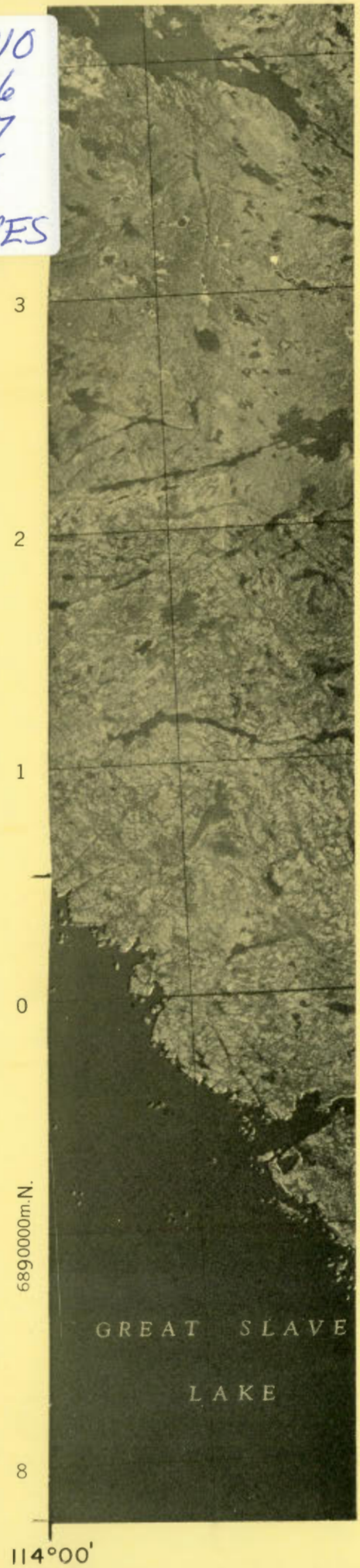

PROCEEDINGS

of the

SEMINAR ON CONTROL PHOTOGRAPHY PHOTO INTERPRETATION and MAPPING

Published by
Surveys and Mapping Branch
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PROCEEDINGS OF THE

SEMINAR ON CONTROL, PHOTOGRAPHY,

PHOTO INTERPRETATION

AND MAPPING

Organized and Presented

by the

Surveys and Mapping Branch
Department of Energy, Mines and Resources

at

Camsell Hall
588 Booth Street
Ottawa

February 26, 27 and 28, 1973

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LIST OF ILLUSTRATIONS

SEMINAR ON CONTROL, PHOTOGRAPHY, PHOTO INTERPRETATION AND MAPPING

SESSION 1

WELCOME ADDRESS

Mr. R.E. Moore, Director, Surveys and Mapping Branch

Ladies and Gentlemen, on behalf of the Minister of Energy, Mines and Resources, the Honourable Donald Macdonald; and the Deputy Minister, Mr. Jack Austin, I welcome you to the Department and in particular to the Surveys and Mapping Branch. Many of you have come a long way to be with us and I hope at the end of the seminar you will feel that you time has been well spent. We hope to show you what we are doing within the time-frame in which we operate; to show you something about current technology and future technology. We intend to publish the results of the seminar, so the discussions today and tomorrow will be tape recorded. From our point of view it will be particularly interesting to have your remarks on tape as it will be a guide for us in serving you in the future.

Before I talk about the Department I wish to introduce our keynote speaker Mr. William McKim. Mr. McKim is from Scotland. He graduated from Cambridge in Aeronautical Engineering. In his early career he was very interested and deeply involved in rocketry in the U.K. He came to Canada and after some time became the Regional Director of Parks in Calgary. He then moved to Indian Affairs and became the Regional Director of Indian Affairs in Toronto. June last he became the Director of Planning and Communications Branch and one week ago today he became the Director of Technical Services Branch. I wish to introduce to you an outstanding engineer, a senior officer in your own Department who will be our keynote speaker today.

KEYNOTE ADDRESS

Mr. W. McKim, Director, Technical Services Branch,
Department of Indian Affairs and Northern Development

Mr. Chairman, Ladies and Gentlemen: I am actually standing-in this morning for Mr. Battle who was to give this keynote address, and because he was to make the address I think I will use some of his words in opening this seminar. I welcome you to this first session on control, photography, photo interpretation and mapping. When I was asked to open this seminar and make some appropriate remarks I had to ask myself what in heavens name does one say to those who want a discussion on control, photography, photo interpretation and mapping. I was reminded that this was to be a very important seminar that had been organized by the Surveys and Mapping Branch of Energy, Mines and Resources for the benefit of users in my Department, and that if we wanted to make certain that maps were available to help to

understand our own programs and activities it was about time that we learned more about the Surveys and Mapping Branch - the difficulties confronting them, and about some of the technology being developed in this field. So putting aside some of the pressure (Mr. Battle was not able to put aside enough, because he was caught up this morning in working with the Minister) Mr. Battle recalled his boyhood days on the Prairies, those mysterious square holes in the corner of his father's farm. He wasn't too sure how they got there or how long they had been there, but was aware that somebody was watching over them and if one tampered with the iron pins something very drastic would happen. Many years later, he had some involvement with survey parties working on an Indian Reserve, and even then often wondered how the early surveyors ever managed to cut those endless lines extending miles over the mountains.

Most of us have read about the experiences of the early surveyors who marked out the route of the railroad and plotted the vast expanse of the western country to open it up for the rush of settlement. Certainly maps and plans, the work of those gallant men who made them possible were indispensable in the development of this land. So much so that we did seem to, and still do take this work very much for granted. Mr. Battle referred not only to those who blazed the trails with mysterious instruments but those who laboured over the drawing boards to transform the data into beautiful coloured maps of all sizes and descriptions to meet the needs of man.

Certainly, data concerning the terrain is vital to all of us and particularly so to my Department, and so we are here to learn more about how this data is produced. We cannot hope to, nor do we expect to become experts on the subject. This is the work of skilled professionals in Energy, Mines and Resources and we have other responsibilities, tasks that we can do better if we understand yours better. These responsibilities embrace National Parks, Historic Parks and Sites, Indian Reserves and Eskimo Settlements, and all of Canada north of 60°. Collectively they make up over 40% of Canada's land and fresh water mass. Individually, each element has its own unique characteristic. There are now National Parks in every province and Territory of Canada. So complex is the job today of establishing national parks that one wonders how Banff and Jasper ever happened at all. Perhaps therein lies the difference; parks no longer just happen they are planned in the real sense of the word.

Indian and Eskimo communities reach into every nook and cranny of Canada and to its extremities, east, west, north and south. Their way of life varies from primitive to advanced, between the means of sustaining life for a food-gathering economy in many northern settlements, to industrial high-rise complexes in a number of major urban centres. In the north, we are at work in close co-operation with other Departments, especially Energy, Mines and Resources, Public Works, and Environment on developing highway and pipeline systems and establishing a suitable base for balanced development with due concern for social, cultural, and political aspirations of the people who call this vast area their home.

Clearly, none of this would be possible were it not for the work of the mapping experts of Energy, Mines and Resources and of their colleagues or associates of the Provinces. Those are some of the words which Mr. Battle wished to bring to you this morning. I would like to continue with a few more thoughts of my own.

This seminar will demonstrate to you the magnitude of the task involved in providing Canadians with an adequate system of maps and charts as aids in the administration and development of our country. You will also become aware of the complexities of the map making process and of the lengthy production times involved. In view of these factors, it will become obvious that a responsibility in the matter of national mapping problems and indeed that of all other users, is to communicate our needs at an early date so that effective steps can be taken to make the information available when it is required. While medium- and small-scale mapping is essential for administration and general planning purposes, we also require an increasing volume of data in the large-scale category for a variety of specialized purposes. For example, we make extensive use of large-scale infrared false colour and colour photography in our archeological investigations of historic sites, for the geological assessment of mineralized areas, for the study of forested areas affected by disease or insect infestation and for many other purposes. Large-scale black and white photography remains the primary vehicle for the interpretation and delineation of resource inventory data, and for the interpretation and classification of terrain characteristics in addition to it being required for photogrammetric mapping processes.

Legal and control surveys are required for orderly settlement and land tenure, and to provide the horizontal and vertical data as a base for large-scale mapping programs. We require the production of large-scale maps and photomaps at scales ranging from 1 to 600 to 1 to 12,000 with appropriate contour intervals for the detailed development planning of our National Parks, Indian Reserves and that area of Canada north of the 60th Parallel. Whatever the need, it is established by programs developed and financed directly by our department, through its various program branches, regions and the territorial government agencies.

The Physical Planning Division of the Technical Services Branch has the responsibility of co-ordinating the requirements and of taking the necessary procurement action. This function is carried out by the Mapping and Cartography Section, which is staffed to provide technical advice on matters relating to survey and mapping projects, provide a limited drafting capacity for the production of mosaics, the revision of site plans and the production of specialized maps and basic photo interpretation studies. The Department of Energy, Mines and Resources, most specifically the Surveys and Mapping Branch of that Department, undertakes a technical management of and is the inspecting agency for the production of legal and control surveys, aerial photography, mapping and photomapping required by many federal departments and agencies. In the case of large projects the work is generally done by the appropriate sectors of private industry under

contractual arrangements made by the Department of Supply and Services. Alternatively, we also have the necessary facility to obtain urgently-required data for small projects by the consulting service contract route, in which case the Surveys and Mapping Branch also acts as our inspectors for the work completed by contract. Ladies and Gentlemen, this in brief is the situation with regard to our area of interest and the role that surveying and mapping plans play in our everyday life. At the end of this seminar I believe that you will agree that this has been an interesting and worthwhile experience.

ORGANIZATION OF THE DEPARTMENT OF ENERGY, MINES AND RESOURCES

Mr. R.E. Moore

Mr. McKim, in your talk you expressed the thought that the main objectives of the seminar were to understand the time-factor constraints and to look at new technologies of surveys and mapping. I do hope we will in our small way achieve this in the two days, and thank you, Mr. McKim, for setting the tone and direction of our discussion.

Before calling on our first speaker I wish to take this opportunity to put the Surveys and Mapping Branch into proper context in relation to the Department, to show you where we fit in, and how our department is structured. I realize that diagrams are rather dull so I didn't use the normal diagram, I am just going to talk around a few headings. The Department actually has three major thrusts - energy, minerals, and science and technology. I suppose it is better to call the last one earth science. The first two of course have a high political visibility. Science and Technology is what used to be the old department of Mines and Technical Surveys. There are two branches in each of the first two units, and in the Science and Technology Sector we have the Mines Branch, the Geological Survey of Canada, the Earth Physics Branch, the Continental Shelf, and the Surveys and Mapping Branch.

In the Surveys and Mapping Branch there are the International Boundary Commission and four major units: the Geodetic Survey of Canada, the Topographical Survey of Canada, the Map Production Directorate, and Legal Surveys which you are all familiar with. There are a number of sub-programs in the branch but these five cover the main thrusts of the branch activity. To give you some idea of the dollars that we have, we spend somewhere between $17-18 million dollars per year, the largest part of it being spent in our program of the solid earth description made up of geodesy, topography and the national atlas. The other services are map distribution, photographic services, aeronautical charts and legal surveys. We class these as support to other government agencies.

I would like to draw your attention to the two items that will be of particular interest to everyone in the future. They are the Earth Resources Technical Satellite (E.R.T.S.) in the remote sensing program, and what we

call Automated Cartography. I suppose everyone has heard of the E.R.T. satellite that was launched by NASA last summer. There are pictures of it around and later you will be going to the Canada Centre for Remote Sensing to see this rather intriguing setup, so I will only mention this, as there will be a speaker on this later. It is something to keep looking for.

The next point I wish to make concerns automated cartography, and it will have a direct bearing on what you and others will be doing in the future. In this system we hope to automate map data, store it on tape and make it available through peripheral devices such as the cathode ray tube. The topography of Canada, involving about 85% of the populated areas, will, with some official thrust be completed in about four or five years, and data will be stored in this automated system. This has a tremendous impact on anyone who uses maps because it is an in-and-out system. Tomorrow I believe you will see this equipment. These are the two main thrusts of mapping technology with which we are now involved.

To start the seminar it is appropriate that we begin with air photography, because this is where we all start in making a map today. The first speaker is Mr. Dave Baker, who is well qualified to speak on air photography, having spent considerable time in the last three decades in it. He had war-time airphoto experience in the R.C.A.F., and post-war photo-logistics in the Air Material Command. He retired from the R.C.A.F. in 1959 but it was not the end of his involvement with air photography because he spent four more years in the technical field in the photo industry and then he came back to our department in 1964 and joined what we previously called Airphoto Production Unit at Rockcliffe. In 1971 he became the Secretary of the Interdepartmental Committee on Air Surveys. Its role, I believe, is his theme today. I introduce to you Mr. Dave Baker.

AIR SURVEY PHOTOGRAPHY

Paper Presented
by

D.H. Baker
Secretary, Interdepartmental Committee
on Air Surveys

AIR SURVEY PHOTOGRAPHY

It is a pleasure to speak to representatives of I.A. and N.D., our best customer and the second largest user of air photography in the federal government.

Before discussing Air Survey Photography, I wish to define two terms, namely, "Existing Photography" and "New Photography". "Existing Photography" is available through the National Air Photo Library, 615 Booth Street, Ottawa; "New Photography" is taken at the users request and is paid for by the user. My purpose this morning is to discuss what happens when "New Photography" is ordered.

The organization that co-ordinates federal photo flying is the Inter-departmental Committee on Air Surveys. This Committee was established by Order in Council in 1925. Its duties then were very similar to its duties now, as set out in Treasury Board Minute 524790 dated 1958 and amended to date. These duties will be discussed in a few minutes.

The ICAS Committee is made up of representatives from six other departments besides Energy, Mines and Resources. The Committee Chairman is Mr. R.E. Moore, Director of Surveys and Mapping, see Fig. 1, page .

This Committee is a policy making body and meets each January to review the past year's photo programme and to discuss and approve the current year's programme. The ICAS programme for new photography usually runs at around one million dollars a year.

Supporting the main Committee are the Technical Sub-Committee and the Secretariat or the Contract and Inspection Section (Fig. 2, page).

The Technical Sub-Committee, in co-operation with the air survey contractors, is responsible for the technical aspects of the programme. It investigates, tests and makes recommendations to ICAS on the acquisition of Federal aerial imagery and specifications covering its acquisition.

The Secretary of ICAS receives requests for new photography from the members of the Committee on behalf of their departments and co-ordinates these requests, raises requisitions on the Department of Supply and Services, reviews the tenders received from commercial air survey contractors and recommends the awarding of the contract. When the photography is received by ICAS, it is carefully inspected and then sent to the user and to NAPL with a copy of the inspection report, film report and index.

When new photography is wanted by your department, ICAS Form No. 1 is filled out, attached to a map showing the area to be photographed and forwarded to Mr. Burton. He consolidates your requests, breaking them down into National Parks, Indian Reserves, Historic Sites, etc. by province or area and forwards your requests to ICAS for an estimate. When he receives the estimates, he requests the necessary money from the regions.

At ICAS, we assume that someone has investigated existing photography that may be available at the National Air Photo Library or from provincial sources. We on our part, keep in touch with the provinces regarding the current year's programmes.

This brings us to the question of lead time. We must have your requests by or before 31 December to present your requirements to the Committee in mid-January. Our letters to departments request that details of major programmes reach us by 30 November, even if they have not been officially authorized. Because of the great amount of new photography required yearly by your department, many of the requests do not make the deadline. Anything you can do to improve the situation would be appreciated.

It takes ICAS at least two months to draw the necessary flight line maps, consolidate the requests by area and prepare the requisitions. At the same time we are writing the final reports on last year's photography, assessing discounts, preparing financial statements for each contract and submitting requests for final payments, before 1 March, to allow Treasury time to pay final bills in the current fiscal year. From 1 January to 30 April is a pretty hectic time.

In the past, we have often had trouble getting the current year's photography to you before you have to decide what you will need for next year. It is hoped that by means of tighter controls on deliveries from contractors and a bigger and better inspection staff, we will be able to get the photographs to you within two months after they have been taken.

Immediately after the annual meeting in January, we send details of our approved photo programme to all contractors and to the provinces. This enables contractors to estimate the scope of the programme. However, it is essential that the main contracts by awarded by 30 April to permit contractors to make definite plans for the season, as these same contractors handle all the provincial and company photography in Canada.

We are also prepared to accept unscheduled requests at any time. Through the co-operation of Mr. A. Costello, Chief, Purchasing Operations Branch, DSS, we are able to get small emergency contracts out in three days. However, the usual time is three to four weeks, depending on the complexity of the contract. On most contracts, other than jet flying the contractors need up to ten working days to submit a tender.

Contract Details: On the back of ICAS Form 1 (copies of which are available here if desired) are listed some of the things that cause confusion and delay in ordering photographs. Form 1 states under "Explanatory Notes":

(a) Timing: Photography that is scheduled for a particular period and which necessitates a special flight, may cost up to ten times that of non-scheduled photography. Leaf-free photography is scheduled photography, and, as a result, usually costs more than non-scheduled photography. Leaf-free autumn photography is often more difficult to obtain than

leaf-free spring photography because of the low sun angle and the possibility of ice and snow on the ground.

(b) Targetting: Targetting can cause delays, confusion and misunderstandings in the procurement of air photography. Targetted photography is not necessarily scheduled photography and there may be a period of weeks between the targetting and the photography, unless the photography is scheduled at the time of the original request.

(c) Costing: A summary of the cost of the current season's photography is sent to all interested government departments to assist them in preparing estimates. ICAS will provide estimates on a particular project when requested to do so.

I wish to stress that the main contracts let, are a consolidation of requests from all departments in a given area. Thus, a site contract covering the Maritimes, Newfoundland and eastern Quebec usually includes requests for photography from Agriculture, Forestry, Fisheries, Public Works, DND, IN and ND and Hydrographic Surveys. This consolidation cuts down the cost. However, if photos of an area on the northern tip of Ellesmere Island are wanted and there is no other photography near it, the chances of getting it are poor, unless one is willing to pay the cost of a special flight.

Regarding the actual taking of air photographs, let us start by stating that a lot of expensive equipment is required. First of all, the light aeroplanes used on air photo work cost from $100,000 to $300,000 each. Most of these light planes have a useful ceiling of up to 20,000 feet ASL, a few can operate at 25,000 feet and one or two a little higher. However, any photography over 30,000 ASL requires a jet, costing one million dollars and up. A typical large Canadian air-photo company will have seven or eight photo aircraft, six cameras, a photo lab equipped with two continuous film processors, a sensitometer, densitometer, annotation and checking tables and several electronic-dodging contact printers.

Cameras: Air cameras like the one displayed here, start at about $50,000. The standard 9 x 9 camera used on air photography is equipped with a 6" lens. The super-wide 3" lens is also being used to some extent in mapping. The 12" lens is used when first class colour photography is desired; 70 mm. cameras of various focal lengths are also used although the contractors are not generally equipped as yet. Cameras can be used singly or in mixed or matched pairs, depending on the requirement.

Films: Two types of black and white films are in general use - standard 2405 panchromatic and infra-red. Three types of colour films are regularly used - colour negative, colour positive and colour infra-red.

Black and white contact prints can be made directly from black and white negatives and from colour negatives. Colour prints can be made directly from both colour negatives and colour positives. Black and white enlargements up to 40" x 60" are available from B & W and colour negatives.

Colour enlargements up to 40" x 40" from colour negatives and up to 20" x 20" from colour positives are also available. Maximum sizes are determined by available processing equipment. Details and prices can be obtained from the National Air Photo Library, telephone 994-5457.

Now to return to the procurement of "New Photography". According to Treasury Board Minute 524790, the only legal way for a federal government department to obtain new air photography is through ICAS, the government's Air Photo Agency. (Fig. 3, page) It is recognized that now that the entire cost of obtaining new photography is paid by the user, he will insist on getting good photography and good service. The Federal Government has set up ICAS for this purpose and I hope the service being paid for will be demanded. Photography that is not obtained or late can be very wasteful. In this regard, IA and ND has a real champion in Mr. Burton. I have known him since the war years and can say that not only is he a dedicated and capable officer but he has likely done as much or more for air survey photography than anyone alive today.

Later in the week you are going to visit the Air Photo Centre at 2464 Sheffield Road, known far and wide as Morley's Manor or the Sheffield Hilton. This building houses one of the biggest and best equipped air-photo labs in the world and the Canada Centre for Remote Sensing. Figure 4, page , shows the Units of the Air Photo Division.

The photographs on display here illustrate what can be obtained from air photography. Mr. George Nitschky, Chief, NAPL/RC is here today and will assist in answering questions on his Unit and on the Remote Sensing Unit.

DISCUSSION PERTAINING TO MR. BAKER'S TALK

Question: What, in your view, is the involvement of industry, and of Government in taking photographs? Do you think the Government should be in this business or do you think industry should carry it on?

Answer: I have two views on this. I think when the Government sets up a unit to do a job, then the Government should back the organization doing the job. I am referring to the Reproduction Centre in particular. With ICAS the contractors are definitely involved and are part of the whole air photo picture. Personally I think we're seeing the end of an era because of the advent of the satellite program. We have this satellite whirling around out there 570 miles distant, taking pictures such as that large orange one on the board over there in which you can see the narrow bridge of Vancouver and details like that. The other thing that is affecting the program is the advent of the jet aircraft. So just what's going to happen to the relations of government and air contractors in the future I'm not quite sure. I hope I've skated around that nicely?

Answer: You did.

Question: I just wondered, in cases where one needs a small amount of photography, and a plane is available to fly at a calculated minimum, does one go to ICAS or set up a contract on the spot?

Answer: I'll give you two answers as usual. The official way is to come to ICAS as that is the only legal way to get a photograph, but on the other hand if somebody has to do a half a mile or mile of photography it seems kind of stupid to go through all that trouble if there is somebody sitting right there that can do it, but don't tell us. The other thing that prompts an objection to local effort is that the Government likes to get all flown photography into the National Airphoto Library. If anything is flown outside the ICAS we would still like to get it in the Library. No questions are asked.

Question: How do you obtain photography flown for private interests or a province? We can't be assured that that photography is available to ICAS, this means we have to go to the people who did it.

Answer: In ICAS we are talking only about federal photography. Photography that has been paid for by federal funds. Some of the provinces have their own libraries and their own systems. They let their own contracts. We have nothing to do with provincial photography.

Question: ICAS is concerned only with federal photography?

Answer: That is right.

Question: Why can't legislation be enacted to ensure that this photography is placed in the national library? Would you second this?

Answer: This is one of the things I have always dreamed about. It would be nice to think that we had a really national airphoto library with everything in it. But at the present it isn't practical. Maybe I could comment on the National Airphoto Library. We had a consultant (which is what you do when you have a problem) come in and look at the library and he travelled across the country to look at the ramifications of it. His report, said in essence, that we should become the marketing agency for all photography in the country and that in our files we should know where all the photography is and charge a marketing fee for people who want to come through this central agency. Well it's been our view that you don't make much money marketing someone elses products so we stayed away from this idea, but it's down the road and wihin a year or so we are going to look at the role of the National Airphoto Library very carefully. In this library we have all the photographs taken since 1922, when the first photographs were taken under Federal auspices in Canada. I think we do have a fairly good record of the photography, that is the recent photography taken in Canada by provinces but there is a big gap as far as industry is concerned. I think we know about some large industrial photographic projects, but for some of the smaller industries we certainly wouldn't know where the photography is so your point is well taken. Maybe it's up to the regional people to take some initiative in this area and let us know what's going on.

Question: I would just like to comment that in my area my first line of ordering data and material in photography is not from the National Library but from the provincial one. Can't this be improved?

Answer: On that point some of the provinces have already put their film in the national collection: Saskatchewan, Manitoba, Newfoundland and some of Nova Scotia and some of New Brunswick. If everybody did it, your problem would be solved but the rich provinces retain their own photographs up to the present. We try to keep in touch with them and they tell us what they are going to do and what they have done currently in the past year but we don't have direct access to it any more than you do.

Question: Is there any current effort to augment all this original material so that it is all dated and perhaps hold this material, and the index itself, in Ottawa. Will you have any better access to that material than a province?

Answer: From the information that the provinces give us, the National Airphoto Library makes up an index of each province by years so that they have an index which indicates what areas are flown and at what scale but they do not have the roll and negative numbers in most cases. Mr. Morris said they wouldn't know the quality.

Question: In one of the problems which I have come across recently it would be useful to know what data is available to the National library. Is there any sort of an index published or sent out by mail so that we know in fact what is available?

Answer: Your own department makes up an index of what is available and this has been published at least for the last two years and it covers the photography that is available north of sixty degrees in general.

Question: What is the time span between request and delivery?

Answer: I knew somebody was going to ask that one. It could vary from a month to six months. Most of the photography contracts are given to the contractor on a photo season basis. In other words he can fly it anytime during the season between April and September and if yours doesn't get flown until September you are not going to get it until November but if he flies it in April you'll get it in June.

Question: I was thinking more of existing photography, something flown two or three years before.

Answer: Then you are talking about the delivery service from the National Airphoto Library and the Reproduction Center. This varies with the work load, of course. There are just so many people doing this job and as it often happens these orders come in at particular seasons of the year, they flood the library and the Reproduction Center and it takes some time to work out of it. I'd like to comment on that. For the first time, this year

we're going to have a realistic price on airphoto products, so instead of the thirty cents you were paying for a single photograph, you will now pay a dollar. This allows us to bring industry into our organization at all of those rush periods. For the first time this summer if you have an urgent requirement let us know, we should be able to turn this around very quickly for you, but you pay for it. In other words we'll have a premium run, a rapid run, and a regular run, and this type of thing requires overtime. Previously we were not able to react to overload because air photography until just recently was subsidized very heavily by the government (and I mean very heavily except for the taking of it) the reproduction part of it was subsidized very heavily. Look at that nine by nine enlargement. It may cost something like $45 to $60 to produce. We were selling those things for $8, $9 or $10, and this gives some indication of the type of subsidy; we feel that the air photography business has grown up, people are accustomed to using it and we don't have to propagandize this anymore, it has come of age so the user should start paying for it and this improves service for everyone. We know that customers were building their own archives. We have had examples of orders for colour photographs in amounts as high as $40,000. We had no way of refusing them. $40,000 worth of photo products would keep one scientist going for eternity so one knows they were just building archives. The main thrust now is to make sure we are serving the right people and in order to do that we want a money return on a realistic cost basis. Now the prices we are charging this year are subsidized heavily still because we can't get authority to do any more than to double them. They should be tripled or quadrupled. However at this date and time, for various obvious reasons we can only double them. I hope that certainly next fall or next winter we'll be able to produce photos when you want them.

Question: Talking about time spans, for example if 50 copies were requested from the field could we expect them back in a month?

Answer: Oh! Now you're talking days. The biggest problem there is the postal service.

Comment: Would you like to comment on that, Mr. Nitschky? As Mr. Baker already said, it depends on the pressure of business in the NAPL and its Reproduction Center at the time. If it's one order coming in, it can be done in a matter of days, if it's during the rush period it could take two or three days for the National Airphoto Library to select the area required before it gets to the Reproduction Center and into reproduction. We are aiming at a two week delivery date for all orders and I think that's the date that you are looking for.

Question: Is it possible for the film to be sent to a private firm in Vancouver which could provide us with photos in a short time span?

Answer: We will say no to that, but there are some unusual circumstances where we do allow the film to go out, but it is our policy not to let it out of the Reproduction Center.

Question: When is the Airphoto Library busiest?

Answer: We have our ERTS program where the satellite program is a continuing thing, and do a fair amount of work on that on a day-to-day basis. Then you have the airborne, and remote sensing program and spring to fall the air surveys program. This is our biggest demand period.

Question: Will regional libraries be set up?

Answer: In the consultants report that Mr. Moore mentioned, it did suggest that maybe we should set up regional centres across Canada, but they would not hold the real aerial photographs. It would be a microfilm system and this is under investigation right now. There would be indexes available in the future. Even some regional photography available on microfilm. If one likes it, it can then be ordered from the National Airphoto Library. This is an idea that we are studying right now.

Comment: I think you have a good point. We have this continual requirement for immediate response to a need and we have talked about it, but we are going to have to set up a system, a rapid response system, which is more expensive. Rather than decentralize we would rather set it up in-house. A rapid response system needs a telex. The real problem is for you in the regions to have enough information so that you can make an intelligent order. In other words, if you have the microfilm of all the indices in the region, which we will sell you, set up in each of your regional offices for instance, you could pick off the type of photography you want and telex the order, then we should be able to get it back to you very quickly. The problem is everybody claims their own order is first priority and the only real way to set a priority and make it stick is to require users to back up priorities with money. Then there is no problem. This is what we are attempting to do.

Question: I understand that there is a suggestion to increase the cost of aerial photography? Will this improve the service?

Answer: That is the idea. The idea is to charge more so that we will be able to hire people to do the job.

Question: What is the real reason for the long delay in getting prints?

Answer: There are many reasons. Yea, one million of them. Suppose we make a million prints a year and if the work was scheduled, so every week we do X prints, it comes to a million in a year, and we could guarantee delivery right on the minute. But if 50% of these are ordered and required within two weeks, somebody is not going to get them. Its just like any other business, there has to be controlled input of workload. You couldn't go to your corner grocers and order 100,000 dozen eggs and expect to get them that day. You must wait on a hen.

Question: Why didn't we get the aerial photography requested last year?

Answer: This happens. Your request no doubt was put through the usual channels and went out to a contractor who wasn't able to get it for some reason. What area was it? There was an area around Whitehorse that wasn't done last year. Was that it? Yes. This happens, the contract is given to a contractor and he does his best but if he goes in a couple of times and he can't do it because of weather, at the price he has quoted, he might have to give up. This is caused by several things. The contractor may have quoted too low and there is a certain number of trips beyond which he cannot go. There is another course, if the area is very important. We issue a stand-by contract. In other words, we hire an airplane and a crew, and they go in and sit there until they get it. Under those conditions they don't always get it if it is a large area, but we do let stand-by contracts. They are expensive. It boils down to the old question of money. You can do almost anything if you are willing to pay for it. There is a practical consideration to all these things. Every year we have some areas that are not photographed for various reasons. The thing to do if they are important and you need them within a certain time is to say so and of course on this Whitehorse job, it is not on this year's program. It wasn't put up again this year.

Question: A good way to get prints is to go to a local firm who has prints and copy them.

Answer: You mean you are copying the prints. This again is illegal, but a very good way to do it.

Question: How do you ensure that your contractor takes good photography?

Answer: Government-contractor relations is a difficult area. If photographs are very poor or useless, we reject them. If they are sub-standard, but of some use, we pay for them at a lower rate. We have all sorts of penalties for things that can happen. This year, because our present system hasn't worked too well, we will likely have more stringent regulations regarding contractors.

Question: What if the local office makes a contract and gets poor quality, can something be put in contracts to cover this?

Answer: As I said before, such contracts are illegal under the Treasury Board regulations, and if you set up a local contract, and you get stung, I guess this is the reason for such regulations.

Question: Are you on metric or British scale?

Answer: What scale for what?

Question: Is there a standard scale for air photography?

Answer: Air photography is all in the metric scale now and we normally think of it in metric terms. We never think of it in other terms. In other words 1 to 5,000, 1 to 50,000 or whatever the case may be. Its a metric scale. All the cameras are metric. All measurements in the cameras are metric. There is no real problem here. Its a matter of getting used to looking at a scale of 1 to 5,000 and saying it is 200 feet to the inch or 400 feet to the inch or whatever.

Question (Editor's interpretation): Questioner talked about the Calgary office and the advisability of ordering through this office rather than through Ottawa.

Answer: The office in Calgary is there for two purposes. To aid in the department's functions and to assist the whole oil industry and the local population to look at photography. It is also an order office. This separate office is a bit of an experiment from our point of view. I believe there are about 600,000 photographs there and that represents a capital investment, on the new price scale, of something like $550,000 which we are not going to duplicate again. This was something rather unique. To set up a library like that is very expensive.

Question: Will it be kept current?

Answer: Yes to some degree.

Question (Editor's interpretation): Poorly recorded but apparently had to do with function and scope of regional libraries, especially the one in Calgary.

Answer: This sounds like a press clipping from last year. We had a lot of static on that particular library. I am not going to answer your question directly, I am going to evade it until a little later. What we are attempting to do is improve the service in Calgary, and we are going to look at the type of service, in other words, the library there may be short of some photographs in some areas. The original intent was that everything from Winnipeg west and north would be in that library. I think there is some jet photography from 1970 and some Arctic photography that is not in there, and some of the latest photography in the Mackenzie Valley is not in the library. But what we are attempting to do in that library (just forgetting about the research part) is to set up there and in each province, with the co-operation of the provinces, and probably with the co-operation of industry something like 25 or 30 ordering offices. What we want to do is have people come in and be able to go up to a microfilm system, have the order forms there, and make out their orders. They will be able to press a button and see the photography, even the latest photography, and be able to make out the order directly. Drop it in the slot, it is picked up and sent to Ottawa. One of the major problems is the cost of correspondence. We look at the dollars and cents involved in this, we were selling photographs for 60 cents and when a letter is processed it costs the organization $29.00. If we process across the counter, it will cost about a dollar and a half, so we are talking about a service charge. We have become very money conscious,

as you can see. It is a poor thing to talk about if you are trying to sell a product, but we have become very money conscious in this business. To give you an idea, ours is a $2 million business with a revenue of $350,000. This next year, we hope it will be a $2 million business with a revenue of $1.9.

Question: (Editor's interpretation): Question unclear, but apparently concerns the need for processing orders from the Alberta region through the Calgary office.

Answer: Come through the office in Calgary if it is convenient, if it is not, then send it direct.

Question: Would it make any difference which office was approached by our Northern Regions because of mail service etc.?

Answer: This is the argument that was used. Photos would be in the Calgary office. It actually slows orders down for a day or two when another office in the local area gets in the middle. On the other hand, the Calgary office can be of service because they can point out directly the best type of photography for people with special needs.

Question: We were talking about the use of microfilm as a means of presenting the information. In view of the ERTS program, has any thought been given to some type and data bank where it could readily be examined and assessed?

Answer: Yes that has been considered. The question was whether or not there will be direct access to the ERTS through a terminal system to the ERTS computers. Is that what you are talking about? Or a data bank? The ERTS system at this stage in time has been operating about a month. They just got the lazer beam recorder going and the initial plan, as I understand it, is just for ERTS imagery to be available on microfilm. Just the straight imagery itself. There is no plan for anything beyond that at this stage in time. Now you might check it. They may have changed their mind. You might check it when you meet them tomorrow.

Question: When ordering photographs from your library is there any benefit in ordering an older photograph rather than a new one?

Answer: It doesn't make any difference. These films, as you will see when you go to Sheffield Road, are all in rolls and it is just as easy to pull out a 1922 roll as it is a 1972 roll.

Question: When we order aerial photography for the purpose of developing contour maps, there has to be control; now do you put control in or is this up to the ordering department and how do we tie that into what we request because we don't see anything from ordering time until the photographs are back?.

Answer: Is this an order for a map or a photograph?

Answer: Photography.

Answer: The question is - you order a photograph for the purpose of making a map and you are wondering about the relationship between control and photograph. To illustrate the cost, the relative cost of photography to the map, may be two or three percent. Ground control is about 25 to 30 percent of the cost of the map. And all the ICAS really does is facilitate the taking of photography. A number of government departments give a contract for the total package to a contractor to produce a map and let him prepare the ground control, the air photography and the compilation of the map. This is not a bad idea.

Question: This would be in our request to ICAS?

Answer: No not necessarily, that would go through Mr. Burton's group for quite a separate reason.

Question: We assume everything we order through you goes through Mr. Burton.

Answer: Yes, but he may decide at this time he is going for a mapping contract which includes photography. If photography is an integral part of the mapping contract, that means it goes out under a separate blanket and we know about it, and the photography then comes back to us. Photography is not the major component of the map, of the product, in that case. I just illustrated the difference in cost. In other words maybe three or four percent of the cost of that product is the photograph so the main ingredient is the map. We, the branch, would then monitor the contract for you. You will be seeing this work. This is maybe a key point for you to watch. You will be seeing that the interrelationship between ground control, map and air photography is quite a fundamental relationship. One more question.

Question: What is the cost of transferring forestry information from the photograph to a base map.

Answer: In other words, you are talking about transferring forestry information from the photograph to a base map. These are the costs of the photographs themselves.

Question (Editor's Interpretation): Question poorly recorded. Apparently is concerned with availability of photo-centers and tie points and the cost of compiling them.

Answer: We do not normally provide that in the branch. We would have it on file. In other words if you had an area you were working in, and it had been mapped at 1 to 50,000, we would have somewhere in our archives the photo-centers, if not the photo-centers then certainly the tie points between the flight lines, with latitude and longitude coordinates. And there is probably an elevation on this. The problem that we run into then is we would like to have you come and get it out of our archives, rather than have us do it because you would know exactly what you wanted. Now there are

certain other areas where we wouldn't have this information. We quit marking photo-centers about 15 years ago when we left the slotted-templet and went to the stereo-templet. About a decade ago we went to the computers, so we no longer deal with photo-centers. So probably for the last ten years we really have no information on photo-centers that would be useful to you. But the cost of doing this is the cost of an adjustment and the cost of an adjustment is about 10 or 15 percent of the cost of a map, so if a map cost you $4,000 you know you can think of this kind of a price, 10 or 15 percent to make the lay-down.

Question: What is the cost of the photography in relation to the cost of the map?

Answer: The photography normally, unless very very low altitude, is three to four to five percent the cost of the map.

INTERDEPARTMENTAL

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DEPARTMENT OF PUBLIC WORKS – J.A. FULLERTON

STATISTICS CANADA – PIERRE J. HUBERT

FIGURE 1

Members of the Interdepartmental Committee on Air Surveys

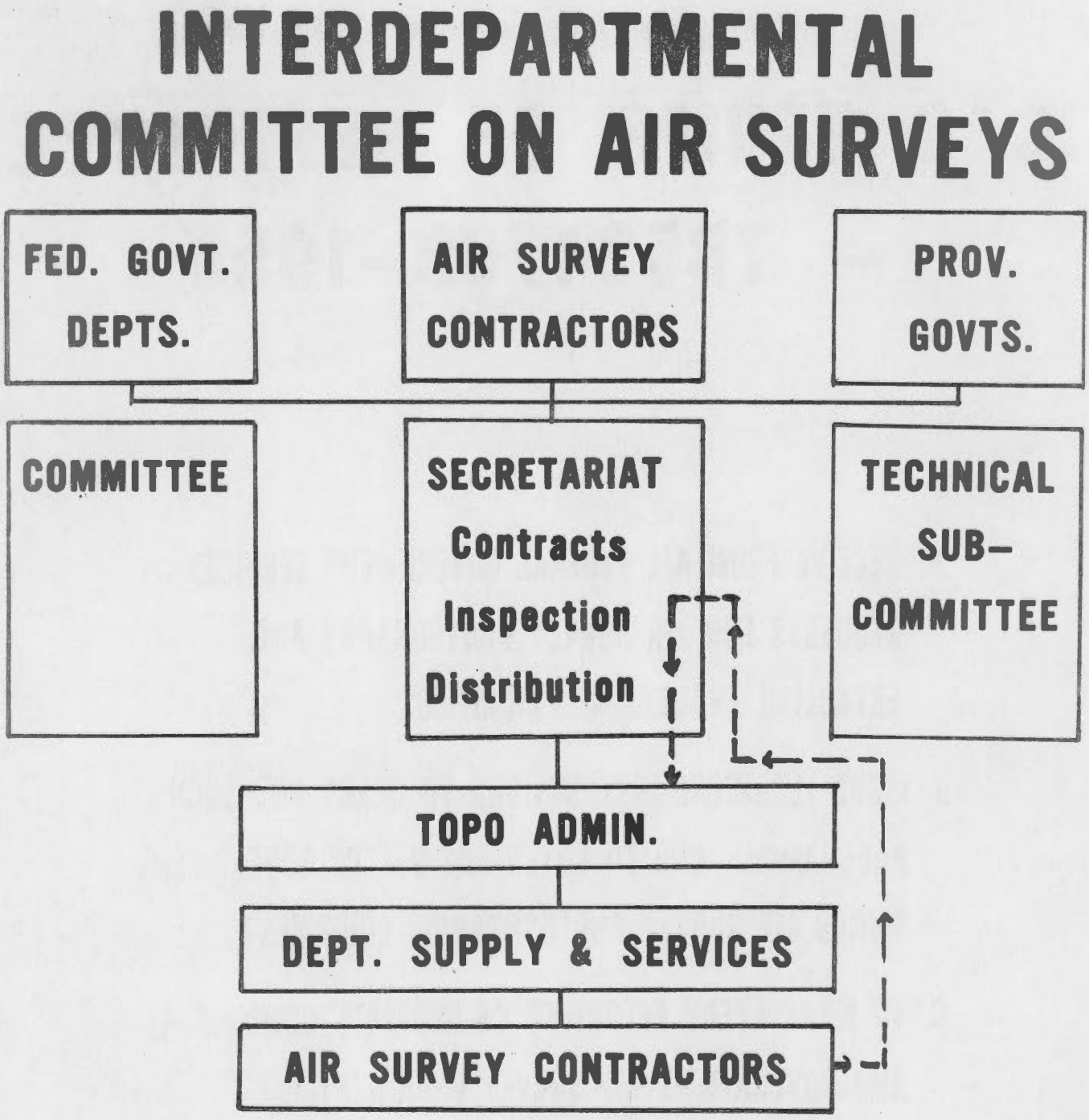

FIGURE 2

ICAS - Co-ordination with other Federal and Provincial Agencies

ICAS TERMS OF REFERENCE – TB524790–1958

.A. RECEIVE FROM ALL FEDERAL GOVERNMENT SERVICES REQUESTS FOR AIR SURVEY PHOTOGRAPHY AND ESTABLISH PROGRAMME PRIORITIES.

.B. ISSUE TECHNICAL INSTRUCTIONS TO CARRY OUT SUCH PROGRAMMES AND TO COVER THE USE OF GOVERNMENT OWNED AIR SURVEY PHOTOGHRAPHIC EQUIPMENT

.C. TO MAKE EVERY EFFORT TO CO-ORDINATE COMMERCIAL AND GOVERNMENT AIR SURVEY ORGANIZATIONS

.D. UNDERTAKE OTHER TYPES OF AIR SURVEYS.

FIGURE 3

ICAS - Terms of Reference

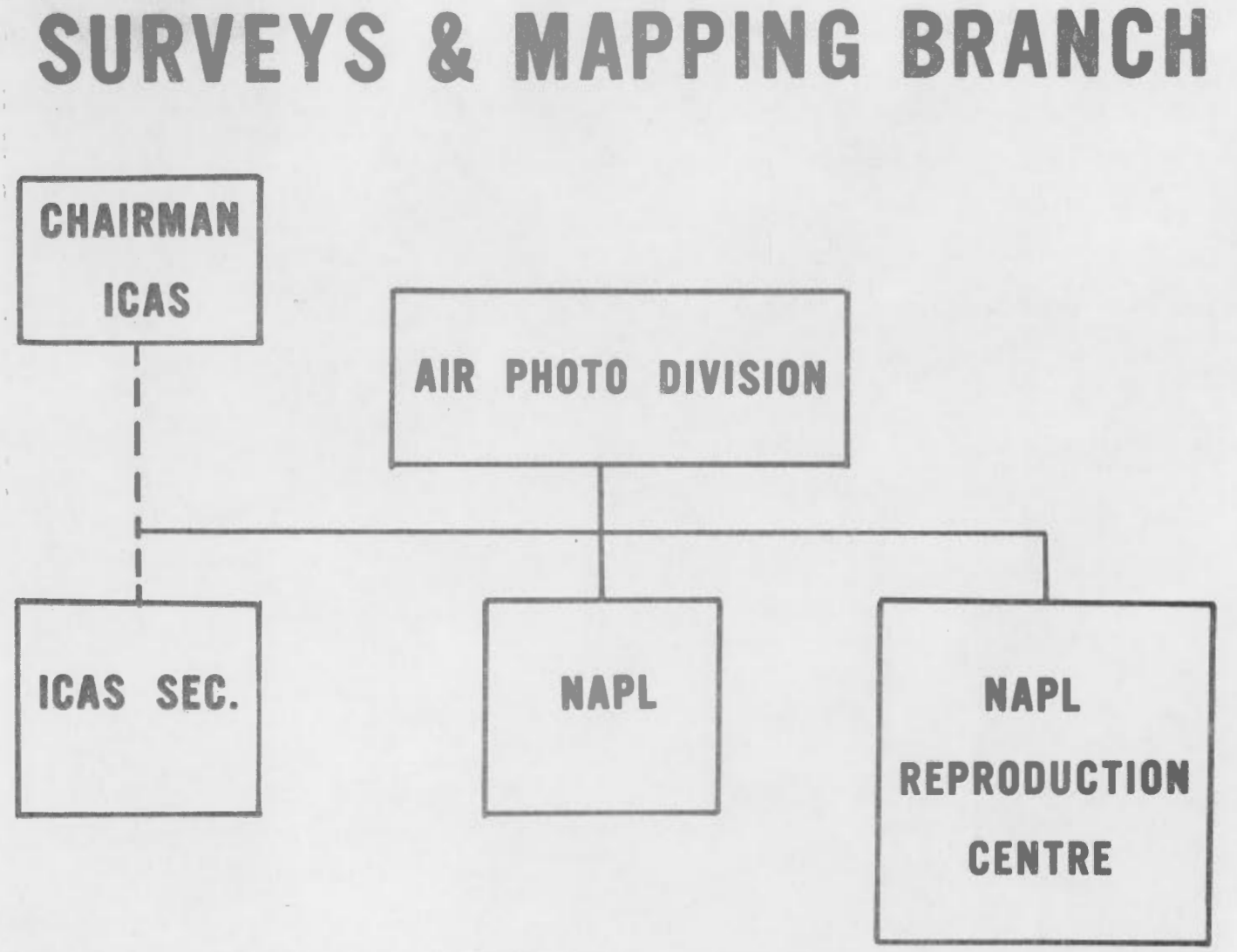

FIGURE 4

ICAS - Organization within Surveys and Mapping Branch

CONTROL SURVEYS

Paper Presented
by:

J.V. Thompson
Geodetic Survey of Canada
Surveys and Mapping Branch

CONTROL SURVEYS

Today it is my privilege to talk to you about control surveys, and, hopefully, to bring out some association between what we do, and what you do.

I would like to start off with a brief outline of the Geodetic Survey, its organization and responsibilities. We are a division of Surveys and Mapping, and directly responsible to the Branch Director. We have a nominal establishment of 102 permanent staff and 57 man-years casual staff, and our current budget is approximately $3,400,000. The division is organized into a field group of four sections whose primary responsibilities are to collect control survey data; and an office group of three sections whose prime responsibilities are to process, store and distribute survey data, plus a small capability for research and development.

The objective of the Geodetic Survey is to fulfill the federal obligations in the field of Geodesy and to ensure that national systems of control surveys are readily available to effectively serve all phases of conservation and use of the Canadian physical environment for the present and future benefit of the nation.

Now that you know who we are and why we are here, I will try to associate our work to those areas where I believe you have an interest. First, I would like to give you a brief look at the national vertical and horizontal control systems as they exist today. You have copies of these maps so I won't spend much time on them. Behind this basic framework is a tremendous amount of lower-order levels, baseline and meridian levels in the west, river levels in many parts of the north, trigonometric elevations in the horizontal control networks, and barometric levels used in the mapping programs.

The Horizontal Control Framework consists mainly of ground triangulation, augmented by Aerodist (an airborne method of establishing horizontal control at a spacing of 60 to 100 miles). In the far north, where ground triangulation and Aerodist have not ventured, the framework is supplied by the Shoran network (Shoran was another airborne method of establishing horizontal control at a spacing of from 200 to 300 miles). As in the case of the vertical control, behind this rather tenuous framework there is a vast amount of lower-order control, much of which was established to provide control for the 1/250,000-scale mapping program.

One of the major tasks of the Geodetic Survey is to incorporate all these lower-order surveys, both vertical and horizontal, into consistent, homogenous systems, controlled by high order frameworks.

One of the basic responsibilities hidden within the general statement of objectives is the provision of control for the National Topographic Mapping Programs. As you are aware, the 1/250,000-scale program was completed several years ago, and the prime thrust of the branch at the present

time is the 1/50,000-scale mapping program. I won't attempt to outline the 1/50,000-scale program, I am sure Topographical Survey will do that much better. It is suffice to say that the Topographical Survey checks with our Data File and decides if adequate data is available to produce a map or block of maps to the desired standard; if the data is inadequate we are asked to produce what is needed.

What we are asked to produce may vary from a few photoidentifications of existing control points, to a complete horizontal and vertical control system. To illustrate a complete system I will use a medium sized project we carried out in the Peel Plateau area of the Yukon last summer. This project provided complete horizontal and vertical control for a block of 80, 1/50,000-scale sheets, and in addition, left a monumented system of good quality control for future use in the area. First we produce a horizontal control system by running perimeter control around the block using second-order traverse methods, connecting to higher-order stations in the national framework, breaking down the block with an internal traverse grid and at the same time producing a grid of trigonometric elevation control by the simultaneous measurement of vertical angles between the horizontal control stations. In this particular example, the southern portion of the area is rough and mountainous so we put in a denser grid here, not because we need it for horizontal control but to provide better vertical control. Over this trig elevation grid we superimpose a network of barometric traversing controlled by the trig elevations, and thus provided the detailed vertical control needed to compile the 25 or 50 foot contours. More detailed information about this project and a similar project carried out around Great Bear Lake in 1971 is shown on the display boards at the back.

We also supply horizontal control for mapping in conjunction with our Aerodist operation. Aerodist is an airborne method used to produce high-order control at a spacing of from 60 to 100 miles; there is an example illustrating the 1972 Aerodist operation on the display boards.

To indicate the status of mapping control in northern Canada, I will fall back on some Topographical Survey material, and trust I am not stealing something from a later speaker. During the years 1973-76, we expect to look after the requirements in Keewatin, with the exception of the northern bump which the Mapping and Charting Establishment of DND will handle, in northern Quebec, and in northern Ontario and Manitoba, this year. We are have discussions with DND at the present time and it looks as if the Mapping and Charting Establishment will handle the requirements in the Hudson Bay Islands and Baffin Island in 1974 and 1975. We expect to look after the western requirement in 1974-75. Vertical control requirements are handled at the same time as the horizontal control. There are some additional vertical control requirements, but these will be handled by the Airborne Profile Recorder system which is managed by Topographical Survey.

To sum up, if all goes well, the control for the 1/50,000-scale mapping program will be completed on the northern mainland by 1975. There will

doubtless be some specific requirements in the Arctic Islands, but the major problem is not the lack of horizontal mapping control, but anomalies and inconsistencies in the present system. We are proposing a major two-year project, starting in 1974, to establish an overall doppler satellite grid throughout the Arctic Islands and at the same time integrate the existing traverse networks to the doppler grid, improving the traverses network by additional traverse ties, etc., and adding azimuth control. We also propose to determine the position of Greenland relative to Canada to a high degree of accuracy. I understand that Topographical Survey proposes to establish the vertical control by augmenting and improving the Airborne Profile Recorder system which was established in the 1/250,000-scale mapping program.

In southern Canada, the picture is not quite so clear. Most of the 1/50,000-scale maps have been published, and it is a case of determining whether map revision will require additional or more accurate control; Topographical Survey will make this decision.

Now I would like to be more personal, and talk a bit about control surveys in such places as national parks, selected Indian Reserves, settlements and development areas in northern Canada. Over the years we have done some of this work for you, and have often been consulted on work eventually done by private contractors. In the main, I think we have met your requirements, and you have obtained the particular map or plan that you needed. We have always been a little unhappy about the fact that these jobs were "quick and dirty" to meet an immediate need, and quite often, within a very few years, it was necessary to go back and extend the survey, or even re-do the survey to a higher standard of accuracy, or re-do it because the stations of the original survey were inadequately marked and the stations are gone, and so on. Wherever possible, we highly recommend that every piece of federal property that is large enough to worry about should have thoroughly planned horizontal and vertical control system which is adequate to meet all foreseeable needs, either in itself, or by extension or densification by relatively cheap, low-order methods.

Suppose you have several thousand square miles of parkland and park development can be seen going on for many years, we think you should have an overall high-order horizontal control framework, preferably first order. For example, some 10 or 20 stations scattered over the park at 5 to 10 mile spacing, this first-order framework would be followed by a systematic second-order traverse breakdown connected to the first-order work, and these traverses would provide a control point, good for all practical purposes, within a mile or two of any place in the park. These two parts of the system should be well monumented, and the monuments protected and maintained, even to the extent of erecting neat little picket fences around those located in well travelled areas subject to vandalism. Similarly, a vertical-control system should be established based on a first-order line or grid with second-order breakdown. In suitable terrain, or with special monumentation the two systems, vertical and horizontal, can use the same monuments. Such systems are expensive but the long term benefits are immense.

You will save yourselves a lot of trouble, and a great deal of money over the years. We know, we have the same problems as you; we are spending millions of dollars integrating many millions of dollars worth of discordant surveys, done at different times, by different people for different purposes, into two national homogeneous systems so that we can meet the needs of our users.

It has been suggested that I talk a bit about the establishment of 3rd-order control for large-scale photogrammetric topographic mapping. I think I will by-pass this one. We have not been directly involved in establishing control for such a project, and our tendency is to shy away from any surveys of 3rd-order and lower these days, as we have more than our hands full with first- and second-order work. Legal surveys has carried out on one or two projects of this type on Indian Reservations.

When we take on a job for a client department, as we are usually not funded for such work, we ask the client to pay. Up to now, we have not been too difficult to deal with. We ask the client to fund the actual field costs of the project; this includes field travel expenses, salaries and benefits of casual summer employees, rental of aircraft or vehicles if required, etc. We do not charge for the salaries or benefits of permanent staff; planning costs; data processing costs; depreciation of instruments, vehicles and trailers; camp equipment or other overhead costs. With cost recovery rearing its ugly head, this may change.

If you want us to do a major job for you, such as I outlined for a first- and second-order system in a large park, we would want at least a year's lead time. Even when funds are supplied from outside, it can sometimes be quite a job to fit such a project into our normal program. It is probable that a reconnaissance of the area would be required before we could come up with a detailed plan and costing. Monumenting for vertical control benchmarks should be done a year in advance if the benchmarks are in soil, and so on. We might take on a small job on fairly short notice, or advise you that we could do it next spring or in the fall; but nowadays, if the job involves only 3rd- or 4th-order surveys we will probably recommend that you do it by contract. However, we are always available for consultation on any survey matter regardless of order or type of survey.

After field observations are obtained, they are processed in-office and are placed in our control-survey data file. This file has always been, and still is, a manual file. We have map indexes which show the location of practically all federal control surveys in Canada, and a considerable amount of provincial and even private surveys. We are presently reviewing the status of all surveys on our record in order to determine the quality of each survey, and to determine what, if anything, needs to be done in the field or by an office readjustment to improve the quality of the survey and fit it into the national systems. For the past year or so we have been developing an automated data file, where survey data is stored in an electronic computer, and can be recalled and distributed on short notice. We have a pilot project pretty well in hand now, but just when the whole

file, both vertical and horizontal, will be automated as a question. A fair amount of money is required to get the whole thing done, and we just don't have the funds required at the moment. In the meantime, we can supply data fairly promptly, just ask us for what you want, either by letter, Geodetic Survey, 615 Booth Street, K1A 0E9, or telephone Ottawa 994-5079.

I have talked quite a bit about first-second- and third-order control, but haven't really specified what I meant by these various orders. A new "Specification for Control Surveys" is to be issued by the Branch; but it is a bit esoteric and is based on things like degrees of freedom, error ellipses, confidence levels etc., all of which require considerable explanation, so to illustrate the different orders of survey I will stick with the old specification originally published in 1961, and shown below.

Horizontal Control

Maximum Anticipated Errors in Adjusted Horizontal Control

		Length	Azimuth
First Order	Distance greater than 400 miles	$2\sqrt{M}$	4"
	Distance less than 400 miles	1 in 50,000	4"
Second Order		1 in 20,000	10"
Third Order		1 in 10,000	20"
Fourth Order		1 in 5,000	40"

M is distance in Miles

Vertical Control

Maximum Anticipated Errors in Vertical Control (Feet)

First Order	$0.035\sqrt{M}$
Second Order	$0.07\sqrt{M}$
Third Order	$0.20\sqrt{M}$
Fourth Order	$1.0\sqrt{M}$

Note that these are maximum anticipated errors, and should seldom if ever be exceeded. The actual accuracy of the surveys will normally be considerably better than these maximums.

First-order horizontal control is used primarily to establish the national framework on which all the lower order surveys are tied in. It is also used to provide area frameworks for control of municipal coordinate survey systems. Second-order horizontal control may be used in the national

framework to get survey control in to where it is needed; it is also the first level of breakdown in a municipal system. Third-order horizontal control might be termed as the working level control, this is the breakdown of the still rather scarce second-order control to provide a control point readily accessible for use in tieing-in the corners of a lot by fourth-order methods, or locating services on city plans, i.e. sewers, gas lines, telephone conduits etc. In municipal surveys, first-order spacing of stations will be from 5 to 7 miles, second order 1 to 2 miles, and third order 1/4 of a mile or less.

First-order vertical control, like first-order horizontal control, is used primarily to establish the national framework. We are actually starting to do some of our levelling to a slightly higher standard, and eventually all new levelling will be to this higher standard. First-order is also used to form a perimeter or even a grid of control for municipal surveys. We do not actually carry out any second-order control in the Geodetic Survey. If we get involved in a breakdown of first-order control, we do it by one-way first-order levelling. Third-order levelling is used primarily for mapping control.

Practically all of the lower-order levels just mentioned are third-order levels, the river levels, baseline and meridian levels etc. A considerable amount of third-order levelling was done in the 1/25,000-scale mapping program.

I have talked a great deal, and I can only hope I have hit upon some things of interest to you.

DISCUSSION PERTAINING TO MR. THOMPSON'S TALK

Question: Could you plan irrigation systems, extending over 10 miles, from a 1/25,000 map?

Answer: You probably could, for a distance like that, depending on the contour interval you want and whether your vertical control could be adequate or not. I think if you are looking for three-foot contours, no. If you were looking for ten foot contours, maybe. If you will accept 25 foot contours, yes.

Question: Has there been special geodetic surveys of the larger cities?

Answer: This is true. Ottawa has been done, for example. For many of the larger cities we have provided both the first-order horizontal control and the second-order breakdown. The cities and municipalities have gone on to do the third-order and the fourth-order tie work. We have provided them with a good deal of first-order vertical control and some breakdown of one-way first-order control and they have made further breakdowns. Most of the major cities in Canada have been covered.

Question: I understand that the Geodetic Survey has found large errors in the DLS system. Where are these errors and how large are they?

Answer: I can't give you an exact answer on that. It was done quite a while ago. We didn't tie our system to the DLS we tied the DLS to our system. It was very systematic over a large block of the country out west. It was between 50 and 100 feet.

Question: Do discovered errors change the size or shape of farms, reserves, etc.? What about the International Boundary? Is it in the right place?

Answer: The International Boundary is no problem at all. First, the monuments are on the ground and a monument doesn't move, and second, it was a very good overall control survey system along the whole boundary.

Question: Where is the International Boundary in respect to the true 49th parallel? I believe in some places the parallel is well inside the USA.

Answer: In places. Some places it's in Canada, some places well North of the 49th and some places south of the 49th. It doesn't really matter. In boundary surveys, particularly one where it is marked on the ground, and where the marks on the ground are well tied in to a complete control system and we know exactly where it is, we can put it back if someone tears out a monument. Whether it's North or South of the 49th doesn't really matter, it's where it's marked.

Question: Is it practical to order all the 1/50,000-scale maps which are published?

Answer: Sure. At .50¢ a sheet. You had better hurry, it might go up.

Mr. Burton announced that the National Parks of Canada have provided funds for an investigation into all the types of control in National Parks, and is engaged in that study at the present time. The purpose of the study is to determine in what parks first- and/or second-order control will have to be done so that a third-order control net can be established for large-scale mapping. It is hoped to have this study completed some time in July or August of this year. When this study is completed there will be a meeting with the National Parks to determine what net density of third order control will be required for their future mapping.

LARGE AND MEDIUM SCALE MAPPING

Paper Presented
by:

L.M. Sebert
Topographical Survey Directorate
Surveys and Mapping Branch

LARGE AND MEDIUM SCALE MAPPING

The 1:50,000-scale series is very important in Canada because it is the largest scaled, most detailed mapping that exists for a large part of the country. At present most of the settled areas are covered as well as many areas of northern Canada which are of economic or defence interest. The present production of the Surveys and Mapping Branch is about 350 new and 200 revised sheets each year, and present plans call for the completion of coverage of Canada within 30 years. The actual count of sheets produced or in manuscript at the present time is as follows:

Printed	-	4,700
In manuscript	-	800
In early stages of compilation	-	600
Not started	-	7,050
		13,150

There are actually two problems in satisfying the needs of the Canadian 1:50,000-scale map user. First of all there is the problem of providing the user with a reasonably up-to-date map of his area of interest. The second problem is providing the map that will be most useful to the majority of users. In short, there is the problem of production, and the problem of design. The design aspects will be considered first.

Most countries of the world turn out a map at about 1:50,000 (i.e., 1:63,360, 1:62,500 or 1:50,000). In fact, the only countries of any size not mapping in this range of scales appear to be Finland, Peru, Saudi Arabia and Somalia. There is, of course, a certain resemblance in the maps turned out by the world's mapping agencies at 1:50,000 and kindred scales. For instance, all show the railway net; all depict the drainage in the same way; most, if not all, show individual dwellings outside the built-up areas; most divide roads into different categories depending on the road construction; most show vegetation either by a green area tint or by symbolization. In considering the design of a 1:50,000-scale map the map designer is, from the beginning, assisted by certain conventions that have, quite rightly, gained world-wide acceptance. He has, however, some freedom in deciding the following items in his specifications:

(a) The actual scale of the map

(b) The horizontal and vertical accuracy of the map

(c) The number and type of colours to be used

(d) The precision with which a feature will be described: for example, whether a coniferous forest will be distinguished from a deciduous one, etc.

(e) The method of portraying relief, and, if by contours, the contour interval

(f) The extent to which minor features will be depicted. The examples here are almost without number, and range from decisions on the symbolizing of such features as gravel pits, quarries, historic sites and camping sites, to the depiction of anchorages and submarine contours

(g) The general usability of the map in conditions of adverse weather and poor light

(h) Whether or not the map will use more than one language.

In Canada the design of the 1:50,000-scale map has evolved mainly from the military maps at 1-inch-to-1-mile which were started in 1904 in Southern Ontario. As the original topographers were members of the British Army on loan to the Canadian Government, the original maps bore a distinct resemblance to the British 1-inch mapping. As maps at this and the 1:50,000 scale have always had an important user in the military, the question of general readability was settled from the first. The sheets must be usable in the open in poor light. Regional influences did, of course, play a role in the development of this series, and some of the symbolization used on the Prairie 3-mile maps was originally carried over to the early 1-mile sheets of Western Canada. However, over the years the depiction has been standardized, with the decision to use, alter or drop a symbol being the result of:

(a) A change in the user requirement

(b) The cost of the field-work to determine the position and extent of the symbol

(c) The cost of the office work to plot or to revise the symbol

(d) A change to modernize the appearance and precision of the sheets.

To examine the efforts to produce the best possible Canadian 1:50,000-scale map, it might be well first to examine the various classes of users of this scale in an effort to discover what information each wants to obtain from such a map.

To bring the requirements of the various map user classes into perspective, Table 1 was constructed to illustrate the various users and their requirements in the three general categories into which map information may be divided; this is: horizontal measurement (lengths, distances, areas etc.), information on heights above sea-level, and general terrain depiction. Not all users demand the same degree of accuracy from the map in furnishing information in these three map information categories. Each category has therefore been given two sets of limits beyond which the error or omission would be considered serious:

(a) Horizontal measurement

Primary importance - an error of over 1/8 inch in a measurement of 10 inches

Secondary importance - an error of over 1/4 inch in a measurement of 10 inches

(b) Height information

Primary importance - an error of over 25 feet in a height read from a map

Secondary importance - an error of over 100 feet in a height read from a map

(c) General Terrain Depiction

Primary importance - an omission of, or error in, over 10% of cultural detail

Secondary importance - an omission of, or error in, over 25% of cultural detail

The following are some observations which can be drawn from this chart:

Probably the most surprising result of this investigation is the discovery of the limited number of users of Canadian 1:50,000 maps who employ them to take accurate length and distance measurements. It would appear that only the military user is really interested in horizontal accuracy. Engineers, geologists, even geographers, expressed the thought that the 'nearest quarter-inch is good enough'. This is in direct contrast to the requirement for vertical accuracy where criticism is easy to find concerning the 50-foot contour interval which is used on many sheets. Engineers in particular expect to find precise 25-foot contours, and indeed put surprising trust in the contouring in such projects as designing saddle dams around artificial lakes, construction of irrigation canals, etc. The question rising from this appears to be 'is the horizontal accuracy that is at present built into the 1:50,000-scale series really necessary?' It must be understood that with modern photogrammetric methods of map compilation it is difficult to separate vertical and horizontal accuracy. The photogrammetric model, from which the map is drawn, is scaled horizontally and any error in this scaling produces a concomitant vertical error. But the map designer should specify his contour interval with great care, for the user is often frustrated in his work by trying to interpolate between precisely drawn contours at too great an interval.

The chart also illustrates the proportional size of the various user classes, and it will be noticed that those using the 1:50,000 for precision measurement are small in number but important from the point of view of resource development.

MAP ACCURACY REQUIREMENTS

Users	Horizontal Measurement	Height Information	General Terrain Information	Class % of Total Use
1. Engineers	Secondary	Primary	Secondary	8
2. Administrators (various levels of gov't)	Secondary	No req.	Primary	19
3. Business (not including petroleum or mining but including real estate development)	Secondary	No. req.	Primary	6
4. Armed Forces	Primary	Primary	Primary	25
5. Tourism (including recreation and travel)	Secondary (unless orienteers or automobile rallyists, in which case interest would be Primary)	Secondary (unless they are mountaineers in which case Primary)	Primary	15
6. Educators (use in schools and universities)	Secondary	Primary	Primary	15
7. Scientists	Secondary	Primary or Secondary depending on field of investigation	Secondary (unless investigating geographical distribution of cultural phenomena in which case Primary)	2
8. Land Surveyors	Secondary	Secondary	Primary	1
9. Geographers	Secondary (unless comparing land use by area etc. in which case Primary)	Secondary	Primary	1
10. Geologists and others in petroleum and mining industry	Secondary	Primary	Secondary	8
				100

Many scientific users, such as engineers and geologists, are little concerned with the completeness of cultural detail. If sufficient culture is available for position location they will be satisfied. The tourist, of course, wants his map to reflect a proper view of the countryside, and is considerably more demanding.

Almost all users of the 1:50,000-scale series know of the problems in keeping a large series such as this up to date. Hence few are alarmed to find the outskirts of cities somewhat out-of-date. Rather unreasonably, some accept this urban explosion but expect the road network to be as up-to-date as the annual oil company road maps. Almost no user, however, is prepared to forgive a down-grading in the quality of information shown due to the change from plane-table methods to photogrammetry. In former days the topographers covered, on foot, every square mile of settled areas, and hence all buildings were correctly classified, all portages and rapids were discovered and labelled, the classification of forests was correctly made into at least three categories (coniferous, deciduous, and scrub). When this detail is less precisely depicted today, critics are quick to point out the deficiencies. They do not realize how much more accurately the contours, drainage, and forest edges are plotted today.

Topographic map production problems usually stem from a heavy user demand for new and revised sheets from a government mapping agency operating on a fixed budget that is not immediately adjusted in accordance with the law of supply and demand. The production of the Canadian 1:50,000-scale series is no exception. However, there are problems, other than the mundane shortage of personnel and funds, which are influencing the production of sheets of this series.

In 1947 the armies of the NATO countries decided to standardize their military maps on the natural (or metric) scales of 1:25,000, 1:50,000 and 1:250,000. Canada was at the time using the 1-inch-to-1-mile scale, and when the Canadian Army decided to adopt the 1:50,000 there immediately arose a conflict in requirements. The tremendous expense of publishing at both scales made such a solution unthinkable. After due consideration, and the realization that Canada would eventually adopt the metric system, the decision was made in 1949 to publish at 1:50,000, but with spot heights and contours in feet.

This decision was not universally popular. In fact, certain important organizations (such as the Geological Survey of Canada and the mapping agencies of the Province of Ontario) have ever since taken the 1:50,000 sheets and reduced them to 1:63,360. But the decision was made, and this triggered a number of design changes. The increased size of a 15-minute by 30-minute sheet made it too large for the military presses of the day, and each sheet therefore had to be divided into two halves. This in turn caused a major reorganization of the border information so that sheets that were now longer in the North-South direction could be fitted economically onto standard size paper.

Very little change was made to the face of the map in going from 1:63,360 to 1:50,000, and in fact it can be proven that less information is now carried on our maps due to the reduction in field work mentioned previously. The exceptions to this are those 1:50,000-scale sheets derived from 1:25,000 where almost all of the cultural symbolization of the larger scale is carried. Sheet 92 G2 New Westminster is an example of this heavy but legible depiction of culture.

Other less drastic conflicts of interest have occurred between user classes. The depiction of forest cover is not needed by some users, and it becomes a nuisance if they want to symbolize other land characteristics by a colour code. The presence (or absence) of detailed cadastral information is another point of contention. For many years a special edition of the 1:50,000-scale sheets of British Columbia has been prepared for the British Columbia Government without a green tint, but with individual timber and mining claim outlines and numbers.

The question of the rectangular grid is another design conflict that has come to a happy conclusion (in the opinion of most users). Originally the 1,000-metre grid was a military requirement, but as it is the only practical point-referencing system, its use has grown during the last few years in civilian circles, especially in the engineering, scientific and administrative fields. By changing from the rather oppressive purple to a screened blue the appearance of the gridded map has been much improved.

The Surveys and Mapping Branch operates under a budget provided from the annual tax revenue, and in so doing must compete with all government operations for funds. No one will argue the necessity for topographic mapping in the development of Canada, but this work must be considered in relation to the many other vital works and projects. The result is that the Branch always has more work than it can handle, and good planning (and good engineering) must be employed to produce the maximum amount of mapping within the confines of the budget. The result has been to turn to a less elegant and less complete product, the provisional map.

Various styles have been tried in the past, each producing certain economies. The first design was the Arctic Provisional Map which came out in 1956 and employed only two colours, blue for the open water and the grid, and black for all other detail. In actual fact the black plate was prepared by photographing the manuscript. The blue plate was quite simply and quickly prepared by printing the black manuscript-image on peel-coat, and peeling open the lakes and wide rivers. It had many disadvantages. The line work and the hand-numbered contours were not professional looking, the single-line streams became confused with contours, and any culture that existed tended to get lost in the general black background. However the maps were suitable for Arctic areas where the culture is sparse and where they are used only by experienced map users.

For areas south of the Arctic but not heavily settled, an improved provisional style appeared in 1959. On this map all lines were scribed,

but still only black and blue colours were used. All drainage was printed in blue to avoid the confusion of black streams and black contours. All other detail was printed in black with the forest cover indicated by a tree-patterned stipple. This style reduced photo-mechanical and printing time, but the fact that all line work was scribed meant that little time was saved in drafting.

With the increase in use of two-colour presses it was found possible to improve on the 1959 provisional by employing four colours. These are black for culture, blue for drainage and brown for contours. Red and green were used as 'swing colours', as it was found on many sheets that the green forest cover predominated but the few roads could be shown in black. On the other hand, on the prairies there are many localities with a good road net but no forest cover, and here red would be used. In those localities with both roads and forests the fifth colour must be used, so that often a sixth colour (orange for secondary roads) is used as well.

The problems of the production of 1:50,000-scale mapping have already been mentioned in the discussion of user requirements, map styles and budget limitations. The production program that has been developed within these guidelines and restraints is outlined below.

In general, it may be said that new and revised maps in this series are produced on demand, but the annual demand is always greater than the annual production capability. Therefore decisions have to be made in balancing the effort, for example, between new mapping and revision, between the oil country of the Mackenzie and mining country of the Coppermine, between the hydro-electric interests of Northern Ontario and the forestry interests in central Quebec. It is probably sufficient to say that all demands for mapping are very carefully considered and the annual effort is turned in the direction that will benefit the country most.

All mapping that is done fits into the basic framework of the National Topographic System, so if the current schedule of 350 new sheets and 200 revision sheets per year is maintained, complete coverage will be available by 2,000 A.D. However, for the sake of survey efficiency an attempt is being made to keep new work in large blocks where full advantage can be taken of modern survey aids such as Aerodist, the air profile recorder, and computer block-adjustment.

With the large presses now available, the two half sheets have once again been joined to produce a 15- by 30-minute quadrangle. This produces a large map in a size that is very popular with the user. (No adverse comment on this change has been received except from map librarians who now report that the shelves they have installed are too small.)

Much greater emphasis is being given to field checking on those sheets with appreciable culture, and thus to a certain extent the surveyor is being put back into the area being mapped in order to gather the detail that cannot be obtained by photo interpretation.

In symbolization, it is still the intention to identify public buildings such as schools, churches, post offices, etc., but there is no plan to return to the symbolizing of country industries such as saw mills and cheese factories.

In forest cover, only one classification is shown and that is a green tint for a wooded area. Landmark trees will not be shown, and orchards will be depicted as a wooded area, but will be labelled.

The symbolization must, of course, take count of the regional peculiarities of the vast reaches of Canada. When the 1:50,000-scale mapping penetrated the Arctic a number of Arctic symbols had to be intorudced, such as those for string bogs, palsa bogs, tundra polygons, eskers, and pingoes. On the Prairies where water is a valuable commodity, symbols for springs, dug-outs and wells are used. The marvellous Prairie landmark, the grain elevator, has recently returned to the 1:50,000-scale series (as the symbol E) after an unaccountable absence of many years. The location of telephone lines is still of use as a landmark and a communication indicator in wilderness areas, and a symbol is provided, but it would be ridiculous to try to apply such a symbol in rural Ontario.

It is possible to make a few predictions about the way ahead, but it must be emphasized that none of the following has been passed by the Surveys and Mapping Branch Policy Committee.

First of all, there is a general feeling among Canadian map users and map producers alike that the cartographic frills and niceties of past years are no longer necessary. The clean-cut appearance of the present provisional map is proving popular, and this, with minor modifications, may become the standard format.

The photomap is seen as a most useful map substitute. It certainly will precede the line map in many areas, and for many Canadian regions (e.g., flat tundra areas) it may provide the most useful of all cartographic depictions.

Finally, that typically Canadian problem, the language to be used on the face of the map, must be discussed. As has previously been mentioned, a bilingual surround has been used since 1960, but to date the labelling of features on the face of the map has been done in English. These labels are far more numerous than the average user suspects (on the East half of 92 G/3 there are 170), and they include such features as greenhouses, golf courses, theatres, radio towers, race tracks, hospitals, transformers, peat cuttings, tunnels, pilings, swing bridges, etc. In addition, there are abbreviations which use the initials of English words such as DND, BM, DOT, CNR and so on. There are also qualifying adjectives such as abandoned, under construction, underground, etc.

The present policy is to symbolize as many of these features as possible and in so doing remove the necessity for the label. On the above

mentioned sheets, there are four oval tracks, all drawn to scale, and all dutifully labelled 'race track'. They could hardly be anything else, and when this sheet is revised the label will be dropped. It would be easy to devise a golf course symbol, a hospital symbol, and quite a few others for the more common features now labelled.

But symbolization is not the complete answer. For very small symbols such as swimming pools, gravel pits, greenhouses, etc., the label may be needed to draw attention to the symbol. In other cases the symbols, no matter how cleverly designed, would be difficult to distinguish from the symbols of other similar features.

It would seem that the most logical solution is to continue using labels but to carry them in the language used in the area shown on the map. There would be several advantages, as follows:

(a) It would aid the principal user of the map. With large-scale maps of settled areas the local inhabitants form the largest body of users. They, then, would be accommodated by having the language of the map in their native tongue.

(b) The map would give a clear indication of the language used by the majority living in the area. This is valuable demographic information, and for many map users would be as important as an indication of, say, the drainage pattern. Businesses planning sales campaigns, for example, would find from the map the language their salesmen will have to use. There are many other uses.

(c) Topographic maps would be an aid in bilingual instruction, and would hlep the traveller in translating road-signs, etc. For example, if you have lost your exact position on the map in eastern Quebec, and in trying to spot yourself you look around and find a company sign which reads 'Carrière Letourneau', you won't be helped if your French is weak and your map shows only the word 'quarry'. This same type of map language instruction would interpret parish and county boundary signs and all manner of road-signs both private and public.

Very little confusion would result from this policy. Most Canadians old enough to use a topographic map have a reading vocabulary in the second official language of at least a hundred words, many of which are the common terms for geographical features. For strange words the position on the map often discloses their meaning, and if this fails, the legend is always at hand.

In conclusion, it should be stressed that the specifications of the Canadian 1:50,000-scale series are not rigid and unyielding, but in fact are adjusted periodically to meet the changing needs of the country. Major changes in style and design tend to confuse the map user, and in this regard we have probably been guilty of too frequent alterations during the past two decades. The nine different styles listed in the current Catalogue of Published Maps give evidence of this. However, the present specifications

(with possibly some of the alterations that have been predicted) should produce a series that will satisfy the major needs of the user, and be economical to produce.

DISCUSSION PERTAINING TO MR. SEBERT'S TALK

Question: 15 years is a period for revisions to what?

Answer: For the rural and recreational areas. As I mentioned 99.9% of all Canadians live and work in the areas where sheets have been published, so we cannot let our revision cycles slip because we would not be serving this very large segment of the Canadian population.

Question: A number of people have been worrying about mapping time. We keep hearing about lead time. Could you suggest a time frame for setting up a project, including budgeting, control, etc.?

Answer: Yes, I would like to start answering that question by quoting Mr. Baker, who mentioned that for the coming season's photography, he would like all orders in by the end of the calendar year, by the 31st of December. If the orders are in at that time, there is no problem for us to find a good contractor who will fly your photography in the late spring when the snow is gone and before the leaves are on the trees. Then with photographs in the contractor's hands, the compilation time depends on how large a job it is, but unless it is a very big area, I would estimate about three months or maybe a little less. So by the end of the summer you should have something in your hands to look at.

Question: Would that time include obtaining the control?

Answer: That is a different question. There may be monuments in the area. There is no place in Canada that is much more than 40 miles from a monument. So in Parks and Indian Reserves, the monuments are probably there. The contractors then would have to go to the field and put targets up on the monuments. If he has to do a local survey, and it depends upon how big the area is, all of this, of course, adds a bit to the time, but don't be misled with this two and three years. That would be the installation of new first-order monuments which in very few cases are necessary to project. I would think that it would be an unusual job that you couldn't have finished the same year. Perhaps Mr. Burton will contradict me on that one.

Comment: I would like to comment on that. In many cases, if it is indicated to us that you require mapping of an area at certain scale and contour interval, then we will investigate to find what photography is available and suitable for producing that type of map. If photography is not available, and generally speaking the density of control that we require is not available to produce the map, then we issue what we call a package contract, including the photography, the control and the mapping.

Now if we are told say in October or November, that next year an x amount of large scale mapping (I am speaking now of a scale of 100', 200', or 400 feet to the inch) is wanted of a substantial sized area, I would say that probably you should be able to get that, weather permitting, and God willing, etc. by November or December of that year. Possibly if it is a small area, we would be able to give it to you in August or September. If photography and control is available, we should be able to furnish a manuscript of the area in question within six weeks to two months. Now I would like to ask Mr. Anderson to comment on this. He acts as our monitor and inspector and is also in charge of what may be called, the mapping program.

Comment: I'll make just a couple of comments. I was thinking as the question was posed, that a complete job, when all the information is not available, when there is not suitable photography, (in terms of both scale and vintage) or content (does it show what you want), and if there is not sufficient ground control in the area, we would prefer to let a package contract rather than go through the ICAS for the photography and to another contractor for control and mapping.

If you let a package contract to a member of the Canadian aerial survey industry, you are much more liable to get your job done and get it done correctly. If you want just a few line miles of photography flown in Nova Scotia or some remote place, it is not a very attractive proposition to a contractor. But if you ask for control, mapping and photography, all in one job, then it is an attractive proposition for him. Also there is another advantage. If, when you check the map, it is not correct in the final analysis, there is only one to blame, and that is the contractor. He can't say "You gave me the wrong photography" or "You gave me poor control". The responsibility rests with him.

In the case of a package contract, the figure I had in the back of my mind, from the time that you submit the job to Mr. Burton, whom I assume would need two or three months of lead time to do financial planning, until you would have a printed monochrome map in your hand, is something in the order of one year. I think you should be doing your planning in late fall so that he can tell us at the first of January that National Park X, 25,000 acres, is to be mapped at 200 feet to 1" with 5' contours. That gives us time to write specifications, set up the job properly, and get it out to industry. This alone, if we had nothing else to do, is a six week period of writing specifications. Going out on a tender call to industry requires three weeks. And we, of course, have many other things to do. If you really need an area where there is deciduous foliage or even if you have tall grass, and want five foot contours, and the grass is that high, you have a problem right away. Generally speaking, you should be thinking of spring photography, that is really the only suitable time to get photography. Many times you have to take something less than that. If you are not going to get spring photography, you are not going to get a good product. It is just about as simple as that. If you try to get fall photography, you have long shadows and invariably the first snowfall brings down the leaves but you have snow on the ground. Occasionally you might get lucky depending on location of the area, but you should be thinking of spring photography.

So put your request in in the late fall, I don't know whether that is what Mr. Burton likes, but we certainly like to have him give us a full program about the first of January so we can write it up. The contracts can then be awarded in March, so that when the snow goes they can get in and do their photography. Ground control, if necessary, can be put in in the late winter; your mapping then can be started in May-June, and your compilation done during the summer or early fall depending on the size of the job. Drafting, again depending on the size of the job, can be done from September to October or September to December and you will get your job about the end of the year.

We have a problem with getting the industry to produce on time. In general, they turn out a good quality product but there is a real problem getting them to produce on time. Realistically, you should allow a year from the time you think you want a map until you get it. Don't start thinking about it in June, and come in and say I need a map. I say the next time you can get good photography is next spring. So you have a problem. You are into this cyclical review where you should be reviewing your needs in late fall with the idea that in a year from now you want a map. If you are not in phase, it could mean more than a year.

In another case where Mr. Burton says you must have something, you need it now. These situations come up all the time. We look to see what photography exists and then predict what quality of map can be prepared from it. There is a direct relationship between the flying height and the contour interval that can be produced. And as a rule of thumb, if the area is open and you can put adequate spirit level elevations into it; divide the flying height by 1500 to find the best contour interval. If it was flown at 7500 ft. and you wanted a 5' contour, you could have it. Divide the flying height by 1200 if it is not as open, to find the contour interval. If compilation depends on aerial triangulation, divide the altitude by about 800. Also you have to consider the date of the photography. If the photography was flown fifteen years ago and you want to show some development done since then you are just beat. But if you find that you do have photography and if you do have acceptable control, which usually is not the case (because control is not always located in the right spot for the photography) then something can be turned out fairly quickly. Mr. Burton said something like six weeks to two months. I think that is optimistic. I believe that if it is a very small area, we will do it ourselves. This is no problem. If it is a substantially large area, it would be something in the order of about four months.

There is one other point if I may take the liberty to mention to the field surveyors here, and that is identification of control. I have emphasized the problems as I know them. The one thing that gives us more problems than anything else, is the matter of identification of horizontal control. Very good surveyors can close a traverse to one part in 50,000 and then drive a nail through a photograph and say, "that is where the point is". You should know that the resulting map is not going to be too accurate. The identification becomes all important. Have I covered what you wanted?

Comment: Gentlemen, you have heard from the expert. He mentioned that we have trouble with contractors. This is the first year in which we will be putting penalty clauses in contracts in the hope that we can bring more integrity into the mapping and air survey industry. In other words, if they agree to produce on a specified date and they don't produce, it is going to hurt them as well as hurt us. Thank you. You had a question?

Question: What is the cost of aerial photography?

Answer: It is very hard to put a cost on a thing without looking at it. The compilation costs of a 200' to 1" map with 5' contours is around $.75 an acre, but there is a relationship between the size of the job and specifically the flying height. When it is flown at the optimum flying height, it is much less expensive to get 5' contour than from photography flown too low because you have fewer photographs and stereo models to deal with. There was one other point I would make. Mr. Sebert mentioned it and I would like to emphasize it. Be realistic in asking for contour intervals. We get cases of people wanting 5' contours in Long Beach National Park through coniferous trees 50 or 60 ft. high. How on earth can that possibly be done? It is foolish. They can be compiled in open areas or up the side of places like ski runs in Banff National Park. Trailor your contour interval to what is realistic because if you tell us that you want a 5' contour your cost will be higher. The cost is directly related to the flying height which in turn is related to the contour interval you want. So don't ask for something you don't need. If you need 5' or a 2' contour for certain purposes by all means ask for it. Try to sort out in your own mind what you really need.

Question: What flying height do you recommend under normal situations?

Answer: It depends what you want. It is tailored to what you want. If you are talking about a 200' to 1" map with 5' contours and in an open area, it could be flown at 7500'. If the area is covered with vegetation, and access is difficult and you must go through the aerial triangulation process to establish supplementary control, you are probably down to something like 4800'.

Question: Isn't it cheaper, quicker and just as accurate to hire a local surveyor to map an area on the ground, especially something less than 200 acres?

Answer: I don't believe I am qualified to answer that for I don't know the cost of local surveys. But there are some things you should bear in mind. If there is something you cannot get from a photogrammetric operation, for example, if you want to put a 5' contour through 100' trees, then obviously you have got to do it on the ground.

Question: Is it not cheaper to do an area of 10 acres by ground survey?

Answer: There is some point I suppose, at which it is better to do a job with a plane table or by a similar method.

Comment: There is one important point about putting out a package deal contract, I am not sure whether Mr. Anderson mentioned it or not, but it is cheaper and we can assure ourselves of better service than by having one outfit do the photography, another the control and still another the mapping.

Question: If penalty clauses are used what about bonus clauses for finishing early?

Answer: No, there are no bonus clauses.

Question: Is vertical control necessary for producing a sketch map?

Answer: I don't believe you can plot contours without control.

Question: Why not just establish a zero point (vertical reference) and start from there? Don't reference to sea level but just to an arbitrary zero point. Have a basic relief map.

Answer: Yes, but to scale the map, you still need control. Where there is horizontal control, there is generally vertical control handy and you might as well reference it to sea level and then it will be useful to other people.

Comment: For a small area where you have an adequate water surface you could probably level on the water if you had a horizontal scale distance, but you would not be turning out a standard product. Your product would be sub-standard.

Question: Do you publish rough figures on the cost of aerial photography for estimating purposes?

Answer: Yes there are figures and they change every year, but that is what you have an expert like Mr. Burton for. He can give you the rule of thumb cost and he can do the mathematics like dividing the flying height by 1200 and all that sort of thing. Consult your expert even before you get your project underway. I hesitate to quote contract costs because they change so drastically depending on how hungry the contractors are when your job comes along.

Question: Can you prepare some kind of budget for a job so we can know the costs involved?

Answer: I think that probably we could get something drafted up for the costs now and then a year later we could give you new costs. Mr. Burton is as near as the phone, they say.

Comment: If our various clients, let us say the Parks Branch, the Indian-Eskimo Affairs Branch, and Historic Parks give us their requirements far enough in advance, we will certainly be able to furnish a fairly firm estimated cost on the project so they can dig up the funds. But we need lead time. The one thing to remember, ladies and gentlemen, is the lead time.

Question: You spoke about the detailed maps of Finland and on their mapping of the different type of trees. Is it practical for you to do this kind of work say for a national park, I am thinking of requests made by forest conservation people.

Answer: Yes it certainly would be possible, but we would have to bring in specialists. They have resident foresters and we don't because we have agreed amongst ourselves that this is impossible for Canada. But for a park area or some small area we could have this done for the forested areas and incidentally we had Queen's University do a study of a typical park map. Waterton Lakes Park is an example, and if any of you are from that area, you will remember two years ago how they had students talking to people who were going into the park and those coming out of the park and they assembled quite a body of information which we are studying to try and produce a prototype park map that will be a lot better than those in existence and I anticipated one of the questions you may ask is why are our park maps so out-date and so lousy. You have kindly not asked that. It is just that we have so much else to do, we are going to get around to park maps as quickly as we can and now that you people are paying for mapping, I should think that those interested in park maps will put that high on your budget.

Question: Does not the Dept. of Environment employ foresters who could help with the identification of tree types?

Answer: Yes of course, and our own federal foresters are working on it but we have never included this information on a typical topographic map.

Comment: Forest inventory maps being prepared by our Deparment are on a scale of 1320' to 1". There is a lot of that being done at the present time.

Mr. Burton announced that he would like to have, on Thursday morning, a meeting with the Parks personnel from the Regions and the program branches at Headquarters who are interested in the mapping photography situation and on Thursday afternoon if at all possible a meeting with the Indian Affairs people. If this can be arranged he thought some of the problems that have just been thought of may be resolved.

Question: Is there a legal reason why mapping cannot be contracted locally?

Answer: I don't believe there is any legal reason why you can't deal with local contractors. Mr. Baker said that there was legal reason why you can't get air photography locally. So far as I know it is OK for mapping very small areas. Maybe Mr. Anderson can answer.

Answer: No reason at all. We are not jealous of private contractors. If you can get it done to your satisfaction locally by all means do so.

Question: How important is an inspecting officer on contract work?

Answer: If it gets around that you are not checking work, you will find the quality may go down.

We are going into lunch time. I presume that all of you know you can get on the mailing list for indexes and for status maps like that green one--there is another one coming out in about four weeks time. They are an annual event. Cards which tell you the publication of new topographic maps are also available. All of this can be arranged at the Canada Map Office which you will visit on your tour. So we will be back at one thirty.

CADASTRAL SURVEYS

Paper Presented
by:

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Legal Surveys Division
Surveys and Mapping Branch

CADASTRAL SURVEYS

Throughout this seminar you will be hearing a great deal about mapping. The one unique feature of my paper is that our product is quite different from the normal product of our branch, in that our division deals with legal surveys or definitive property surveys. To describe our division one could say that the Legal Surveys Division engages legally qualified land surveyors to carry out legal surveys.

In the next few minutes I will attempt to explain our apparent obsession with this word legal by placing it in the context of our purpose and primary function. The Surveyor General who heads our division is charged with managing the surveys, subject to the administration, direction and control of the Minister of Energy, Mines and Resources. He is charged with managing all surveys of lands under the Canada Lands Surveys Act. In addition to this act there are a variety of other acts under which we operate. To name a few; the Canada Mining Regulations, Canada Oil & Gas Land Regulations, Land Titles Plans Regulations, Territorial Lands Regulations, Yukon Placer Mining Act, Yukon Courts Mining Act, Canada Mining Regulations, Territorial Dredging Regulations, Dominion's Water Power Regulations, and the National Parks General Regulations.

This list may help to clarify why the word legal appears as part of our divisional title and why we refer to our surveys as legal surveys. The distinction to be drawn is not legal as opposed to illegal, but that all our surveys are carried out to the provisions of Acts or Regulations and the intent is to establish the limits of legal rights in property.

The chaps who do this are known as land surveyors and you will run into two types of them as you travel across Canada; the Dominion Land Surveyor who qualifies under the federal jurisdiction, and the Provincial Land Surveyor, either Ontario, Manitoba or Alberta as the case may be, qualifies under the various surveyors acts of the appropriate provinces. To arrive at the exalted state of obtaining a commission as a Land Surveyor, either Dominion or Provincial, the candidate is required to serve a term from one to four years under article and to successfully pass the examination prescribed by the appropriate Board of Examiners.

In the case of a university graduate with a degree in Surveying Engineering or a closely allied science, the requirement in most jurisdictions would be one year of articles and from 6 to 10 examinations. In the case of a high school graduate with neither a university degree nor a graduation from a technical school, it could amount to maximum of four years articles and up to 35 examinations. In the past decade, the examining boards have continually been increasing the number and improving the calibre of exams so that today you will find those who obtain commissions as land surveyors virtually have to be graduates of the technical school as a minimum, and we hope that in the very near future graduation from a university in a surveying engineering course will be the basic requirement.

To discharge his responsibilities as the manager of Crown Canada Lands, the Surveyor General and the division he heads have two primary functions, regulatory and operational.

The regulatory function involves the establishment of standards to control and maintain the quality of surveys under his jurisdiction. The current standards are found in the "Manual of Instructions for the Survey of Canada Lands". This manual includes specifications regarding such details as methods of survey, accuracy, monumentation and the returns of surveys, by that I refer to the plan of survey and the relevant documentation. In addition, specific instructions are issued for each survey to deal with the peculiarities in that particular survey.

To maintain the quality of such surveys, our division has a Plans Examination Section, which takes the incoming plans, whether they are done by staff surveyors or by contract surveyors and gives them a rigorous examination to ensure that they comply with specific instructions and that they are in accord with the provisions of the manual.

In addition to this, our regional people carry out ground inspection surveys on a random basis. They pick these surveys arbitrarily, generally in areas that they are to visit for some other purpose. They also pick surveys done in the past two or three years and do a field inspection of the survey. This generally entails measuring about 10% of the distances, checking the quality of the monumentation, the line cutting and blazing, and particularly the evidence that the surveyor used to establish his survey, which is evidence of the previous surveys.

The operational function consists mainly of the surveys services we provide to client departments, that is the execution of the surveyors requested of us each year by staff or contract surveyors. Theoretically these requests come from any department of the federal government, in actual practice, virtually 100% of them come from your department. The survey requests come directly from three separate branches, as you are well aware, the Indian-Eskimo Economic Development Branch, which requests about 80% of the total; Northern Economic Development Branch, accounting for 15%; and National & Historic Parks Branch, with about 5% total. Indirect survey requests come about when private individuals, corporations, or provincial governments wish to acquire some right in the land which you administer.

To go on to the actual organization of our division, we have the administrative headquarters and all our office sections located in Ottawa, just across the street, and we have nine regional offices, located in Amherst, Quebec City, Toronto, Winnipeg, Regina, Edmonton, Vancouver, Whitehorse and Yellowknife. Prior to 1972, our entire staff was located in Ottawa and worked on a seasonal basis across Canada, however, this was found to be less than satisfactory in that we continued to fall behind in the demand for surveys. So starting last year, we went through a regionalization campaign, in which we set up these nine regions, with the exception of Vancouver, which has been operating since 1961. All the other

regions were established in the past year and I am sure many of you had occasion to deal in one way or another with our regional personnel. I will have a bit more to say about the regional setup later on.

The main purpose of this new organization is to place more emphasis on the administration of surveys and much less on actually doing the surveys. In the past, we wrote contracts only where our own staff could not cope with demand, however, under the new setup, our guidelines are to do about 25% of the surveys with our own staff and the remainder will be contracted out to the surveyors in private practice throughout Canada. This policy allows the staff of our regional offices to play a much greater consultive and educative role in dealing with our clients. This is critical in the case of the officials of Indian Affairs and also the Band Councils because many of these people, due to their background, do not have an adequate knowledge of the complexities or technical dimensions of a legal survey and our regional personnel will be there to advise on whether a survey is needed, if so, what type is needed and give them guidance in that way. And we hope that both our headquarter and regional staffs will make a point of attempting to provide these services to the best of their abilities and we hope that you, in the regions, will use them.

The division is broken down into several sections, Instructions and Support Section, Field Surveys, Plans Examination, Administration and Research Development and Training. We will look briefly at the functions of these sections. The Instructions and Support Section prepares and issues instructions to surveyors and negotiates contracts with private surveyors, compiles and drafts reference plans and prepares legal descriptions. The Instructions Group writes survey instructions authorizing the survey, outlining the area to be surveyed and if it is complex or non routine, giving specific technical instructions. Routine specifications as I mentioned before, are contained in the manual. With these instructions, we provide the surveyor with copies of relevant legal plans, control data that they might need, National Topographic Maps, or anything else they will require to execute the survey properly.

The Drafting Group, as the name implies, is employed primarily in drafting reference plans of Indian Reserves, and in the North, of maintaining our group sheets. These are essentially indexes used to correlate all legal surveys within a given area. On the reference plans of Indian Reserves there is also included a table of transactions which shows the complete history of the land dealings on the particular reserve.

The Descriptions Group writes precise and concise legal descriptions of parcels of land for inclusion in various legal documents such as Crown grants, Orders-in-Council, leases, visaes, permits, etc. In short, wherever there is a transaction or regulation affecting the Crown Canada lands these are passed to the Field Section.

As I mentioned earlier, the increasing requests for legal surveys forced us into regionalization. Through the regional offices we expect

that staff in regional offices will be able to play a major role in expediting all our surveys. The regional surveyor travels extensively throughout his region, investigating proposed surveys, holding discussions with the Band Councils on request - or at his initiation - and also meeting the various District Indian Affairs staff helping them to set up their survey priorities, giving them advice on the best type of survey and giving them some feeling for the probable cost of the survey. An advantage of regionalization is the advisory role where the regional surveyor is in the area and can deal directly with your staff as well as with the Indian Band Councils. In the past we did not have staff in those areas, with the exception of the short summer season. At that time the surveyors were generally so bent on completing their projects while the weather held, that they weren't particularly keen on getting involved in many lengthy discussions. It was an unfortunate fact of life and we hope that this new policy will give them and you the time needed to discuss these matters. The surveyor can also discuss proposed land developments. The planners approach a proposal from only one aspect. The land surveyor can possibly at times point out limitations to the proposal or suggest minor modifications which will expedite the finalizing of plans and make sure that it doesn't run into any unforeseen snags.

The surveyor can also negotiate to a much greater extent with the contract surveyors which we are now using because he is in the general locality, quite often in the same city, and they can get together over the phone or in one of their offices and discuss things in general. We feel that this will enable our regional surveyors to get a much better feel for the different contractors we deal with and visa-versa. The contractor will get a better idea of who we are, how we operate, and what we want from them.

The surveyor in the region can also expedite the issuing of instructions. In the past, this process of drawing up instructions was quite often delayed a considerable length of time due to lack of information in the documentation and we had to contact Indian Affairs Headquarters who would contact the region, who would come back through that chain of command and eventually we would get the information. With our staff permanently in the region there is a much faster exchange of data and the regional surveyor can probe to the bottom of each survey request and there is a much better likelihood that we will not lack any documentation when we start to write the survey instructions.

Since many of our surveys, particularly Indian Reserves and National Parks, are in the provinces their boundaries must of necessity contact provincial land. The regional surveyor because of closer contact with provincial officials can be in a much better position to expedite such surveys, because these surveys have to be prepared to conform with certain provincial requirements or else the province gets up in arms. This causes delay in certain surveys just to get them into shape so the provinces will find them acceptable.

Another reason in favour of regionalization is the longer survey season. In the past, our men went out in April or May, depending on the area of Canada they were going to, and returned anywhere from September for the Arctic parties to November at the latest for most of southern Canada. This was because while there are days, before or after the season, in which you can operate technically, there was so much bad or cold weather it wasn't worthwhile to keep a full party in the field. With the regional setup, if an important priority survey comes up, the regional staff are already in the area, not back in Ottawa, so they can look into the job and see if they can possibly send a crew out to do survey on the spot. In the past, it would generally have meant that the department would have been advised that next April or May, we would send our parties out into that area and would talk to them.

The Plans Examination Section is a section I mentioned before. Their basic function is to control the quality of surveys by checking the plans, relative field notes and other documentary records submitted by the surveyor, as well as this, they manage the Canada Land Surveys Records, which is another responsibility placed on us by the Act. This section comprises 17 Plans Examiners and checks about 600 plans a year. The examination of a plan is quite an important matter because the plan provides the only link between the paper proof of title and the survey which defines the actual title on the ground. You will appreciate that once a person has a proof of title, any errors that are uncovered subsequently in the survey, which might result in him having to move a house over, or some such thing, is not going to engender much good will for surveyors. So we ensure that, to the best of our abilities, by the time the Surveyor General approves a plan, it is correct legally and technically, and within the terms of its content and the requirements of the Act and Regulations under which it was made.

There are six categories checked on a plan. Together they add up to some 85 items, but I won't bore you with all 85 items. The first category is layout. The first thing we check, and this sounds rather surprising, is that the surveyor did survey the piece of ground that he was asked to do in his instructions. It is not the usual thing to find that he hasn't, but there have been occasions in the past where he incorporated parts of other lands or neglected to incorporate all the lands that Indian Affairs had requested be surveyed. The approved sketch or the description given to us by Indian Affairs with their request is the basis for our confirming that he followed his instructions in that regard.

The second category is the status of the land. Since our surveys apply only to work done under the Canada Lands Surveys Act, we have to ensure that the surveys which the Surveyor General confirms deal only with lands as defined by this Act. Occasionally we have discovered that surveyors have incorporated small bits of provincial lands or privately held lands which, of course, he had no business incorporating. We could not approve or confirm them because they were not under our jurisdiction.

The third thing to check is the mathematical data and this is easily the simplest and the least important. The computers today can check plans at a very fast pace and this ceases to be a time consuming thing. It is a simple matter of listing the dimensions of the boundaries and running it through the computer and the computer says it is okay or it is not. If the survey does not close mathematically, there is a little search to find out where the blunder or the error is and rectify it. In some cases we have to go back to the surveyor to get additional information. The reason that I said that the dimensions are the least important part is that it is a recognized principle of law pertaining to real estate that the monuments on the ground are the controlling factors in determining the extent of the person's possession, so if the monuments are placed 101' apart and the plan says they are 100'- well the monuments govern. The dimension on the plan has to bow to the actual position on the ground. Also we are not interested in the precision that the Geodetic Survey or Topographical Surveys might be interested in because of this principle that the monuments govern and the dimensions are really just an indication to enable you to find your way back to the positions of those monuments. We would like to think that in the surveys made today, the measurements are of a fairly high standard and I think as a general rule they are, but this is not the critical factor.

The fourth category in examining a plan is completeness. We much check to ensure that the surveyor has done everything that is required by law; for example, all plans must have their dimensions substantiated by field notes, these being the original field notes that were taken in the field, quite often spattered with mud, rain and dead mosquitoes, but in the eyes of the court the original field notes are the record of every aspect of the survey and the thing the judge will give first authority to.

In addition, the surveyor must connect his new surveys to previous ones if there are any in the vicinity; the field notes must have a sworn affadavit on them in a prescribed form, certain types of monuments must be used to mark certain types of survey corners and the designation of the parcel of land that the surveyor has created must be described in the prescribed manner.

The fifth category is the evidence. Almost any survey made today is either a subdivision of a previous survey or it adjoins a previous survey. To avoid having little gores and wedges of land which are not covered by the new plan, is very critical. The surveyor must take every effort to find the original monuments of the previous surveys so that his survey will cover exactly the area covered by the previous survey of the subdivision or adjoining park land.

The sixth category is of great importance only to Legal Surveys; it is the accounting procedure where surveys done under contract have to, of course, follow the various rules and regulations that our department requires. After the plan has been declared correct mathematically and technically, it is sent to your department or another department administering the lands, for the Minister's approval. It is then returned to our office and the

Surveyor General signs it, confirming it, and it is passed over to our Lands Surveys Records Group where they give it a record number and record it in the Canada Lands Surveys Record. A copy of the plan is sent to the appropriate registry office in the district in which the survey is made. The register or the master of titles as the case may be in that area records the copy there and sends us a record of his number under which it has been recorded.

At present we have about 35,000 plans, and about 7,000 field books in the Canada Lands Surveys Record. We just recently completed micro-filming our entire records and have provided copies for our Regional Offices and to your Headquarters, and the masters have been sent to the Public Archives for protection against disastrous fires which could have destroyed our entire records previous to this micro-filming process.

The Administration Section handles just the normal routine administration of our Division, they are involved in the preparation of financial estimates and program forecasts. They process accounts, contracts, and look after personnel and the procurement of furniture and supplies.

The basic concern of the Research, Development and Training section is research in all phases of the work of the Legal Surveys Division to enable it to properly discharge its regulatory and operational responsibilities. We do this by performing research into methods, instruments, and new techniques. We also are charged with revising the manuals and various specifications and directives issued by the office of the Surveyor General to ensure that they are contemporary and in tune with today's status of the art, in both the technical and other aspects of legal surveys, and we try to look ahead to the years to come and to second guess some of the problems that the public will be confronted with and how they affect our operations today.

One way in which we are doing this is by the initiation of coordinate surveys in settlements and areas where there is a relatively high density of surveys, because the cost today of resurveying areas after the original monuments have been destroyed, with much of the survey fabric, is becoming just too excessive. We have to try to come up with some way of enabling the surveyor to go back into an area after the bulldozers and builders have passed through and get these monuments back in the ground at a reasonable cost.

We see these coordinate surveys as being at least a partial answer. The area is blanketed with very dense monumentation which is accurately measured and adjusted by least squares to give the best possible values for each control monument. The legal survey fabric is tied to these control monuments and in the event of destruction, by going to the nearest control monument.

Another area of interest to the Research and Development Section is oil and gas rights, both in the Territories and the Offshore. You are all

aware of the offshore development that is taking place and, of course, on the territorial side of things there has been quite a bit of exploration going on for some years. This section devised the system by which oil and gas leases are controlled. The entire geographical area concerned is sub-divided into grid areas which are further sub-divided into sections and units. These are all defined by their geographical coordinates so that in the exploratory stage, the oil companies just by using the National Topographical Series can generally locate themselves quite adequately for the purpose of exploration and do not have to get involved with expensive legal surveys. It is only at the production stage that the Canada Oil and Gas Lands Regulations require a full-blown legal survey. Then it is a simple matter of defining on the ground, the boundaries as defined under this system. In the offshore case, it is a much more complex problem in that while we have the same system set-up, monumenting on the high seas is a bit of a problem, and unfortunately at the moment, we really haven't got an adequate system for accurately positioning points several hundred miles offshore. Amazingly enough, off the east coast, some of the areas under consideration are in excess of 400 miles offshore. So an awful lot of our effort in the past couple of years has been devoted into research on instruments available and methods of positioning and we are collaborating with the universities and Hydrographic Surveys in attempting to come up with a good system before some oil company comes up with a good well. We sort of work against the odds and we have to more or less pray that they don't come up with a producing well in the near future.

A function that ties in a little more closely with the branch operations is our experiments with Photogrammetric Survey. Since 1958, we have been experimenting using photogrammetry to replace conventional ground measurements on legal surveys. Our first experiment was on the Alnwick I.R. near Peterborough where we positioned about 280 legal corners by means of the photogrammetric process. We also did the entire survey by conventional means, so that we would have an accurate comparison between the two systems. We discovered that the accuracies were generally acceptable on short lines, the maximum difference in the length was in the order of 2 inches; however, we found that it was much more expensive than by conventional means. To a large extent we attributed this to the fact that it was a relatively small area and, of course generally speaking, the benefits of photogrammetry are obtained over large areas. In 1961 we attempted to repeat the experiment on the Cornwall Island I.R., and benefitting from the mistakes and the inefficiencies of our previous attempt, we were able to come up with costs which were comparable to conventional surveys. The third attempt was made at Caradoc I.R. and this was the first one of fair extent. It covered 18 sq. miles and dealt with about 1,000 legal corners. In this project we got away from the dense ground control we had been putting in for the previous photogrammetric tests and used perimeter control with the block adjustment to establish secondary control for the models. There were some 84 models controlled in this scheme. Again the accuracy was much the same as the first two surveys and the cost was, if anything, slightly less expensive than conventional surveys. Over in the corner we have a display which deals with the Six Nations Reserve near Brantford. This one covered about 50 sq. miles and there were about 1100

legal corners positioned. We found again, our cost and accuracies were much the same as the Caradoc I.R. It still seems that the big criterion of the advantages of the photogrammetric approach is that it has to be a fairly extensive area and, of course, the tree cover has to be reasonable. The less tree cover you have, the more points you can identify right on the ground, without extensive cutting of trees around property corners or off-setting your target to get out where the targetting will show up on the air photo.

Of course, above and beyond the actual benefits we derived is that the photogrammetric surveys can also provide as a by-product all of the additional natural and artificial features of the area covered to the planning people, the administrative people, and everyone involved in administering the Indian Reserves or whatever the area under consideration is, that is important. If the legal boundaries are plotted with respect to this information it will give future generations the opportunity to graphically review the position of the legal boundaries with respect to the terrain, an advantage which, when we are looking at surveys of a hundred years ago, we did not have. We have often wished we had because the inaccuracies in the measurements of surveys 100 years ago are such that sometimes the accuracy obtainable by just scaling it on an air-photo would be far better.

Another off-shoot of photogrammetry that we are starting to explore, is the orthophoto mapping technique, which you will be hearing something about later on, and this, of course, because the resultant map shows all the detail of an ordinary aerial photograph with the added advantage of being corrected for tilt and relief displacement. Hence one can accurately scale distances or azimuths and determine conditions right off of the map with a fair degree of precision. We see this as being a very useful tool for surveys of Indian Reserves' holdings, because of the nature of the holdings. They are quite often scattered haphazardly all over the reserve and to survey by conventional ground means, requires hopping and skipping from one part of the reserve to the other, and it is a rather expensive survey. Also, in many cases, the documentation of these holdings is very sketchy, sometimes amounting to just a statement that John Doe has some right in some land somewhere on the reserve, and it is left to the surveyor to track down what his rights are and where they are, and the extent of them, once he locates them. With orthophoto maps of a reserve, the surveyor and the administrator can get together and with these vague descriptions and the sketches they have, which together comprise the register of the holdings of that reserve, they can identify the bulk of holdings on the orthophoto map. When the surveyor went to the field to make the survey, he would be much better prepared for it, he would know the magnitude of it, the number of holdings he was dealing with, and their extent. As it stands at the moment, in some cases, he goes out to prepare to start to work and does not know if he is going to be finished in a week or a month or if it is going to take him two seasons to finish it, because he keeps finding holdings as he progresses.

Finally I wish to mention the other new development which we are starting to look into, that is data banking, storing on a computer all the records pertaining to lands; their position, description, designation, and ownership. The type of ownership, whether it is outright, fee simple or lease or whatever the basis. Also assessment records, whatever information is appropriate or of interest to any party can be added to it. The method of putting the information into the computer is to identify it by a process called geo-coding which seems a promising one. It consists of entering the horizontal coordinates of the corners of each piece of land and by that means the computer can identify every parcel of land in Canada. These co-ordinates should be based on the U.T.M. system, which makes it easy to identify any peice of land anywhere in Canada.

Now that you have heard a bit about what we do in the Legal Surveys Division, if you have questions about any aspects of our work, I shall be glad to try and answer them.

DISCUSSION PERTAINING TO MR. MACDONALD'S TALK

Question: If I wanted to ask you to locate and tie in all buildings for a legal survey, is that generally done in all your work?

Answer: Sometimes it can be done but it depends on the circumstances. In the survey that Mr. MacDonald was talking about they made connections to the buildings because it was more or less a planning set-up, they wanted to make sure that the buildings would be included in the properties and not ignored at the time they were laying out property lines. I believe that's correct. It was because the town planner had used a totally uncontrolled line map on which to base his plan and we couldn't correlate it to the ground with reasonable accuracy. To ensure that our proposed lot lines would in fact fit when they were laid out on the ground we had to make sure we had all the buildings precisely positioned.

Question: Does that mean that it is the responsibility of the planning section to provide the information on the subdivision that will go out to private contractors?

Answer: Yes it certainly is ideal, when they do provide the appropriate and accurate information because it can really run up the cost of the survey without it. You can't get this correlation once you get on the ground.

Question: (Editor's interpretation) Question appears to deal with method of letting contracts.

Answer: No, we don't. We ask for estimates, and we make a study of the estimates to see which one is fairly reasonable. Really what it boils down to is, we usually ask for three estimates for a large job, and we accept the one that is closest to our own estimates.

Question: It gets around the bidding.

Answer: Yes, it is against the codes of ethics to ask for straight bids in all the provinces except perhaps Newfoundland. I might comment on this. We had a complaint from Newfoundland for not accepting a fixed price contract. At the same time one from British Columbia claimed that asking for estimates from more than one surveyor was getting into the business of bidding and tendering. Here we had contrasting complaints from opposite sides of the country on bidding and accepting estimates and fixed prices and so forth.

Question: Was this last one recently in B.C.?

Answer: Yes, just about in January as a matter of fact.

Question: Would you feel it a good idea if each region could coordinate its activities with respect to the laying out of subdivisions and the construction program within a district?

Answer: It seems to me this would be desirable, although it could be that with respect to a construction program, you may be doing engineering surveys which might have no effect on the legal surveys.

Question: (Editor's interpretation) Questioner wanted to know why the legal surveys were not done after construction so their work would not be destroyed.

Answer: I think actually that this is a very good idea. In my opinion there are many instances where it would be much better if the construction had taken place in the first instance. This is particularly applicable to highway surveys in the Territories. It is far better, when they are running through Crown Lands, to establish and construct the highway first and then do the legal survey afterwards. However, this can't always be done if there is some transaction needed between a private individual wanting rights in Crown Lands and Indian Reserves and National Parks and sometimes you have to do the legal survey first.

Question: What are the mechanics if you haven't a subdivision and you haven't completed the survey and the Band wishes to change it? Is there anything legal you can do or do you just go up and resurvey it?

Answer: I think really if you did that you would have to wipe out at least the part of the first survey that is affected by the change.

Question: How is that done?

Answer: It could be done by just a simple request from the region. However, I think this can get to be dangerous under certain circumstances. Let us say some Indian or somebody in the park has been granted rights in a piece of land. Then you are getting into legal situations which might be a little tricky. But if no transaction has taken place, then I would say there would be no real problem. It would just be a matter of request. Does that answer your question?

Question: Yes, but I was wondering about procedure?

Answer: I think the best procedure would be to approach our regional surveyor in the first instance. He could take it from there.

Question: When you do a title search do you check the certificate of possession as well?

Answer: Yes, either that or probably we will ask the Indian Affairs staff to do it for us. We have done it on many occasions. I think that it is the duty of Indian Affairs, but often to get the job done, our surveyors have had to do it themselves. This will prohibit a lengthy delay, if the search hadn't already been done.

Question: Then quite often the certificate of possession will be from a fence post to a tree. Do you tie that down legall?

Answer: Eventually, yes.

Question: (Editor's interpretation) Question appears to deal with possibility of changing highway locations from those indicated on old plans.

Answer: Maybe the old plans still exist, but I think that some amendments were made in the Canada Lands Surveys Act in 1966. I think one of the amendments took care of the situation you are talking about. If your Minister wishes to make some amendment to a previous plan he can do so.

Question: I am thinking of the situation in the western provinces (Northern Saskatchewan) where there is no Canada Lands Survey. If the monuments are all destroyed what do they tie in?

Answer: This is correct, there are no township lines up in northern Saskatchewan, but ...

Question: What do you tie in, then?

Answer: We will tie into any geodetic monument that happens to be in the vicinity. If there is no geodetic monument in the vicinity we might tie into some other legal survey that happens to be nearby. Failing that, what we usually do, is tie into an identifiable feature on an aerial photograph, so that you could presumably always find the feature at some time in the future. Unless, of course, it was the corner of a building that may have been destroyed, but we would look for such things as a creek entering a lake or something that can be positively identified on the ground.

Question: Is that accurate enough?

Answer: If everything is destroyed, it may not be right on the nose, but I would say it would be pretty close. You can identify points, depending upon the scale of the photographs, within maybe two or three feet.

Question: How fast are we moving to tie all these surveys into the UTM grid?

Answer: We haven't gone very far. There are only six or seven coordinate survey areas. One is Whitehorse, one is the Yukon, one is Banff, one is Dawson, one is Ross River and there might be one or two others, but we have a long long way to go before all the surveys will be tied into the UTM grid. The provinces are just starting to get into this and as a matter of fact, there is bit of a problem because although we are advocating the UTM grid at the present time many of the provinces have their own systems, in other words they are using different projection system for their legal surveys.

Question: Is the UTM with 6^{o} zone survey used for legal surveys?

Answer: In the Territories, yes.

Question: Do you have plans to revise the Group System in the Territories to bring it into conformity with the UTM or NTS systems?

Answer: We are just going through that situation right now. We are hoping to revise the whole group system in the Territories to make it coincide with the NTS system and we already have a plan pretty well laid out. I think the next step in it is to install two people to see whether it is satisfactory to you.

Question: Can you tell us more about the plans, and will copies of the new sheets be available?

Answer: I think the thing to do is come over to our office and talk to Mr. MacDonald. He is the one who has been handling the situation, but we hope in the very near future, to revise the whole set-up so that a 1:50,000-scale map is the base of a group sheet or at least a subdivision, maybe I shouldn't call them group sheets anymore because we hope to get away from the group system, but the base I think will be a 1:50,000-scale sheet, except that it will be enlarged to 1:25,000 scale.

Question: When you register a plan of subdivision for a leasehold area, the plan is given a Canada Lands Surveys Record number, as well as a Land Titles or Registry Office number, is that plan registered in the Provincial Office or the Canada Lands Surveys Records?

Answer: Copies of the plans are required by the Canada Lands Surveys Act to be deposited in the local registry office. This doesn't necessarily mean that the survey is registered, but they are required to be deposited there. However, occasionally a registrar refuses to accept the plan, not because he thinks the plan is no good but because he seems to feel he has no authority to accept this plan, regardless of the Canada Lands Surveys Act. We have had problems in two or three places in Ontario in this regard and one registry office in British Columbia. For some reason or another,

apparently, they are pretty automonous. The registrars can interpret the acts as they see them and there have been cases where our plans have been refused.

Question: Does that mean then that the leasee does not have title to that land?

Answer: If it is a leasee it doesn't matter quite so much. The leasee can get title to something within a national park or an Indian Reserve on the basis of the administration here. However, the transfer of a title, does create a bit of a problem. The situation has actually happened in the past, something which we deplore very much. The prospective owner has had to have a survey made to satisfy the Canada Lands Survey Act and then turn around and have another survey made to satisfy the local registry act. We have taken steps to try and get around this and now whenever a transfer is anticipated, we will seek advice from the legal people here to see whether we can't have the survey done under Provincial regulations and this appears to be okay, so that we are going along with this principle now.

Question: Can you prosecute anyone for removing or damaging a monument?

Answer: You can't. As far as I know it has never been processed but we hope to amend the Canada Lands Surveys Act. We are working on some amendments now and one of them is that whoever damages a monument, no matter how or by what process, will have to either pay for its replacement, or have it done by a surveyor under our instructions. But regarding willful damage, there is no way you can prove this. To me the section of the criminal code does not appear worthwhile.

AIR PHOTO ANALYSIS AND INTERPRETATION

Paper Presented by:

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AIR PHOTO ANALYSIS AND INTERPRETATION

An aerial photograph is a true picture of a segment of the land surface containing all visible details at the time of exposure. In the hands of an engineer, resource manager or planner it becomes a technological tool that allows a rapid and economical evaluation of the land surface pattern and extraction of required information.

The management of natural resources, development of a new townsite, selection of proper site for a campsite, a river crossing or building a new road - all require careful planning based on an intimate knowledge of the land surface: physical characteristics of the land, its present biological productivity, potential capability, inherent limitations, etc. Numerous questions must be answered, such as type of the terrain, drainage conditions, depth to bedrock, kind of vegetative cover, size of the river, its gradient and material along the banks, character of shoreline along a lake, and many others. Some of the questions may be answered directly from a stereoscopic analysis of aerial photographs and limit field investigations to selected alternate proposals.

The purpose of my presentation is two-fold: to describe in a condensed form the fundamentals of air photo analysis and interpretation, and to illustrate the application of air photo interpretation techniques in the analysis of land surface and recognition of its physical and biotic components.

The final result of all airborne remote sensing systems is an image of the area under observation. This image may be stored on magnetic tape, telemetered to a receiving station to be transformed into geometrically corrected "hard copy" (photographs), or it may be recorded directly on a sensitized film and reproduced in a form of photographic print or transparency. Aerial photographs are the images of the sensed area obtained from aircraft, balloons, rockets, or satellites.

Aerial photography may be classified in several ways: geometric classification, scale classification, and spectral classification.

(a) Geometric classification - refers to the direction in which the camera was pointed at time the picture was taken.

- Vertical photography is taken with the camera axis pointed directly toward the earth.

- Oblique photography is taken with the optical axis of the camera pointed at an angle: high oblique and low oblique.

- Trimetrogon - a combination of oblique and vertical: three photographs are taken simultaneously, one vertical and two high obliques, in a direction at right angles to the line of flight.

(b) Scale classification - refers to the representative fraction and may be large, medium, small and ultra-small.

- Large-scale - larger than 1:12,000
- Medium-scale - from 1:15,000 to 1:31,000
- Small-scale - from 1:40,000 to 1:80,000
- Ultra-small-scale - smaller than 1:100,000

The scale of a vertical aerial photograph is defined by the focal length of the camera and altitude above ground datum. It is usually shown as a "representative fraction" (RF), which is a fraction of focal length and altitude above ground:

$$RF = \frac{f}{H} \frac{\text{(Camera focal length in feet)}}{\text{(Altitude above ground in feet)}}$$

e.g. f = 6" or 0.5 ft.
H = 18,000 feet.

$$RF = \frac{f}{H} = \frac{0.5}{18000} = \frac{1}{36000} = 1:36000$$

Scale may be also expressed as a map-ground linear relationship, e.g. 1:36,000 is 1" on photograph corresponds to 36,000 inches on the ground, or map-ground relationship is 1 inch to 3000 feet (36000÷12).

(c) Spectral classification - defines the segment of the visible electromagnetic spectrum in which the energy that exposed the film is located. Aerial photography may be:

- Panchromatic (all colors) includes the entire portion of visible spectrum from 0.40 to 0.76 microns wavelengths.

- Infrared - the exposing energy lies in the visible infrared region of the spectrum (0.76 to 1 micron).

- Modified infrared - exposed through a filter that allowed both visible and infrared light to pass through it.

All of Canada has been covered by aerial photography flown for federal, provincial or private agencies. Negatives and sample prints are on file at the National Air Photo Library in Ottawa (federal contracts), at some provincial centres (coverage of the province), and air survey companies (contracts for private firms).

A limited coverage by IR thermal scanners, SLAR and color aerial photography is also available from the above agencies. The Canadian Centre for Remote Sensing (CCRS) is a distribution centre for ERTS imagery.

British Columbia, Alberta, Ontario, Quebec and New Brunswick maintain their own air photo libraries and sell prints from available negatives directly. The National Air Photo Library in Ottawa maintains a complete listing of aerial photographs by years, flying height and types. Each roll of aerial photography flown for the federal government receives a consecutive number preceded by a capital "A". It is possible to tell from the roll number the year of particular photography, e.g., Roll Nos. A1 to A6510 were flown between 1928 and 1938, Rolls A21374 to A22205 during 1971, while in 1973 roll numbers are in the A23000 group.

Photo-interpretation is defined as "the act of examining photographic images for the purpose of identifying objects and judging their significance". The purpose of photo interpretation is to identify objects and collect information by the analysis of photographic imagery.

Interpretation of aerial photographs and other remote sensing imagery is a "tool science" and may be divided into three levels.

(a) Photo "reading" - elementary level, a simple identification or description of photo images without analysis of their meaning, (e.g. rivers, roads, trees, farmland, etc.).

(b) Photo analysis - break down of air photographic pattern into components, or elements - relief, drainage, erosion, vegetation, land use, tone, etc. related to the landscape under observation.

(c) Photo-interpretation - utilization of photo analysis techniques that enables skilled scientific or professional personnel to produce significant, reliable, and detailed information, concerning the natural or cultural features of the area photographed or sensed for a specific use.

These three levels may be better explained by the following example: let's assume we have a photograph taken of all of you sitting in this auditorium, where looking at this photograph one could "read" it as a "group picture" of people in a large room. One can distinguish a proportion of men and women, also one could observe something about their dress. This would be probably something like "photo reading".

When we look carefully at this group picture and describe the recognizable details of the room, analyze each person individually and group them by sex, dress, posture or other characteristics - this will describe approximately the second level, or photo analysis.

Applying the photo analysis techniques and adding more specific information, such as names and other data for each person in the group photograph, may be considered as the photo interpretation level.

In order to interpret an image the basic components of local environment must first be detected. Once detected they must be identified. In order to be identified the basic image components must be "sorted" or classified according to: size, shape, shadow, tone or color, location, texture, relationship to other objects.

Interpretation of remote sensing imagery is defined as an "art" and a "science". The "science" part may be mastered through intensive reading and study, but the "art" part must come from the actual working experience.

Some of the more important requirements of the photo interpreter may be listed as follows: formal training in the earth sciences or related disciplines, such as geology, geography engineering, forestry, hydrology, pedology, plant ecology; keen interest in the subject; inquiring mind, keen powers of observation and ability to reason analytically and logically; wide ranging travel and a good memory for details; ability to see relief stereoscopically; and familiarity with the main identifying features of various landscapes in different physiographic settings.

The final results may be presented at various confidence levels which are closely related to the objectives of photo analysis, complexity of the area, quality of remote sensing imagery, available data on "ground truth", experience and training of the interpreter, and others.

For detection, recognition and identification, the major features registered on remote sensing imagery may be grouped into two main categories: natural and man-made.

Figures 5 through 10 illustrate some typical examples of natural features related to physiography, geology, natural vegetation, water, natural shoreline features and combinations of these.

The man-made features, or man-modified environment may be seen quite clearly in Figures 5 and 7 prepared from black and white and color vertical aerial photographs. These man-made features may be divided into groups, such as agricultural features (cultivated fields, orchards, irrigated fields), engineering structures (dams, canals, bridges, reservoirs), mining and excavation (strip mining, open pit mining, sand and gravel excavation), industry and utility features (power plants, pipelines, pulp mills), transportation and communication features (highways, railroad, airports), and urban residential features (residential or business areas, schools, motels and hotels), and others.

The aerial photograph, the most common remote sensing tool, is composed of a pattern of images showing surface forms in various shades of gray tone or hues of colors. The analysis of this surface pattern on a three-dimensional model is the basic concept of the photo interpretation technique. Basically, it is a careful study of main components or elements that form the surface pattern. In the analysis of natural environment the following six main components or elements of the landscape pattern are considered: (1) Land form (2) Drainage (3) Erosion (4) Vegetation (5) Land use (6) Tone.

Landform is a topographic arrangement of surface features and is indicated by relief, relative size, shape and orientation of hills, ridges and depressions, degree of accordancy of ridges and boundary characteristics. Figures 6, 8 , 9 and 10 illustrate the regional relief and its characteristics: proportion of hilly, flat or depressional topography, relative length, breadth and height relationship of upland areas, lowland areas, etc.

Local relief is composed of slopes having a variety of surface configuration.

Drainage is any channel that carries run-off. It may be natural or artificial, continuous or intermittent. It is controlled entirely by soil permeability and ground slope. Figure 10 gives an example of external drainage or run-off, and erosion. Other types are internal drainage or permeability and drainage systems consisting of major streams, secondary streams or tributaries and headwater channels or gullies.

Major streams occupy basically a prominent position and follow old structural trends. Drainage patterns are often related to landforms and physical characteristics of underlying material. In stereoscopic analysis, drainage patterns are grouped by their shape and texture, which often indicate soil permeability and resistance of surface material.

Drainage of an area may be classified as a fine textured or coarse textured. Climatic factors of the area must be considered when applying drainage texture in evaluation of land conditions. As a general rule, the complete absence of surface drainage usually indicates a pervious material.

Many materials within a climatic region have a characteristic drainage pattern and texture directly related to their permeability and hardness. A fine textured drainage pattern occurs usually on silty shales in the area of heavy rainfall and high relief without vegetation cover, while a coarse-textured drainage is found in extensive sandy lake beds or outwash plains.

There are two major types of erosion: (1) blow out and streaks produced by wind; and (2) sheet erosion, rill and gully profiles produced by fluvial activity.

The density of occurrence and cross-sectional shapes and fully profiles are important indicators of texture and general cohesive properties of materials. Examples of the most common types of gullies associated with certain landforms and soil textures: (a) cohesive - silty clays and clays; (b) slightly cohesive - silts and sandy silts; (c) non-cohesive - sands and gravels.

In general, the fine grained silts and clays, being relatively impervious, have many gullies developed on their surface. Sands and gravels in contrast, being highly permeable, have few or no gullies. Climate, vegetation, ground slope, topography and locally a specific land use control the extent of gullying.

There is a close relationship between the vegetation types and physical land characteristics, and recognition of vegetative cover on aerial photographs is used frequently as an excellent indicator of local environmental conditions: kind of surficial material, texture, drainage, etc. Vegetation types - (forests, shrubs, grass) that are closely related to physiography and climatic conditions are shown in Figures 6, 9 and 10.

FIGURE 5

Small-scale (1:80,000) panchromatic vertical aerial photograph taken with a short focal length (88mm) superwide angle lens. Area covered is over 120 sq. miles. Land use pattern (Alberta oil field).

FIGURE 6

Medium-scale (1:15,840) modified infrared aerial photograph taken with a standard lens, (6" or 152 mm focal length). Area covered on a single 9" X 9" frame is about 5 sq miles.

Example of slumping topography, Organic depressions and a mixed pine-spruce forest cover on glacial till plain.

FIGURE 7

Large-scale (1:6000) panchromatic. Example of urban and industrial features. Area covered on a single 9" X 9" frame is about 0.5 sq. miles.

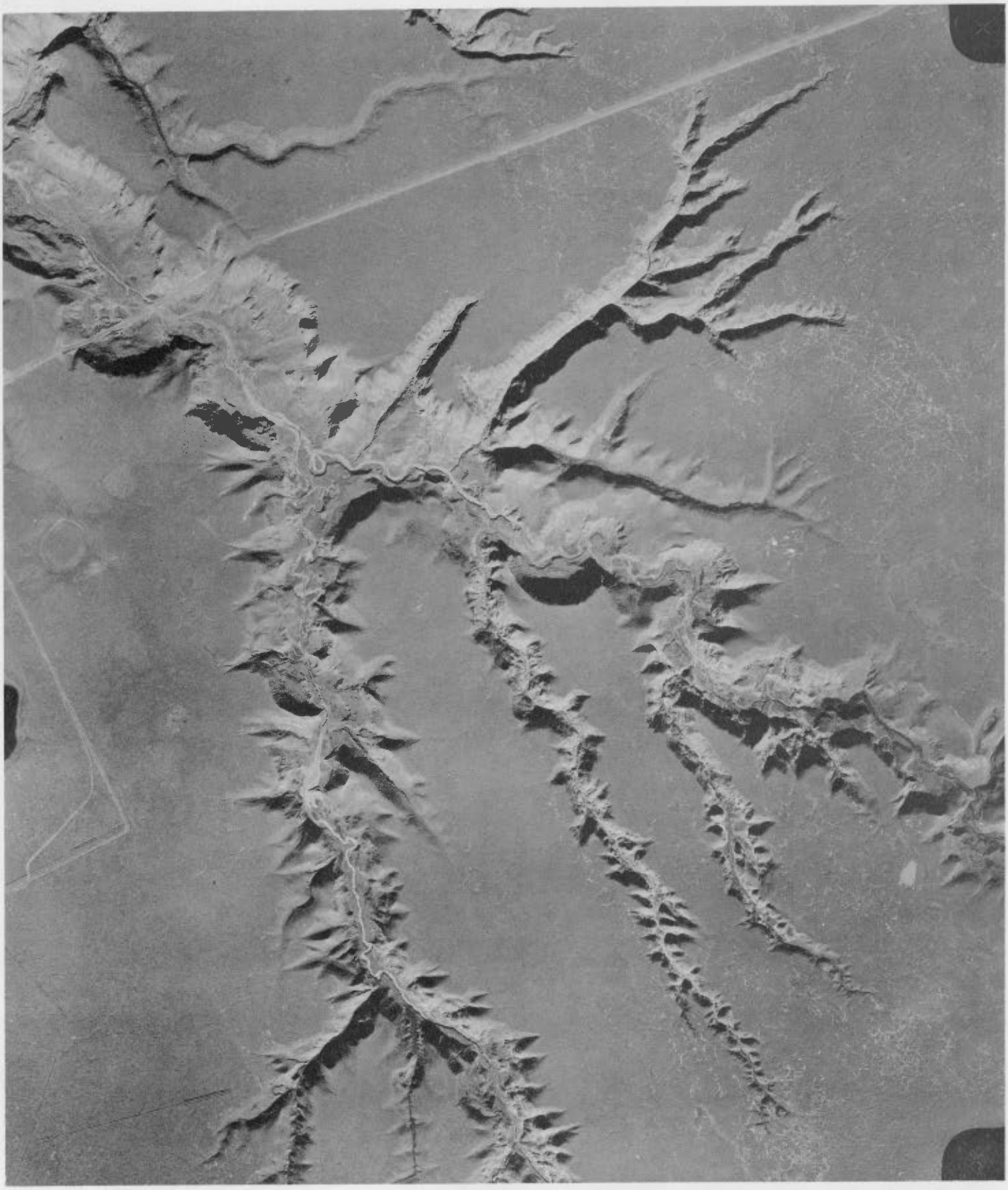


FIGURE 8

Example of erosion pattern.

FIGURE 9

Topography, landforms and vegetation - modified-infrared, medium-scale photograph. Landforms: Esker, Esker-delta, drumlins, organic depressions. Note a sharp contrast between deciduous and coniferous vegetation.

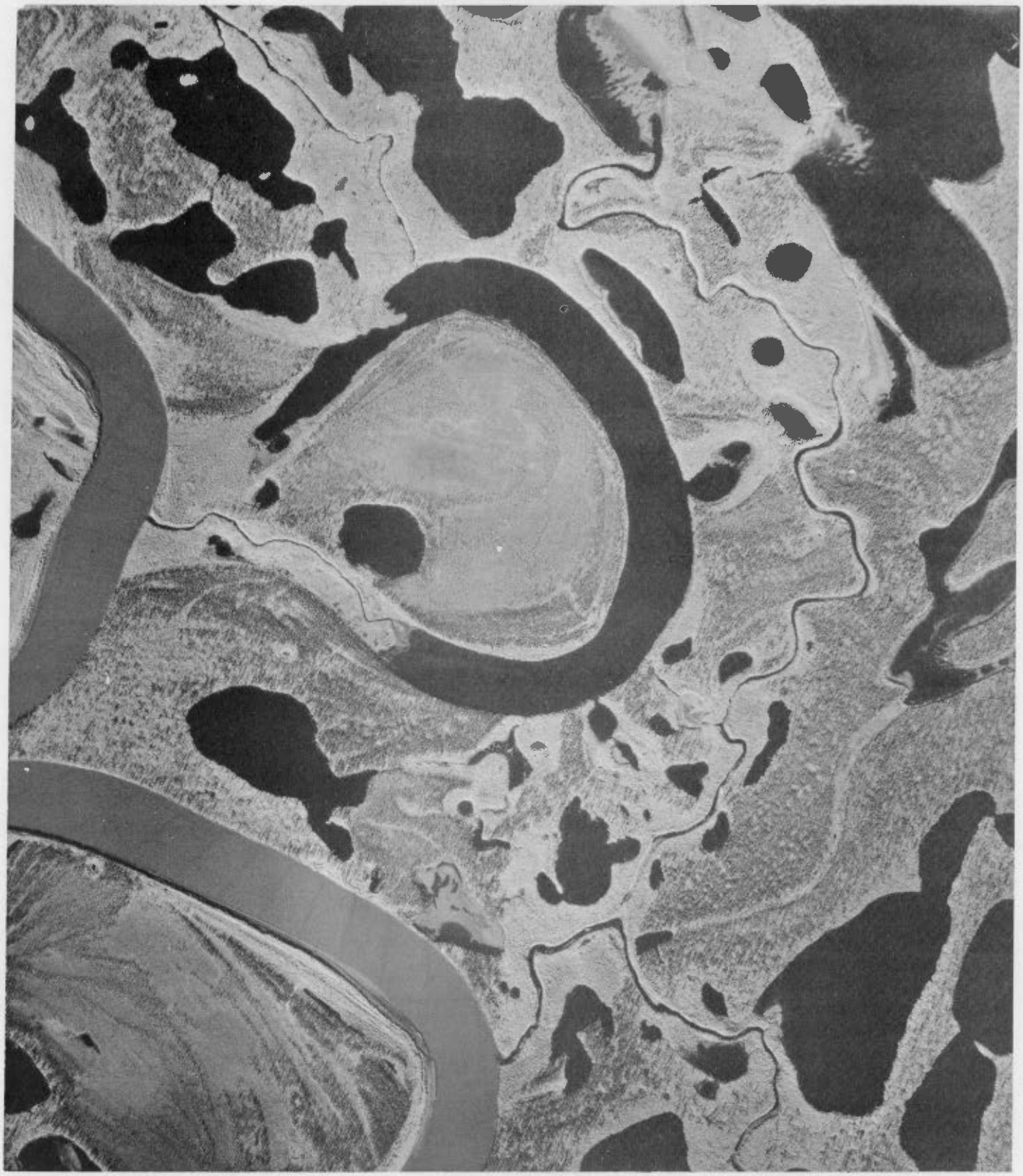


FIGURE 10

Air photo pattern of large lowland area (The Mackenzie River Delta).
Tone may be used as an excellent indicator of drainage conditions.

Any available detail on the use of the land is often a valuable indicator in the interpretation of physical land properties. There is frequently a direct correlation between the landform, drainage, texture of the soil and a dominant land use practices. Illustrations are the presence of gravel pits, shape and size of cultivated fields, pattern of a road system, rock piles and rock fences, irrigation and drainage ditches, regional farming practices and restrictions of cultivated fields to special soil types or landform positions, contour plowing, terracing and strip cropping as erosion characteristics, orchards on well-drained soils, etc.

Photo tone on black and white photographs obtained by aerial cameras, I.R. Scanners and SLAR is composed of various shades of grey. Color photographs register hues of principal colours.

The landscape pattern as seen on a three dimensional model under a stereoscope is a direct result of deposition or erosion performed by glacier ice, moving water and wind, or a combination of these forces. Landforms resulting from the work of similar forces are characterized by a distinctive type of relief, texture of the surface material, a specific vegetational complex, and qualitative land characteristics. In the analysis of land conditions it is important to determine the origin of the landscape pattern and geomorphologic processes responsible for the formation of the landform because surficial deposits formed under similar conditions will have similar identifying features on aerial photographs regardless of geographic location. The recurrence of a given landform as recognized on aerial photographs usually implies the recurrence of certain basic characteristics, as for example, a sand dune area will retain its shape and composition whether it is found in Northern Alberta, on the Atlantic coast or in the Sahara desert.

PHOTOMAPPING

Papers Presented
by:

Mrs. E.A. Fleming

and

E.G. Jessiman

both of the

Topographical Survey Directorate
Surveys and Mapping Branch

PHOTOMAPPING

PRESENTATION BY MRS. E.A. FLEMING

The aerial photographic image is a very useful commodity, it contains a great deal of information about the visible nature of the ground surface.

Aerial photographs are essential tools in interpretation and preliminary planning. They are available soon after photography, and can be enlarged to make details visible, also they can be mosaiced together to give an overall picture of the terrain.

When using aerial photographs for their information content, one must always remember that they are not maps - that measurement of distance or area will often be in error.

In making a map, the photogrammetrist uses his knowledge of lens distortion, central perspective projections, earth curvature and film shrinkage to reconstruct either optically or mathematically the exact configuration of the ground. He does this from an aerial image, which in itself is often quite inaccurate planimetrically.

The line-contour map usually takes a long time to produce and is much more expensive than the original aerial photograph.

Somewhere between the air photograph and the line map is the photomap, which combines the planimetric accuracy of the map with the image detail of the photograph. It can be made available in a shorter time and with less cost than a line map.

The photomap has characteristics of its own which are different from those of a line map. The two complement each other, and in a development project, the photomap will often proceed the line map.

The cartographer uses symbols on the map to portray details of ground features such as buildings, roads and urban areas. On the photomap, the photographic image is the detail of the map. All the detail visible to the camera is shown at its true scale. The patterns of land use, not recorded on a line map, are clearly visible.

The cartographer enhances important features. If one is travelling by road a map will tell one where the road goes. However, for someone travelling by air this map might not be so satisfactory for pin-pointing an exact position in areas where there are no mapped features.

On a line map the cartographer has selected and symbolized features of the terrain which he considers important to the user. On the photomap the user is presented with all the natural details from which he must make his own selection of the important and unimportant.

On a map, the effect of a meandering river can be shown by its water courses, whereas, on the photo-image a much more complex pattern is visible.

These differences often make the photomap a very useful planning map - since it can accommodate the interests of many disciplines - those who want to study land use, vegetation, as well as those who want to measure distances and areas.

As I have already stated, aerial photographs as they stand are not planimetrically accurate enough to meet map accuracy standards. Their inherent errors must be corrected in the making of the photomap.

Most vertical aerial photographs are slightly tilted. This tilt introduces scale distortions in the aerial photograph. Ground relief in the area of thephotograph results in the photograph having a number of different scales - valleys are at a smaller scale than mountain tops, and these differences in scale cause planimetric error - quite often referred to as radial displacement due to relief.

The basic component of the photomap is the Orthophoto. If the ground is relatively flat, the errors in the tilted picture can be corrected by an instrument called a Rectifier. The aerial negative is reprojected with the same tilt as it had at the instant of exposure. Its image, projected onto the easel, is then true in scale throughout.

The instrument used for correcting displacement due to terrain relief is the differential rectifier. There are a variety of these instruments working in Canada:

KELSH Orthosphotoscope
SFOM Orthophotographic Unit
and, GESTALT Photomapper.

Photomaps are produced by a series of steps which are directly comparable to those used in the production of line maps. If terrain relief is not a problem the rectifier is the compilation instrument for the production of the orthophotos. However, in areas of significant relief the photographs must be differentially rectified.

In order to determine whether the rectifier can be used, the planimetric error due to the radial displacement of relief must be computed. If it is greater than the required map accuracy, differential recitification must be used.

Most photomaps are a mosaic of a number of individual orthophotos, which must be tone matched, positioned accurately, and waxed in place. The accuracy of this assembly must be constantly checked. Contours are plotted on the photomap base with a conventional stereo plotter, additional planimetric details can also be added at this time. These contours are then scribed for the contour overlay. The component masks and overlays required to produce a photomap are then registered together, exposed on to negative material in the vacuum frame in a series of individual exposures to form the negative of the final photomap, which can then be reproduced by contact printing, or cronaflex and ozalid, or offset printing.

The photomap is not without its flaws. Photomap users tend to want their maps to look like single aerial photographs. Unfortunately if the map sheet is composed of several orthophotos, the joins between photos often show. Even tone - matching can't hide a join in a tree-covered area. As a partial solution to this problem grid lines can be used effectively as join lines. There is no doubt in the user's mind as to the artificiality of this line.

However, the easiest solution to this objection is to plan the photography for photomapping so that each map sheet can be produced from a single photograph, by making use of enlargements up to 5 X photo scale. Then the photomap sheet has no discontinuities resulting from photo joins, differences in tone, or differences in perspective centre.

Steep slopes can also present problems in the production of orthophotos. In the process of orthogonalizing such a slope the same photo detail may be duplicated on several scans of the differential rectifier. The Gestalt Photomapper, with electronic correlation, can provide a better image, but even it has slope limitations - after all you can't create a picture if no detail exists on the original photo. And of course there is no means of orthogonalizing a vertical discontinuity like a building, pole or tree because these always appear in perspective in a photomap.

Another disappointment which photomap users face, is that the image quality of the map does not equal that of the original aerial photograph. There are often as many as six reproduction steps in producing the final map. Although great care is taken at each step, nevertheless, loss occurs.

Notwithstanding these shortcomings we have at our disposal a means of producing an accurate map base quickly; one common base that can be used by many specialized disciplines. Just to rapidly run through some current Canadian uses of orthophotomaps, they are: soil maps, mining claims, aeromagnetic maps, plotting track recovery, land registry, recreation, property holdings, and standard 1:50,000-scale maps in Canada's north.

The second speaker is Mr. Jessiman who is very closely involved in this phase of our work in the production of the photomaps for our Northern areas at 1:50,000 and other scales. Mr. Jessiman will carry on at this time and then both of us will be available to answer any questions you may have.

PRESENTATION BY MR. E.G. JESSIMAN

Mrs. Fleming has described the making of photomaps, and the equipment used to carry out their construction. I will try to avoid going over too much of the ground she has already covered so well.

My presentation is mainly confined to the actual product, the one we are spending the greatest amount of time on, and this is the National Topographic Map Series which our Directorate is responsible for.

We have production problems. The photomap, you might say, is unique. Most of my experience has been in line mapping, and since being made responsible for the Photomapping Area I have been running into problems that are quite different from those found in producing line maps. The primary goals is to establish an extremely good quality control arrangement from the very beginning. You might say this is true about any product and be right, but in photomapping one starts off with imagery in the form of an aerial photograph and if there is anything wrong with it, it most certainly will show in the final product. It takes a graphic arts expert to remove the flaws and discrepancies that irritate people in the photo imagery, whereas in a line map if you have a hair or a piece of dust which happens to stick to the negative, you simply opaque it out and repair the line. But how would you correct that on an aerial photograph? Portrait photographers can repair a picture of a person and do a pretty good job, and sometimes a few blemishes are acceptable. But what happens if a geologist or someone doing surficial work is looking for a feature? He wants to see the real thing and if people have taken too many liberties they can distort and destroy this product. So the touching-up of photomaps is a real problem for which there is no real solution in sight.

We have been working on different types of photomaps for quite awhile, products for special purposes, large- and small-scale, but we really haven't been publishing anything. We produce a great number of reproducible types like cronaflexes, from which one can make prints; we have produced hundreds, even thousands of paper prints, but it is only in the last year that we have been actually producing press negatives for quantity reproduction. So we can't say that we have really been in the business too long.

Now a picture is worth many words, so a selection of our products has been made to illustrate types of photomaps and photo mosaics being produced by the Topographical Survey Directorate, either in-house or by contract, as part of the National Topographic Series.

One of our map products is the 1:25,000-scale series of the NTS system. We haven't produced many of these sheets because it takes a lot of time to construct a good 1:25,000-scale photomap and there are numerous 1:25,000-scale line maps in the area. This sheet is a supplement of the line map bearing the same NTS number. I am going to use the word supplement fairly often. It means that there is a line map in existence in the NTS series, and we are supplementing it with a photomap. This type of photomap has not been enhanced. We haven't drawn any roads or anything like that on it. You can appreciate that it would be very difficult to try and pick out and mark buildings in such a way that it would improve the natural imagery, but it does give one the photographic imagery for the same area as the line map for which an interpretation has been done.

The next product (Plate 1) is designated a full photomap. It is a section of the MacKenzie River area. Notice that the rivers, lakes and practically all the features, which would be interpreted for a line map area shown on this map. The amount of enhancement can vary, this is something

we haven't really put our fingers on yet. There have been many articles written about it but enhancement seems to be done for special forms and the amount and kind that belongs on a National Topographic Series type of map is not really fixed yet. It is something still being worked on and I don't believe we will really know what is correct until we receive reactions or information back from the user. We are just beginning to put the maps on the shelves in the Canada Map Office. We may think we are experts because we can do a lot of writing and read all kinds of articles, but it is not until a reaction from the user is received that one really knows whether the function is being fulfilled or not. We have been trying to produce the best product we can, but the answer at the present time seems to be with a lot of enhancement in case you have overlooked something and then perhaps in following years one finds out what can be dropped. This is the type of map of which we have quite a few in hand at the present time. Some of these maps were produced in-house but the majority of them are being produced on private contract. A line map covering the same area is shown on Plate 2.

Plate 3 is a photomap supplement of which we have quite a few in production. We have more of these than we do of full photomaps because they can be produced very quickly. Plate 4 shows a line map of the same area. Both of these products are, or will be, published. The supplement may be constructed from later photography so there could be features shown which are not apparent on the line map and this is all to the good.

Another map product is the 1:250,000-scale NTS series. It supplements the multicolour line map of the same area.

Other NTS map scales such as the 1:125,000 or scales smaller than 1:250,000 have not been started yet. We made some preliminary tests and we intend to pursue our investigation further into this area. Right now we are concentrating on the 1:50,000-scale series. We figure that this is "bread and butter" and gives the taxpayer the greatest return for his dollar.

Having covered the more standard types of products, and while I am addressing members of the Department of Indian and Northern Development which is a real good customer of ours, I should cover some of the other products. I am sure some of you are familiar with the type depicted in Plate 5. We have produced quite a few for your department. In appearance the mosaic looks every bit as good as the one done to National Topographical Map accuracies, but we had to make this map in an area where we lacked the proper field or photogrammetric control. We can produce a good looking mosaic, but from a straight accuracy standpoint it is not the equivalent of the National Topographical Series Map even though we put the geographic grid and a border on it. This semi-controlled product is constructed by mosaicing on an enlarged part of the 1:250,000-scale map (Plate 6). You can see it is the same area and can only be as good as the map it came from. The 1:250,000-scale map has errors which would certainly not be accepted in

the larger-scaled NTS maps but if you have nothing better, if there is nothing there but the small-scale map to begin with, you enlarge this map photomechanically and then mosaic onto it. One can produce a base which has been found to be very useful in the Arctic. Indian and Northern Affairs is using these extensively. Sometimes we provided the 1:50,000-scale base, done in-house or by contract and it is enlarged photomechanically to 1:31,680 for use in the field. Geological Survey also uses a great number of this type either at 1:50,000-scale or enlarged or reduced to another scale for different types of maps. I understand that the Geological Survey also intends to publish their field information on these bases in order to get the information out to the user quickly. This semi-controlled type product will not be published by us, at least not by the Branch, however, we are filing them with the National Air Photo Library who will arrange to make them available to any customer on order. This is to ensure that the information will not be lost to the general public.

That concludes my presentation. I will be glad to answer any questions you may have.

DISCUSSION PERTAINING TO THE TALKS BY MRS. FLEMING AND MR. JESSIMAN

Question: This is an elementary question, I don't really understand the use of the terms "large-scale" and "small-scale". Yesterday we talked about large-scale and small-scale maps and my understanding this morning is that the definitions are reversed. Is 1:25,000 a large-scale map or a small-scale map?

Answer: It depends on what country you are in, if you want to get technical about it, but 1:25,000 is what you might say is the largest scale National Topographical Series Map produced in Canada at the present time. We are thinking of going larger than that, but at the present time 1:25,000 is the largest scale National Topographical Series map, but a large scale map can be 1:10,000 or 1:5,000 and when one goes to a still larger scale, it is generally called a plan.

Question: When a previous speaker called a 1:50,000-scale map a large-scale map, he was using the reverse. When we think of a large scale map, that would be 1:25,000. In other words he was using the reverse for photo interpretation.

Answer: It is a relative matter. It depends on whom one talks to. An engineer considers the 1:25,000 a small-scale map because he likes 100 or 50 feet to the inch. A soldier, however, considers the same 1:25,000 map a very large-scale map because he deals in another range of maps, so you are quite right, there is no definition. I can tell you which is the larger scale of two maps if you name them to me, but I can't tell you whether you should consider that a large- or a small-scale map, until I know in what discipline it will be used.

Question: I personally received the understanding today that it would be the reverse.

Answer: Oh no, a 1:25,000-scale map is larger scale than a 1:50,000 which is again larger than a 1:100,000.

Question: If your section produces photomaps for areas where 1:50,000 line-maps have been published, why is this?

Answer: We do so because the photomap is a supplement to an existing line map.

Question: I received the impression that this was confined to the northern areas.

Answer: Oh no, for any area where we have a client.

Question: What's the length of production time, say for an area covering a 1:50,000-scale map?

Answer: Time for producing the supplement, the photomap supplement, should be about a month.

Question: What would be some of the control criteria for photomaps?

Answer: A controlled photomap uses the same control as a line map.

Question: Is the line map used in the production of the photomap?

Answer: We use the line map as a base to develop the photomap supplement. You saw the rectifier instrument. We put a stable base map manuscript on the rectifier easel and using the film of the actual aerial photography we produce prints fitted to that base, fitting the photo images to a map previously compiled on a photogrammetric plotter.

Question: Could you take a 1:50,000-scale map and enlarge it to the equivalent of 1 inch to ½ mile?

Answer: You can do that, yes.

Question: What would that cost?

Answer: You are saying enlarge the photomap to twice the scale?

Question: Yes right now we think we need black and white line maps at about 1" equal to ½ mile in our work. Can you take that 1:50,000-scale map and enlarge it to 1 inch equals ½ mile?

Answer: Yes you can enlarge by any ratio. You can blow it up to just about any scale you want.

Question: Would it not be less expensive to have a draftsman redraw the 1:50,000-scale detail at the larger scale?

Answer: It would be cheaper to have it enlarged photographically. It would cost you about $30.

Question: Why is not more use made of photographic enlargements of maps?

Answer: You must remember that you're losing accuracy. As soon as you enlarge a product it no longer retains the accuracy that was called for in the specifications under which the map was compiled. You must refer to the accuracy of the basic map you enlarged.

Question: We have used photo mosaics at 1:31,680 scale. How accurate are these?

Answer: They were enlarged from 1:250,000. That's the problem of the last illustration which I showed, one could be deceived by it. It looks good. We put geographical coordinates and a border on it, and the mosaicing looks good as the assembly of the picture is matched quite well, but it is enlarged from 1:250,000 and hence has only the accuracy of the 1:250,000-scale maps.

Question: I would like to know how reliable a photomap is, if it is made as you say, with a 1:250,000-scale base.

Answer: I think you'd have to ask yourself if on a photomap you measured a line that was say 5 miles long and it was wrong by 200 feet would that destroy the usefulness of your work or not?

Question: What is the horizontal accuracy of NTS maps?

Answer: I'd like to define the accuracy in a handy way. To get the horizontal accuracy of our maps take the scale of a map in thousands, say 250, divide that by two, that is the accuracy in meters we guarantee. Any point on the map is correct within plus or minus 125 meters. On a 1:50,000-scale map we guarantee the accuracy within 25 meters. So when you have a map that has been blown up from 1:250,000-scale it looks like a 1:50,000-scale map but the accuracy of a point would be 125 meters instead of the 25 that we would guarantee for the map compiled at 1:50,000 scale. So if this destroys the usefulness of the work you should then request 1:50,000-scale maps through the representatives here. If on the other hand, great accuracy in measurement is not too important to you then you can use a blown-up product.

Question: I can give you examples of prospectors giving coordinates of their claims that are in error by ½ mile.

Answer: Is that the fault of the map, do you think, or the prospector's map identification?

Question: If there is very little map detail in the vicinity of a claim, how does the prospector identify his claim corners?

Answer: If thephotograph is what it should be he first spots his claim on the photo, then transfers the identification to the map using the additional detail on the photo for comparison.

Question: Can the prospector always get photos of his area?

Answer: He should be able to get them. Every square inch of Canada is covered with photographs and he should be using the photographs to spot the position of his claim and then transfer that to a map so he can get the grid coordinates. That's the approved system.

Question: (Editor's interpretation) Question poorly recorded but apparently deals with the difficulty of transferring local surveys of claims to maps.

Answer: I think the danger comes in when people start applying detailed survey information to a map. If the map is very accurate it works out well but when its inaccurate and you are applying quite precise information to it, you are bound to get a conflict. Particularly when these claim areas start to close in. As one person was saying, you get gaps or overlaps and a 1:50,000-scale map can only stand up to so much. It is only accurate within a 75 to 90 foot horizontal accuracy. The 1:250,000-scale map is only accurate up to about 400 feet. Now you could lose a lot or a claim if there was relative inaccuracy across the sheet.

Question: Can an enlarged map be used as an engineering plan?

Answer: I think you're asking a little too much of the base map in applying actual measurements on the ground to part of the map. You should be dealing with the plan, you should be working with a precise plan if you're going to put precise measurements on it.

Question: Can a black and white drawing be obtained before a map is published?

Answer: Yes. It's in manuscript form.

Question: I would like some more information on map staking. Sometimes there are two features that look exactly the same and there is no way to distinguish between them unless you go up and find out by helicopter.

Answer: This is becoming more and more important. Claim staking from maps rather than posts in the ground is coming in. Two provinces, and I believe the Yukon are now allowing it. This means that map reading and air photo reading must be very good. The old prospector, the one-man prospector, is on the way out. Prospecting is big business and these new people are very good at air-photo reading. If the corner of a claim exists and you've got a good stereo-pair and good magnification you can spot it. It may

take some time. One might have to go a couple of hundred yards to a point of detail on the photograph and work back with measurements to the claim corner. Now if you have the claim corner pinpricked very carefully on your photograph and you have one of Mr. Jessiman's photomaps it's then only too easy to transfer the photograph image to the photomap image because they are basically the same. The photomap has a UTM grid on it, which is required by the mining recorder. So it is these steps that must be taken and if the map is inaccurate it will still be a relatively small error. If you say a claim is an inch out on the map, that is a mile and a quarter, and you must be better than that or you shouldn't be in the prospecting business.

Question: I think there is one thing about accuracy that is not quite clear. We talked about some 400 feet at 1:250,000 scale and 90 feet at 1:50,000 scale. This is the relative accuracy as compared to geodetic accuracy. It doesn't mean that if you measure from here to the far side of the lake you are going to be out 90 feet or 400 feet. In short measurements the error should be much less. So when Mrs. Fleming is speaking about errors of 1 inch obviously something is wrong, because the amount you are out should be very small if the map reading is well done.

Answer: I would just like to drop a word of caution if you happen to be using the semi-controlled mosaics that are enlarged to 1:31,680. There is no ortho-photo work involved here. The product really couldn't afford to make use of the ortho-photo which runs about $50 an overlap, so as a result of not having the relief properly taken care of, you have discrepancies. You will have the actual pictures being put together with overlap or gaps in certain areas and that is a localized error, so you could lose the top of the hill as a result of trying to assemble the water or if you match the high spots you could see duplication in the lower areas, so when you are talking about the accuracy of a product, first of all you must know what the product is. There is a substantial difference between a standard NTS map or (maybe I shouldn't use the term standard) but between an NTS map which is supposed to have that type of accuracy and a semi-controlled product, so just be careful and realize that what you are using when you are out in the field or in the office.

Question: In the 1:50,000 series how many sheets have you published on the Territories?

Answer: The military have had quite a few published. They have been in the Arctic photomapping longer than we have. As regards to photomapping, they have published well over a hundred, but they are mostly involved with their exercise areas in Northern Canada, in the upper coastline of the Northwest Territories and the Baffin Islands, and some of the Northern Arctic Islands. We have printed about 30. As I say it is only in the last year that we have been forwarding reproduction material of photomaps for press printing.

Question: Can you get enlargements of only certain colours of a map?

Answer: Yes you could. I think this is quite a problem product, to take the negative separations and enlarge from them, and get a combination of whatever colours you want.

Question: What about a map showing only black and blue?

Answer: You would want the grid and the water and perhaps some culture but normally the thing to do is indicate the combination you want and how much you would like it enlarged, within reason.

Question: Is there much business in reproduction material?

Answer: I think that if you save that question for Mr. Long who is the next speaker, you will get a better answer. I was just talking to staff from his section and they say there is a tremendous amount of business in this very thing, for commercial companies and publishers.

Question: What is the fastest product to be produced to cover an area, a photo mosaic?

Answer: If you are asking just for a mosaic that is not semi-controlled it goes to the National Airphoto Library and is done relatively quickly, in two or three weeks, but that is a common service that they offer to anyone in Canada.

Question: How does one know what is available in photomaps, is there an index of these?

Answer: Yes the new index of 1:50,000-scale sheets will show photomaps. We are so new in this business that it will be the first index showing photomaps. It hasn't been published yet but I believe it is in preparation at the moment.

Question: In general where is photomapping being carried out?

Answer: All over the country. The military photomapping incidentally has covered all of the Arctic townsites, there are 140 sheets in this series and they will be included on our new indexes.

Question: Do you make photomaps of southern areas?

Answer: Yes, but we have been spending most of our time in the North. You know there is the Mackenzie Corridor with about 500 map sheets in the corridor alone, and that keeps us pretty busy, besides trying to handle the requests for semi-controlled mosaics from your department and the Geological Survey, and the second pipeline corridor, and other corridors being mentioned, into which we have to hop and get the mapping done, so we are stretched pretty thin.

Question: If I ordered a photo supplement in a month from now, when would I get it?

Answer: It would have to be a special order. You said a month didn't you? Lets say that everything goes well. If we started to make a supplement today we should have it finished by the end of March. Now whether it would be printed or not I can't say. That is in the jurisdiction of other people.

Question: What is the cost of photomapping?

Answer: If you try to turn out a standard product which is going to pass all the quality control stages right down the line and finally be printed and put on the shelf for general distribution, 1:50,000-scale maps would run up around a thousand dollars and if you want to put contours on this and if there is orthophoto work involved, which costs $50 a unit, with anywhere from 20 to 30 units across the sheet, quick mathematics shows that could run a thousand dollars in itself. If you wanted to put contours and full enhancement on a photomap to make it the one and only map for that particular 1:50,000-scale area it would run the cost up to three or four thousand dollars. We have about 90 sheets out on contract right now. I think that indicates why you need a specialist like Mr. Burton to tell you how much it is going to cost because as we have heard it can vary from $250 (for semi-controlled mosaic) to $4,000 (for a contoured orthophoto map).

Question: Have you your own orthophoto machine?

Answer: Yes we do have one instrument. Its now about coffee time and before we stop I hope we haven't left you with the impression that we are con men or something like that. Here I am saying that everything is as accurate as a pin prick and then Mr. Jessiman who is a little more honest say watch out for blow-ups to 1:250,000 scale and Mr. Anderson over there says we can turn out something for $250 dollars and somebody else says it may cost $3,000. All of these are honest answers and that is why you have a representative in the person of Mr. Burton, who for heavens sake use. I mean if you want to find a specific answer for a specific problem which you can describe to him, he can consult with us and give you an honest answer. You can budget for, it but using fast rules of thumb in our business tends to be dangerous.

There is one thing that is all important. When you are sending in requests for maps make sure you tell us in detail what you want, then we will do our best to give you an estimate on that product. Another point Mr. Jessiman brought up this morning is also important. Very shortly the people here will be receiving copies of the various types of maps that have been produced, what we would like to have is an input from you as to what you think of those maps. Be honest about it. Constructive criticism hurts nobody.

Question: Mr. Burton, are you asking us to tell you what we want or what we are going to use it for?

Answer: What type of map you would like and what you are going to use it for. And we will do our best through EM&R to determine the best product possible for you and give you this information and let you know what it costs.

Question: Did I understand you to say that people here will shortly be receiving indexes?

Answer: I wasn't speaking of indexes I was speaking of copies of the actual map product itself. The indexes will be forwarded to you as soon as they are printed.

Question: Will we be getting sample maps? Are you saying that those attending this conference will shortly be receiving samples of these various types of mapping products? Do we have to do anything to make sure that we do receive it, or will it be automatic?

Answer: It will be automatic, as soon as we have the time to get them out to you.

Question: Ok, and did I also understand you to say then that the people who are attending here will automatically receive an index when it is available or do we have to do something?

Answer: Indexes are always available. They are being turned out, every six or eight months. We will put everyone on this conference on our mailing list.

There is one thing I would like to ask you to do. It is to act as monitors within your respective briefing to get the other map users together for discussion on these mapping products and get their views as well as your own and send them to us. They will then be turned over to EM&R so that they have an input from you.

Question: Can I ask one more question? Talking about the availability of aerial photograph indexing are there any plans in that area as to precisely what steps should be taken in order to insure that we receive an index of aerial photographs?

Answer: There is virtually no way of indexing aerial photographs except on our master copy because there are so many of them. There are seven thousand indexes and they are increasing every week. I believe they are publishing a coverage map which indicates roughly the scale and age of the coverage of Canada, that is one of the questions that you may ask when you visit the National Airphoto Library this afternoon. I think that is a very good question, how the coverage map is coming along. We haven't published these for seven years and I think that's much too long.

Question: Do you keep indexes of old aerial photography?

Answer: There are very old indexes, but they are still good. We never throw an air photograph away and consequently the index has built up over the years.

Question: We make our own indexes, is there anything wrong with that?

Answer: They are good only for the photographs that you have, and may not be the total coverage for that particular sheet.

Question: I gather that the master index here in Ottawa is the only one in existence. Is this correct?

Answer: I think there is a plan to microfilm all of our indexes and make these available to regional offices, but that is out of my area. Ask this afternoon at the National Air Photo Library about that.

Question: Is there a delay between the taking of the photos and the preparation of an index?

Answer: No, all of our ICAS contracts for photography stipulate that the contractors will provide two flight-line indexes of the completed contract. Oh, now it is up to three.

CARTOGRAPHY

AND

MAP REPRODUCTION

Paper Presented
by:

D.E. Long
Directorate of Map Production
Surveys and Mapping Branch

CARTOGRAPHY
AND
MAP REPRODUCTION

I am to talk to you in simple terms on Cartography and Map Reproduction, how maps are made, and we'll be following it up this afternoon with a tour of some of the working areas. In both the talk and the tour, however, you'll be seeing only a portion of the Directorate's activities, so I'd like to take a few moments now to discuss its role in the Surveys and Mapping Branch.

There are specific mapping and charting activities for which the Directorate of Map Production is responsible. These include: Firstly, the National Atlas of Canada, of which the Fourth Edition is now in its final stage. Secondly, Aeronautical Charting; at the present time this activity comprises a total of 54 different products, in the sense that a chart series is a product, and a flight publication, the Canada Air Pilot is a product. Thirdly, General and Small Scale Mapping; this includes the International Map of the World Series at 1:1,000,000 scale, and a variety of regional maps such as The World, North America, Canada, Northwest Territories and Yukon, National Capital Region, etc.

We also have the responsibility of providing cartographic services to other agencies. Some of the major involvements here are the provision of federal electoral maps, the supply of cronaflex prints from our map reproduction material and theprinting of maps and charts for agencies outside the Surveys and Mapping Branch. This latter responsibility includes the printing of National Park Maps for your department, Geological Maps, for the Geological Survey Branch, Hydrographic Charts for the Dept. of the Environment, and Soil Maps for the Dept. of Agriculture. Added to our Branch commitments this comprises a substantial printing work load. To give you some idea of the volume, in the current year, we will have printed more than 3,000 maps and charts for a total of about 40 million printing impressions.

Last but not least, we undertake the drafting and reproduction of the topographic maps for which manuscripts are prepared by the Topographical Survey Directorate. It is this particular aspect of our work I'm going to talk about. The stages and processes in the production of a map is normally a four-stage operation; compilation, drafting, reproduction and printing. But in our look at map production this morning we will be omitting the compilation stage as that has been done in Topographical Survey, so we'll be looking at the stages involved in taking a topographic map from manuscript form to a multicolour product ready for distribution.

Let us start by looking at the components of a printed map. As you know manuscript content has been sorted out by colour and symbol to provide better communication of information. Colours used for different types of information are fairly standard on topographic maps around the world; Black for cultural features; Blue for hydrography and UTM Grid information; Brown for contours; Red and Orange for roads; and Green for vegetation. This adds

up to six colours. An even number of colours like this is advantageous as printing requires only three runs through a two-colour press.

Each of these colours comes from a specific printing plate. In turn, the printing plates are made using the information on map negatives. So for every map like this there is a package of negatives, we call it the reproduction package. While there are only six printing plates, the reproduction package for this job contains 16 different negatives. You will see the reason for this as we go along. Map negatives can be roughly divided into three groups: line negatives, type negatives and open window negatives.

Line negatives contain the line and point symbols to be shown, such as shorelines, streams and marsh symbols. The black line negative would carry building symbols, railways, geographic grid, etc. The brown would carry contours; and the red and orange negative would carry the roads. Type negatives are self-explanatory, there is one for the Black type, one for the Blue type, one for the Brown type, and occasionally one for Red type.

Open window negatives are sometimes called artificial negatives because they are produced manually rather than by a camera operation. They are used for open areas of water, for wooded areas, and for built-up areas. Remember these three types of negative, line, type and open window as we will be dealing with each of them in turn in discussing the drafting process.

Because there is only one printing plate for each colour it is necessary to combine the line negative, the type negative and the open window negative on the printing plate for that colour. This is done by a succession of exposures to the printing plate, and the data on our 16 negatives is thus transferred to six printing plates.

This reproduction package is very important; it is carefully handled and stored. It is used for all succeeding reprints of the map, and as the base for future revisions. If as happens periodically we have to certify as to the authenticity of a map in a legal action, it is this package of negatives to which we check back.

The map manuscript is like a book manuscript in that it contains everything that is to go into the final product - and all the operations from here on are aimed at making it more easily read, a little more attractive in appearance and making it available for mass distribution. Our first step is to obtain it in negative form using a camera. The manuscript is placed on the copy board, photographed and the film is processed resulting in the manuscript negative. This negative is the base for all the images the draftsman needs to follow in drafting. And since, he will be separating into different colours, a separate image is required for each line colour; black, blue, brown, red and orange.

Images of the manuscript are obtained by a photomechanical process which involves coating a sheet of stable plastic with a special opaque coating and exposing the manuscript to it to get an image on that coating.

To obtain a uniform coating is important, and for this purpose whirlers are used. Once the coating has the copy printed on it the resultant piece of material is called a scribe-coat. The manuscript negative must then be exposed to five of these scribe-coats and an image developed on each one.

Once these images have been printed on the scribe-coats the job is now ready for the drafting operation. This is more specifically called scribing and is performed on light tables so that the scribed image is visible. It might be appropriate here to say a few words about the scribing operation. If you were to paint a window pane, let it dry and then used a sharp instrument to cut through the paint and write your name on the pane, that's essentially the scribing process. Instead of glass, we use a stable transparent plastic (but we could use glass - some countries do). Instead of paint we use a special opaque coating which cuts cleanly without chipping. Instead of drawing freehand the draftsman uses a scribing instrument and follows an image which is in negative form. The advantage of scribing in negative form is that the completed job is the final negative and no subsequent camera or contact operations are required.

The draftsman has quite a wide variety of cutting tools. He can use rigid gravers for straight line work, swivel gravers for other lines, cutting points in quite a range of line widths, templates for various symbols such as marsh, schools, churches, buildings, etc. and a dotting instrument for sand symbols. So with these tools, and his manuscript images on a light table the draftsman is able to prepare final line negatives for each of the line colours - the Black, also containing dots for the sand symbol; Blue; Brown; Red, i.e. paved roads; Orange - the secondary roads, and street pattern; and Grey - used for boundary symbols.

This doesn't print as a grey printing colour, but is combined on the plate for printing in a screened black. Through this whole process, close registration between all colours is important, and for this we use a punch registration system. With this system all material is punched to provide three precisely positioned slots, usually at the top edge of the material. Punch bars with studs which fit into these slots are used in all cases where registration between pieces of material is required.

There is another process by which we can obtain final line negatives, the automated process. In essence this involves the recording of all line and point data on tape, and then having it plotted by an automated plotter. The process of recording the information on tape is called digitizing. The draftsman doing the digitizing gets a little different type of image, one with an etched track that he can follow with a digitizing instrument, something like a sharp pencil. If he places this etched copy of the manuscript on the digitizing table, and allots a code number to each class of feature to be recorded and if he then points or tracks this feature on the etched copy. Coordinates, or a stream of coordinates are thus picked up by the electronic equipment in the digitizing table and fed into the computer. This data can then be programmed for scribing the detail on the automated plotting table - the brown, the black, the blue, the red, etc. So, in summary, by using the manual or automated process, line information on the manuscript is transferred to final negative form.

A somewhat different approach is required for type negatives. Map type comprises geographical names, along with labels, elevations, contour values, and border information. This latter group is relatively standard, but geographical names must be authenticated by the Canadian Permanent Committee on Geographical Names. In practice, this means that the names we propose to show are compiled and listed by our nomenclature staff and a print is sent to the Permanent Committee for processing through the provincial or territorial authority. In due course, and often after a longer time than we like, additions and changes are fed back to us, and a list of all type requirements can be made up. This list, along with a print identifying each feature to be named, is supplied to the type sizing unit. Here each name is coded in accordance with type family and point size. Point size being related of course to the importance of the feature. Given this list, the keyboard operator in the photo-type unit can process the type requirements for the job and the end product is a sheet of type in transparent film positive form. In affixing type to the map a special wax adhesive is used so before it is ready for the draftsman, each sheet of type is given a coating in a waxing machine. It is the draftsman's job to cut out the appropriate piece of type and affix it in its proper position on a transparent overlay on each of his line negatives. The negative being flipped over to get the image in positive form. For each colour requirement a type positive is prepared, and for the final negative package each positive in turn must be contact printed to make a negative. This process completes the type negative part of the package.

The final group of negatives is what we referred to earlier as open window negatives. They are used for large open areas of vegetation, for water areas and for built-up areas. They are made by a manual process. This involves obtaining a negative of the area outlines. In the case of vegetation, it was obtained directly from the manuscript overlay - in the case of water blue the scribed line negative can be used. The process involves exposing the negative to another kind of specially coated plastic. In this case the coating is somewhat rubbery and has only a moderate adhesion to the base. After exposure, the area outlines are etched into the coating (we call it a peel coat) - so that it is possible to peel out the areas you want to show in colour, the light blue, or the wooded areas. Negatives produced by this method are somewhat subject to damage and it's normal practice to transform them to film negative form with some retouching being done before adding them to the negative package.

The negative package is now complete, but an edit of the complete and assembled product is required. For this we make a photo-colour proof. It involves coating a sheet of plastic with a succession of chemicals with each chemical giving one of the colours we require, exposing the appropriate negatives to this coated plastic, and then processing for each colour addition. The proof, when completed, doesn't precisely represent the printing colours, but enables our editing staff to examine it against the original manuscript, and any supplementary copy such as type lists, for errors, omissions, and conformance to specifications. Corrections required are indicated in the margin of the proof and changes required are made on the final negatives. The reproduction package is now complete, and ready for plating.

As I mentioned earlier, detail from a number of negatives must be combined on the printing plate for that colour. Here is a brief look at the combinations: On the black plate we combine the line negative, the type negative and the boundary symbol. In the case of township and reserve boundaries, insertion of a screen between negative and plate is required to obtain a grey image.

The blue plate is a little more complicated since five negatives have to be exposed to it. Drainage and drainage type are in solid form, as are the UTM grid notes in the margin. UTM grid lines are given a 40% screen and water areas a 30% screen.

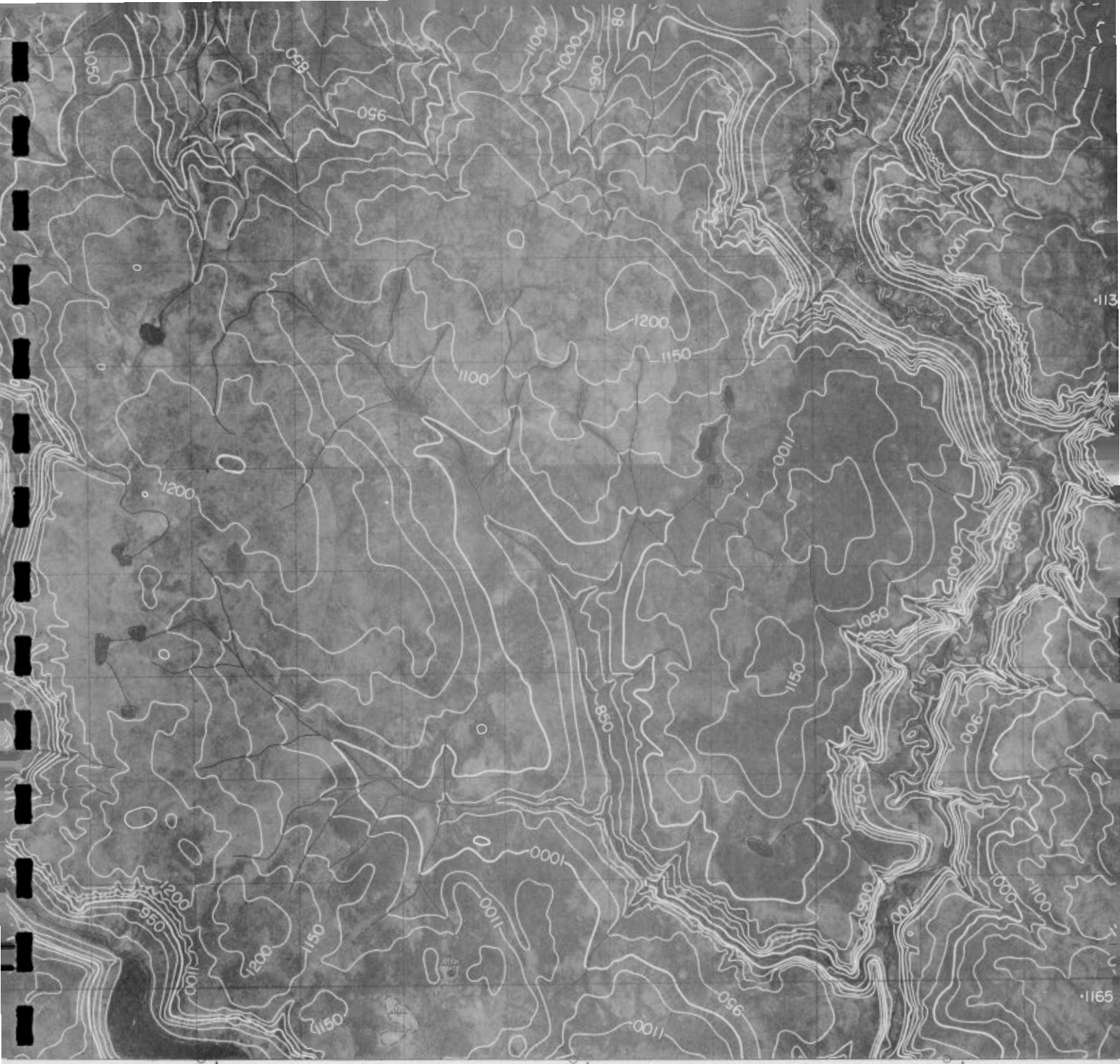
Brown line and brown type are exposed successively in solid form.

Red line and type are in solid form. Built-up areas are given a 30% screen. Orange roads are a single exposure as is the vegetation negative.

All negatives are exposed separately to the appropriate printing plate and the plate is developed to make it ready for printing. This develops image areas which are ink retaining and non-image areas which retain water in the printing process and repel ink.

We're now ready for the printing process. The Directorate uses rotary offset presses which means that the image is transferred from the cylinder carrying the printing plate to a blanket on a second cylinder and from there offset to the paper. In a two-colour press, two plates can be locked on and two colours printed in a single pass of the paper through the press.

Map making is a complicated process. In the cartographic and reproduction stages which we've just talked about, some fifty to sixty different operations are required before the map is ready for distribution. You'll see most of these operations in your tour this afternoon and I hope you'll avail yourselves of the opportunity to ask any questions you wish. There is also a question and answer period coming up now and if you have any queries on techniques, or on any aspects of map production as they might relate to your role in your Department, we'd be pleased to hear from you. I noted this morning a considerable interest in cronaflex prints from parts of our reproduction material package and I have Mr. Smith here from the Reproduction Division and I know he can supply any information you wish on our capabilities in this aspect of our work.



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DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

Scale 1:50,000 Échelle

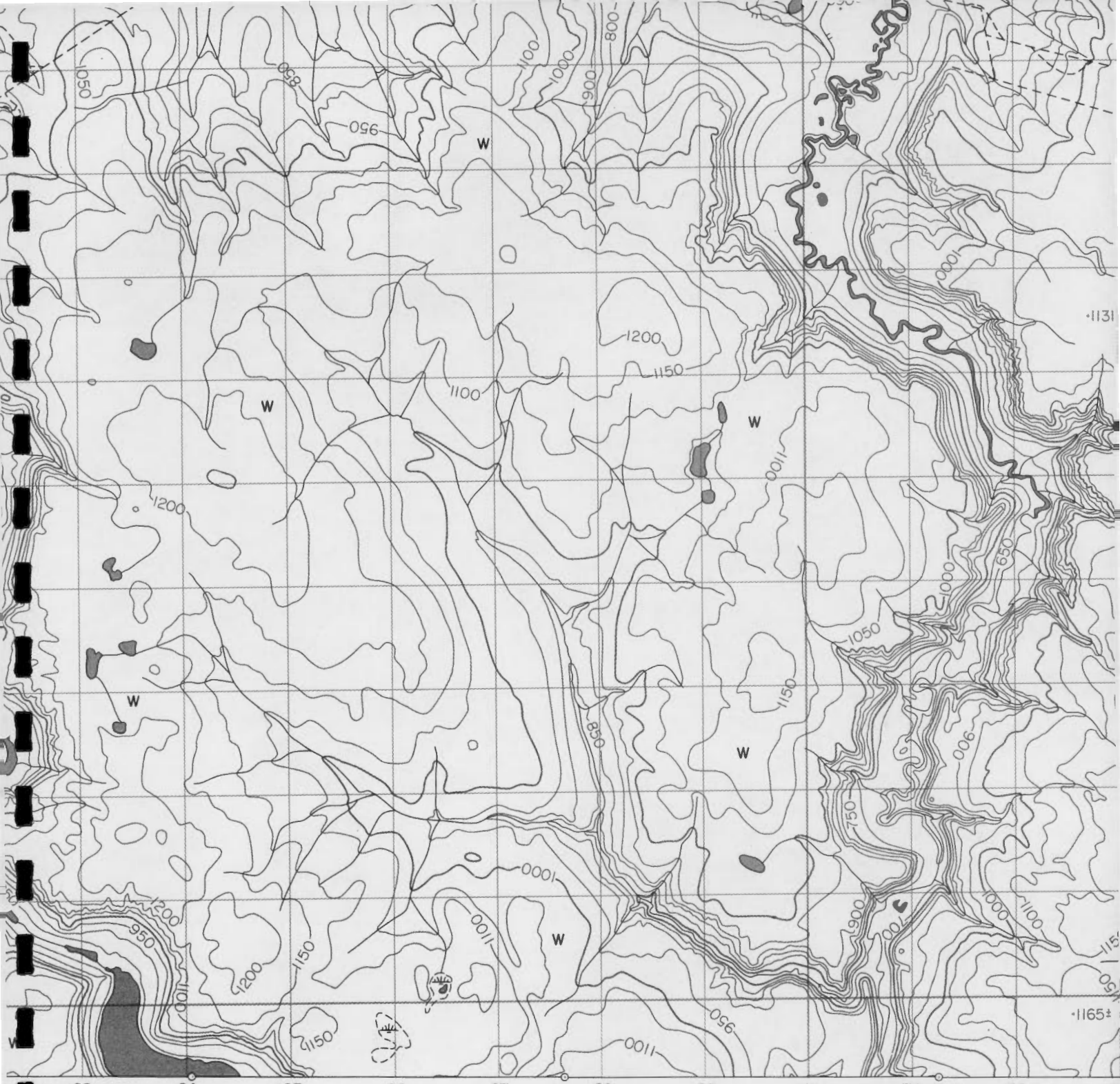
Miles 1 0 1 2 3 Miles

Metres 1000 0 1000 2000 3000 4000 Mètres

Yards 1000 0 1000 2000 3000 4000 Verges

Plate 1

95/96



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DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

CES CARTES SONT EN
DES CARTES, MINISTÈRE
DES RESSOURCES, OTT

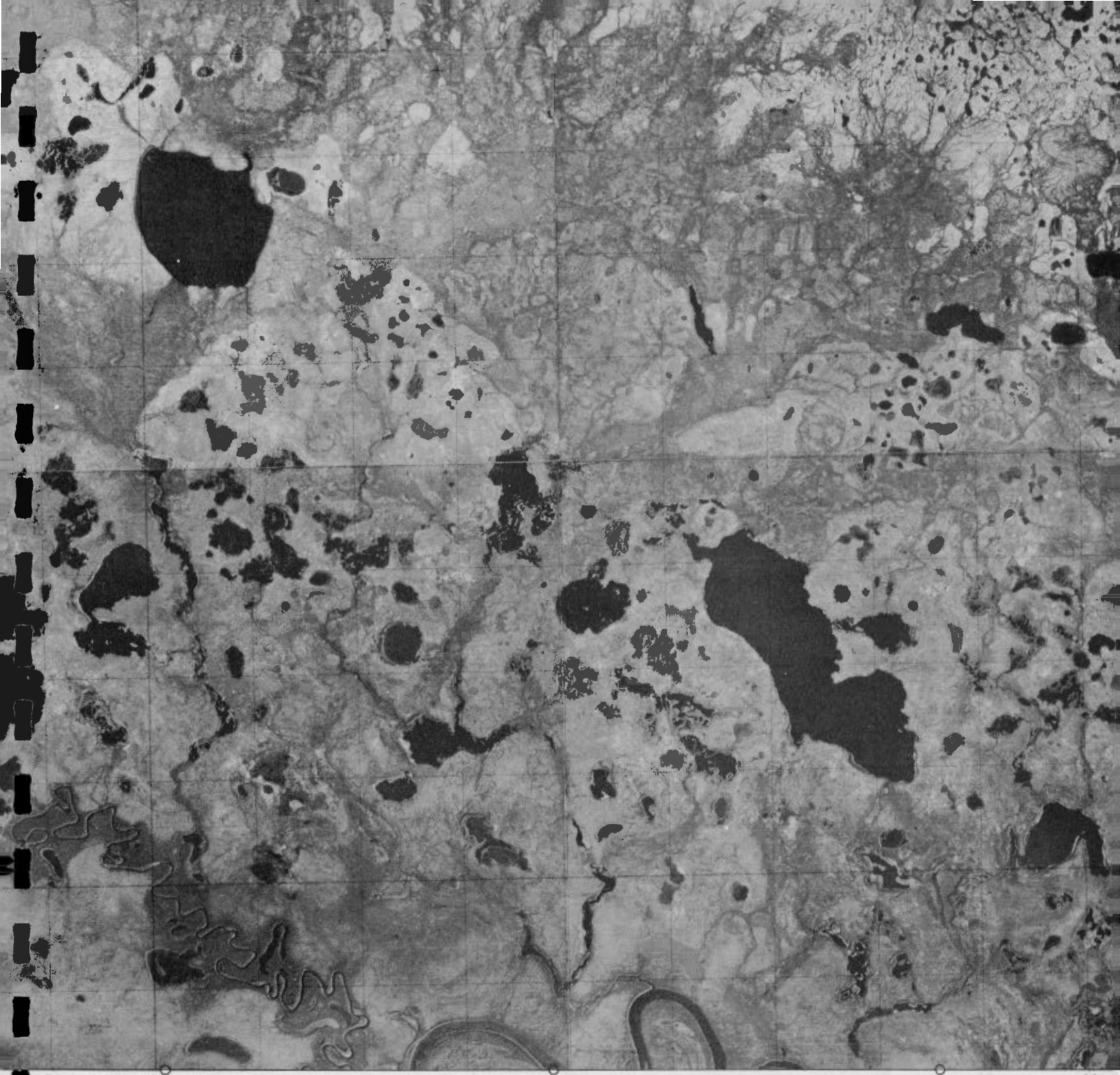
Scale 1:50,000 Échelle

Miles 1 — 0 — 1 — 2 — 3 Milles

Metres 1000 — 0 — 1000 — 2000 — 3000 — 4000 Mètres

Yards 1000 — 0 — 1000 — 2000 — 3000 — 4000 Verges

Plate 2



STRIBUTION
RESOURCES, OTTAWA.

DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

Scale 1:50,000 Échelle

Miles 1 0 1 2 3 Milles

Metres 1000 0 1000 2000 3000 4000 Mètres

Yards 1000 0 1000 2000 3000 4000 Verges

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SYSTÈME DE RÉFÉRE

Plate 3

IBUTION
SOURCES, OTTAWA.

DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

Scale 1:50,000 Échelle

Miles 1 0 1 2 3 Milles

Metres 1000 0 1000 2000 3000 4000 Mètres

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CES CARTES SONT
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SYSTÈME DE RÉFÉRE

PROJECTI

Plate 4

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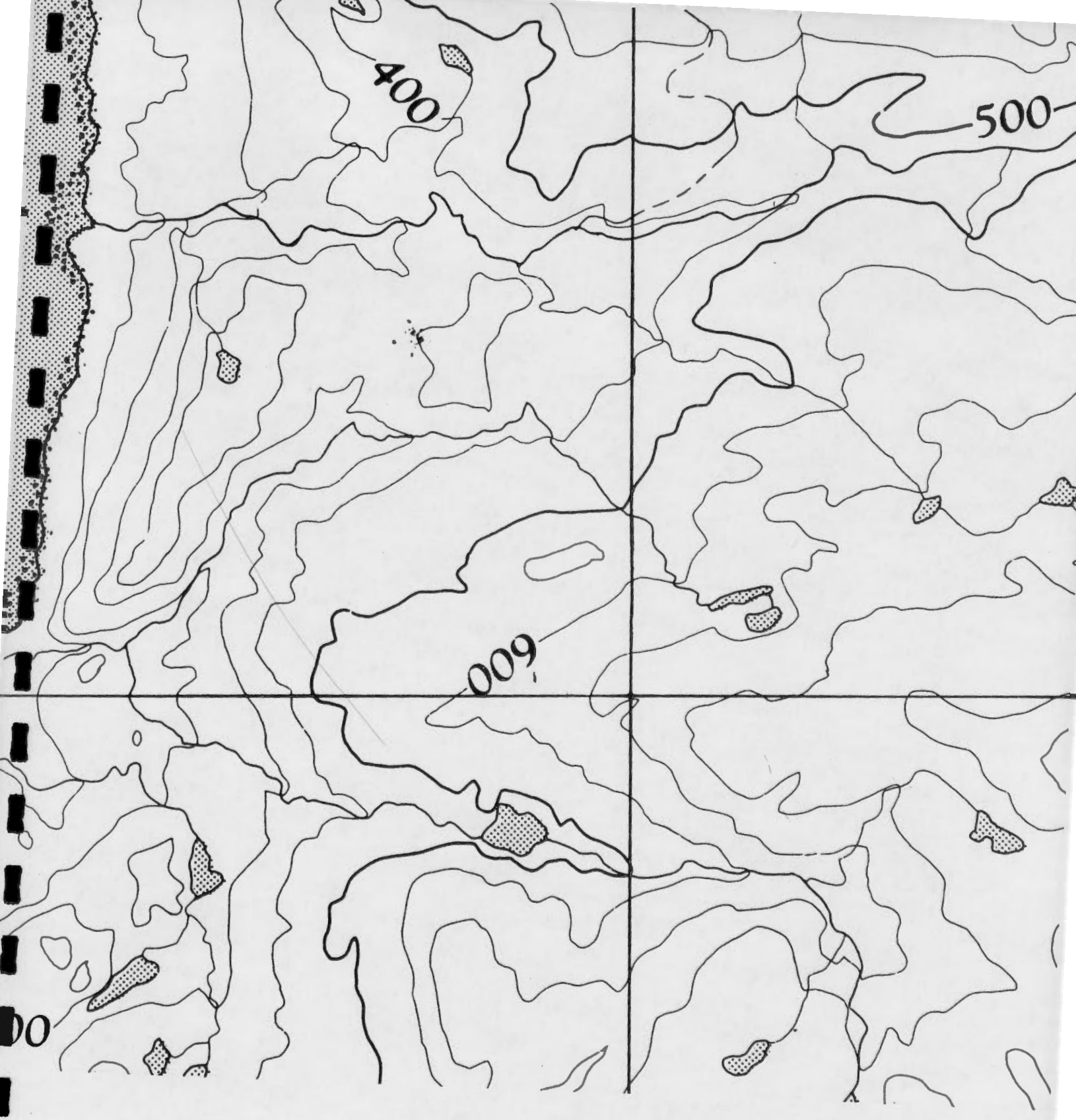
DISTRICT OF FRANKLIN

NORTHWEST TERRITORIES

Approximate Scale 1:50,000



DISTRICT OF FRANKLIN

NORTHWEST TERRITORIES

Approximate Scale 1:50,000

Plate 6

APPENDIX 1

AGENDA

Seminar on Control, Photography, Photo Interpretation and Mapping

February 26, 27 and 28, 1973

Chairmen: R.E. Moore and L.M. Sebert (E.M. and R.)
Co-Chairman: J.W. Burton (I.A. and N.D.)

Session 1 - Feb. 26 - Charles Camsell Hall, 588 Booth Street.

8:30- 8:45 a.m.	Welcome; R.E. Moore Opening Address; R.F. Battle, ADM, Administrative Programs, Dept. of I.A. and N.D.
8:45- 9:45 a.m.	Lecture; Air Survey Photography, Mr. D.H. Baker, Sec., Interdepartmental Committee on Air Surveys (I.C.A.S.), E.M. and R.
	Question and Answer Period
9:45-10:15 a.m.	Coffee, Cafeteria, Camsell Hall Bldg.
10:15-11:15 a.m.	Lecture; Control, Mr. J.V. Thompson Geodetic Survey, E.M. and R.
	Question and Answer Period
11:15-12:15 a.m.	Lecture; Large and Medium Scale Mapping, L.M. Sebert, Head of Program Sec., Topographical Survey, E.M. and R.
	Question and Answer Period
12:15- 1:30 p.m.	Lunch, Cafeteria, Camsell Hall Bldg.
1:30- 2:45 p.m.	Lecture; Cadastral Surveys, Mr. D.K. MacDonald, Legal Surveys, E.M. and R.
	Question and Answer Period
2:45- 3:15 p.m.	Coffee, Cafeteria, Camsell Hall Bldg.
3:15- 4:30 p.m.	Lecture; Photo Analysis and Interpretation, Philip Gimbarzerski, Forest Management Inst., Dept. of Environment.
	Question and Answer Period

Session 2 - Feb. 27 - Charles Camsell Hall, 588 Booth Street.

8:45-10:00 a.m. Lecture; Photomapping, Mrs. E.A. Fleming and Mr. E.G. Jessiman, Topographical Survey, E.M. and R.

Question and Answer Period

10:00-10:30 a.m. Coffee, Cafeteria, Camsell Hall Bldg.

10:30-11:45 a.m. Lecture; Cartography and Map Reproduction, Mr. D.E. Long, Map Reproduction Directorate, E.M. and R.

Question and Answer Period

11:45-11:55 a.m. Remarks by Chairman

11:55- 1:00 p.m. Lunch, Cafeteria, Camsell Hall Bldg.

1:00 p.m. Technical Tours; Coordinator, Mr. C.E. Martin. Assemble in Main Foyer of Surveys and Mapping Bldg., 615 Booth Street.

1:00- 1:15 p.m. National Air Photo Library; Statement on the Library's Role and Function, Mr. P.K. Andrews, N.A.P.L., E.M.R.

1:15- 1:30 p.m. Canada Map Office; Statement on Role and Function, Mr. G.A. Clemmer, Chief of the Canada Map Office, E.M. and R.

1:30 p.m. Seminar members assembled in the Main Foyer will be divided into two parts - Group "A" and Group "B" and will tour the mapping facilities as follows:

Group "A" - Section 1

Topographical Survey Directorate, 7th Floor
Monitor: C.E. Martin

1:30- 2:00 p.m. Aerotriangulation; Tour leader, Mr. W.G. Winges

2:05- 2:35 p.m. Compilation; Tour leaders, Messrs. R.F. Snook, A.E. Kemp, H.J. Handy, J.R. Lortie, R. Simser

2:40- 2:50 p.m. Interchange with Group "B" in main lobby, First Floor.

Map Production Directorate
Monitor: Guy Arbique

3:00- 3:30 p.m. Cartography; Room 160

3:30- 4:00 p.m. Reproduction; Room G72

Group "A" - Section 2

Topographical Survey Directorate, 7th Floor
Monitor: C.E. Martin

1:30- 2:00 p.m. Compilation; Tour leaders, Messrs. R.F. Snook, A.E. Kemp, H.J. Handy, J.R. Lortie, R. Simser

2:05- 2:35 p.m. Aerotriangulation; Tour leader, Mr. W.G. Winges

2:40- 2:50 p.m. Interchange with Group "B" in Main Lobby, First Floor.

Map Production Directorate
Monitor: Guy Arbique

3:00- 3:30 p.m. Cartography; Room 160

3:30- 4:00 p.m. Reproduction; Room G72

Group "B" - Section 1

Map Production Directorate
Monitor: Guy Arbique

1:30- 2:00 p.m. Cartography; Room 160

2:05- 2:35 p.m. Reproduction; Room G72

2:40- 2:50 p.m. Interchange with Group "A" in main Lobby, First Floor

Topographical Survey Directorate - 7th Floor
Monitor; C.E. Martin

3:00- 3:30 p.m. Aerotriangulation; Tour leader, Mr. W.G. Winges

3:30- 4:00 p.m. Compilation; Tour leaders; Messrs. R.F. Snook, A.E. Kemp H.J. Handy, J.R. Lortie, R. Simser

Group "B" - Section 2

Map Production Directorate
Monitor: Guy Arbique

1:30- 2:00 p.m. Reproduction, Room G72

2:05- 2:35 p.m. Cartography; Room 160

22:40- 2:50 p.m. Interchange with Group "A" in Main Lobby, First Floor

Topographical Survey Directorate - 7th Floor

3:00- 3:30 p.m. Aerotriangulation; Tour leader, Mr. W.G. Winges

3:30- 4:00 p.m. Compilation; Tour leaders, Messrs. R.F. Snook, A.E. Kemp, H.J. Handy, J.R. Lortie, R. Simser

Session 3 - Feb. 28 - Continuation of Technical Tours

N.A.P.L. Reproduction Centre and Canada Center for Remote Sensing
E.M. and R., 2464 Sheffield Rod. Tour Coordinators:

Reproduction Center - Mr. G. Nitschky, E.M. and R.
Canada Center for Remote Sensing - Mr. S. Zelitt, E.M. and R.

The personnel on tour to arrive at the northeast door of the N.A.P.L. Reproduction Center, 2464 Sheffield Road at 8:30 a.m. Tour members will be divided into four sections Group "A" Sections 1 and 2 and Group "B" sections 1 and 2.

Group "A" - Section 1

9:00-10:00 a.m. N.A.P.L. Reproduction Center

10:00-10:15 a.m. Coffee

10:15-10:45 a.m. Canada Center for Remote Sensing

Group "A" - Section 2

9:05-10:05 a.m. N.A.P.L. Reproduction Center

10:05-10:20 a.m. Coffee

10:20-10:50 a.m. Canada Center for Remote Sensing

Group "B" - Section 1

9:00- 9:30 a.m. Canada Center for Remote Sensing

9:30- 9:45 a.m. Coffee

9:45-10:45 a.m. N.A.P.L. Reproduction Center

Group "B" - Section 2

9:05- 9:35 a.m. Canada Center for Remote Sensing

9:35- 9:50 a.m. Coffee

9:50-10:50 a.m. N.A.P.L. Reproduction Center

1:15- 4:30 p.m. Free discussion period - Regional staff with their counterparts in the Headquarters Program Branch areas.

6:00-12:00 Mid. Seminar Wrap-Up Session - Dinner in the Richelieu Room Skyline Hotel - Address by K.W. Stairs, Assistant Director, Technical Services Branch, I.A. & N.D.

Question and Answer Period

APPENDIX 2

LIST OF PARTICIPANTS

Department of Indian Affairs and Northern Development

Glen T. Allen
Ken Baker
R. Balaian
R.F. Battle
D. Bessett
E. Bill
L. Blight
Neil Burke
J.W. Burton
R. Campbell
Keith Cloete
W. Coplick
W. Cox
C. Doucet
P. Dooley
Peter Edridge
H. Emergy
M. Fajarsl
Glen Finley
R. Gaudet
H. Gerin
B. Gibson
E.E. Gillespie
G.W. Gilmore
Pam Grey
John Griffith
William Griggs
R. Holden
D.A. Holmes
S. Homolos
E. Hulsman
Keith Judge
S. Kanik
J.D. Kellard
E.E. Kirk
D.J. Lenning
N. Ledrey
A. Masuk
Mrs. Donalda McCormac
Dave McCreery
A. McKnight
N. Mitchel
J. Morin
R. Morrison
D.J. Murphy
A.B. Oliver
A. Omotaui
A. Petahtegoose
I. Petrie
W. Potts
R.L. Price
C.F. Reardon
C. Robitalle
M. Rodeson
E. Rosbach
Frank Roscoe
R. Settle
M. Sigraidafou
Cid Smolik
J.J. Stewart
D. Sutherland
P. Tassi
W.H. Thrall
H. Toogood
P. Tresch
Van Der Giesson
A.W. Walker
E.W. Wallace
Glen Y. Williams
A.B. Yates

Department of Energy, Mines and Resources

Don Anderson
P.K. Andrews
D.H. Baker
G.A. Clemmer
E.A. Dixon
V.J. Ducette
E.A. Fleming
H.J. Handy
E.G. Jessiman
A.E. Kemp
D.E. Long
J.R. Lortie
D.K. MacDonald
C.E. Martin
R.E. Moore
G. Nitschky
L.M. Sebert
R.M. Simser
D.R. Slessor
E.J. Smith
R.F. Snook
J.V. Thompson
W.G. Winges
S. Zelitt

Department of Environment

Philip Gimbarzevsky