51 (49.0%) use the provincial plane coordinates

From these responses it is clear that all three graphical referencing systems are needed. Which of these should be the predominant one and which one the subsidiaries? It follows from the questionnaire responses above and from section 6.2 that the reference grid of the provincial plane coordinate system should be the predominant reference grid. The UTM reference grid and the reference graticule should be the subsidiary graphical referencing systems.

In view of the fact that with monochrome reproduction it is difficult to clearly distinguish between many reference grids, *it is recommended that:*

i. The reference grid representing the provincial plane coordinate system be the predominant reference grid and that it be shown by heavy lines.

ii. The Universal Transverse Mercator plane coordinate system and the ellipsoidal coordinate system be subsidiary referencing systems.

iii. The subsidiary referencing systems be shown in a way that minimizes confusion with the predominant reference grid.

6.5 PACKAGING

6.5.1 The Packaging Concept

In the English language there is no noun or compact phrase comparable to the French "decoupage cartographique" - literally "cartographic cutting" - to describe a system of sheet lines (neat lines) for map series. Clear terminology on this topic is necessary. Based on Webster's dictionary the definition of package is: "The act or process of packaging a commodity or a unit of product uniformly wrapped". We are proposing that packaging be accepted as the English equivalent of "decoupage cartographique" and that it be extended to cover the equivalent block of map data in digital form.

To distinguish between graphical and digital modes we will introduce the terms "geo-graphical" and "geo-digital". Thus geo-graphical packaging will encompass all aspects of the selection and use of a system of map sheet boundaries or of systems of sheet lines for the production of graphical maps and geo-digital packaging will encompass all aspects of defining the bounds of spatial data in digital files. As illustrated in Figure 6-5-1 it is essential that there be a one-to-one correspondence between geo-graphical packaging and geo-digital packaging.

In this part of the report a package will be the name used for the spatial building block of the integrated position information exchange (Figure 3-3-1). For all parent scales (Chapter 5) the packaging should be agreed upon and all data - graphical and digital - should be uniformly packaged. Specific recommendations on packaging for the Maritimes are made at the end of this chapter.

What does a package contain? A theme package will contain only the data of that theme within the bounds of the package; it may be a geo-graphical package or a geo-digital package. A map package will contain as many themes as the cartographer specifies.

The essential point however is that <u>everyone</u> who is <u>collecting</u> or <u>storing position information agree on</u> and <u>adhere to a packaging guidelines.</u>

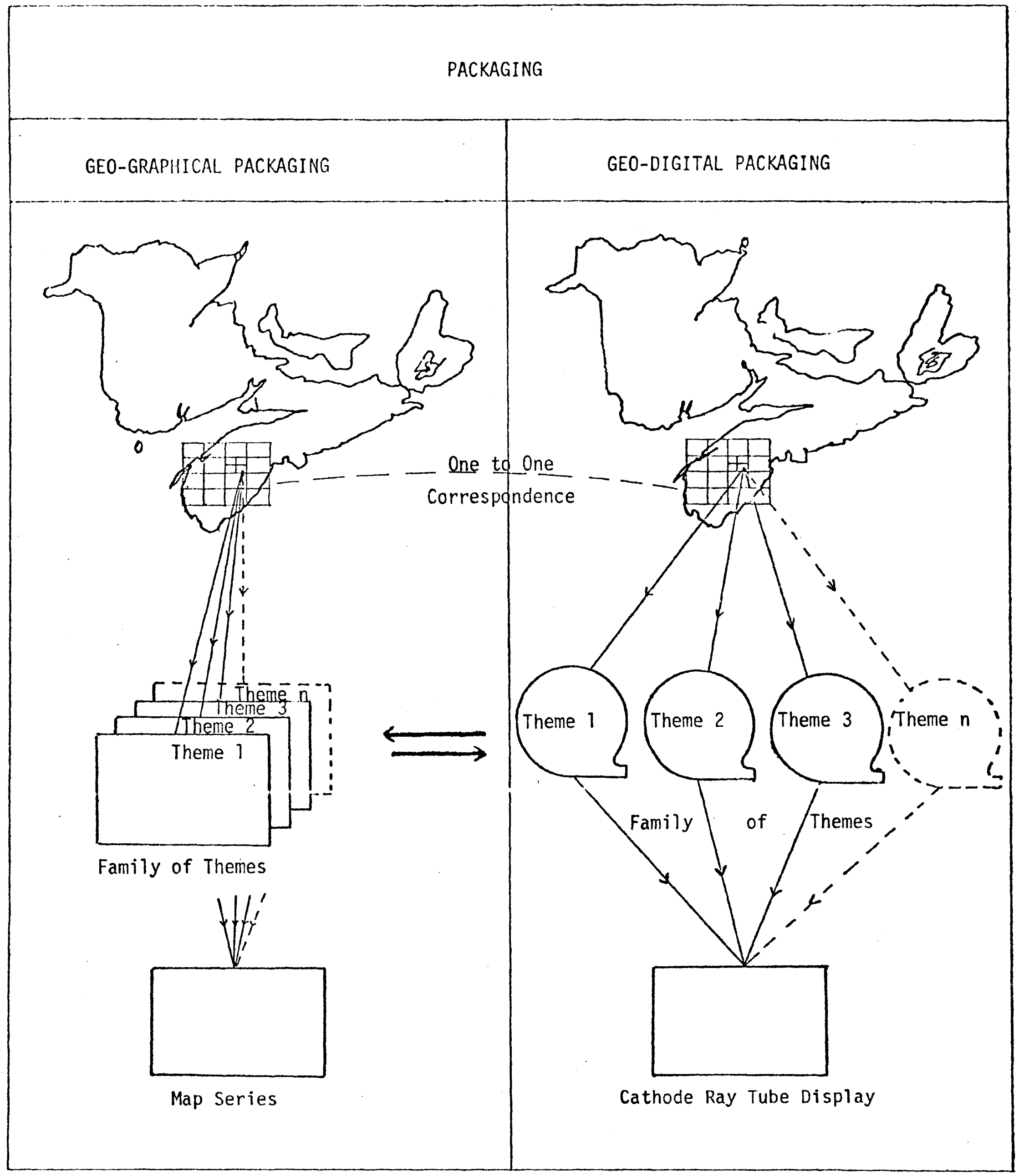


Figure 6-5-1 Maritime packaging concept and its relationship with the theme concept in both graphical and digital form.

6.5.2 Geo-graphical Packaging

The need for geo-graphical packaging does not require any justification. All map users and producers realize that this is a necessary technique to permit the compilation and presentation of the earth's physical and cultural features at medium-small, medium and large scales. However there are limitless ways to package the geo-graphical data. This can be appreciated through an examination of Figure 1-0-2. Consequently a rationalization of geo-graphical packaging in the Maritime Provinces is greatly needed. The geo-graphical packaging must be designed with foresight together with consideration of present technology. The main characteristics can be summarized as follows: it must be unique, homogeneous, preferably continuous, unambiguous, expandable horizontaly (off-shore) and vertically (for condominiums). In order to achieve this goal a territorial coordinate system is required. The four systems that will be explored are:

- The 3^{o} Transverse Mercator (a plane coordinate system)
- The Universal Transverse Mercator (a plane coordinate system)
- The Sexagesimal Degree (an ellipsoidal coordinate system)
- The Decimal Degree (an ellipsoidal coordinate system)

6.5.2.1 Production Aspects

The type of production difficulties encountered with present production techniques will depend on the territorial coordinate system which is selected for geo-graphical packaging. If a plane coordinate system is selected then one set of difficulties is encountered and if an ellipsoidal coordinate is selected then another set of difficulties is encountered.

a) Production difficulties when packaging is based on a plane coordinate system.

If the entire territory to be covered by a map series falls within one zone of a plane coordinate system, the use of plane coordinates for packaging has many attractive features. For instance all the packages can be the same size and all can be rectangular or square. A successful example of square packaging is existing in Great Britain where all packages are in a 10^{o}TM zone*; another successful example of rectangular packaging is in New Brunswcick where all packages are in one stereographic zone.

Maling, P.H., Coordinate Systems and Map Projections, George Phil[illegible] Son Limited, London, 1973.

Difficulties arise when the territory does not all fall within one zone (Nova Scotia falls in two 3^{O}TM zones). The problems that can arise at the zone boundaires will be demonstrated using three possible geo-graphical packaging alternatives (Figure 6-5-2).

Alternative #1

In alternative #1 the packages butt-join at the zone boundaries. Due to the plane coordinate convergence there would always be non-standard packages along the zone boundaries. (Figure 6-5-3). Packages could be produced in many combination of sizes. But how small and how large should the packages be at the zone boundaries?

Type B - Packages could be produced in their respective zones up to 0.6 metre in length;

then

Type C - A new hybrid package 0.2 metre in length could be produced with the orientation based on the meridian at the zone boundary. This could continue until these hybrid packages reach the size of 0.4m, 0.5m or 0.6m.

then

Type D - The package orientations could revert to their respective zone orientation. In this event the packages would be smaller than the standard package format. This could be 0.2m or 0.3m depending on the maximum size of Type C.

Alternative #2

Alternative #2 resembles alternative #1 except that the packages are allowed a greater variation in size and the hybrid Type C is eliminated.

Type B - In this alternative the focal point is that a half metre package is a relatively small package. Consequently packages could be produced in their respective zone until their size reached 0.7 metre in length;

then

Type D - As the packages become larger than 0.7 metre in length, two packages would be produced - a standard half metre package and a non-standard 0.2 metre package.

Alternative #3

The objective in alternative #3 is to produce only standard packages. In doing so an overlap will be unavoidable.

Type E - All packages could be 0.5m x 0.5m.

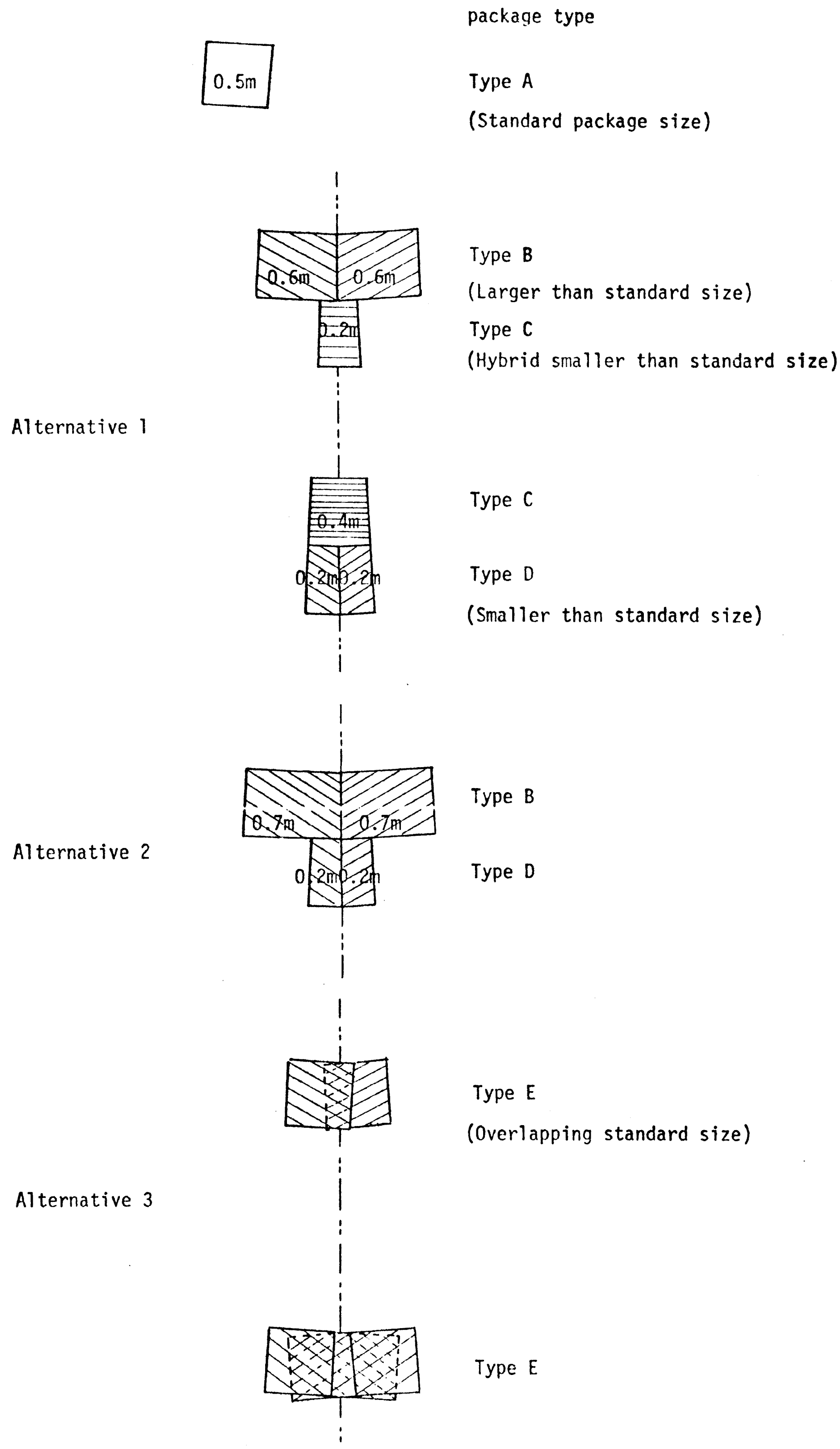


Figure 6-5-2 Alternatives at the zone boundaries with geo-packaging based on the plane coordinate system. It assumes that the standard geo-packaging size would be a 0.5m square.

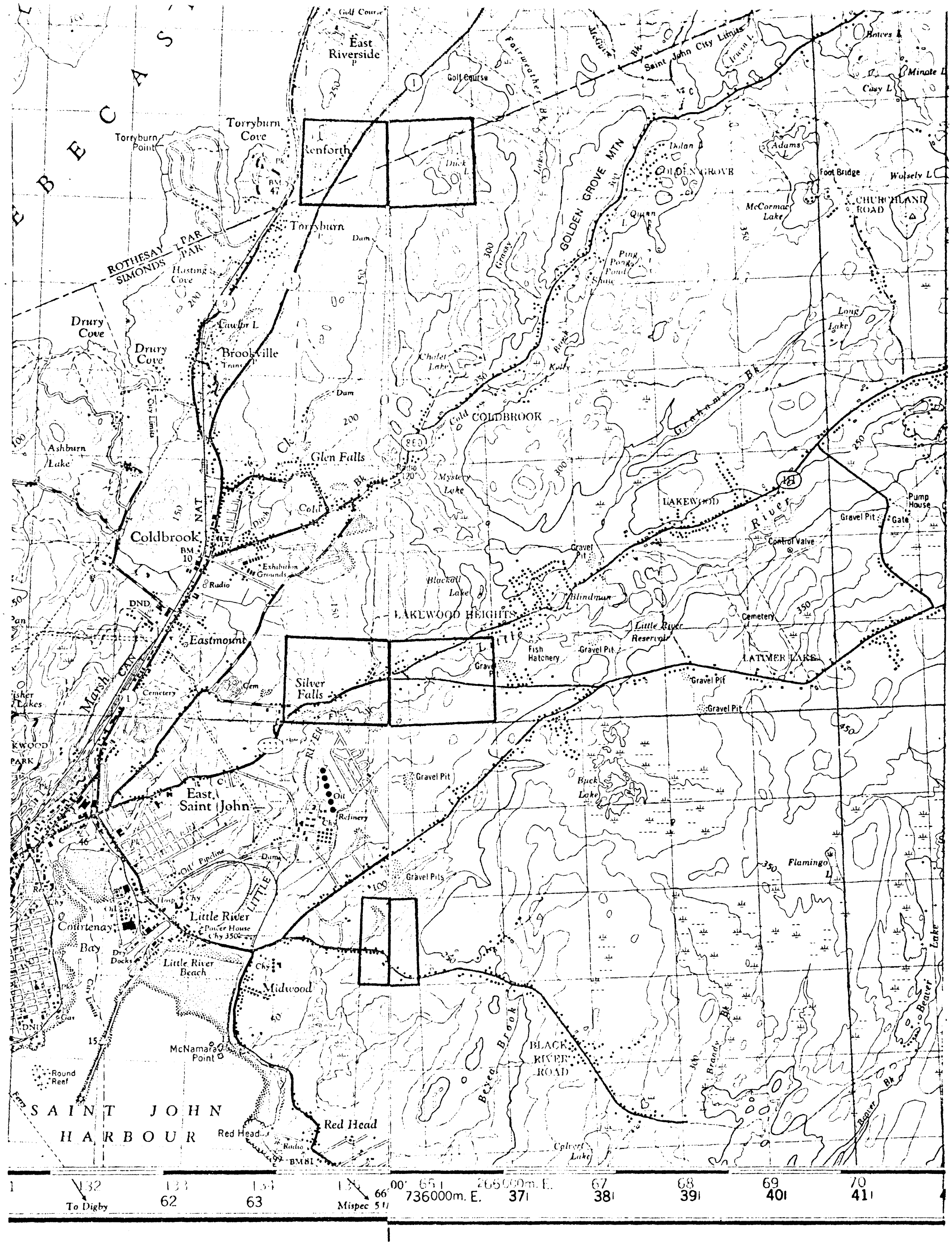


Figure 6-5-3 This figure is a sub-set of Figure 6-5-2. It illustrates Alternative #2 at the zone boundary, in the Saint John area, with packaging based on the UTM plane coordinate system. It assumes a standard package size of 0.5m square.

Analysis of production problems for the three alternatives with respect to: size variation in compilation, printing and filing.

The ideal in the compilation, printing and filing is to have all the map sheets of the same size; to achieve this all the geo-graphical packages must be the same size. In this respect alternative #3 is the best choice because all packages and maps would be the same size. A standard geo-graphical package and a standard map sheet size could be designed and the size variation in compilation, printing and filing would present no problem. The second best choice in this respect is alternative #1. In this alternative non-standard packages would be introduced to permit butt-joins in the packaging. However, the size of the non-standard packages would not be drastically different from the standard one. There are some possibilities that simultaneous design of the packaging and the surround at the boundary could lead to a standard map size. Alternative #2 would cause the most problems in the compilation, printing and filing. This is because there would be a large variation in package sizes at the zone boundaries. Variations in map sheet sizes would be inevitable because there is no possibility that the surround could accommodate the large variations and at the same time opitmize the paper size.

From the compilation, printing and filing point of view alternative #3 is the best; it is followed by alternative #1 and finally alternative #2.

Identification and definition

A geo-graphical package is representing a precise and uniquely defined area of the earth. It implies that the boundaries, the corners and the area of each package are precisely and uniquely defined. The ideal is to have packages which are easy to identify (boundaries and corners) so that there can be no confusion among the various producers with respect to the location of the boundaries or corners of the packages.

In alternative #1 the packages are uniquely and precisely defined however they are very difficult to identify. This is because every package must be checked for validity. Then the result form this check indicates a type A, type B, type C or type D package. Once the type has been identified the package must be defined according to the policy which has been adopted.

At the zone boundary, type B and type D are defined as follows: (Figure 6-5-4)

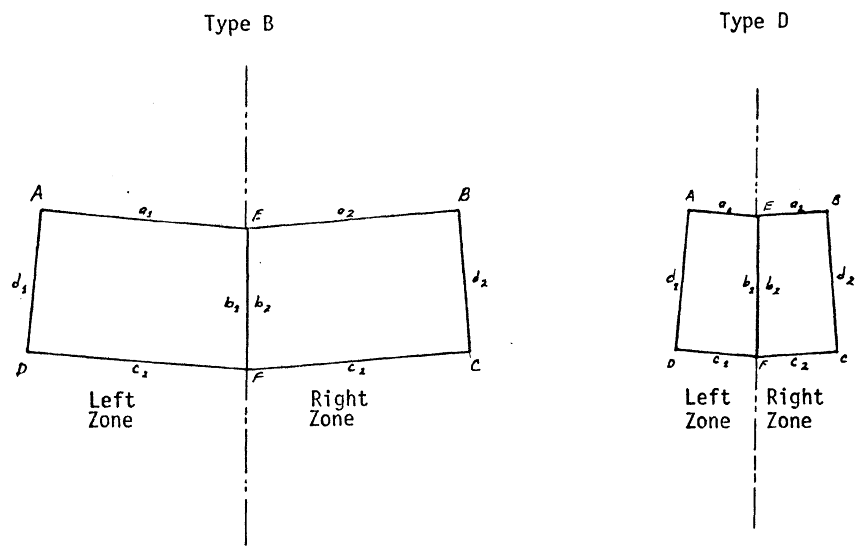


Figure 6-5-4

Corners A & D are defined by coordinates from the left zone.

Corners B & C are defined by coordinates from the right zone.

Corners E & F are defined as the intersection of the right and left coordinate systems with the meridian of the zone boundary.

Consequently

Edges c_1 and c_2, a_1 and a_2 are not parellel.

Edges b_2 and d_2, d_1 and b_1 are not parallel.

Edges d_1 and d_2 are not parallel.

Angles EBC, BCF, EAD and ADF are right angles.

Angles BEF, EFC, AEF and EFD are not right angles.

There are two possibilities to define type C.

Possibility #1 (Figure 6-5-5)

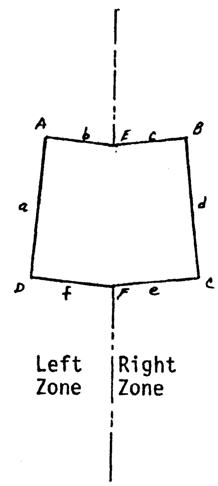


Figure 6-5-5

Corners A & D are defined by coordinates from the left zone.

Corners B & C are defined by coordinates from the right zone.

Middle point E & F are defined as the intersection of the right and left coordinate system with the meridian of the zone boundary.

Consequently

Edges a & d, b & c, f & e are not parallel.

Edges b & f, c & e are parallel

Angles EAD, ADF, EBC and BCF are right angles.

Possibility #2 (Figure 6-5-6)

Corners A_1 and D_1 are defined by coordinates from the left zone.

Corners B_1 and C_1 are defined by coordinates from the right zone.

Middle point E_1 is defined as the intersection of the right and left coordinate systems with the meridian at the zone boundary.

Middle point F_1 is defined as the intersection of the straight line joining D_1 and C_1 with the meridian of the zone boundary.

Corners A_i, B_i, C_i and D_i are defined like A_1, B_1, C_1 and D_1.

Middle points E_i and F_i are defined like F_1.

Corners A_j, B_j, C_j and D_j are defined like A_1, B_1, C_1 and D_1.

MIddle point E_j is defined like F_1.

Middle point F_j is defined like E_1.

In alternative #2 the packages are uniquely and precisely defined but the definition is not simple. Following the validity check a Type A, B, or D. is identified. Type A are standard packages and Type B and D have been defined previously (Figure 6-5-4).

In alternative #3 the packages are precisely defined but they are not uniquely defined consequently this alternative cannot be accepted for packaging.

The problems of identification and definition of the packages at the zone boundaries have been shown. As alternative #3 does not permit unique packaging at the zone boundaries it is rejected. Alternatives #1 and #2 do permit unique packaging but the definition of the packages are rather complex. As alternative #2 presents fewer problems (Figure 6-5-5 and 6-5-6) than alternative #1 it is the best choice with respect to package identificatio and definition at the zone boundaries.

Numbering System

It is difficult to discuss the numbering system because the problems likely to occur will be different with each numbering system. Nevertheless it would be unrealistic to have more than one package having the same number. In other words the package numbering should be unique. In order to achieve a unique number for each package, there must be a distinct numbering system within every zone. This is because

i. It is difficult to carry the numbering system across the zone

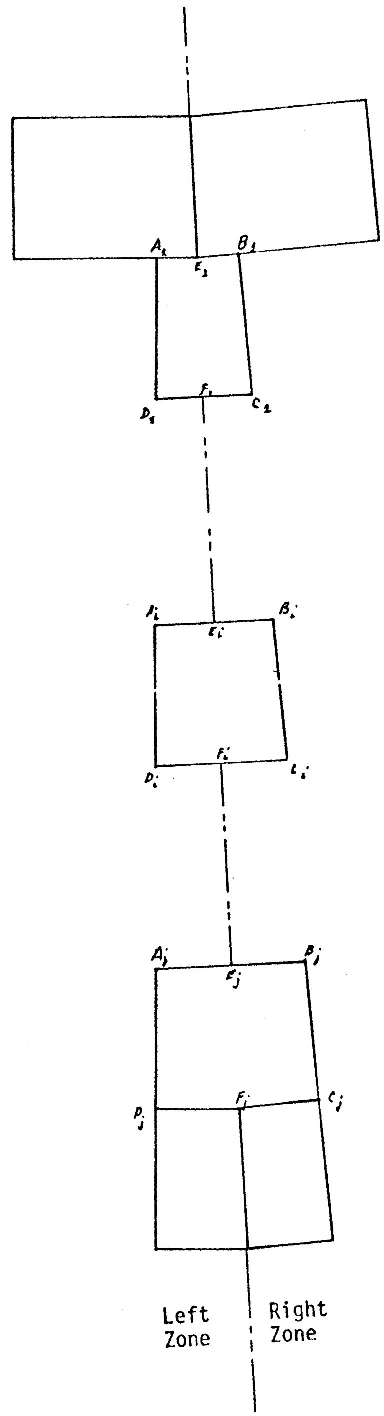


Figure 6-5-6

boundaries due to the discontinuity

ii. The number of zones is unknown in a system which is designed to be expandable

Due to the increasing use of computers in cartography it becomes advisable to select a numbering system which can function efficiently in digital mode while fulfilling the requirements of a graphical system. In other words the numbering of the geo-graphical and geo-digital packages should be identical.

Alternative #1 would cause some problems in the numbering system. More specifically the numbering of type C packages would be a problem because they would not fall in any zone. They are on the zone boundary. In other words special numbering at the zone boundary would increase the complexity of the numbering system. It would be difficult to create a rationalized and integrated numbering system.

Alternative #2 would not cause any package numbering problems because packages are designed to butt-join on the zone boundaries.

Alternative #3 could cause problems One problem is indicated in Figure 6-5-7. In this figure the illustrated package is defined by the plane coordinates of the zone 20 and the package is also numbered in the zone 20 numbering system. Nevertheless the package is in the zone 21. This could happen when uniform packaging becomes necessary for a project at a zone boundary. This could happen in Cape Breton if the land belonging to zone 3 in the 3°TM was packaged in the coordinate system of zone 4 or if the land belonging to zone 21 in the UTM was packaged in the coordinate system of zone 20 (Figure 6-5-7b and c).

Numbering problems are foreseeable at the zone boundaries in Alternatives #1 and #3 but there is no problem foreseen in Alternative #2. Consequently from the package numbering point of view Alternative #2 is the best choice.

Referencing System

In Section 6.4 it has been recommended that a predominant reference grid and two subsidiary referencing systems be printed on maps to represent the three coordinate systems used in the Maritime Provinces. The predominant

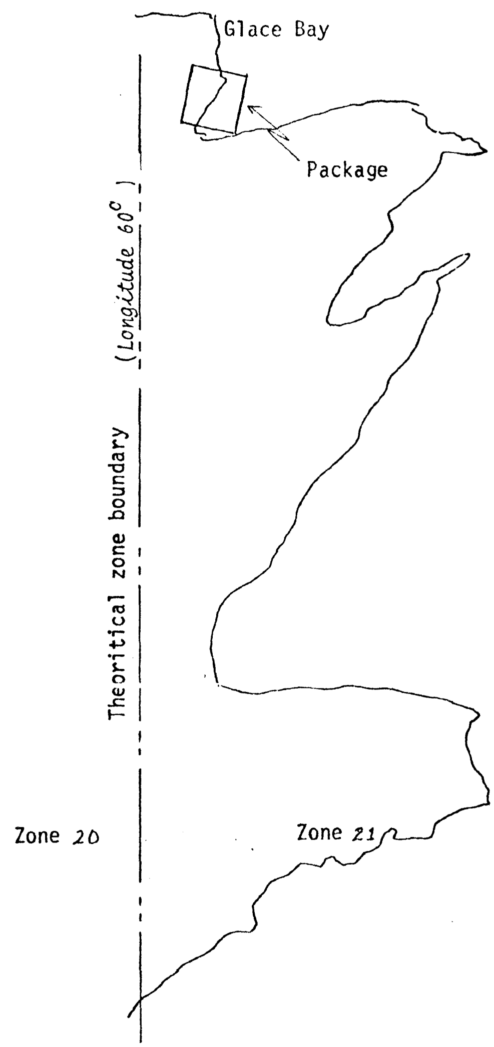


Figure 6-5-7 The above package in Glace Bay area is shown to be packaged in the coordinate system of zone 20 to avoid the discontinuity of the zone boundry. How should the package be numbered? This is a problem.

reference grid represents the most used plane coordinate system but at the zone boundaries there are two plane coordinate systems which are overlapping one another. Consequently there are also two predominant reference grids representing the two plane coordinate systems. So the problem is - which predominat reference grid should be printed on any map at or close to a zone boundary? In the plane coordinate system it is customary to overlap the systems for a width of approximately 25 miles. This procedure is necessary to enable the users to extend one plane coordinate system across a zone boundary to complete a project without changing to another plane coordinate system. This need is well recognized in field operations but is it also recognized in mapping? If so, there is a need for the predominant reference grid to overlap for a considerable distance. This may not necessarily be 25 miles at all scales. A ground distance could be selected for every parent scale. Let's assume that the predominant reference grid be carried beyond the zone boundary for a width equivalent to four packages. Then the quantity of map sheets in the Maritimes with a dual predominant reference grid would be as shown in Figure 6-5-7a for the 1:10 000 alone.

	Packaging based on UTM (Predominant reference grid representing the existing plane co-ordinate system)	Packaging based on 3°TM (Predominant reference grid representating the 3°TM plane coordinate system)
Zone length requiring dual predominant reference grid	127 km (Figure 6-5-7c)	632 km (Figure 6-5-7c)
Number of packages with dual predominant grid		
@ 1:10 000	127÷5x8 = 203	632÷5x8 = 1011
@ 1:2000	Difficult to evaluate	Difficult to evaluate

Figure 6-5-7a

This would cause numerous design and production difficulties. There are no methods to eliminate this problem except the elimination of the zone boundaries.

Length of UTM zone boundaries (Inland)

N.B.	304 km
N.S.	152 km
P.E.I.	nil
total	456 km

The number of non-standard packages at 1:10 000 is 182.

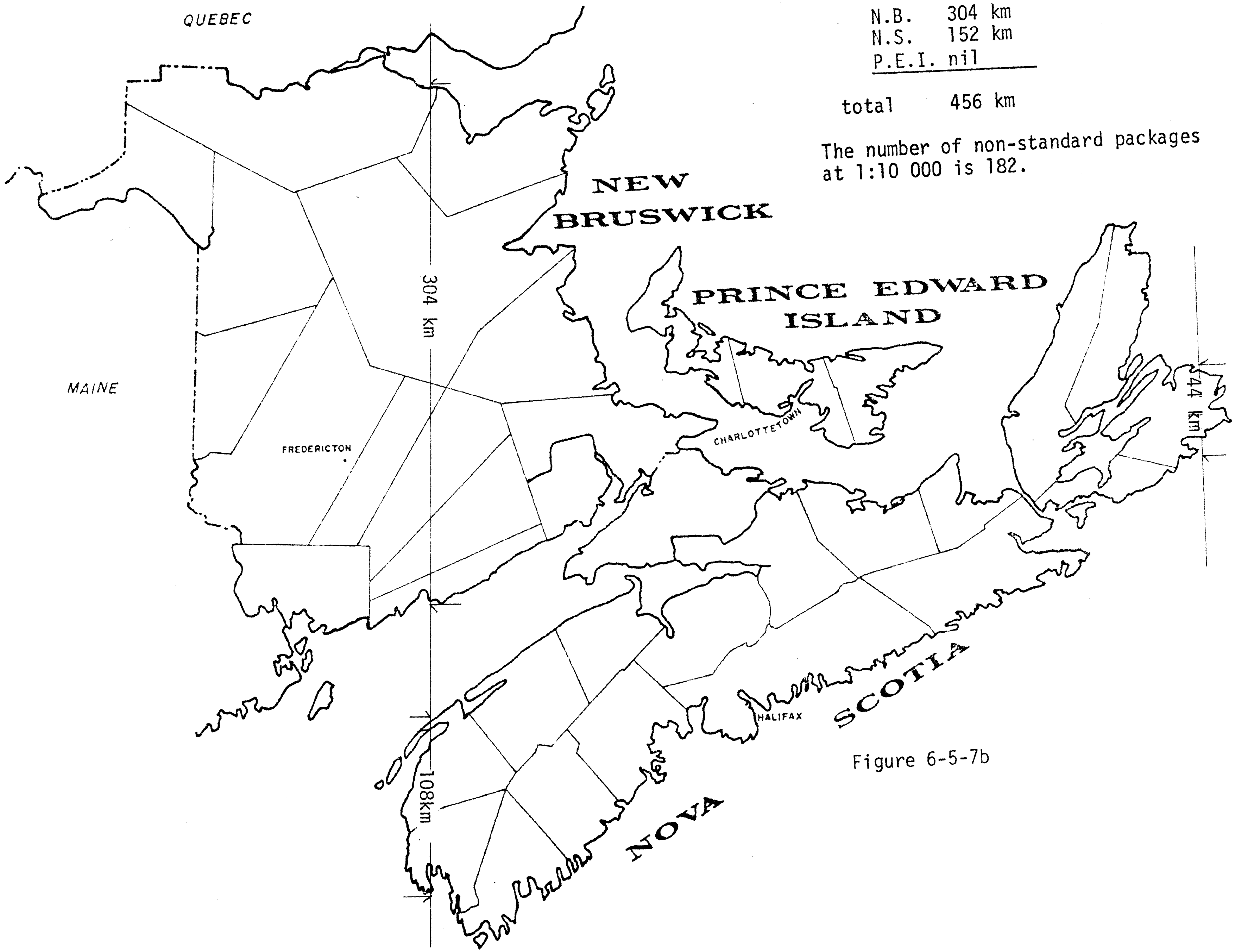


Figure 6-5-7b

Length of 3°TM zone boundaries (Inland)

N.B.	304 km
N.S.	279 km
P.E.I.	44 km
Total	632 km

The number of non-standard packages at 1:10 000 is 253

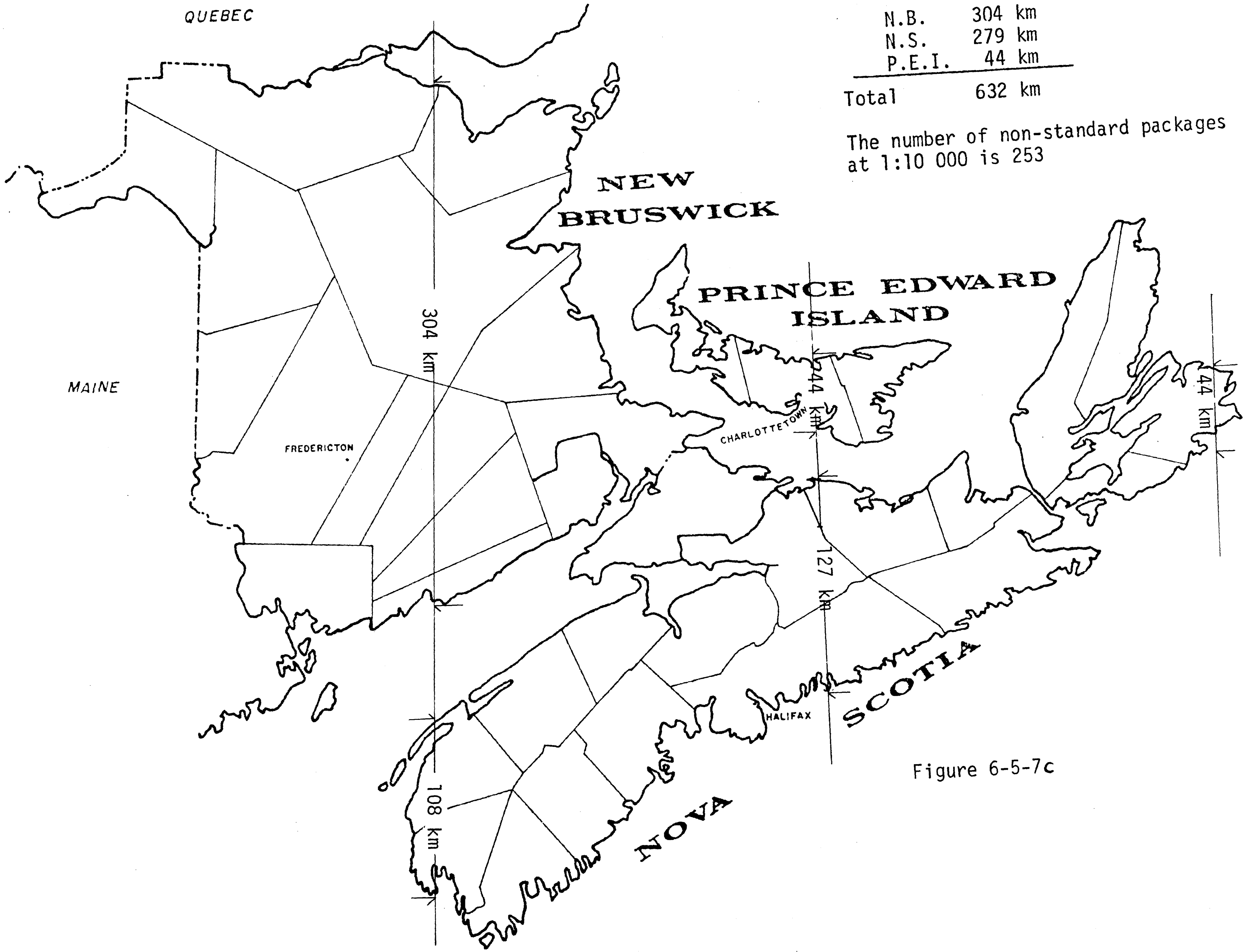


Figure 6-5-7c

Data integrity

Integrity is defined as "the quality or state of being complete or undivided: completeness." To achieve integrity there should not be any package overlap. Any overlap creates duplication; the same information is contained in two different packages. Duplication of data adds to compilation, storage and reproduction costs. However where the problem is most accute is in the updating of theme data for an overlapping area. Errors and inconsistencies between packages covering the same area would inevitably occur. Let's consider only one theme, the cadastral one, among the numerous themes which will be used to produce public map series. Further let's assume that a cadastral mapper is assigned to revise a cadastral theme package as a result of a single lot subdivision which has just been approved. How many times will he revise the theme on one map sheet only? Often. LRIS has already realized the duplication of the same information at two different scales. What is unacceptable for the cadastral theme will also be unacceptable for all other themes.

Alternatives #1 and #2 do meet the data integrity requirements but alternative #3 does not meet this requirement. Consequently alternative #3 is unacceptable for packaging from the data integrity point of view.

Map projection plane

In section 6.2 it has been shown that a map projection plane must be selected before a geo-graphical package could be created. Whereas in alternatives #2 and #3 there is no confusion with respect to the map projection plane to be chosen, it is not the case in alternative #1. This is because type C packages are on the boundary of two map projection planes. (Figure 6-5-2). Should the left half, defined as AEFD, (Figure 6-5-5 and 6-5-6) be on the left map projection plane and the right half, defined as EBCF, be on the right map projection plane or should the whole package be on the right or left map projection plane? There is no obvious rationale on which to make a decision.

From the map projection plane selection point of view alternative #1 should be avoided.

Plane coordinate systems

The choice of plane coordinate systems (UTM or 3°TM) has no direct impact on any of the three alternatives. However indirectly the packaging problems are proportional to the frequency of the zone boundaries. At medium scale, say 1:10 000 there would be:

a) 182 non-standard packages for packaging based on the UTM plane coordinate system (Figure 6-5-7b)

b) 253 non-standard packages for packages based on the 3°TM plane coordinate system (Figure 6-5-7c).

At a scale of 1:20 000 the number of non-standard packages would be reduced by a factor of two. The number of non-standard packages increases by twice the scale increase i.e. four times greater scale leads to 8 times more non-standard packages. As many boundaries on both the UTM and 3°TM plane coordinate systems in the Maritimes fall in economic zones, there would be a large number of non-standard large scale packages produced. It is difficult to estimate the number of non-standard packages likely to be produced but it is possible that in the long term there might be as many at large scale as at medium scale.

The number of non-standard packages in either 3°TM or UTM is not significantly different consequently the quantity of non-standard packages does not influence the choice of plane coordinate system (UTM or 3°TM) for packaging.

This completes the analysis of the production problems associated with each of the three alternatives for geo-graphical packaging of data at the zone boundaries when the packaging is based on the plane coordinate system.

A summary of the production difficulty ratings is presented in Table 6-5-1. It is apparent that none of the alternatives is effective in eliminating the production difficulties.

In the following section the production difficulties when packaging is based on the ellipsoidal coordinate system will be discussed.

Type of Production Difficulties	Alternatives (Manual & computer assisted Production) #1	#2	#3
Size variations in compilations, printing and filing	B	C	A
Identification and Definition	C	B	E
Numbering system	D	A	B
Referencing system	C	C	C
Data integrity	A	A	E
Map projection plane	D	A	A
Plane coordinate system		-	-
Worst production difficulty	D	C	E

A no difficulty
B minor difficulty
C considerable difficulties
D severe difficulties
E unacceptable

Table 6.5.1 Rating of production difficulties when packaging is based on the plane coordinate system.

b) Production difficulties when packaging is based on an ellipsoidal coordinate system.

In the previous section it has been shown that there are a number of production problems associated with packaging based on a plane coordinate system. All of these are due to zone boundaries. When geo-packaging is based on ellipsoidal coordinates the zone boundaries are eliminated in the packaging and consequently all the zone boundary problems are removed.

<u>Size variations in compilation, printing and filing</u>

Presently the manual production of maps based on the ellipsoidal coordinates is being done by many agencies with no major difficulty. However the use of the ellipsoidal coordinates for geo-graphical packaging generally requires more compilation skill than the use of plane coordinates. There are two main compilation problems. The first one arises because the packages are not quite square (Figure 6-5-8); the sides being meridians of longitude are not parallel. However because of the limited range of latitude in the Maritimes (43.5° to 48.0°) the maximum difference in package width is approximately 7 cm. This variation would not be sufficiently large to warrant a change in paper size. It can be accommodated in the design of the map surround without any difficulty. The significance of the convergence of the east and west map boundaries ΔL and the singificance of the sag ΔS is a function of the size and the scale of the packages. Table 6-5-9 shows the ΔL and ΔS values for the range of scales recommended for the Maritime Provinces.

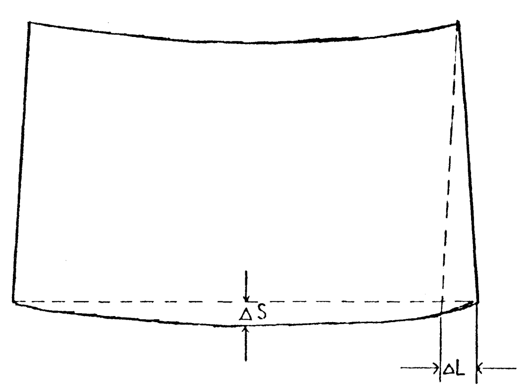


Figure 6-5-8

SCALE	ΔS (inches)	ΔL (inches)
1:20 000	7/1000	37/1000
1:10 000	3/1000	18/1000
1:5000	2/1000	9/1000
1:2000	1/1000	3/1000
1:1000	< 1/1000	2/1000
1:500	≪ 1/1000	1/1000

Figure 6-5-9

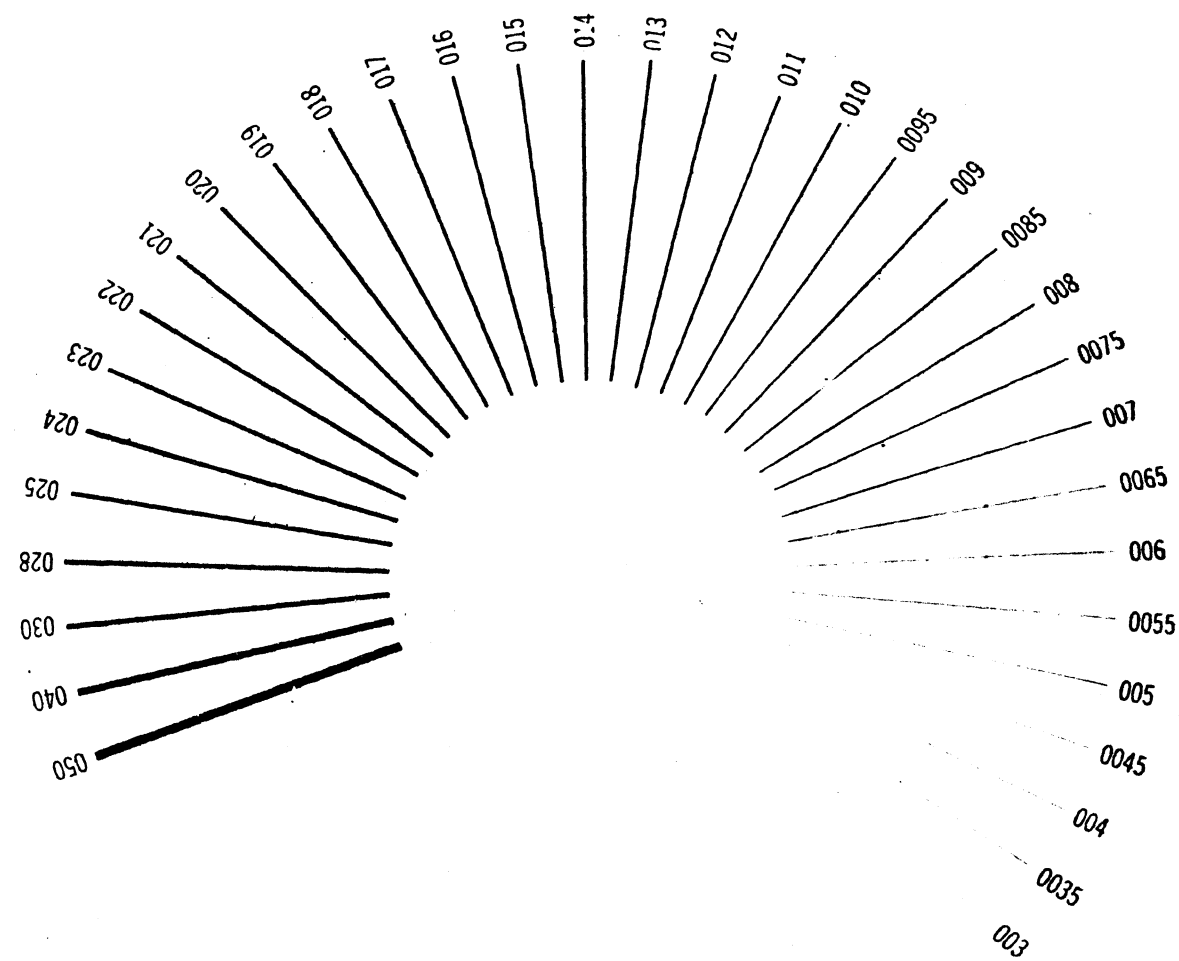


Figure 6-5-10

The package size which has been chosen for these computations are the existing 1:10 000 in New Brunswick and Nova Scotia. In order for the reader to comprehend the graphical significance of ΔS and ΔL a line width templet is printed in Figure 6-5-10. The second compilation problem arises in the establishment of the package boundaries. The plane coordinates of the package corners must be computed using the ellipsoidal coordinates. The computed plane coordinates of the corners are not even numbers. Example:

Latitude	Longitude	(Stereographic)
45.5°	66.0°	E1 128 208.33 ft N635 741.67 ft

This requires more care, skill and checks in plotting than does the plotting of the even coordinates that are used when packaging is based on the provincial plane coordinate system. *Example*:

E976 000.00 ft   N808 000.00 ft

In computer-assisted production these two problems would become trivial; development of the software for producing package boundaries is a relatively simple matter.

In the short term, packaging based on the ellipsoidal coordinates presents no filing and printing problems. The compilation problems are minor and will be removed in the long term with the introduction of computer-assisted cartographic equipment.

Referencing system

The problems related to the printing of the referencing systems are minor when packaging is based on the ellipsoidal coordinates but they are not completely eliminated.

Primary referencing system - provincial plane coordinate systems

The use of ellipsoidal coordinates for packaging allows the Maritime Provinces to retain the existing map projection planes and the existing coordinate systems. Consequently it would be possible to carry out mapping without introducing zone boundaries in New Brunswick and Prince Edward Island. In avoiding zone boundaries the predominant referencing system problems caused by the zone boundaries do not occur. The zone boundary remains in Nova Scotia consequently the predominant referencing system problems persist there.

Subsidiary referencing system - ellipsoidal coordinates:

The representation of the ellipsoidal coordinate referencing system can be achieved very easily. This is shown in Figure 6-5-11.

Subsidiary referencing system - UTM plane coordinates:

In representing the UTM plane coordinate system there are difficulties regardless of whether the packaging is based on the ellipsoidal coordinate system or on a territorial plane coordinate system.

The production difficulties when packaging is based on the ellipsoidal coordinate system are summarized in Table 6-5-2.

A comparison of the production difficulties based on the plane coordinate system (Table 6-5-1) and those based on the ellipsoidal coordinate system (Table 6-5-2) shows that in the latter case production difficulties are either eliminated or reduced significantly.

It is concluded that from the production point of view, packaging based on ellipsoidal coordinates is the better choice for packaging in the Maritime Provinces.

6.5.2.2 User's Aspect

a) Coordinate requirements

In Section 6.4 it has been shown that three coordinate systems are used extensively in the three Maritime Provinces. In order for the users to effectively benefit from their preferred coordinate system, they must be able to go from the maps to the earth's surface and vice versa. This is achieved by printing on maps three geo-graphical referencing systems. In Section 6.5.2.1(b) it has been shown that it is easy to print the three geographical referencing systems with packaging based on the ellipsoidal coordinate systems. However there is no easy way to do it when packaging is based on plane coordinate systems. Consequently in order to meet the user's coordinate requirements without confusion, packaging should be based on the ellipsoidal coordinate system.

b) Map planning

Judging from the response to the questionnaire, planning is an important activity among map users (63.3%). Both inside and outside LRIS, preparations for map production and map requirements for planning are frequent acitivities. If one could pick a small scale map and quickly identify the individual medium and large scale maps desired this would be a great

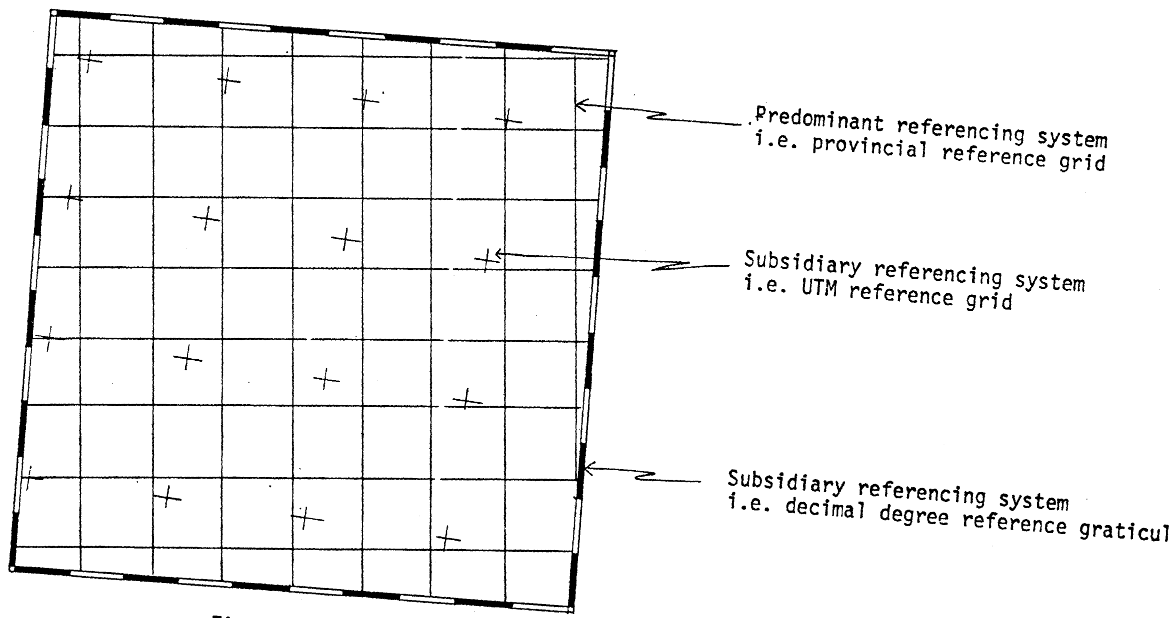


Figure 6-5-11

Geo-graphical referencing when packaging is based on the ellipsoidal coordinate system

Type of Production Difficulties	Manual Production	Computer-assisted Production
Size variations in compilation, printing and filing	B	A
Identification and definition	A	A
Numbering system	A	A
Referencing system	B	B
Data integrity	A	A
Map projection plane	A	A
Plane coordinate system	-	-
Worse production difficulty	B	B

A no difficulty
B minor difficulties
C considerable difficulties
D severe difficulties
E unacceptable

Table 6-5-2 Rating of production difficulties when packaging is based on the ellipsoidal coordinate system.

advantage.

From that point of view, geo-graphical packaging based on the Universal Transverse Mercator is the best (Figure 6-5-12). This is because the packages at medium and large scales could be made to correspond with the reference grid of the small scale maps. Consequently, not only the general area required could be picked out, but the individual packages or map sheets could be determined together with the number of package or map sheets required. No technician would be required and no delay experienced. Discussions could be made quicker, planning time could be reduced and the quantity of maps could be minimized.

Map planning when packaging is based on the ellipsoidal coordinates is less convenient. This is because, currently, the graticule is shown as subsidiary reference system (Figure 6-5-14). It is however a relatively simple task to identify packages for the medium and large scales on these maps by joining the graticule marks with a straight edge.

Map planning when packaging is based on the provincial plane coordinate system is very difficult. This is because the reference grid of the provincial coordinate systems is not shown on NTS maps even as a subsidiary reference system. If it were shown, the same approach as described above could be used. When the provincial reference grid is not shown as a subsidiary system the user must go through the computational and plotting steps necessary to show it. This is such a complex and time-consuming task that, for all intents and purposes, it would rule out the use of NTS maps as a planning guide for a provincial plane coordinate packaging system.

c) Map use

A common map use is the map assemblage. It consists in joining many map sheets together to form a large map covering the whole area of interest (such as for mounting on a wall). There are always problems in the map assemblage whether the geo-packaging is based on the ellipsoidal or the plane coordinate system.

As shown previously, geo-packaging based on the ellipsoidal coordinate system yields map sheets which are not quite square. The top

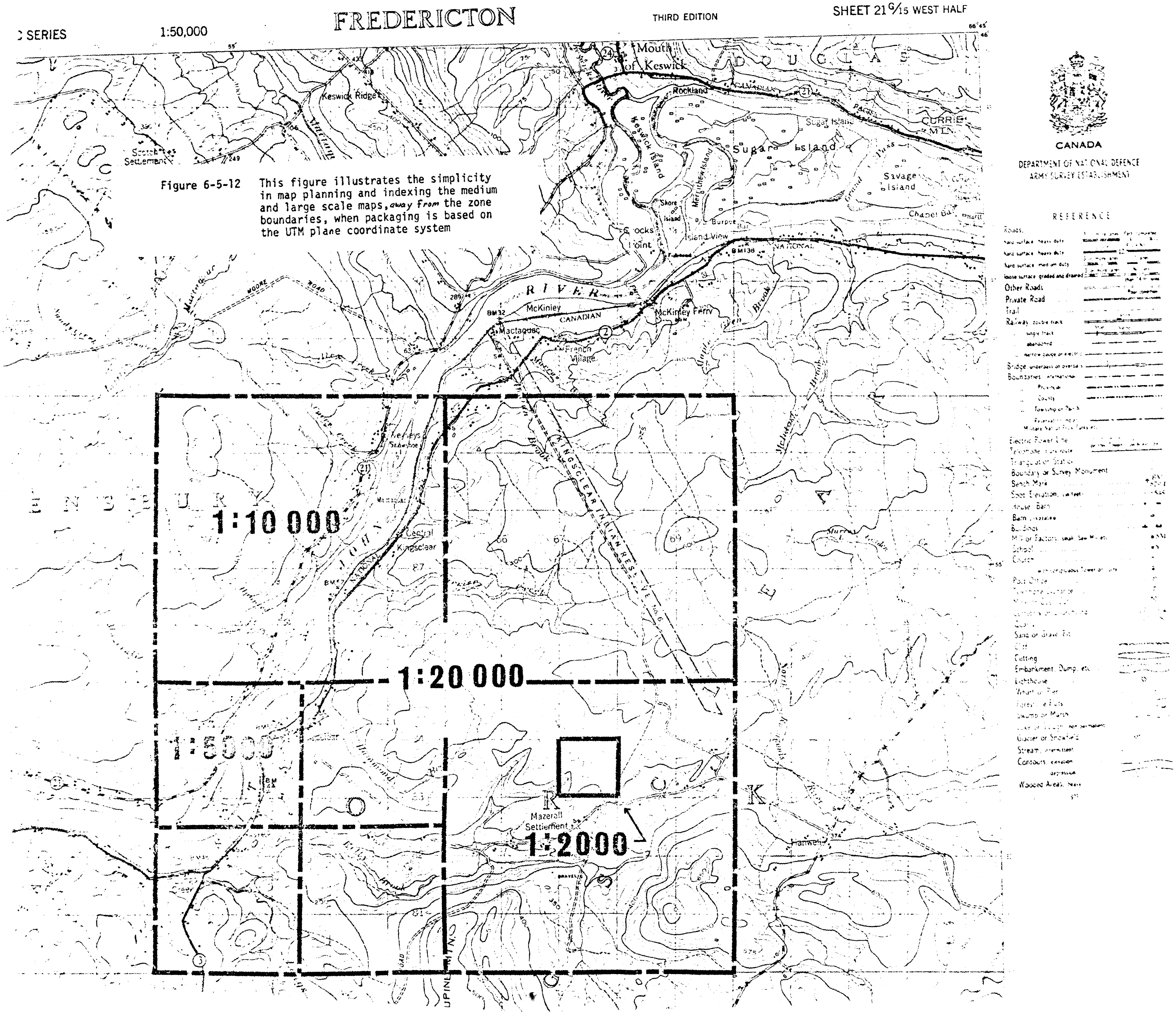


Figure 6-5-12 This figure illustrates the simplicity in map planning and indexing the medium and large scale maps, *away from* the zone boundaries, when packaging is based on the UTM plane coordinate system

of the sheets are shorter than the bottom. The east-west map assemblage produces a concave arc. This is especially noticeable at small scale. Map users who have assembled a wall map at 1:1 000 000, 1:500 000, or 1:250 000 can clearly visualize this problem. However as the scale increases this problem decreases. At a scale of 1:1000 it cannot be noticed. The deviation from a horizontal line would be 4 mm in an assemblage of seven map sheets. (Figure 6-5-13). At the end of seven sheets (4.6 metres) the 4 mm deviation would be barely noticeable. This is considered an insignificant problem at medium and large scale.

The geo-packaging based on the plane coordinate system yields map sheets which are square (or rectangular) and, within one zone, they can be assembled very easily. However where the problem arises is at the zone boundaries. Along the entire zone boundary there would be maps side by side produced on two different plane coordinate systems. They would butt-join but they would not fit together in a continuous fashion. Maps side by side would always be at an angle with respect to one another (Figure 6-5-4). The angles would be approximately six degrees and three degrees for geo-packaging based on the Universal Transverse Mercator and 3° Transverse Mercator respectively. No matter which plane coordinate system is selected the zone boundaries cannot be avoided.

The Saint John area is intersected by a UTM zone boundary. This is illustrated in Figure 6-5-3. It is also intersected by a 3°TM zone boundary. Consequently geo-packaging based on plane coordinates would create inconveniences and difficulties asssociated with map use at the zone boundary. More specifically the users would be confronted with a non-continuous geo-packaging system, a non-continuous map numbering system, a non-continuous plane coordinate system on the ground together with possible variations betwee the practical zone boundary on the ground and the corresponding zone boundary on the maps. These difficulties together with variations in sheet and package sizes (Section 6-5-2-1) in both medium and large scale maps could cause considerable frustration and dissatisfaction among map users.

6.5.2.3 Other aspects

a) Surround

The production of the individual map surround is comparable in many respects for the geo-packaging based on either ellipsoidal or plane

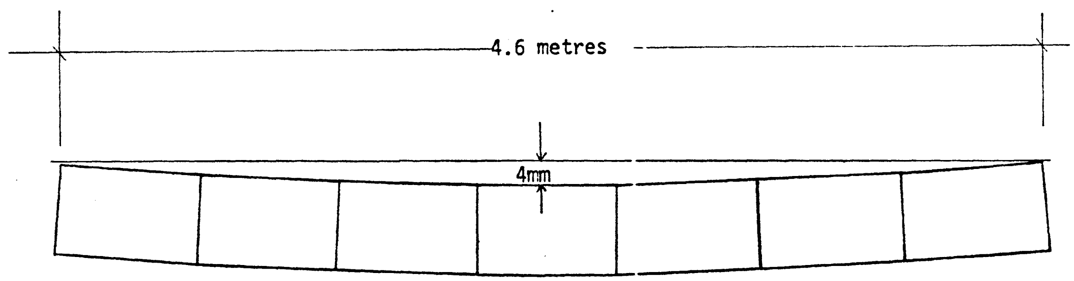


Figure 6-5-13 A map assembly composed of seven map sheets deviates 4mm from the horizontal at a scale of 1:10 000

coordinates; the same components, material, and time in the map production are required.

If ellipsoidal coordinates are selected for geo-packaging the possibility of a different surround for each tier of latitude arises. This is not necessary. Usually there is a "master surround" - one for each public map series - and a "particular surround" - one for each map sheet. The master surround is rendered possible in the Maritime Provinces because there is only a 4.5° range in latitude. The corresponding difference in map sheet length between the most northerly and most southerly map sheets is approximately 7 cm. Aesthetically, the surround can be made to look attractive in all cases. While being attrative it can also be functional for the most northerly and the most southerly sheets.

If plane coordinates are selected for geo-packaging different groups of problems arise. These are mainly due to the large variation in package and map sheet sizes at the zone boundaries. In Section 6.5.2.1 the alternative #2, presented in Figure 6-4-7, has been chosen as the best geo-graphical packaging choice. However the final sheet size choice cannot be made yet because there are metric external factors (see Section 6.5.5) which are unknown. Nevertheless it is easy to see that the variations can be as much as 0.5 metre - the width of a standard package. This would probably lead to a special surround design for the small and large packages at the boundaries together with another one for the standard package size. The theme production concept may bring about other variations in the design of the surround because the size and style may change from one producer to another. In other words maps representing themes like geology, forestry, soil, land use, cadastre may all need a different surround size for legend and explanatory notes.

The surround design is a flexible element of map production. It can be accommodated in both types of geo-packaging, nevertheless one universal surround is a worthwhile goal for simplicity and uniformity in design, handling, storage and exchange. It can be achieved much easier with geo-packaging based on the ellipsoidal coordinate systems than with geo-packaging based on any plane coordinate system.

b) Indexing

An index map or a series of index maps are prepared for every map series produced by an agency. This permits the users to see the coverage available and it helps them to select the maps of interest. The scale of the base selected for indexing purposes is ordinarily 20 to 100 times smaller than the maps to be indexed. For the Maritimes' large and medium scale maps, the National Topographical Secires of maps provide a suitable base. They cover the entire Maritimes and they are available in the right ratios. The 1:250 000 is used for the indexing of the medium scale maps and the 1:50 000 is used for the Maritime large scale maps. These scales are presently used with success, and, since there are no other viable alternative, this practice is likely to continue.

The National Topographical Series of maps is the ideal base for indexing large and medium scale maps if they are based on the ellipsoidal coordinate system. This is because the large and medium scale maps are sub-sets of the small scale national topographical series. From the production point of view it permits the production of index maps quickly and accurately. From the users' point of view there is no confusion in map selection because the large and medium scale maps are multiples of the small scale maps.

Packages based on the plane coordinate system yield maps which are more difficult to index than those based on the ellipsoidal ccordinates. Furthermore the indexing problems are a function of the plane coordinate system selected. The UTM plane coordinate system presents the least indexing problems. This is because a UTM reference grid is plotted on the small scale maps. Designing the package to coincide with the coordinate values of the reference grid permits one to quickly index large and medium scale maps on the National Topographical Series of maps. Nevertheless the large and medium scale maps cannot be designed to be sub-sets of the National Topographical Series. This causes difficulties in indexing close to the edges of the small scale maps. As illustrated in Figure 6-5-14, it is possible that map sheets could be left unindexed or that map sheets could be indexed twice. In nearly all indexing activities, it would be necessary to consult the adjacent small scale map to ensure uniformity. This uniformity is achievable within one organization however, in a dispersed user-producer environment, it would be very difficult to achieve.

Finally, packaging based on any other plane coordinate system woul create serious indexing problems. Large and medium scale maps would not be sub-sets of the small scale map; the bounds could not be made to correspond with the UTM reference grid; and finally the indexing at the edge of the small scale maps would be confusing.

No indexing problems are encountered when packaging is based on the ellipsoidal coordinate system. There is no confusing to either the producers or the users. This is the best choice from the indexing aspect.

c) Flexibility

The geo-packaging should be selected so as to provide the most flexibility possible in the cartographic framework. The packaging based on the ellipsoidal coordinates offers the most flexibility because:

i. It is independent of the map projection plane(s).

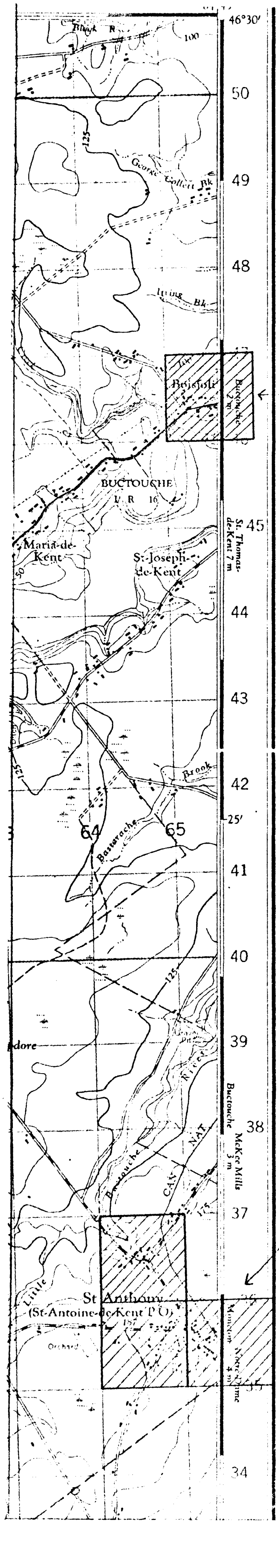
ii. It is independent of the primary reference grid.

iii. It is independent of the subsidiary reference grid.

iv. It is independent of the plane reference systems.

Consequently each province can have its own provincial map projection plane, its own plane coordinate system to meet the engineering and surveying requirements, and finally it can meet future off-shore requirements.

Packaging based on the ellipsoidal coordinates provides territoria geo-packaging which is unique, homogenious, continuous, unambiguous and expandable. At the same time it gives flexibility in local, provincial and off-shore needs with respect to the mapping plane, the coordinate system an the referencing system.

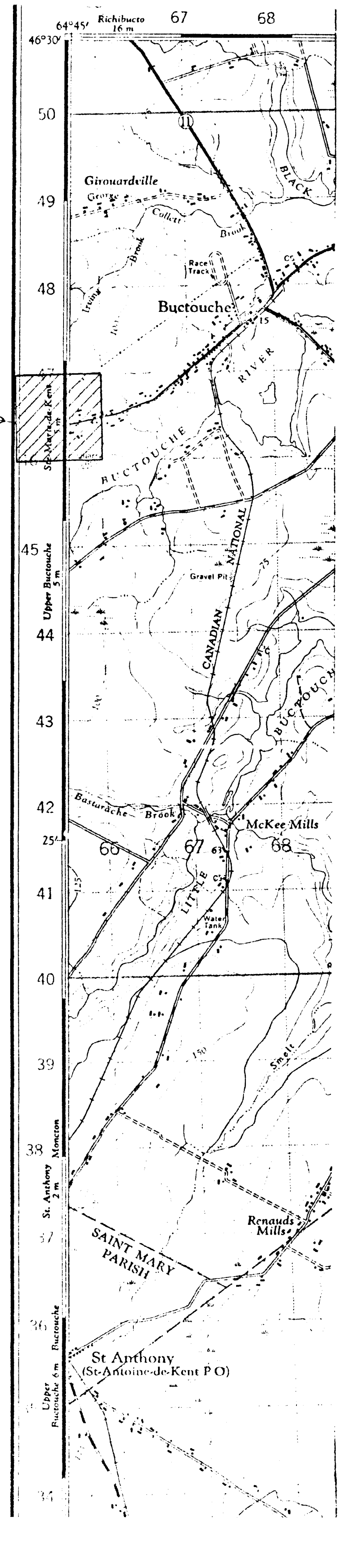


Index twice

Figure 6-5-14

Index once

A user must resort to the adjacent NTS map for the coverage of the second half.



d) Redefinition, readjustment and metric conversion influence on packaging

Upon the introduction of the redefined, readjusted and metric plane coordinates, all maps produced prior to the changeover will become obsolete to a certain extent. The usefulness of maps will be greatly reduced because the map referencing system will be in Imperial units whereas work on the ground will require SI units.

In 1979 more than half of the medium scale mapping in the Maritime Provinces will be completed and a large quantity of large scale maps will have been published. Consequently it may take many years after the redefinition, readjustment and metric conversion before all maps in the Maritime Provinces can be published with the new referencing system corresponding to the redefined and readjusted coordinate systems. The time required to make the changeover will depend on the technique selected for the changeover. There are three choices:

i. To reprint all the map sheets;

ii. To modify the referencing systems of each map sheet until revision; or

iii. To leave the maps unchanged until revision.

Each of the three choices has a different influence on the packaging.

Choice i has little influence on the type of packaging. This is because, in reprinting, each map sheet would have to be repackaged. It would be approximately the same task to repackage maps based on either ellipsoidal or plane coordinates.

Choice ii is an intermediate solution. It may be required if the users cannot wait for either to implement at the medium scale. It would imply two changes. The first one would be to remove the ellipsoidal coordinates from the corners and insert the corresponding new one and to draw the new referencing systems on the original transparencies. The old one could be retained until revision or it could be erased. Should this approach be necessary, then the packaging would be completely irrational in the interim period.

Since it is reasonable to assume a 15 metre shift between the present and the 1979 readjustment, the shift at various scales would be as follows:

3.0 mm @ 1:5000

1.5 mm @ 1:10 000

0.8 mm @ 1:20 000

As the scale decreases one can observe that the difference between the present map position and the 1979 map position becomes quite small. Medium scale maps based on the readjusted coordinates would require an edge tie at a boundary with old mapping. This could be done by printing beyond the package limits (say 1.5 mm at 1:10 000) if the shift happened to be in one direction; or by printing an overlap if the shift happened to be in the opposite direction. The overlap and overhang would eventually disappear in subsequent revisions.

In contrast with medium scale maps, the present large scale packaging does not favor one packaging over the others. This is because the present large scale packaging in most cases, are based on the imperial unit of the plane coordinate systems. The readjusted metric plane coordinates or ellipsoidal coordinates will create the situation where no packaging can be designed to match any existing packaging.

Should the third choice be selected (i.e. to leave the maps unchanged until revision) then neither packaging based on plane coordinates nor packaging based on ellipsoidal coordinates has an advantage over the other.

6.5.2.4 Conclusion

In section 6.5.2.1 it has been shown that there are much fewer production difficulties when geo-graphical packaging is based on the ellipsoidal coordinates.

In section 6.5.2.2 it has been shown that:

i. In order to meet the user's coordinate requirement geo-graphical packaging should be based on the ellipsoidal coordinate system;

ii. In order to meet the map planning requirement geo-graphical packaging could be based on either the UTM or ellipsoidal coordinate system;

iii. In every day map use the geo-graphical packaging based on ellipsoidal coordinates will create negligible problems compared to geo-graphical packaging based on a plane co-ordinate system.

In section 6.4.2.3 it has been shown that:

i. For simplicity and uniformity in map use, handling, storage and exchange it is desirable to have one surround design and one map size. Unless geo-graphical packaging is based on the ellipoidal coordinate system this will be difficult to achieve.

ii. In order to avoid confusion among producers and users in indexing, geo-graphical packaging should be based on the ellipsoidal coordinate system.

iii. In order to permit the maximum flexibility in local, provincial and offshore needs with respect to the mapping planes, the coordinate systems, and the referencing systems then geo-graphical packaging should be based on the ellipsoidal coordinate system.

It can be concluded that from the geo-graphical packaging point of view it is highly desirable to have the packaging based on the ellipsoidal coordinate system.

6.5.3 Geo-digital packaging

There is every indication that an information explosion is occruing due to the development of new technology. The coupling of communication networks, computers and cathode ray tube displays creates a great information potential. Nevertheless we think that:

i. For at least a generation most data will be in a graphical format although there will be a gradual accumulation of geo-digital data.

ii. graphics will be required in a large number of activities

iii. computer-assisted cartography will be improved.

In other words the co-existence of the geo-graphical and geo-digital information systems is inevitable. Consequently, to fully benefit from this co-existence an interface between the geo-graphical and geo-digital information is necessary. The interface is the coupling or merging of themes in graphic form with others in digital form. It implies a close relationship between the geo-graphical and geo-digital formats. This relationship can be achieved if there is a one-to-one correspondence between the geo-graphical packages and the geo-digital packages. This is symbolically shown in Figure 6-5-1. The figure also shows that:

i. the geo-digital themes, which are the building blocks of geo-digital packages, are stored separately like the geo-graphical themes, the building blocks of a geo-graphical package.

ii. on inquiry the geo-digital display is very much the same as a map or geo-graphical package containing the same themes.

Figure 6-5-15 is an expansion of Figure 6-5-1. It shows the actual sequence between the time the geo-digital data is collected and the time it is used. There are three main components to the Figure: the source, the computer memories, and the inquiry. In the Figure the source represents the

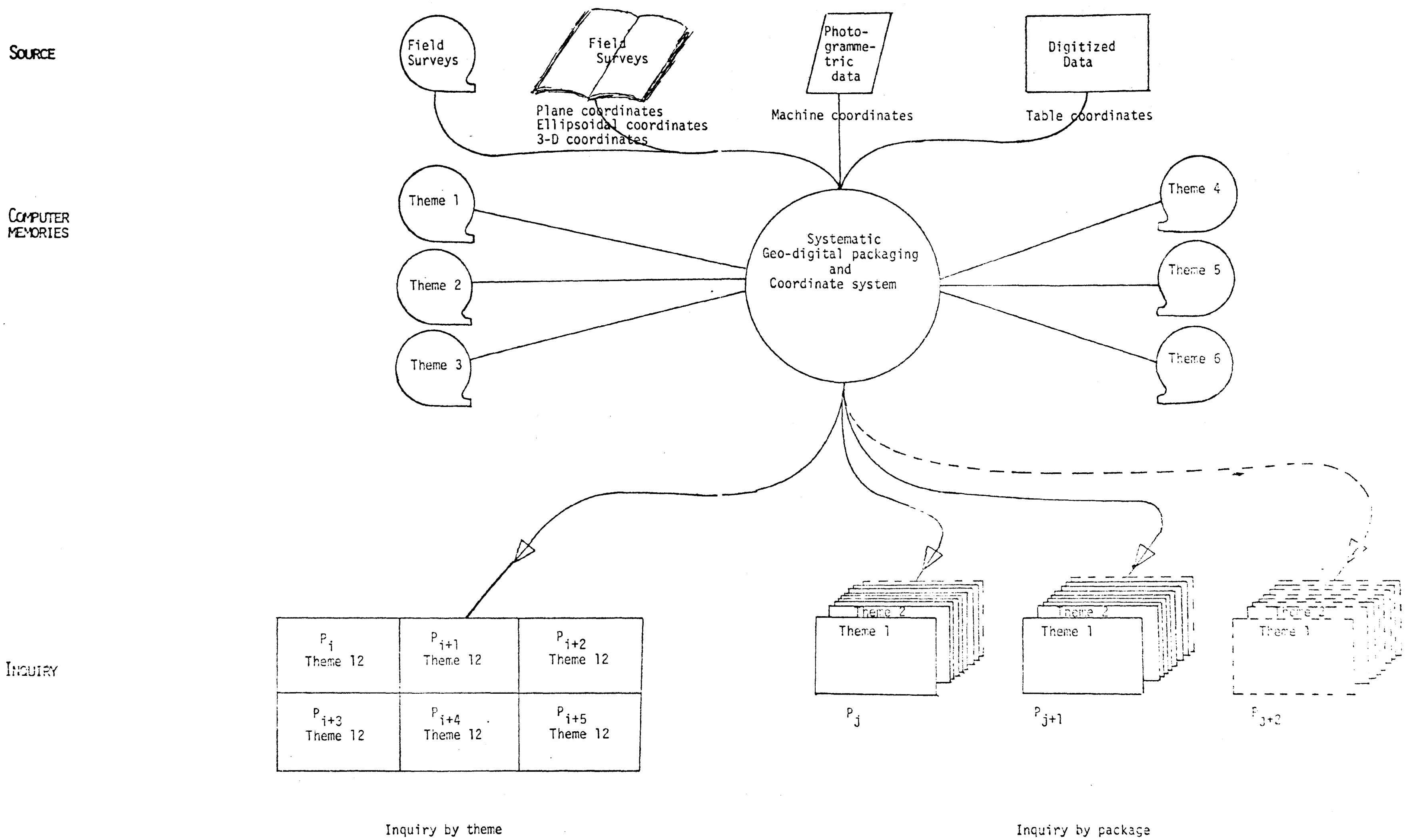


Figure 6-5-15

This figure illustrates the role of systematic geo-digital packaging in the integrated positional information exchange. Geo-digital packaging is an essential part of the data structure. It allows the input data to be organized in order to achieve quick access in the retrievals.

collection of data which is done and will continue to be done with instruments which are necessary to accomplish a predetermined task quickly, efficiently, and at a minimum cost. The results from these surveys are incoherent sets of data. The computer storage includes the usual normalization of the geo-digital data enroute to the computer memory. In the present graphical system the collected data is plotted on maps. This normalization is done so that the collected data may be more accessible to internal and external users. The symbols on maps are a language which needs little documentation to be understood by the users. The need to portray information on maps with symbols is evidence that the collected data must be normalized in order to make it more readily available. The graphical system is a very simple system nevertheless normalization is required for simplification. In a computer system which is a hundred times more complex it is inconceivable not to normalize the data. The need for simplicity of any system cannot be enough emphasized. In order to achive it, a common and systematic coordinate system for storing data in computer memories is required. The inquiry represents the types of output which will be normally required i.e. visual display of packages composed of a desired theme or family of themes.

There are three ways to look at Figure 6-5-15. It can be looked upon as an agency or department sub-system, as a clearing house or as a combination of both.

As an Agency of Department

The source indicates the different techniques that might be used by the department or agency to collect its themes of interest. The computer storage indicates that, following data collection, the theme data is:

i. Packaged into a Maritime systematic and uniform geo- digital packaging system;

ii. Normalized according to a Maritime systematic and uniform coordinate system; and

iii. Stored in the assigned theme file.

The inquiry indicates the retrieval of the geo-digital data. It may be a package, a group of packages, or a sub-package with themes in any combination available.

As a Clearing House

The source indicates a wide range of instruments employed in the collection of geo-digital data in the Maritimes. The computer storage indicates:

i. That all participating agencies are packaging their geo-digital data according to a Maritime common and systematic geo-digital packaging and coordinate system;

ii. That the theme files are satellite files which are administered by the participating agencies each of which has the full responsibility for the content of its files. In other words the collection and up-dating of the theme files is the full responsibility of the producing agency. Other agencies can have access to the agency's files but they cannot change the content.

iii. An exchange through which themes produced by other agencies can be accessed.

The inquiries indicate that standard visual and graphic inquiry can bring forth a package, sub-package and multi-package in any combination of themes available through the exchange.

The two major questions raised in Figure 6-5-15 are:

i. What should be the coordinate systems to store data in computer memories?

ii. What should the geo-digital package be based upon?

The first question is a very important one but it will not be analyzed. This is because it is a highly technical question which can only be answered by computer specialists in consultation with users and cartographers. In the following sub-section the choices of geo-digital packages will be analyzed in a broad perspective.

6.5.3.1 Alternatives for geo-digital packaging

In section 6.5.2 four territorial coordinate systems have been examined as possible geo-graphical packaging systems. Among them there were two plane coordinate systems - 3° Tranverse Mercator and Universal Tranverse Mercator and two ellipsoidal coordinate systems - Sexagesimal Degree and Decimal Degree. The difference between 3° Tranverse Mercator and Universal Tranverse Mercator is very small from the geo-digital packaging point of view. Similarly the difference between the sexagesimal degree and decimal degree is also very small in geo-digital packaging. Consequently the alternatives for geo-digital packaging are between the two types of coordinate systems - plane or ellipsoidal.

a) Geo-digital packaging based on plane coordinates

In section 6.5.2 the geo-graphical packaging based on the plane coordinates has been analyzed. It has been shown that virtually all the difficulties are due to the zone boundaries. Three geo-graphical packaging alternatives at the zone boundaries have been outlined and the associated problems have been identified. The packaging concept implies a one-to-one relationship between the geo-graphical and geo-digital packages. Consequently the same alternatives should be analyzed. Rather than being very repetitive we can say that generally the graphical problems are duplicated in the geo-digital packaging.

b) Geo-digital packaging based on the ellipsoidal coordinates

In the analysis of ellipsoidal coordinates for geo-graphical packaging it was seen that the main difficulty encountered was related to skill. Consequently it required meticulous cartographers. However, this accuracy requirement can be easily achieved with a computer-assisted cartographic system. As a result no difficulty can be foreseen in the use of ellipsoidal coordinates for geo-digital packaging.

The ellipsoidal coordinate system is a stable and yet a flexible system for packaging. It is stable because there is no event in sight which could change the structure of the system. (Should the "grad" system have been a serious contender, it would have been introduced with metric conversion). It is flexible because within the packages it gives the computer scientists the freedom to select any coordinate system they require to optimize the storage within computer memories. Geo-digital data can be stored using plane coordinates, table coordinates, ellipsoidal coordinates, or any other type of coordinates.

6.5.3.2 Conclusion

Among the two types of territorial coordinate systems the ellipsoidal coordinate system is a better choice for geo-digital packaging. Its flexibility, stability, continuity, homogeneity, and expandable properties are such that it provides packaging in which there is no room for confusion and ambiquity among either the producers or the users.

6.5.4 Package Numbering

If we accept the packaging concept then each package must be numbered so that it can be filed and retrieved at will. (Filing and retrieval apply to both geo-graphical and geo-digital packages). The geo-graphical package numbering is normally called map numbering system. The geo-digital packages do not yet have a commonly used name. In reference to both the term "package numbering" is being used here.

It is desirable that the package numbering serve the cartographers, the users, and the computer scientists equally well. In order to achieve it there should be a common package numbering for both the geo-graphical package and the geo-digital package. Three types of package numbering will be analyzed. The arbitrary, the matrix and the geo-code numbering.

6.5.4.1 Arbitrary numbering

The arbitrary numbering is very common. In Canada it is wide-spread at the federal, provincial, and municipal levels. In this type of numbering the rational or natural pattern between the numbering of adjacent packages is practically non-existent. The numerical, alphabetical, and alpha-numerical numbering may zig-zag from east to west and vice versa or from north to south and vice versa. In some cases it is a combination of both. One example of this type is the numbering of the National Topographical Series. Similar types of arbitrary numbering also exists at the provincial and municipal levels. In most cases the map numbering has been designed to cover limited map series and a limited portion of the earth's surface. In other words map numbering systems cannot, ordinarily, be expanded or combined with those of other mapping agencies.

The irrational pattern, the lack of flexibility, lack of expandability, the mixture of alpha-numeric and symbol are serious limitations of the arbitrary type of package numbering.

6.5.4.2 Matrix numbering

The matrix type of package numbering is different from the arbitrary type in the sense that there is, some time, a logical or natural relationship between the adjacent packages. It resembles the arbitrary in the sense that it establishes no direct relationship between the packages and their positions or space locations. The matrix numbering can be autonomous but rarely is. Most of the time it is a mixture of two types.

Examples:

Province	Scale	Map Number
New Brunswick	1:2400	12U 82 Matrix Arbitrary
Quebec	1:5000	31P07 - 050 - 0508 Arbitrary Scale Matrix

In the first example the matrix is used as a prefix and in the second one the matrix is used as a suffix. For various reasons this mixture in the types does not give any significant advantages over the arbitrary numbering. In most cases the numbering lacks flexibility. The autonomous matrix numbering also lacks flexibility. This is because the maximum size of the matrix must be predetermined. Should one wish to prepare maps outside the area covered by the matrix then the numbering breaks down.

The matrix numbering can be an improvement over the arbitrary numbering but the system does not have sufficient flexibility to be applied extensively off-shore.

6.5.4.3 Geo-code numbering

The geo-code type of numbering makes use of spatial coordinates, usually the spatial coordinates of a package corner, to identify the packages. The numbering is rational consequently the number of the neighbouring packages can be identified without an index. Also a package number establishes a clear relationship between the package at hand and its location in the territory. This type of numbering is expandable, flexible, numerical, continuous, rational and space sensitive. It has the potential of satisfying the cartographers, the computer scientists and the map users.

The geo-code type can be divided into two sub-types: the plane coordinates geo-code and the ellipsoidal coordinates geo-code.

a) Plane coordinate geo-code

The plane coordinate sub-type can be used when packaging is based on the plane coordinate system. Examples of this sub-type of numbering can be found in Alberta, in British Columbia, in Ontario (Task Force on Geographical Referencing), in the British Isles, in Germany and in many other countries.

b) Ellipsoidal coordinate geo-code

The ellipsoidal coordinate sub-type of numbering packages is very similar to the plane coordinate sub-type. It can be used when packaging is based on the ellipsoidal coordinate system. This is difficult to implement with the sexagesimal degree system but it is simple to implement with the decimal degree system.

6.5.4.4 Conclusion

Among the three types of package numbering the geo-code type is the most promising alternative. It can be learned quickly by the users; it can be entirely numerical to satisfy the computer scientists; and it can be practical for the cartographers. Viewed as a regional system it is expandable, flexible, continuous, rational, and space sensitive. This is the best choice.

6.5.5 Packages and map sizes

There are two components which contribute to the size of a map. There is the geo-graphical package area and the surround area. Together these two areas form the total area of a map sheet. The map's length and width is limited by production materials, filing cabinets, ease of handling, printing equipments, and users' preference. In other words the size of the maps and geo-graphical packages is limited. However, there appears to be no factors controlling the size of the geo-digital packages in the range of sizes acceptable in mapping. Consequently the subject becomes a purely cartographic one.

Until recently very little attention has been given to paper sizes. The lack of standards has created the situation where the market has reacted to the demand. It was an uncontrolled supply and demand. This has led to hundreds of paper sizes. Recently, however, in the planning of metric conversion, the opportunity of standardization has been recognized. It has led to acceptance of two standards: one for correspondence (CAN 2-9.60 M-76) and one for printing (CAN 2-9.61 M-76). However, there is no standard yet for engineering drawing, mapping, charting, etc. The Canadian Government Specification Board (CGSB) has had a few meetings on the subject but it cannot give any indication yet as to what might be the standard.

Whenever available the mapping paper sizes should be selected with the following considerations in mind: paper economy, and map series efficiency.

6.5.5.1 Paper economy

Economy in paper can be achieved by increasing the efficiency of paper in mapping. The efficiency ratio is defined as the ratio of the geographical package area to the total area of a map sheet. It is recognized that a minimum of information regarding each map sheet must be printed in the surround, however care should be exercised to ensure that the area of the surround is not larger than it needs to be. Otherwise one gets into higher production costs due to the size of production components which are larger than necessary; one gets into higher reproduction costs due to the size of repor-duction material which are larger than necessary; and finally one gets into higher filing costs due to cabinet size which are larger than necessary. Table 6-5-3 shows the efficiency ratio for a variety of selected maps. It can be observed that as the area of the geo-package increases, the efficiency ratio ordinarily increases. Consequently one should design the largest possible geo-package and design a surround which is not unnecessarily large. One must also consider that a map wider than 30 inches becomes inconvenient for users to handle. The length is less restrictive. Maps can be square or rectangular.

6.5.5.2 Geo-packaging yield and efficiency

The geo-package yield is defined as the quantity of geo-packages of a given size, required tocover an area, at a given scale. Table 6-5-4 shows the the yield of the 1:10 00 series in Prince Edward Island, New Brunswick, Nova Scotia and Quebec. As the package size increases the number of map sheets to produce, file and handle decreases. This should create an increase in effeciency for both the producers and users.

One benefit of computer-assisted cartography should be an improved production efficiency. Large geo-packages should result in higher efficiency due to the lesser number of map sheets to initiate, manipulate and store. Consequently in light of computer-assisted cartography attention should be given to the selection of geo-packages with a low yield to increase the production efficiency. However, even if efficiency increases as the size of packages increases, it is recognized that beyond a width of thirty inches some of the existing production and filing materials would be obsolete. Users would also have difficulties in map handling.

Map considered	Geo-graphical package area (sq. in)	Surround area (sq. in)	Total area (sq. in)	Efficiency ratio
Maritime 1:10 000 (present paper)	460	405	865	.53
Maritime 1:10 000 (A1 paper)	460	315	775	.59
Quebec 1:10 000 (present paper)	1017	566	1583	.64
Quebec 1:10 000 (A0 paper)	1017	531	1549	.66
P.E.I. 1:5000 (present paper)	342	378	720	.48
Ontario 1:10 000 (proposed paper)	390	383	775	.50
Nova Scotia 1:1200 (production material)	750	390	1140	.66
Nova Scotia 1:1200 (printed paper)	750	626	1376	.55

Table 6-5-3

Geo-packages dimensions at the scale of 1:10 000		Average Area		Yield (number at geo-package to cover the Maritimes)*	Geo-package yield ratio
		mi^2	km^2		
Lat.	Long.				
2.5'	3.75' (as in P.E.I. series)	9	23	5778	2.9
2.5'	5.0' (as in N.B. & N.S. series)	12	31	4333	2.1
3.75'	7.5' (as in Quebec)	26	68	2000(Ref.)	1.0

* The area of the Maritimes is 52 000 sq. mi. (135 000 km^2)

Table 6-5-4

6.5.5.3 Other factors

At this moment we may be thinking of a particular localized requirement but one may never know when looking ahead how these particular maps might be wanted in the future. Although at the present time LRIS might be thinking of diazo production, some litho production might be printed in the future. The problem with larger sheets is that sometimes one may have to go a long way to find a printing press.

6.5.5.4 Conclusion

A small map does not make efficient use of paper. A high geo-package yield does not cover a territory efficiently. In other words small packages create handling, printing and filing inefficiency. Consequently geo-packages should be the largest possible. However extra large geo-packages could produce problems in printing equipment, filing cabinets and handling by both the producers and the users. In between there is an optimum size.

6.5.6 Evaluation of the Packaging Alternatives

The factors affecting the choice of packaging have been discussed in the five previous sections. In order to show the packaging alternatives in perspective a network diagram is shown in Figure 6-5-16. The network diagram leads to four tables.

The first one, Table 6-5-5 shows the advantages-disadvantages of the sexagesimal degree vs decimal degree. The decimal degree outweighs the sexagesimal degree by a ratio 2 to 1 consequently this eliminates the sexagesimal degree for the Maritime packaging.

The second one, Table 6-5-5, shows the advantages-disadvantages of the UTM vs 3°TM. It is important to realize that even if UTM was not selected as the common Maritime map projection plane, UTM could still be selected for the packaging. However, as shown in the table, neither UTM or 3°TM presents any significant advantages for packaging.

The third one, Table 6-5-7, shows the advantages-disadvantages of 3°TM vs decimal degree. Decimal degree outweighs 3°TM by a ratio of 2 to 1.

The fourth one, Table 6-5-8, shows the advantages-disadvantages of UTM vs decimal degree. Decimal degree also outweighs UTM by a ratio of 2 to 1.

The conclusion emerging from the four tables is that the Maritimes packaging should be based on decimal degree.

6.5.7 Recommendation

It is recommended that decimal degree be adopted for geo-packaging in the Maritime Provinces.

The proposed system is shown in Figure 6-5-17 to 6-5-20. It has the following characteristics:

i. Packages are designed to be sub-sets of the 1:50 000 and 1:250 000.

ii. All medium and large scale packages have the same aspects as the 1:50 000 NTS packages.

iii. Map sheets are the same size at all scales.

iv. The numbering system is composed of the latitude and longitude of the southeast corner. It has, as prefix, a scale identifier.

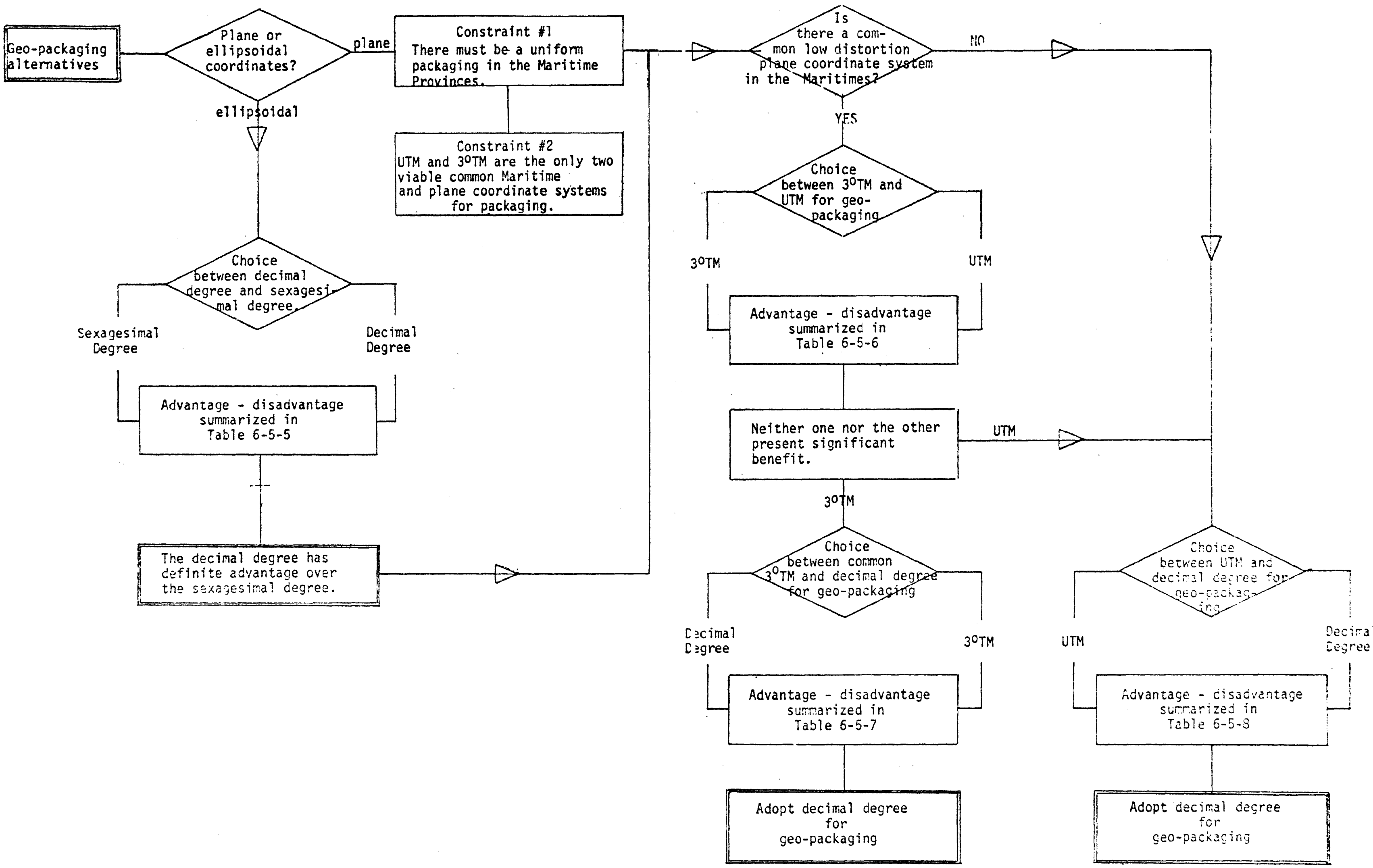


Figure 6-5-16 Flow chart showing the steps leading to the choice of coordinate for geo-packaging

COMPARISON BETWEEN SEXAGESIMAL AND DECIMAL DEGREE FOR THE MARITIME PACKAGING

	Sexagesimal Degree (Degree, minute, second and decimal of second)			Decimal Degree (Degree and decimal of degree)		
	LONG TERM EFFECT					
SUBJECT	ADVANTAGES	DISADVANTAGES	Weight	ADVANTAGES	DISADVANTAGES	Weight
Packaging rationalization		Difficult to make large scale packages sub-sets of both the medium scale and NTS packages. Difficult to produce a coherent family of packages and map scales. A package at the scale of 1:2000 would need to be 36" by 72" to be a sub-set of the 1:50 000.	1	The medium and large scale packages can easily be a sub-set of each other and of the NTS packages. (Figure 6-5-17). A coherent family of scale and packages can then be produced. (Figure 3-1-1)		4
Indexing	The graticule of the NTS can be used for indexing the medium scale maps.		2		The graticule in degree, minute, second of the NTS is of little help in indexing the medium and large scale maps.	1
Package and map sizes		Impossible to produce <u>one</u> package and map size and achieve rationalisation in packaging.	1	Packages and map sheet can be produced at one standard size, at all scales, for the whole Maritimes in land and off shore. (Figure 6-5-17 column 4)		3
Efficiency		Difficult to increase the present package and map sizes to improve the efficiency and achieve rationalization in packaging.	1	Packages and map sizes can be increased (same as 1:50000) and increase the efficiency of the series. (25% less packages and map sheets)		2
Economy of scale		Difficult to use the same production material size for all maps at all scales and achieve economy of scale.	2	Maps can be of a uniform size. Consequently a single production materials size is required for all scales. Thus the economy of scale should be achieved.		2
Packages and map sheets numbering		Package and map sheet numbering cannot be rationalized, (Section 6.5.4) consequently one can neither recall how the numbering works nor deduce the numbers from adjacent packages.	1	Package and map sheet numbering can be rationalized (Figure 6-5-17). It is easy to recall how the numbering works. Adjacent packages or sub-packages numbers, at any scale, can be easily determined.		3
		Package numbering gives no information about the location of the maps and it establishes no direct relationship between the map data and the *ground*.	1	Package numbering easily establishes information about the location of the map. It also establishes direct relation between the map data and the ground.		3
Digital aspect		Package numbering cannot be used directly as a data index.	1	Numbering systems can be used directly as a data index. (Figure 6-5-17 last column).		3
		Sexagesimal degree must be converted to decimal degree to be processed in computers. Coordinates cannot be read as a string of digits i.e. a column is needed for: Deg 45 | Min 16 | Sec 45.167	1	Decimal degree can be processed directly in computers. Coordinates can be read as a string of digits 45.279213.		3
		Total Weight	10		**Total Weight**	**24**
Conclusion	**The Decimal Degree has definite advantages over the sexagesimal degree**					

Note: The sexagesimal degree vs. decimal degree is presented in a condensed form in this table. There is no lengthy discussion presented in the report.

Table 6-5-5

COMPARISON OF UTM AND 3°TM FOR THE MARITIME PACKAGING

SUBJECT	UTM (with stereographic in N.B. and P.E.I. and 3°TM in N.S. as map projection plane and coordinate system) ADVANTAGES	DISADVANTAGES	Weight	3°TM (with 3°TM as the common Maritimes map projection plane and plane coordinate system) ADVANTAGES	DISADVANTAGES	Weight
Graphical production aspect (6.5.2.1) Size variation		Non-standard map sheets are inevitable (at all scales) at the zone boundaries. (456 km of zone boundaries). Figure 6-5-7b. This causes problems in compilation, printing and filing.	1		There is a zone boundary in all provinces. (632 km of zone boundaries). Figure 6-5-7c Non-standard map sheets are inevitable. This causes problems in compilation, printing and filing.	1
Identification and definition		Packages are difficult to define and identify at zone boundaries in two provinces. (Figures 6-5-4 to 6-5-6)	1		Packages are difficult to identify at the zone boundaries in all provinces. (Figures 6-5-4 to 6-5-6)	1
Numbering ystem		Discontinuities of the zone boundaries create discontinuities in the package numbering in two provinces. Confusion would arise if packaging exception was allowed. (Figure 6-5-7)	1		Discontinuities of the zone boundaries create discontinuities in the package numbering in all provinces. Confusion would arise if packaging exception was allowed. (Figure 6-5-7)	1
Referencing system		Map sheets with a dual predominant reference grid cause production difficulties in Nova Scotia. (Figure 6-5-7a).	3		Map sheets with a dual predominant reference grid causes production difficulties in all provinces. (Figure 6-5-7a)	2
	Subsidiary reference grid is parallel to the map sheet edges	Predominant reference grid is not parallel to the map sheet edges.	1	Predominant reference grid is parallel to the map sheet edges.		4
Users' aspects (6.5.2.2) Coordinate use		Difficult to print the three reference systems required by the users. Predominant: provincial plane coordinate system Subsidiary : UTM and ellipsoidal coordinate system	1		Difficult to print the three reference systems required by the users. Predominant: provincial plane coordinate system Subsidiary : UTM and ellipsoidal coordinate system	1
Map planning	Large and medium scale map requirements are easy to delineate on small scale maps. (Figure 6-5-12)		4		Large and medium scale map requirements are very difficult to delineate on small scale maps.	1
Map use		Users' frustrations due to packaging discontinuity, map sheet size variations and package numbering discontinuity in N.B. and N.S.	1		Users' frustrations due to packaging discontinuity, package size variations, and package numbering discontinuity in all provinces.	1
Other aspects (6.5.2.3) Surround		Extremely difficult to design a universal surround.	1		Extremely difficult to design a universal surround.	1
Indexing	Indexing is generally easy and it requires no computation.	Indexing problems for map sheets adjacent to zone boundaries. (Figure 6-5-14)	4		Indexing is difficult. It requires computations and measurements. Some indexing problems at edges as shown in [illegible]	2
Flexibility	Each province can maintain its own plane coordinate system and its own map projection plane.		2		A common plane coordinate system and map projection plane is required.	1
Digital production and use		Similar production and user difficulties as in the graphical mode.	1		Similar production and users' difficulties as in the graphical mode.	
		Geo-digital packages are not sub-sets of the NTS packages.	1		Geo-digital packages are not sub-sets of the NTS packages.	1
		Total Weight	22		Total weight	18
Conclusion	UTM does not have significant advantage over 3°TM for the Maritime packaging					

Table 6.5.6

COMPARISON BETWEEN 3°TM AND DECIMAL DEGREE FOR THE MARITIME PACKAGING

	3°TM (with 3°TM as the common Maritimes map projection plane and plane coordinate system)			Decimal Degree (Degree and decimal degree) (with stereographic in N. B. and P.E.I. and 3°TM *in N.S. as* map projection plane and plane coordinate system)		
	LONG TERM EFFECT					
SUBJECT	ADVANTAGES	DISADVANTAGES	Weight	ADVANTAGES	DISADVANTAGES	Weight
Graphical production aspect (6.5.2.1)						
Size variation		There is a zone boundary in all provinces. (632 km of zone boundaries) Figure 6-5-7c Non-standard map sheets are inevitable. This causes problems in compilation, printing and filing	1	All map sheets are the same size, Package size variation is ±4 cm for a 4.5° range of latitude.		3
Identification and definition		Packages are difficult to delineate *and* identify at the zone boundaries in all provinces (Figures 6-5-4 to 6-5-6)	1	No packaging identification and definition problem.		3
Numbering System		Discontinuities of the zone boundaries create discontinuities in the package numbering in all provinces. Confusion would arise if packaging exception was allowed. (Figure 6.5.7)	1	No discontinuity in the package numbering.		3
Referencing System		Map sheets with a dual predominant reference grid cause production difficulties in all provinces. (Figure 6-5-7a)	2	Map sheets with a dual predominant reference grid cause production difficulties in Nova Scotia. (Figure 6-5-7a)		3
	Predominant reference grid is parallel to the map sheet edges.		4		Predominant reference grid is not parallel to the map sheet edges.	1
Users' aspect (6.5.2.2)						
Coordinate use		Difficult to print the three reference systems required by the users. Predominant: provincial plane coordinate system Subsidiary : UTM and ellipsoidal coordinate system.	1	Easy to print the three reference systems required by the users.		4
Map Planning		Large and medium scale maps are very difficult to delineate on small scale maps.	1	Large and medium scale maps requirements are easy to delineate on small scale maps.		3
Map use		Users' frustrations due to packaging discontinuity, package size variations, and package numbering discontinuity in all provinces.	1	No package discontinuity, unnoticeable assembly curving (Figure 6-5-13), constant sheet size, continuous numbering system.		6
Other aspects (6.5.3.3)						
Surround		Extremely difficult to design a universal surround.	1	Easy to design a universal surround.		2
Indexing		Indexing is difficult. It require computations and measurements. Indexing problems for map sheets, adjacent to zone boundaries. (Figure 6-5-14)	2	No indexing problem. Medium and large scale maps are sub-sets of the NTS. It requires no computation.		5
Flexibility		A common plane coordinate system and map projection plane is required.	1	Each province can maintain its own plane coordinate system and its own map projection plane.		2
Digital production & use.		Similar production and user difficulties as in the graphical mode.	1	No production difficulties and more flexibility in coordinate systems to store data in computer memories.		5
		Geo-digital packages are not sub-sets of the NTS packages.	1	Geo-digital packages are sub-sets of the NTS packages.		3
Efficiency (6.5.5)		Difficult to design to yield an efficient packaging.	1	Can be designed to yield an efficient packaging.		3
		Total Weight	19		Total Weight	43
Conclusion	The advantages of the decimal degree outweighs 3°TM for the Maritime packaging.					

Table 6-5-7

COMPARISON BETWEEN UTM AND DECIMAL DEGREE FOR THE MARITIME PACKAGING

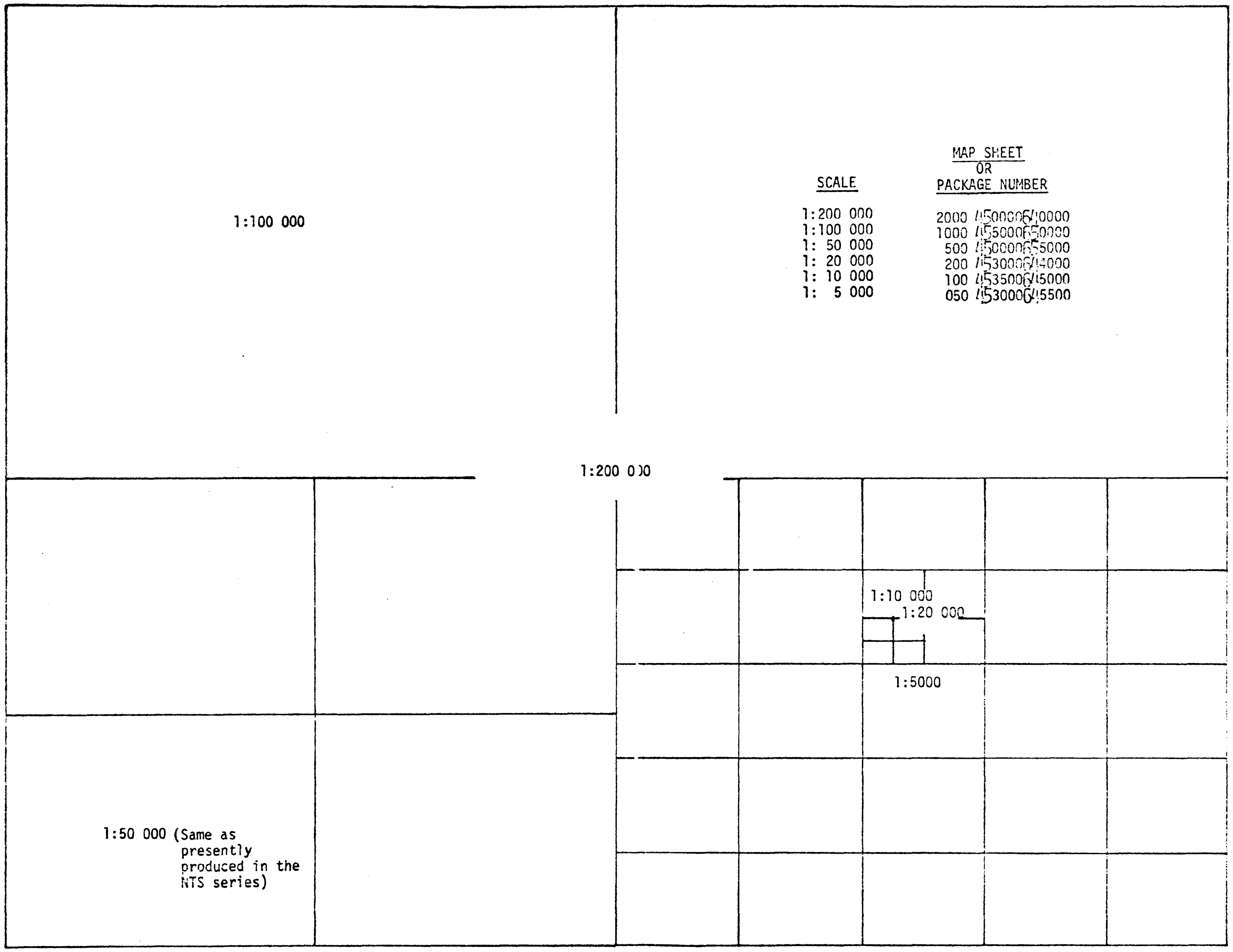
SUBJECT	UTM			Decimal Degree (Degree & decimal of degree)		
	(With stereographic map projection plane in both New Brunswick and Prince Edward Island and 3^{o}TM in Nova Scotia)					
	LONG TERM EFFECT					
	ADVANTAGES	DISADVANTAGES	Weight	ADVANTAGES	DISADVANTAGES	Weight
Graphical production aspect (6.5.2.1)						
Size variation		Non-standard map sheets are inevitable (at all scales) at the zone boundaries This causes problems in compilation, printing and filing. (456 km of zone boundaries - see Figure 6-5-7b).	1	All map sheets are the same size. Package size variation is ±4 cm for a 4.5° range of latitude.		3
Identification & definition		Packages are difficult to define and identify at zone boundaries in two provinces. (Figures 6-5-4 to 6-5-6)	1	No packaging identification and definition problem.		3
Numbering system		Discontinuities of the zone boundaries create discontinuities in the package numbering (in two provinces). Confusion would arise if packaging exception was allowed. (Figure 6-5-7)	1	No discontinuity in the package numbering.		3
Referencing system		Map sheets with a dual predominant reference grid cause production difficulties in Nova Scotia. (Figure 6-5-7a)	3		Map sheets with a dual predominant reference grid cause production difficulties in Nova Scotia. (Figure 6-5-7a).	3
	Subsidiary reference grid is parallel to the map sheet edges.	Predominant reference grid is not parallel to the map sheet edges.	1		Predominant reference grid is not parallel to the map sheet edges.	1
Users' aspects (6.5.2.2)						
Coordinate use		Difficult to print the three reference systems required by the users. Predominant: provincial plane coordinate system Subsidiary : UTM and ellipsoidal coordinate system.	1	Easy to permit the three reference systems required by the users. Predominant: provincial plane coordinate systems Subsidiary : UTM and ellipsoidal coordinates system (Figure 6-5-11)		4
Map planning	Large and medium scale map requirements are easy to delineate on small scale maps. (Figure 6-5-12)		4	Large and medium scale map requirements are easy to delineate on small scale maps.		3
Map use		Users' frustration due to packaging discontinuity, map sheet size variation and package numbering discontinuity in New Brunswick and Nova Scotia.	1	No package discontinuity, unnoticeable assembly curving (Figure 6-5-13), constant sheet size, continuous numbering systems.		6
Other aspects (6.5.2.3)						
Surround		Extremely difficult to design a universal surround.	1	Easy to design a universal surround.		2
Indexing	Indexing is generally easy and it requires no computation.	Indexing problems for map sheets adjacent to zone boundaries. (Figure 6.5.14)	4	No indexing problem. Medium and large scale maps are sub-sets of the NTS. It requires no computation.		5
Flexibility	Each province can maintain its own plane coordinate system and its own map projection plane.		2	Each province can maintain its own plane coordinate system and its own map projection plane.		2
Digital production and use		Similar production and user difficulties as in the graphical mode.	1	No production difficulties and more flexibility in coordinate systems to store data in computer memories.		5
		Geo-digital packages are not sub-sets of the NTS packages.	1	Geo-digital packages are sub-sets of the NTS packages.		3
Efficiency	(6.5.5)	Difficult to design to yield an efficient packaging.	1	Can be designed to yield an efficiant packaging.		3
		Total weight	23		Total weight	46
Conclusion	**The advantages of the decimal degree outweigh UTM for the Maritime packaging.**					

Table 6-5-8

SCALE RANGE	SCALE	PACKAGE SIZE: STEP IN DECIMAL DEGREE OF LATITUDE	PACKAGE SIZE: STEP IN DECIMAL DEGREE OF LONGITUDE	PACKAGE SIZE: cm x cm	COVERAGE: km x km	NUMBER OF PACKAGES PER DEGREE SQUARE	LATITUDE AND LONGITUDE OF THE SOUTHEAST CORNER: LATITUDE	LATITUDE AND LONGITUDE OF THE SOUTHEAST CORNER: LONGITUDE	PACKAGE NUMBERING
SMALL & MEDIUM	1:200 000	1.0000	2.0000	56 x 78	111.2 x 156.4	0.5	45.0000	64.0000	2000 450000640000
SCALE	1:100 000	0.5000	1.0000	56 x 78	55.6 x 78.2	2	45.5000	65.0000	1000 455000650000
RELATIONSHIP	1: 50 000	0.2500	0.5000	56 x 78	27.8 x 39.1	8	45.0000	65.5000	500 450000655000
(see also figure 6-5-18)	1: 20 000	0.1000	0.2000	56 x 78	11.1 x 15.6	50	45.3000	64.4000	200 453000644000
	1: 10 000	0.0500	0.1000	56 x 78	5.6 x 7.8	200	45.3500	64.5000	100 453500645000
	1: 5 000	0:0250	0.0500	56 x 78	2.8 x 3.9	800	45.3000	64.4500	050 453000645500
MEDIUM & URBAN	1: 20 000	0.1000	0.2000	56 x 78	11.1 x 15.6	50	45.3000	64.4000	200 453000644000
SCALE	1: 10 000	0.0500	0.1000	56 x 78	5.6 x 7.8	200	45.3500	64.5000	100 453500645000
RELATIONSHIP	1: 5 000	0.0250	0.0500	56 x 78	2.8 x 3.9	800	45.3000	64.5500	050 453000644500
(see also figure 6-5-19)	1: 2 000	0.0100	0.0200	56 x 78	1.1 x 1.6	5000	45.3300	64.4400	020 453300644400
	1: 1 000	0.0050	0.0100	56 x 78	0.6 x 0.8	20 000	45.3350	64.4500	010 453350644500
	1: 500	0.0025	0.0050	56 x 78	0.3 x 0.4	80 000	45.3300	64.4550	005 453300644550
URBAN & ENGINEER-	1: 2000	0.0100	0.0200	56 x 78	1.1 x 1.6	5000	45.3300	64.4400	020 453300644400
ING SCALE	1: 1000	0.0050	0.0100	56 x 78	0.6 x 0.8	20 000	45.3350	64.4500	010 453350644500
RELATIONSHIP	1: 500	0.0025	0.0050	56 x 78	0.3 x 0.4	80 000	45.3300	64.4550	005 453300644550
(see also figure 6-5-20)	1: 200	0.0010	0.0020	56 x 78	0.1 x 0.2	500 000	45.3330	64.4440	002 453330644440
	1: 100	0.0005	0.0010	56 x 78	0.1 x 0.1	2000 000	45.3335	64.4450	001 453335644450

Figure 6-5-17

Geo-packaging based on decimal degree



SCALE	MAP SHEET OR PACKAGE NUMBER
1:200 000	2000 450000640000
1:100 000	1000 455000650000
1: 50 000	500 450000655000
1: 20 000	200 453000644000
1: 10 000	100 453500645000
1: 5 000	050 453000645500

Figure 6-5-18

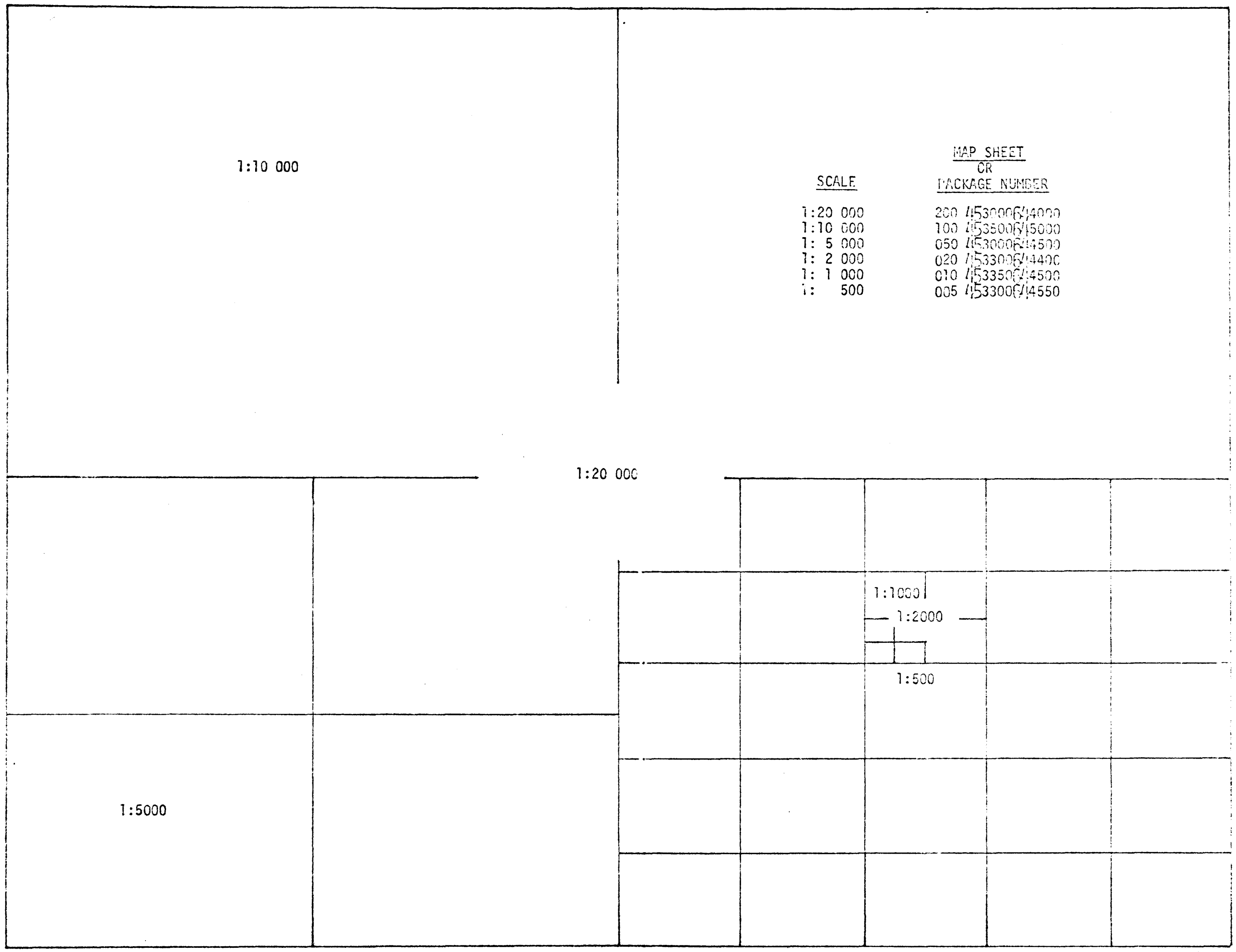

1:10 000
SCALE
MAP SHEET
OR
PACKAGE NUMBER
1:20 000 200 4530006/4000
1:10 000 100 4535006/5000
1: 5 000 050 4530006/4500
1: 2 000 020 4533006/4400
1: 1 000 010 4533506/4500
1: 500 005 4533006/4550
1:20 000
1:1000
1:2000
1:500
1:5000

Figure 6-5-19

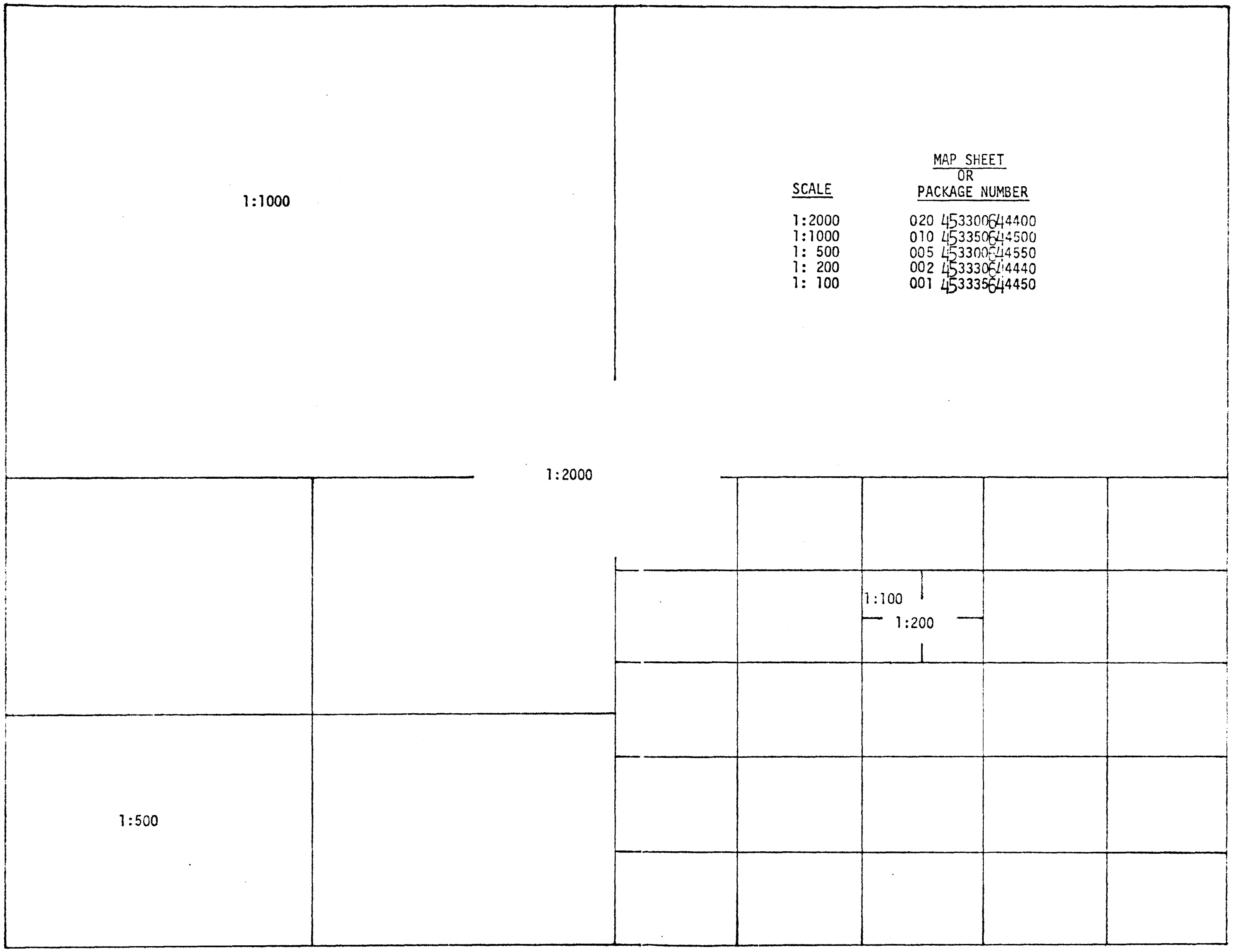

1:1000
SCALE
MAP SHEET OR PACKAGE NUMBER
1:2000 020 453300644400
1:1000 010 453350644500
1: 500 005 453300644550
1: 200 002 453330644440
1: 100 001 453335644450
1:2000
1:100
1:200
1:500

Figure 6-5-20

7. SPECIFICATIONS THAT SHOULD BE SUBJECT TO PERIODIC REVIEW AND MODIFICATION

7.1 MAP CONTENT

The map content, in the Maritimes, is described in the technical specifications in a narrative form. (Figure 7-1-1). It includes primarily those environmental elements which are most easily identifiable on the aerial photography. The maps produced to these specifications are called topographical maps.

Looking at topographical maps produced around the world one sees that some topographical maps contain little information and others, at the same scale, contain a great deal of information. It is easy to see that there is no consensus on the content of a topographical map. As mentioned earlier the specifications for the 1:10 000 series in Great Britain total approximately 120 pages. Similarly there are 120 pages of specifications for the 1:20 000 topographical map series for the province of Quebec. In the Maritime Provinces the specifications are not nearly as voluminous. These three sets of specifications show clearly the wide range of the topographical map content specifications. There are no topographical maps which contain all the topographical information. Even at the largest scales there is always a need for some generalization. For this reason it would be more appropriate to classify maps similar to the existing topographical maps in the Maritime provinces as basic maps, i.e. maps which contain the essential topographical details.

In the early 1960's the general specifications for topographical maps at large scales in the Maritime Provinces were a six page document. These general specifications were divided into six sections: general information, aerial photography, photogrammetric compilation, map content, accuracy and final presentation. The map content section accounted for approximately two pages. Looking at the evaluation of map content in the Maritimes one can observe that the general specifications have changed considerably but the map content specifications are essentially the same as they were in the early 1960's.

The mapping shall show all topographic and planimetric detail that can be interpreted on the photography and that can be shown clearly at a scale of 1/1200 and in general, shall be the following:

a) Building of a permanent or Semi-Permanent Nature

The dimension of buildings shall be determined by the outline of their roofs. Buildings having at least one dimension larger than 10 feet shall be shown to shape and scale. Buildings whose largest dimension is 10 feet or under shall be shown by a symbol.

b) Roads, Streets, Railroads, Tracks, Trails and Footpaths

The width of the roads will be determined either by the width from curb to curb, or the width of the travel path. Driveways longer than 50 feet will be shown. Sidewalks will not be shown. Trails shall be shown by a single dashed line representing the center line. Trails and paths shorter than 100 feet will not be shown. Where the number of trails or footpaths is so great as to influence the legibility of the map, trails of lesser significance shall be omitted. Railroads shall be represented by the center line of the tracks. Railroad sidings and spurs shall be showed.

c) Hydro Telegraph and Telephone Lines

These lines will be shown by individual poles or towers when these are visible on the photography and they shall be connected by a dashed line. When poles or towers are not visible, the lines will be shown by a symbol. Within built-up areas service poles will be shown.

d) Other Cultural Features

All other cultural features that can be photographically interpreted and shown at this scale, such as bridges, major culverts, piers, viaducts, harbours, airport runways, flood gates, dams, large chimneys, mine shafts, pipe lines (above ground), piles, pits, parks, parking areas, radio, radar and microwave towers, substantial rock outcrops, fire towers, ski lifts, oil and gas tanks, reservoirs, silos, retaining walls, water towers, platforms and cemeteries, etc.

All fences, walls and hedges that are visible on the photography shall be shown. All survey lines or cut lines visible on the photography shall be shown.

Any feature not shown by a symbol shall be drawn to scale and annotated.

e) All water features

Features such as rivers, streams, lakes, ditches, rapids, falls, canals, dams (including beaver dams), swamps and flooded lands will be outlined. Where the course of a water feature cannot be definitely established, the approximate position shall be shown by a broken line so as to indicate the continuity of drainage. Meandering of rivers and streams will be shown.

All coastal shore lines will be shown at the mean high water mark; and only man-made detail will be shown below this line. The value for the mean high water mark will be supplied by the inspector.

Drainage features shorter than 100 feet in length shall not be shown.

Streams averaging more than 5 feet in width shall be shown with double lines, each shore being identified by a solid line. Other drainage lines shall be shown by the standard symbol. Ditches which are adjacent to, or obscured by other cultural features, shall not be shown.

f) Vegetation

The outlines of wooded areas, large clumps of trees, shrub areas, and if they constitute land marks, very large individual trees shall be shown. Particular care shall be taken to show the true shape of clearings in extensively forested areas. Clearings smaller than 625 square feet shall not be shown. Orchards shall be outlined and annotated. Clearings of hydro lines, telephone lines, ski tows, survey and boundary lines shall be shown by a clear band of actual width. Where woods are terminated along shore lines or road ways the woods boundary symbol shall not be shown. Areas which constitute shrub or bush only will be outlines and symbolized.

g) Control & Photo Centers

All horizontal ground and photogrammetric control and photo centers used in the compilation shall be plotted in their true position on the compilation manuscript. On the final product only those permanent ground survey points falling within the compilation limits of the map sheet will be shown.

Figure 7-1-1 Map content for 1:1200 mapping as described in APSAMP project 71012.

A comparison of the map content specifications at the scale of 1:1200. 1:2400, and 1:4800 in the early 1960's leads to the observation that the map content specifications were very nearly the same for all these scales. Comparing the same map content specifications of the early 1970's, it is easy to see that the situation has not changed. It appears that the production of the three large scale maps (1:1200, 1:2400, 1:4800) which are in a narrow scale range has led to the copying of the map content specifications from one scale to another with only minor additions and deletions. It appears that the designing of a completely independent map content specification for every scale could not be justified. This observation reinforces the need to introduce parent map scales and to derive maps as the need arises. (See also section 2.1.1) In other words, at large scale, the adoption of the 1:2000 as a parent scale will be an impetus to:

i. Examine the map content specifications of the 1:1200, 1:2400 and 1:4800 and integrate their contents into the design of the 1:2000 parent scale;

ii. Reorganize the map content in a family of themes;

iii. Rate the themes in order of important; and finally

iv. Decide which theme combination constitutes a basic map series.

The introduction of map content, structured on the theme basis, will also provide an opportunity for the analysis in more depth of the elements belonging to each theme. This, hopefully, will lead to improvements in the map content specifications. Even with the theme concept however it is expected that the establishment of specifications for map content will continue to be a dynamic process. The content will be changing as the need of the society is changing and as the Maritime cartographic culture develops.

In the traditional approach the addition of new elements to the map content specifications and consequently to the maps is no problem. It is done by adding a new symbol to the legend. However, in a digital data base the addition of new elements is quite a different process. In a digital system there are ordinarily two parts to each element; the WHAT and the WHERE. The WHAT is a code which is selected to identify an element. The WHERE is expressed by a set of coordinates which define the location or position of an element. The design of the codes to identify elements within a theme will require careful analysis and long-term foresight to ensure that sufficient flexibility remains so that a new elements may be added at any time.

In conclusion it is believed that the themes and consequently the map content will continue to be dynamic; it will change with the need and evolution of the Maritime culture.

It is recommended that a first iteration at defining the family of themes and identifying the elements of each be carried out as soon as possible.

7.2 SYMBOLS

In the Maritime Provinces the map symbolization has been changing very slowly since the first maps were made approximately 40 years ago. This can be observed by examining 20 chain plans and recent medium scale maps. This is basically due to the lack of cartographic specialists and the lack of demanding users. From the early 1960's to the formation of LRIS, the symbolization could be summarized in one page for the larger scales of mapping. (Figure 7-2-1) The paucity of symbolization resulted in extensive labelling of features. As the Maritimes enter into map production from digital data the decision of whether to dispense with labelling or to use extensive labelling and few symbols or to have a mixture of both will arise. At first glance it appears that the least labelling would be preferable.

i. It would eliminate the need for operator intervention to position the label;

ii. It would avoid the problems of bilingual labelling.

However, it is easy to foresee that in the long term a large quantity of symbols will appear with a large number of themes. Whereas up to now it has been possible to print all the legend in the map surround, this may be difficult with a large number of symbols. If a custom legend was accepted rather than a universal one, the problem could be solved. A custom legend is one in

PROVINCE OF NEW BRUNSWICK DRAFTING SPECIFICATIONS (1972)

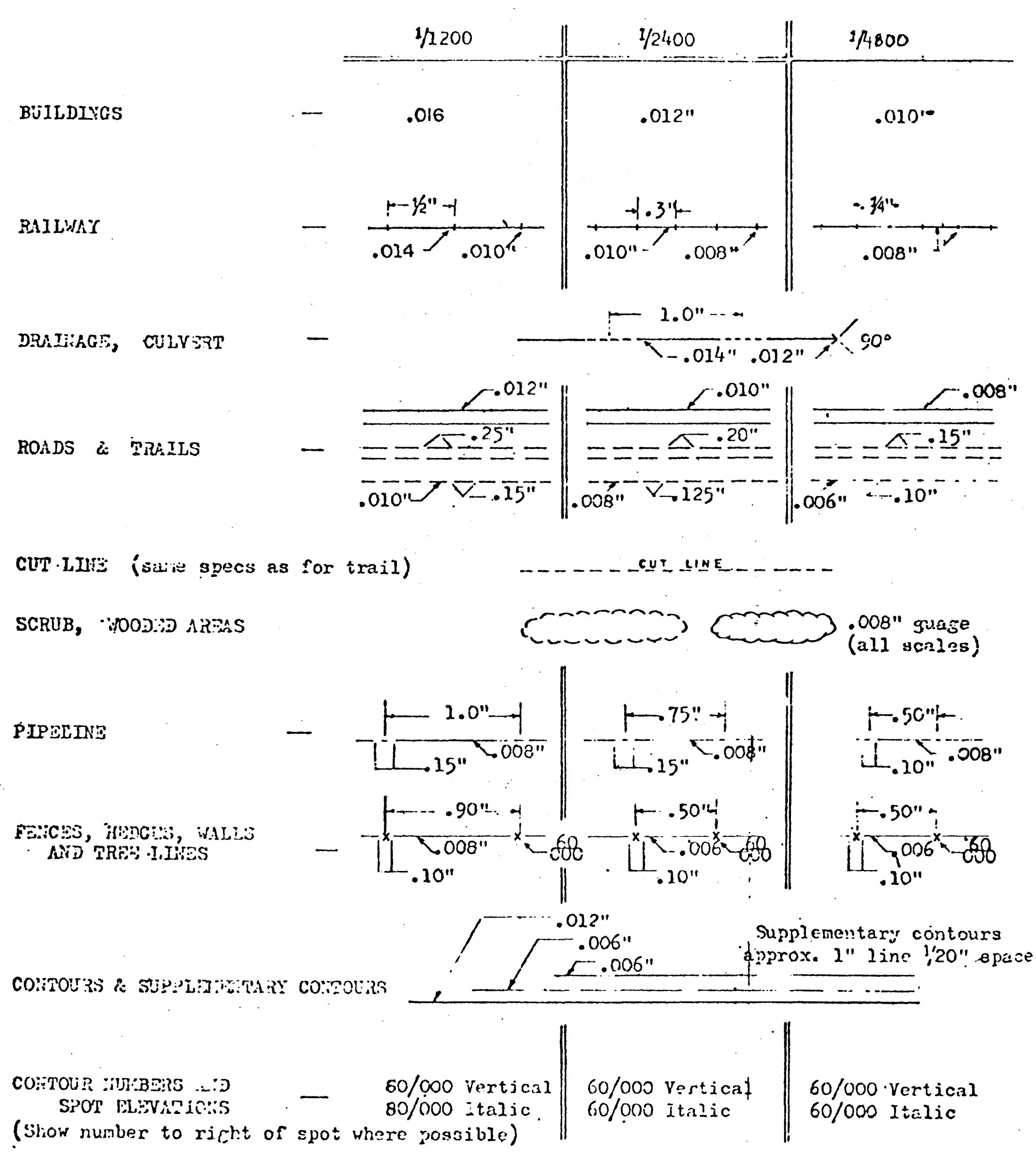


Figure 7-2-1

which the legend block contains only the symbols appearing on the map at hand. A second alternative would be to assume that most users are familiar with the most common symbols and print only the least common ones. In this alternative the legend would be of little help to new map users. A third alternative would be to provide on demand a symbol pamphlet containing all the symbols in use. The third alternative is practical when a State has reached stabilization in symbolization. However at a time when the Maritimes is about to enter into computer-assisted cartography it will take a long time before any stabilization in symbolization is reached. Consequently the third alternative does not appear to be practical in the near future.

Since symbolization will be continuously changing to adapt to new users and technological requirements, it appears that the custom legend will be the positive way to ensure agreement between the map symbols and the legend.

As a consequence of the computer-assisted cartography implementation, the symbolization may have to be completely redesigned. To illustrate this let us consider the symbol in Figure 7-2-2.

Mine shaft

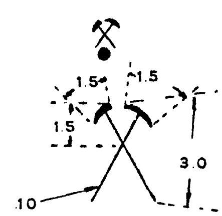


Figure 7-2-2

Assuming that this symbol is to be mapped with a flat bed plotter operating in a scribing mode, a sophisticated sub-routine will be required to direct the scribing point to plot the symbol. The time to scribe the symbol would also be relatively long. This shows that the complexity of the symbol design can have an important impact on the speed of map production.

However a laser plotter using the same graphic sub-routine could be used to overcome the speed limitation of the flat bed plotter operating in a scribing mode. Laser plotter generations are fast because they are electronically controlled and produced with few or no moving parts. Furthermore as computer and communication speed increases the laser speed will also increase. Laser plotter is a promising breakthrough in computer-assisted mapping.

The photo head is another device for plotting symbols in computer-assisted cartography. With this technique one can handle complicated symbols even though it is difficult to deal with large quantities of them. Also the plotting must be done in a dark room which is a poor working environment. So far photo heads have been very expensive and of limited success.

Even though laser plotter and photohead can overcome the speed limitation in scribing complex symbols, they can remain a problem in graphic terminal. This is because the same sophisticated sub-routines are likely to be used. Unless the computer and communication speed is improved, the time to plot complex symbols on graphic terminals will remain relatively long.

Graphic terminals, cartographic plotters, computers (speed), communication systems (speed) are improving at a relatively fast rate. Consequently it is still difficult to evaluate how this hardware will influence the symbology designed for purely graphical map making.

We concluded that with the development of the methodology of the Maritime theme concept in graphical form, there is a need to develop a comprehensive set of specifications for symbols. The symbols should represent the elements of the themes with the least possible labelling. This comprehensive set of specifications will become the base from which the symbology for computer-assisted mapping will be developed. In the transition period from graphic to digital a custom legend should be introduced.

It is recommended that a comprehensive set of specifications for symbols be developed with the least possible labelling. This set of specifications for symbols is to become the base from which the symbology for computer-assisted mapping will be developed.

7.3 PRESENTATION OF REFERENCING SYSTEMS

It has been seen that the geo-packages, the map projection plane and the plane coordinate systems should not be subject to change. Nevertheless there are many ways to graphically present the referencing system. Some variations may be with respect to:

i. The size of the reference grids and graticule.

ii. The number of reference systems and the style of presentation.

7.3.1 The size of the Reference Grids or Graticule

In the Maritime provinces there are many reference grid sizes. The reference grid size in New Brunswick and Nova Scotia is five inches by five inches at *most* scales. (Figure 7-3-1)

SCALE	REFERENCE GRID SIZE	CORRESPONDING GROUND DISTANCE
1:1200	5 inches	500 feet
1:2400	5 inches	1000 feet
1:4800	5 inches	2000 feet
1:10 000	6 inches	5000 feet

Figure 7-3-1

In Prince Edward Island the reference grid sizes vary with the scale. (Figure 7-3-2)

SCALE	REFERENCE GRID SIZE	CORRESPONDING GROUND DISTANCE
1:1250 (P.E.I.)	20 cm	250 m
1:2500 (reduction) (P.E.I.)	10 cm	250 m
1:5000 (P.E.I.)	20 cm	1000 m
1:10 000 (reduction) (P.E.I.)	10 cm	1000 m

Figure 7-3-2

Should the Maritime Provinces adopt a fixed or a scale-variable reference grid? A reference grid is said to be a <u>fixed reference grid</u> when the size of the reference grid is the same on all maps at all scales. As a consequence the ground distances represented by the reference grid is different for every map scale. A reference grid is said to be a <u>scale-variable reference grid</u> when the size of the reference grid is changing in the same ratio as the scale. As a consequence the ground distances represented by the reference grid are the same for all maps in a selected range of scales. (Figure 7-3-3)

SCALE	SCALE	SCALE-VARIABLE REFERENCE GRID	RATIONALIZED GROUND DISTANCE
	1:500 (enlargement)	20 cm	100 m
	1:1000(parent scale)	10 cm	100 m
	1:2000(reduction)	5 cm	100 m
Large	1:1000(enlargement)	10 cm	100 m
	1:2000(parent scale)	5 cm	100 m
	1:5000(reduction)	2 cm	100 m
	1:5000(enlargement)	20 cm	1000 m
	1:10 000(parent scale)	10 cm	1000 m
	1:20 000(reduction)	5 cm	1000 m
Medium & Medium small	1:10 000(enlargement)	10 cm	1000 m
	1:20 000(parent scale)	5 cm	1000 m
	1:50 000(derived)	2 cm existing	1000 m

Figure 7-3-3 Scale-variable reference grid

If the Maritime reference grid is to be a fixed reference grid, it appears that 10 cm is the optimal size. The multiplication of the scale factor by the reference grid size is easy. Consequently the ground distance is easily obtained.

Example:	Scale	1:2000
	Scale factor	2000
	Reference grid size	x10 cm
	Ground distance	20 000 cm
	i.e.	200 metres

It can be observed that removing a zero from the scale factor gives the ground distance in metres. A 5 cm reference grid may be considered as a nuisance by many users who do not use the reference grid. This is due to the high density of the reference grid lines. For other users a 20 cm reference grid may be too sparse to meet their accuracy needs.

If the Maritime reference grid is to be a scale-variable reference grid then the reference grid should represent rationalized ground distances. This is shown in Figure 7-3-3. One of the advantages of the scale-variable reference grid approach is that all large scale maps would have a reference grid corresponding to 100 metres in ground distance and that all medium scale maps would have a reference grid corresponding to 1000 metres in ground distance. The 1:5000 would have a reference grid representing either 100 metres or 1000 metres. The reference grid would be an indication of the source and accuracy of the maps. The users, when looking at a map, will use the reference grid to visualize the ground distances.

Both the fixed reference grid and the variable reference grid are comparable. The decision to adopt one rather than the other depends on:

i. The long term map production methodology.

ii. The users' preference.

iii. Which one will be the best for the users in the long term.

On the assumption that the long term map production methodology, based on the theme concept will lend itself to scale-variable reference grid, it is believed to be the best choice. In other words a reference grid representing a fixed ground distance in the medium scale range and a reference grid representing another fixed ground distance in the large scale range is a better choice.

7.3.2 The Number of Reference Systems and the stype of presentation

The decision as to how many referencing systems should be printed on a map has been discussed in section 6.4. It was concluded that there are three coordinate systems in use in the Maritime Provinces and consequently there should be three referencing systems on every map. The provincial coordinate system should be represented on maps with a reference grid which clearly illustrates the primary importance of the provincial coordinate system. The UTM and ellipsoidal coordinate systems should be represented, however the type of presentation should illustrate their secondary importance.

In Nova Scotia there is a 3^{o}TM zone boundary. In order to permit users to complete their projects in one coordinate system, two primary reference grids should be printed on all maps close to the zone boundary. Unless there are specific requests, the dual predominant reference grid should only be printed on a strip of four map sheets on both sides of the zone boundary.

In New Brunswick there is a UTM zone boundary. It is felt that the Federal practice should be followed. In other words, the subsidiary reference grids should butt-joint on the zone boundary, i.e. no overlap.

On examination of the existing maps, one can observe that all line maps are printed with a full reference grid representing the predominant plane coordinate system and that the grid of the subsidiary plane coordinate system is not represented. Reference grids on the photo maps are a mixture of partial reference grid (cross) and full reference grid. There is also a mixture of white reference grid and black reference grid. In all cases. the photo maps carry only one reference grid, the predominant one.

The decision to have a white or black reference grid on photo maps was associated with two factors:

i. The production technique: map production techniques have varied from province to province. Some techniques lend themselves to black reference grid and some others lend themselves to white reference grid. Within a province the pro uction techniques have changed with time, causing changes in the reference grid presentation. In the majority of cases, the choice of black or white reference grid was partly due to the ease of assembly and the cost of producing the reference grid.

ii. The cartographic aspect: a map, at first glance, looks like a photograph. It is generally quite dark. In order to maintain the "photo-like" appearance of the map, it is preferable to add enhancement with a color which is least contrasting. The black enhancement is then more appropriate This is, in part, why the black reference grid has been used.

The decision to have a full reference grid or a partial reference grid (cross) is also related to the cartographic appearance. A partial reference grid is more subdued than the full reference grid. This technique serves the users who needed the reference grid and yet it does not disturb the users who do not use the reference grid.

The arguments that led to these decisions were valid arguments and they still remain valid arguments. But there are new considerations being added.

i. In the questionnaire it was discovered that, in many cases, the accuracy users expect from maps is much greater than anticipated. Using a full reference grid, the users can plot data more accurately and they can read data more accurately.

ii. The plotting of many reference systems on maps raises the problem of how to display the multi-reference system and not confuse the users.

iii. In Section 6.4 it was concluded that the provincial plane coordinate system be represented on maps with a predominant grid and that the other coordinate systems used in the Maritime Provinces be represented on maps in such a way as to minimize confusion with the predominant reference grid.

In light of the above considerations, it is concluded that:

i. A full reference grid representing the provincial plane coordinate system should be printed on all Maritime maps. On photo maps the reference grid will meet the users' accuracy requirement and, at the same time, it will illustrate the predominance of the reference grid which corresponds to the most-used plane coordinate system.

ii. A partial reference grid (cross as shown in Figure 6-5-11) representing the UTM plane coordinate system should be printed on all Maritime maps. The partial reference grid will avoid any confusion between the predominant and the subsidiary reference grid.

ii. Finally the graticule should only be shown on map perimeter as shown in Figure 6-5-11.

It is recommended that:

i. The predominant reference grid representing the provincial plane coordinate system be a full reference grid.

ii. All large and medium scale maps be printed with a subsidiary reference grid (representing the UTM plane coordinate system). However, the subsidiary reference grid density should (a) be reduced to the minimum, (b) be a partial reference grid.

iii. All medium and large scale maps be printed with the graticule in decimal degrees around the map perimeter.

iv. All large scale maps be printed with a predominant reference grid (representing the provincial plane coordinate systems) corresponding to a ground distance of 100 metres.

v. *All medium scale maps be printed with a predominant reference grid (representing the provincial plane coordinate systems) corresponding to a ground distance of 1 000 metres.*

vi. *The 1:5 000 maps be printed with a 2 cm or 20 cm reference grid depending on whether it is reduced from the medium scale maps or enlarged from the large scale maps.*

7.4 NON-PARENT SCALES

In chapter 5, it has been recommended that the parent scale of maps in the high-density urban area be at 1:1 000 and that the parent scale of maps for the built-up area be at 1:2 000. In the rural area, the choice is between 1:10 000 and 1:20 000. Assuming the 1:10 000 was selected as the regional parent scale, then the range of scales available to the users with a 2X reduction or enlargement is shown in Table 7-4-1. It shows that, with adequate graphical enlargement and reduction technique, the full range of metric scales will be available to the users.

Enlargement	Parent Scale	Reduction	
1:500	1:1 000 (high density)	1:2 000	See also Figure 5-2-1
1:1 000	1:2 000 (built-up)	1:5 000	
1:5 000	1:10 000 (regional)	1:20 000	See also Figure 5-3-1

Table 7-4-1

However, it would be overly optimistic to presume that only these scales will be requested in the short term. There will be mapping requests which do not correspond to metric scales but to minimize them there should be a firm position established that all mapping produced with public funds is to be done at the metric (1,2,5) scales. It is not practical to force users to adhere to metric scales but incentives such as cost-sharing should be available only to those who do accept the metric ratios. There will also be mapping requests which do not correspond to the parent scales. There will be temptation to compile non-parent scales for both LRIS and other producing agencies. Initially, it will be difficult because it will take some time before the enlargement and reduction techniques are developed. It will also be difficult because it will take some time before the parent-scale concept becomes integrated into the production system of the producing agencies. It will take even longer before it gets accepted by the users. However, in the long term, it is the most economical way to meet the mapping requirements of the Maritime Provinces.

In conclusion the success of the parent scale principle lies in the research and application of proper methods of enlargement and reduction through graphical and digital methods.

7.5 REPRODUCTION METHODS

Today most map data is scribed before it goes to the reproduction unit. There are still producers who are inking, but this practice seems to be disappearing. In most computer-assisted cartographic systems, scribing is used with flatbed plotters. Nevertheless, the use of sensitized film in flatbed and laser plotters is also promising. Both the negative scribes and negative films lend themselves to a wide range of reproduction techniques.

In the Maritime Provinces most map production is monochromatic from transparent material. By using a diazo printing process, the reproduction can be made on demand from the master transparency. This is a cheap and effective system which avoids the problems of storing a large map inventory.

In some provinces and in many countires, litography is used for most map reproduction. The disadvantage of lithographic printing is that the unit cost is very high unless large quantities of maps are printed in a press run. The inventory of all these printed maps is also a problem. In the Maritimes, there is a potential of 5 000 parent medium scale maps in each public map series.* It is foreseeable that there will be in the long term 10 000 parent large scale maps in many public map series. Most of these maps will not be required in large volume, consequently lithographic printing is not likely to become feasible in the Maritimes.

Screen printing is another alternative that yields a multi-color product. The set-up cost is lower than the set-up cost for lithographic printing, hence the unit cost for small quantities of maps (300 to 500 prints) is lower. Screen printing could be a feasible printing method for some public map series where it is desired to highlight the primary theme(s). Examples could be geology, flood risk, soil classification, etc. It is not attractive, however, for primary themes which are changing quite rapidly - land use, cadastre, budworm infestation, utilities, etc. Assuming that utilities required continuous revision in either graphical or digital form in high density areas, then the screen printing would not be suitable. If

*Definition of a public map series: A map series printed, advertised, and sold to the technical and general public.

a medium-size city, covered with 500 map sheets, decided to use the screen printing process for utilities themes, then the number of maps to be stored could be between 150 000 to 250 000; this is a relatively large inventory.

The third alternative in multi-color printing is the large format color electrostatic copiers (photocopier). Letter-size color photo copiers are now on the market and it is reasonable to expect that larger formats will be introduced. The multi-color master, color maps could be produced on demand.

In the monochrome map production, microfilm is promising. Laser technology is an excellent method for producing maps on microfilm from digital files. As updating is carried out, new microfilm could be produced. It would be cheap to produce and cheap to make available to regional offices as well as other regular map subscribers. Users could then insert the microfilm in a viewer for a "quick look"; this would not eliminate the need for maps on paper, but it would greatly reduce the number of copies required. A paper presented at the Commonwealth Survey Officers' Conference in 1971, called "The Place of Miniaturisation in Map Production" is included in Appendix E to stimulate thought on microfilm applications in mapping.

It is concluded that the diazo process will continue to be the main reproduction process in the Maritime Provinces until new breakthroughs in printing technology surface in the market place. In order to be able to respond to users' demands with the most up-to-date information, any new technique of reproduction will have to be able to reproduce maps on demand. In other words, from a master copy or a master file, it is necessary to be able to reproduce maps economically without the need to carry an inventory of printed maps.

7.6 REVISION

The goal of the LRIS program is to revise the medium scale maps over a 10-year revision cycle and to revise the large scale maps over a five-year revision cycle. This is a general revision cycle around which a more detailed revision program can be developed. There are other models for map revision: maps can be revised based on the incidence of change; maps can be revised based on a continuous revision program; maps can be revised based on a cyclic revision program; and finally there can be any combination of the three. Looking at continuous revision from a central agency point of view, it would be extremely expensive. There is no doubt that the Maritime Provinces will not have, for sometime, the financial resources to implement a general continuous revision program. The choice in revision frequency is between the incidence of change and the cyclic revision. An essential prerequisite for an effective revision program is the preparation of a detailed plan. Then the plan must be rigorously implemented. In other words, any loosely-planned revision program will fail. The easiest way to achieve this is to adopt a revision program based on cyclic revision. Furthermore, the only way to let users know well in advance which maps are going to be revised and when they are going to be revised is to have a general map revision program based on a cyclic revision.

In the Maritime Provinces, the revision techniques have never been clearly established. The general approach has been to update maps having minor changes and recompile those having major changes. In other words, when the update cost was nearly as much or more than the recompilation cost, then the map has been recompiled. In light of new digital technology, the theme concept, local government pariticipation and the involvement of other agencies in revision, new revision models are needed. The frequency, the techniques, and the locations of map revision will be explored in more-detail.

7.6.1 Medium Scale Map Revision

7.6.1.1 Map Revision Frequency

After having concluded that, basically, the Maritime map revision program should be based on a cycle, it is now necessary to determine the cycle length of the medium scale maps. As the medium scale maps are composed of three parts - the skeleton, the photo base and the themes (Figure 7-6-1), each one must be examined separately.

(a) Skeleton

The skeleton is composed of the general surround, the particular surround, and the referencing systems (Figure 7-6-1). None of these three components is changing with time. Consequently, if the skeleton for a map series is well designed, it should not be subject to revision.

(b) Photo Base

The medium scale photo base cannot be updated unless new photography is taken. This eliminates the possibility of continuous revision. In section 7.6, it is concluded that a revision program should be based on a revision cycle rather than on the incidence of change. In the photo base revision, there are even more reasons in support of cyclic revision. It is impractical to have a medium scale photo base revision program based on the incidence of change because:

i. It is very difficult in practice to set the incidence-of-change criteria; it is scientifically and objectively difficult to carry out the analysis; and finally it is time consuming.

ii. The aerial photography must be carried out in blocks in other words, it is impractical to take photograph here and there. There would be a lot of film wastage, many changes would be missed, and there would be difficulties in setting the control for the photogrammetric models. More specifically, in a sparsely-populated territory, the only practical method of control for the photogrammetric models is

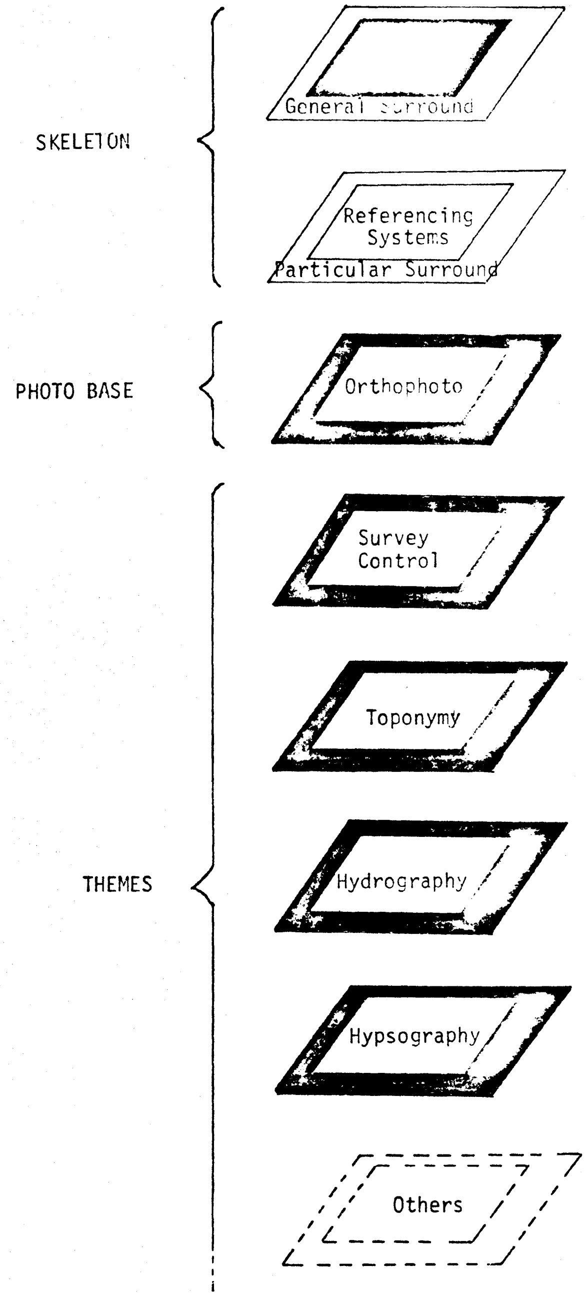


Figure 7-6-1

The components of the medium scale map assembly by aerotriangulation. This lends itself to the revision cycle method, but it is impractical with the incidence-of-change method.

iii. There would be many edge tie and zone difference problems. This can be avoided with cyclic revision carried out in blocks.

iv. The cost of the orthophotography is only 10% of the total map cost.

The photo base can, in round figures, be revised on a 5, 10, 15 or 20-year revision cycle. But, first, it is important to define a revision cycle. For example, a 10-year revision cycle implies that the photo base would never be more than 10 years old. As it takes a minimum of two years to produce a base map economically this indicates that the revision should be initiated six years following the printing of a map series with a photo base (Figure 7-6-2). Furthermore, photography for the photo base is difficult to obtain. This is because the photography must be of good quality. There are very few hours per year in which there is no haze, fog, cloud, turbulence, snow, and a 40^{o} minimum sun elevation. Consequently photography may be delayed a year or more. Thus it is more realistic to allow three years for the production of a photo base. This means that, in many cases, when a photo base is seven years old, revision should be initiated. Quickly one realizes that a 5-year revision cycle would be impossible because more than half of the medium scale maps would be in revision at all times.

In a ten-year revision program, it is most likely that revision will not be started when the base is seven years old, but 10 years following the printing of the previous edition (Figure 7-6-3). As a consequence, the photo base will not be a 10-year cycle, but a 14-year cycle or, due to delays in obtaining photography, a nominal 10-year cycle may extend to a 15-year or even 16-year. However, if in the first place, nominal revision cycle had been 15 years, then the photo base would have been 20 years old by the time the new photo base became available.

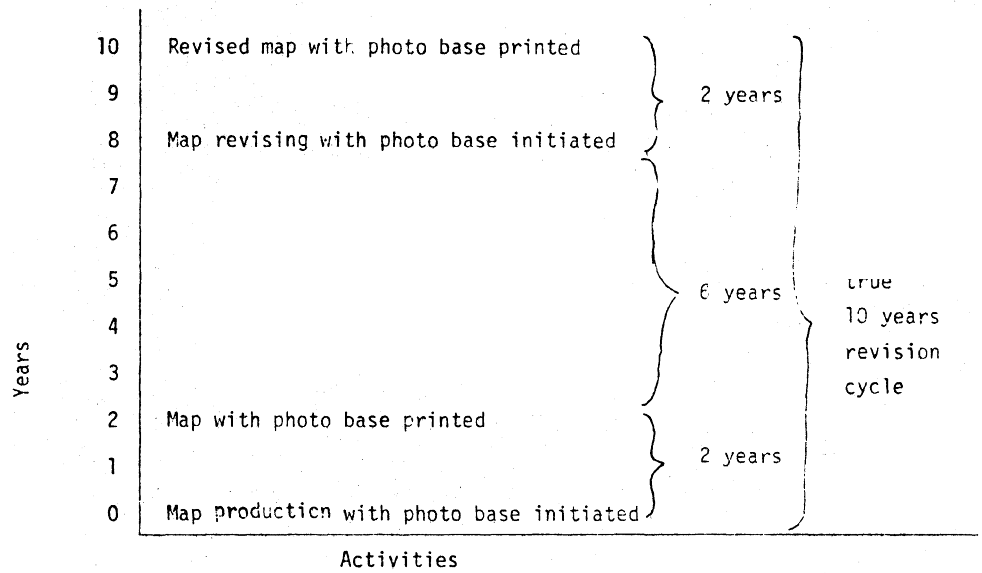


Figure 7-6-2

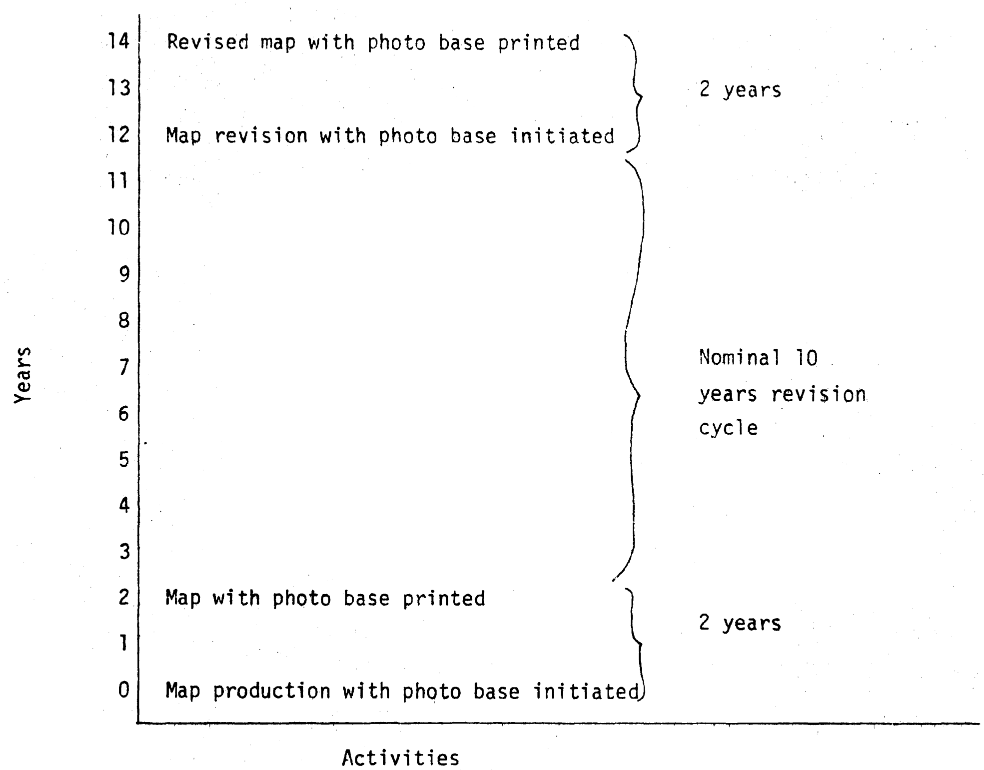


Figure 7-6-3

In practice, a 10-year revision cycle means that photo base revision will be initiated 10 years after the printing of the previous series. It means that the true revision cycle of photo bases will be between 14 and 16 years, depending on the success of the photo mission.

In light of the practice in medium scale photo base revision, it would be unrealistic to increase the cycle length. The revision cycle should stay at 10 years, and in the long term the LRIS goal should be to achieve a true 10-year revision cycle, i.e. one in which the photo base is never older than 10 years.

(c) Themes

It has been shown that the photo base should be revised on a cyclic basis, but this is not necessarily appropriate for themes. Theme revision will depend on whether the themes are in graphical or digital form. Graphical themes will normally be revised when required for the printing of a public map series. Consequently, most graphical themes will be on the same cycle as the public map series. However, it is not likely to be the same with all digital themes. Some digital themes such as the cadastral theme, and the survey control theme, will be revised continuously. Some digital themes will be revised on a revision cycle. Other themes will be revised on an incidence-of-change basis; hypsography is an example. The medium scale map contour interval is 5 metres; consequently only major hypsographic changes will have any effect on the map. Major land slides, major land erosion, major construction are examples. If a mechanism can be set to locate the hypsographic changes as they occur, then there will be no need to have cyclic revision in hypsography.

7.6.1.2 Map Revision Responsibility.

When the entire range of map themes is considered it is apparent that for the foreseeable future some themes should be revised by user agencies, some should be revised by regional offices and some should continue to be revised by a specialized central agency.

For example, as at present, the Province of New Brunswick should continue to revise themes such as the granular resource theme, the Province of Nova Scotia should continue to revise its themes such as its Forest Type theme and Prince Edward Island should continue to revise its Land Use themes. With all users adhering to the same geo-packaging it should be possible for everyone to exchange information and to compare themes with ease.

As a network of regional offices is not yet established and may not be established, it is only possible to cite examples of revision done by regional offices elsewhere. The Ordnance Survey of Great Britain maintains a network of regional offices for collecting information for "continuous" revision of its large scale map series. Regional surveyors or survey assistants check regularly with the office that issues building permits and they tie in all new buildings and delete all demolished buildings as soon as possible after the change has taken place. A copy of this information is kept on file locally and a copy is sent to the central office.

For those themes which are revised with complex photogrammetric instruments there is no doubt whatever that production should be concentrated in one centralized office to maintain a consistant standard of quality at a reasonable cost. However, themes, like property mapping themes, which do not require complex photogrammetric instruments could be decentralized in regional offices.

7.6.1.3 Map Revision Techniques

In the short term, the photo base is essential in all medium scale public map series. This is because there will not be enough themes to produce self-sufficient line maps. However, in the long term, the photo base will become optional. This is because, as many themes become available, the composite of a selected group of themes will give birth to a line map. Some of the themes will be in graphical form and others will be in digital. It is possible that some themes may never be required in digital form. Nevertheless the digital themes will become increasingly popular. This does not mean that a graphical expression of the digital theme will not be required. The digital themes that are likely to be produced first are:

i. Those required for on-line operational purposes.

ii. Those which recur most frequently with other themes.

iii. Those that are already existing in alphanumeric form.

There may be an impetus to compile other themes not belonging to these three categories, but it is difficult to predict which these will be. For example, let us consider the hypsography theme. At first glance, one is tempted to say that hypsography is a static theme. Contours do not change, especially at the medium scale where the contour intervals are five metres. There is little benefit in transforming the graphical scribed theme into a digital theme. Yet, the hypsography may be a dynamic theme and have a very important function in a data base. This is because much of the analysis required from a data base may be a function of the hypsographic data. As an example, one can think of soil classification where the class is a function of the terrain slope. Without hypsography, this aspect of the soil classification cannot be carried out. It may happen for example that, in the use of the forest management series, slope will become an important analytical factor. At this time it is not possible to say whether or not hypsographic data should be digital and this is one of the many cartographic questions that will need to be reviewed from time to time.

In such a fluid situation vis-a-vis graphic and digital themes, it is difficult to foresee how each theme will be revised. The revision technique that may evolve in the digital mode may be substantially different from the revision in the graphical mode. Furthermore, each agency may have a different technique for revising its own themes. This may be due to theme characteristics, organization structure, equipment available and expertise at hand. The important thing is the final result; i.e. a revised file which meets a set standard. But to arrive at this goal, much effort is needed in developing revision models and revision techniques.

7.6.2 Large Scale Map Revision

7.6.2.1 Map Revision Frequency

In the urban area, the 5-year cycle is about the shortest cycle which can be expected from a centralized photogrammetric map revision program. However, with some local government collaboration, the length of the cycle could be reduced. Furthermore continuous revision is feasible. It is also a long-term goal, but it can only be implemented through healthy collaboration with the local governments. In other words, it could be implemented with local governments carrying out some data collection. In such a map revision approach, users needs can be optimised. However, it is clear that the LRIS urban map revision should be based on a 5-year revision cycle unless there is both a need from the private industry and local governments to improve the revision and a willingness on their behalf to collaborate in the revision. According to the "infrastructure study" these two conditions seem to be fulfilled.

7.6.2.2 Map Revision Location

Even though the 5-year revision cycle is supported for a centralized photogrammetric revision program, this does not imply that a central agency should be doing all the revision. It only means that, in the absence of a decentralized map revision program, the 5-year cycle is about the best that can be achieved.

Decentralization is necessary in order to improve the revision frequency. It will bring the decision process closer to the users and consequently it will make it more sensitive to their needs. Decentralization will also bring the revision problem closer to the users and consequently it will be easier to arrive at a balance between need, cost, and up-to-dateness. The first step in decentralization would be the creation of regional map revision offices. The second step would be to have the municipalities doing their own revision. In the long term, it is important that local governments get involved in some revision participation; otherwise the problems, the investment in revision, and the service offered will never get appreciated. Planning must be made in such a way that participation from local governments will be improved.

Looking at the urban scene, one realizes that, of the 256 cities, towns, and villages in the Maritime Provinces, there are only a dozen which are sufficiently large to handle their own map revision. Furthermore, many towns are not large enough to have a full-time mapping office to do their own map revision. In both cases, a flexible participation formula is desirable. With such an approach local governments could get involved in the revision of their maps at their own pace.

In the Maritimes, as elsewhere, one must realize that the large scale map revision is a heavy task - and one that is never finished. This is because the number of large scale maps will increase as the population increases and as users become more aware of the value of up-to-date large scale maps. In a centralized map revision office, there will always be conflict between new map requirements and map revision. There is always pressure to give new map production precedence over revision. T.S. Keates, in his book "Cartographic Design and Production" says: "The proper maintenance of a map series is almost certainly a better assessment of the true quality of a mapping organization than the original production."

In order to achieve the immediate goal of a 5-year map revision program and a long-term goal of continuous revision, it is necessary to initiate the decentralization process. The first level of decentralization is the creation of regional map revision offices. This is a mechanism which is most likely to ensure that the 5-year revision cycle will be implemented. It is the mechanism which will permit the introduction of map revision flexibility, consultation, training, and planning assistance so that local governments can implement map revision at their own place. In doing so, progress toward the long-term goal will be made.

Decentralization is necessary in order to improve the revision frequency. However, its implementation hinges on the development of simple map revision techniques which could be used at regional and municipal levels. In other words the present photogrammetric process is too complex to be decentralized.

7.6.2.3 Map Revision Technique

The long-term map revision technique is the most difficult to assess. It will change with time in a world of changing technology, changing needs and changing organization structures. Maps may be revised with sophisticated analytical plotters; they may be updated with simple instruments, such as the zoom transfer scope, using plans and photographs; they may be revised from field surveys; or they may be revised with a whole range of more or less complicated revision instruments.

In the long-term, map revision will slowly pass from graphical to digital, but it is difficult to predict how fast digital technology can be implemented at the Maritime, regional and local level. It will be necessary to follow the development elsewhere, but also it will be necessary to initiate some Maritime digital development if there is a desire to apply the concept formulated in this report. Figure 7-6-4 shows the graphical approach to data and map revision; it shows the semi-digital approach which is a mixture of graphical and digital techniques; and it shows the fully digital approach to revision. For each approach it shows the task, the tool, and the product in the data collection, data processing, printing of data and data distribution.

At the present time with the graphical approach to map revision, data collection, processing, and distribution could be done by either the central or regional offices if simple or non-photogrametric approach was developed. However, it would be unrealistic to print the transparancies for the public map series at the regional offices.

Looking ahead at revision, it is most likely that:

i. Digital revision will be implemented over a period of time.

ii. The first computer-assisted revision method will be in semi-digital form.

iii. It will be introduced at the central office first.

Should this pattern prevail then initially only the data collection and data distribution would be done in the regional offices. The data processing and printing would be done at the central office.

At a later date the semi-digital method could be introduced at the regional offices and the local government offices. Then the data collection, data processing, and data distribution could be done at the

TASK	GRAPHICAL TOOLS	GRAPHICAL PRODUCTS	SEMI-DIGITAL TOOLS	SEMI-DIGITAL PRODUCTS	DIGITAL TOOLS	DIGITAL PRODUCTS
Data Collection	Aerial photographs Analytical stereo-plotter with plotting table Analogue plotter with plotting table Stereo transfer devices Field surveys plans field notes	Manuscripts with additions and deletions	Aerial photographs Analytical stereo-plotter with plotting table Analogue plotter with plotting table Stereo transfer devices Field surveys plans field notes and data	Manuscripts with additions and deletions	Aerial photographs Analytical stereo-plotter Analogue plotter with encoders Field surveys digital tape	Data set
Data Processing	Scribing Equipment	Revised theme scribe coats	Digitizer Digital plotter or Graphical terminal (for edit) Computer facilities	Revised theme files accessible through inter-active graphic terminal	Digital plotter or Graphic terminal (for edit) Computer facilities	Revised theme files acces-sible through interactive graphic terminal
Printing of Data	Vacuum frame Film processor	Transparancies of public map series	Flat bed plotter or Laser plotter and camera Film processor	Geo-digital files Transparancies of public map series	Flat bed plotter or Laser plotter and Camera Film processor	Geo-digital files Transparancies of public map series
Data Distribution	Diazo printer	Diazo paper copies	Graphic terminals Diazo printers	Electrostatic paper copies Diazo paper copies	Graphic terminals Diazo printers	Electrostatic paper copies Diazo paper copies

Figure 7-6-4 Tools and products related to data collection, data processing, printing of data and data distribution in revision based on, graphical, semi-digital and digital approaches.

regional and municipal offices. Transparancies and microfilm for public map series would still be printed at the central office. The implementation of semi-digital approach at regional offices and municipal government offices will make it possible to locally maintain data up-to-date. It will permit one to access the data anytime through a graphic terminal. However, the semi-digital and digital approach can only be implemented some time in the future. Yet there is a map revision need which cannot wait for the semi-digital and digital approach. Consequently a graphical map revision program must get underway as soon as possible.

At the present time it takes two years to revise a map. In other words there is approximately a two year time lapse from the day the revision of a map is initiated to the day it is available for distribution. With the present map revision technique and a five year revision cycle two-fifths of all large scale maps are on the revision books at all times. This is excessive. Internally the two year lapse time for a map to be revised creates the situation where the revision monitoring is difficult. Externally maps are two years out of date when they are published. there is a great need to develop a map revision methodology which will improve this time lapse. The objective should be to design a revision methodology that will permit the revision of a map in less than six months. This revision method should be applicable to both centralized and regionalized map revision programs.

In light of considerations in map revision frequency, responsibility and technique, in medium and large scale mapping *it is recommended that:*

i. The medium scale photo base be revised on a nominal 10-year revision cycle with a long-term goal of a true 10-year revision cycle.

ii. In the short term, the medium scale may be the composite of the photo base and various other themes.

- *__the basic map series__ be the composite of the map skeleton, the photo base, and the three following themes; survey markers, toponymy, hydrography.*
- *__the hypsography map series__ be the composite of the map skeleton, the photo base, and the four following themes: survey markers, toponymy, hydrography and hypsography.*

-*the property map series* by the composite of the skeleton the photo base and the four following themes: survey markers, toponymy, hydrography and property boundaries.

iii. As the transportation and building themes become available the basic maps series at medium scale be produced with and without the photo base.

iv. In the long term, the revision of the medium scale map series produced by LRIS remain centralized.

v. The large scale map revision cycle continue to be a five year one.

vi. LRIS take all the opportunities to encourage and stimulate users and municipal governments to collaborate in the large scale map revision to improve the revision cycle.

vii. In order to achieve the objective (vi) above, serious consideration be given to the creation of regional map revision offices.

viii. A graphical map revision procedure be developed as soon as possible to meet the immediate revision need.

ix. Long term map revision models be developed taking into account the digital technology, the theme concept, and the regional and local governments participation in map revision.

x. An investigation be initiated as soon as possible with the objective of reducing the time for graphical map revision at large scale to less than six months.

7.7 MAP SERIES IDENTIFIER

In chapter 6, the map and geo-package numbering system is discussed and a numbering system is proposed. However, the proposed map and geo-package numbers do not identify the type of maps. Consequently, it appears that an additional identifier would be practical. This would be a code to identify either the main theme of a map or a specific public map series.

In New Brunswick and Prince Edward Island the various types of maps have been identified by name, i.e. property map series, planimetric map series, etc. In Nova Scotia, the various types have been assigned a series identified. They are:

Series "a" Forest types scale 1" = 1/4, 1/2 and 1 mile.
Series "b" Forest types special projects on Crown Lands.
Series "c" Original Land Grants and Crown scale 1" = 1/4 mile.
Series "d" Planimetric Base with Crown Lands map scale 1" = 1/4 mile.

The general principle of the series identifier in Nova Scotia is good. However, in order to differentiate the metric from the imperial series, upper case letters should be used.

Before any series identifier can be implemented fruther consultation with the Nova Scotia Department of Lands and Forests is necessary to ensure that no conflicts will arise in assigning series identifiers. Since new series would be added periodically, as new public map series are introduced. it appears that some criteria should be developed for assigning series identifiers. The first criteria should be that any new series identifier should be mutually acceptable by the three provinces.

Together with series identifiers, series names should be continued. It is suggested that the series name reflect the main theme of the map series.

Series Identifier	Serial Name (Main Theme)
Series A	Basic map series.
Series B	Forest type series.
Series C	Original grant series (if continued)
Series D	Property map series (including publicly owned land)
Series E	Hypsographic series
Series F	Agriculture series
Series G	Geology series
etc.	

Table 7-7-1

The main observation from the above Table is that the topographical map series, the resource map series and the planimetric map series are not shown. The term "topographical maps" has been so much misused that the only way to correct the situation is to drop the use of it. For some people a topographical map is a NTS map; for others the planimetric map is a topographic map; finally other people are asking for planimetric maps or topographical maps with contour. The present planimetric map and topographic map series do not clearly characterize these two series; consequently these map series names should be dropped and renamed more appropriately. It is suggested that all map scales (medium and large) showing height information as the main theme, in land, be called "Hypsographic series".

The resource maps series without hypsographic information and planimetric maps series have some similarities. They fulfill the same need and they contain the same basic information over which themes can be printed. Consequently they should have a common name. However they have differences, planimetric maps series implies line maps. Consequently the two series cannot have planimetric map series as a common name. Resource map series implies medium scale maps which can be photo map or line map. Consequently resource map series cannot be used as the common name for large and medium scale map series. Due to the lack of a better name it is suggested that "basic map series" be used as the common name to replace the resource map series and the planimetric map series. The basic map series could take two forms. It could be the basic line map series and the basic photo map series.

It is recommended that LRIS and other map producers consider assigning both a serial identifier and a serial name to every public map series.

7.8 CARTOGRAPHIC EVALUATION AND DESIGN OFFICER

Chapter 7 reviews the specifications that should be subject to periodic review and modifications. In the next few years, there is a tremendous amount of cartographic design needed in the Maritimes' specifications. The initial thrust will be in the development of specifications for the metric map series. However the design and evaluation should not stop with metric conversion. This is because the needs will be ever changing. In order for LRIS to keep up with the changing needs and changing technology *it is recommended that LRIS appoint a cartographic evaluation and design officer.*

8 SUMMARY OF RECOMMENDATIONS

From section 3.5

It is recommended that a Centre be created with the task of developing and testing the concepts for a fully integrated position information system. It is expected that this Centre would be located close to or at a University where a nucleus of expertise in handling position information already exists.

From section 4.4

It is recommended that a seminar or workshop be organized as a follow-up to the questionnaire. The objective would be to develop a consensus and quality (scale, content, accuracy) of regional mapping needed for the Maritimes.

From section 5.5

i. *For high density urban areas it is recommended that the basic map data be compiled at a quality level equivalent to that of 1:1000 scale maps.*

ii. *For low density cities, suburbs, towns, villages and urbanized rural communities it is recommended that the basic map data be compiled at a quality level equivalent to that of 1:2000 scale maps. Further, as an essential step in the planning and budgetting for this series, it is recommended that an index (see Appendix D) showing the boundaries of cities, towns and villages be compiled.*

iii. *For both of the above series it is recommended that the "LRIS standard" not include "field completion" data. It is further recommended that a program be introduced whereby local governments have an opportunity* to provide field completion data and in return receive a map that is "tailored" to their particular needs.

iv. Project mapping: If there is a likelihood that the data compiled during project mapping will be of value in the LRIS data base then a co-operative or joint venture with the project agency is recommended. If it is anticipated that the data will be of negligible value to the LRIS data base it falls outside the terms of reference of this study.

v. For agricultural areas: As the requirements vary depending on the type of agriculture it is suggested that agricultural requirements be included in a proposed Resource Mapping Workshop (See vi below)

vi. Regional requirements: There is a definite need for a medium scale map (and map data base) covering the whole of the Maritimes. It is recommended that a Resource Mapping Workshop be held before a firm recommendation as to scale (quality level) and content be made.

vii. Regional requirements at medium/small scale: The 1:50 000 NTS map series meet this requirement very well. The design of the regional cartographic information system should provide for the flow of certain theme data from the medium and large scale data base to the NTS data base.

viii. Compilation of a digital cartographic data base: On the assumption that in the long term (20 to 30 years), the data base for all map products will be in digital form, it is recommended that a theme-by-theme (Figure 3-1-1) approach to digitization be followed. It is further recommended that an in-depth analysis of the family of mapping themes be made in order to establish the sequence in which the themes should be digitized.

From section 6.2

It is recommended that:

i. *The map projection plane be consistent with the predominant reference grid.*

ii. *The planes of the provincial plane coordinate systems be adopted as the map projection planes within the Maritime Provinces.*

From section 6.4

It is recommended that:

i. *The reference grid representing the provincial plane coordinate system be the predominant grid and that it be shown by heavy lines.*

ii. *The Universal Transverse Mercator plane coordinate system and the ellipsoidal coordinate system be subsidiary referencing systems.*

iii. *The subsidiary referencing systems be shown in a way that minimizes confusion with the predominant reference grid.*

From section 6.5

It is recommended that the decimal degree be adopted for geo-packaging in the Maritime Provinces.

From section 7.1

It is recommended that a first iteration at defining the family of themes and identifying the elements of each be carried out as soon as possible.

From section 7.2

It is recommended that a comprehensive set of specifications for symbols be developed with the least possible labelling. This set of specifications for symbols is to become the base from which the symbology for computer-assisted mapping will be developed.

rom section 7.3

It is recommended that:

i. The predominant reference grid representing the provincial plane coordinate system be a full reference grid.

ii. All large and medium scale maps be printed with a subsidiary reference grid (representing the UTM plane coordinate system). However, the subsidiary reference grid density should (a) be reduced to the minimum, (b) be a partial reference grid.

iii. All medium and large scale maps be printed with the graticule in decimal degrees around the map perimeter.

iv. All large scale maps be printed with a predominant reference grid (representing the provincial plane coordinate systems) corresponding to a ground distance of 100 metres.

v. All medium scale maps be printed with a predominant reference grid (representing the provincial plane coordinate systems) corresponding to a ground distance of 1 000 metres.

vi. The 1:5 000 maps be printed with a 2 cm or 20 cm reference grid depending on whether it is reduced from the medium scale maps or enlarged from the large scale maps.

From section 7.6

It is recommended that:

i. The medium scale photo base be revised on a nominal 10-year revision cycle with a long-term goal of a true 10-year revision cycle.

ii. In the short term, the medium scale may be the composite of the photo base and various other themes.

- <u>the basic map series</u> be the composite of the map skeleton, the photo base, and the three following themes; survey markers, toponymy, hydrography.

- <u>the hypsography map series</u> be the composite of the map skeleton, the photo base, and the four following themes: survey markers, toponymy, hydrography and hypsography.

- <u>the property map series</u> by the composite of the skeleton the photo base and the four following themes: survey markers, toponymy, hydrography and property boundaries.

iii. As the transportation and building themes become available the basic maps series at medium scale be produced with and without the photo base.

iv. In the long term, the revision of the medium scale map series produced by LRIS remain centralized.

v. The large scale map revision cycle continue to be a five year one.

vi. LRIS take all the opportunities to encourage and stimulate users and municipal governments to collaborate in the large scale map revision to improve the revision cycle.

vii. In order to achieve the objective (vi) above, serious consideration be given to the creation of regional map revision offices.

viii. A graphical map revision procedure be developed as soon as possible to meet the immediate revision need.

ix. Long term map revision models be developed taking into account the digital technology, the theme concept, and the regional and local governments participation in map revision.

x. An investigation be initiated as soon as possible with the objective of reducing the time for graphical map revision at large scale to less than six months.

From section 7.7

i. It is recommended that LRIS and other map producers consider assigning both a serial identifier and a serial name to every public map series.

From section 7.8

i. It is recommended that LRIS appoint a cartographic evaluation and design officer.