SPECIAL ARTICLE

METROPOLITAN TORONTO CONTROL SURVEY

by R. A. Smith

Metropolitan Toronto has grown during the last few years to one of the great cities of the world. Co-ordinating and organizing the activities of both private and public bodies, is an important part of any urban development plan. It will result ultimately in tremendous saving. To accomplish this, a program of control surveys was started by Metropolitan Toronto.

On November 4, 1958, a report prepared by the Commissioner of Roads was submitted and approved by the Metropolitan Council. It authorized the establishment of a vertical control network in the Metropolitan area. Arrangements were made to have the Roads Department survey staff work in co-operation with the Department of Mines and Technical Surveys, Ottawa, to establish a system of precise bench marks in Metropolitan Toronto. As you are likely all aware, this work was completed and 255 new bench marks and 40 old ones were tied in to a precise system related to geodetic datum.

In 1960, the survey was completed and, in 1961, a booklet was published listing the elevations and locations of all these bench marks. It is the intention that this precise network form the basic fabric to which many additional bench marks will be related. We are hoping that the local municipalities in the Metropolitan area will, as soon as possible, establish a dense system of bench marks in their own municipality all related to the precise network.

Having carried out the primary work necessary for the bench marks we then turned our attention to the larger and more complex problem of horizontal control. The Metropolitan Council was approached and this time it approved the establishment of a horizontal control system; again the work was to be done in co-operation with the Department of Mines and Technical Surveys, Ottawa.

In the summer of 1960 the Geodetic Survey of Canada, part of the Department of Mines, sent a reconnaisance crew to Toronto to determine the best locations for the establishment of a number of first order triangulation stations. The party of two men worked here for over two months locating between 20 and 25 stations which could be used the following Summer for survey work. One of their major problems was to set up triangles which had sufficient strength of figure to be used for geodetic work. The accuracy of the first order survey was approximately one in one hundred thousand, or one foot in twenty miles.

The following summer a large survey party came to Toronto and commenced work on the actual survey. During that Summer 22 first order stations were established and triangulated. Shown on this plan are the locations of the various stations, the red lines indicating the lines measured. The main focal point of this network was a station set on the roof of the Imperial Oil Building on St. Clair Avenue. If any of you have ever gone up to the observation deck you will realize the magnificent view of the whole city that is obtained from this building.

Other stations were located on the roof of Victory Mills, Gledhill Public School, an apartment building in Don Mills, The Carling Building in Etobicoke, Morgan's Store in Cloverdale Mall and the roof of the HEPC Lakeview Generating Plant. At the other points shown on the map, ground stations were established; over the majority of these, towers were erected 100 feet in height because the stations had to be intervisible. Using modern electronic surveying methods the angles and distances between all the stations were measured and their relationship to a base line joining an existing geodetic station in King City to one in Uxbridge was measured.

That winter the geodetic values of these stations were calculated on an electronic computer in Ottawa. The results were expressed as latitudes and longitudes given for each station to four decimal places of a second, at sea level.

These first order stations are approximately five miles apart. It was then necessary to establish control stations on the ground at a much greater density and in locations readily accessible to local surveyors and engineers. By a stroke of luck, we were again able to have the Federal Government co-operate in the establishment of this network. Not long after we requested their co-operation, the City of Montreal asked that a similar project on a much smaller scale be undertaken. The Federal Department agreed to do both the Toronto and Montreal projects.

In the summer of 1962 a survey party from the Topographic Section of the Federal Department was sent to Toronto to carry out second order traversing between the first order triangulation stations. Shown on this map are the approximately 230 ground stations established last summer. These stations are marked by concrete monuments 14" in diameter, 4'6" deep, set flush with the ground. The east half of Metropolitan Toronto has now been covered and during the coming season approximately 200 stations will be established in the west half. The entire network will then be adjusted by electronic computer and the latitude and longitude for each station then be known.

It will be necessary to convert the positions for the points from geographic co-ordinates to plane rectangular co-ordinates. A projection will be decided upon for the plane co-ordinate system. A projection is simply a representation of the earth's surface on a plane. In any projection it is essential that there be one and only one point on the earth corresponding to each point on the plane.

Thus the plane co-ordinates of any point in the Metropolitan Toronto area can be expressed in terms of two distances. One of these distances to be known as the X co-ordinate will give the position in an east and west direction; the other to be known as the Y co-ordinate will give the position in a north and south direction.

The establishment of primary control points in Metropolitan Toronto will be finished this Summer and the plane co-ordinate values will be available approximately one year from now. The next step is establishment of a number of survey monuments at a greater density. We expect this will be accomplished by the various Government surveyors who have modern electronic survey equipment relating their large projects to the control network. These monuments should be established at an accuracy of at least one in twenty thousand. This will insure that the absolute position of any point related to the co-ordinate control survey will be positively known.

What is the purpose of a survey in the first place? Certainly surveys are performed for a variety of purposes, but it is quite generally true that one purpose of a survey is to enable subsequent identification of a point or parcel of land, frequently by another person. This is an important part of mapping operations, and it is very important in legal and construction surveying. Part of the results of a survey is a means whereby other surveyors can locate the same point or parcel of land as that originally surveyed. All surveys carried out by various independent surveying and engineering organizations related to the control network are automatically related one to the other and the information can be used interchangeably with little if any further field work.

A co-ordinate system properly used, is the best method of insuring that a monument has been restored in its true position. By tying all surveys to a

common control system, the surveyor will be able to express the position of any point in a simple direct manner. The system prevents large blunders and uses the basic principle of proportioning for setting points. Computation can be quickly made using co-ordinates and they are also easy to use with an electronic computer. They provide a simple and direct way for plotting plans and maps and enable the preparation of accurate city maps. They also provide the ground control for all aerial mapping projects.

Control monuments should be considered as permanent monuments and located where they are least likely to be disturbed. All property monuments can then be considered as temporary points that are likely to be disturbed or removed by construction. It would be ideal to have control monuments 600 feet apart in residential areas and about 300 feet apart in the core of the city. The present surveys are only suitable for co-ordinating large public works projects which require expensive surveys.

The Municipality of Metropolitan Toronto is aware of the need for control survey and has taken positive steps to establish networks that are acceptable to all.

It is now up to the membership of this group to see that the Province officially recognizes this network and passes legislation that it be completed, maintained and used to relate all legal surveys.