
COMPUTER MAPPING DEVELOPMENT AT THE CITY OF CALGARY

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INTRODUCTION

AS THE CITY OF CALGARY has grown, it has experienced a rapid increase in cartographic and geographic information requirements. There are over 60 map series produced manually in the City. Some of these maps contain similar information. They all use some form of a City base map. This situation results in much duplication of effort, particularly with respect to the continual redrafting of the City base map.

In the 1970s the city recognized this problem and developed plans for the coordination and automation of this mapping effort. The implementation of computer graphics methodology is well underway. The base maps were the first to be automated. Other mapping applications and data linkage facilities are following in a phased implementation.

THE COMPUTER MAPPING PROGRAM

Calgary's computer mapping program involves several City departments. The program is based on a system whereby a single digital base map is created and departmental data are mapped as digital overlays on this base. This procedure eliminates redrafting of the base, and assures compatibility of map data across departments. It also allows for multipurpose and distributed use of data traditionally used and maintained for only one function.

The legal base map is produced by the Engineering Department, utilizing data supplied by the Province. This base map is then transmitted to the Data Processing Services Department. There, the ownership/tax parcel base map information is overlaid on the legal base. A composite base map consisting of both the legal survey data and the parcel data is used by other departments, such as the various utilities. The parcel mapping project contains information and facilities linking the parcels to the City street network and to related data bases.

All computer mapping activities within the City are based on Intergraph interactive Computer Graphics equipment. The Engineering Department and the Data Processing Services Department each own a PDP 11/70 based system with several graphic work stations. Currently map files are moved between systems manually, but direct communication links are planned in the future.

The major computer mapping activities of the City are coordinated by a Computer-assisted Mapping Steering Committee. This committee consists of the Directors of the major departments involved in computer mapping activities. The committee provides direction and guidelines for the operation of the program.

THE LEGAL BASE MAP

The first computer mapping activity started in the City of Calgary was that of creating the Legal Base Map. In 1980 the City began the production of a digital series of cadastral base maps under an agreement with the Province of Alberta. The series consists of approximately 1000 map sheets of a 600 × 800 metre format. The maps are prepared based on a recomputation and reconciliation of all registered survey plans, using field ties between the registered plans and the new survey control network. The Province performs the computation step and the production of the final base maps is done by the City (Piepgrass, 1980).

The Province supplies the City with lot and block corner coordinates and blockface data in digital form, along with copies of the manuscript map sheets. The survey points and blockface lines are automatically loaded into a graphics design file along with the legal lot frontages in both metric and imperial units. The base map files are then completed using the information contained on the manuscript map sheets. Street names and hydrographic features are also inserted. After thorough editing, the base maps are forwarded to the Province for a review cycle. The legal base map is created by the Engineering Services Division of the Engineering Department.

Calgary's base map series production differs from the automated mapping systems of most other cities in that the maps are created directly from the geographic coordinates computed by the Province, rather than from digitized data, aerial photography, or other sources. The x-y coordinates are measured from the equator and the 114 meridian in the 3 degree Central Transverse Mercator System. All dimensions are held to 1/25 of a millimetre to provide exact metric to imperial conversion. The scale of the digital maps is set at 1 : 1 ground scale. This is possible due to the precision at which the mapping system can store graphic data.

THE PARCEL BASE MAP

The Parcel Base Map Series depicts all ownership parcels, as opposed to legal surveyed lots, in the City of Calgary. The Parcel Map is produced by the Computer Mapping Section of the Data Processing Department. It is created in exact correspondence to the Legal Base Map. The basic Tax Parcel Map Product consists of a digital map and an associated data base. The data base contains information about each parcel in the City. Other facilities allow for linkage of parcels to the City street network and related data files. The Parcel Map is an overlay on the Legal Base Maps, but is partitioned by sections, rather than cadastral sheet boundaries. There are currently 195 sections covering the City of Calgary, containing more than 160,000 parcels.

Contents of the Parcel Map

The Parcel Map is basically an ownership parcel and address indicator map. As such, it contains the following major features:

Parcel Boundaries: These are the property lines as opposed to the surveyed legal lot lines;

Parcel Addresses: Each parcel has a unique address;

Municipal Addresses: A parcel may have additional or alternative street addresses;

Parcel Areas: The areas of all parcels are automatically calculated;

Roll Numbers: Obtained from Assessment files;

Building Names:

Street names and block numbers are indicated, as obtained from the Legal Base Map. An underlay of Legal Base Map information is also supplied, including lot lines, lot numbers, and lot frontages.

The Parcel Data Base Capabilities

The major data relating to each parcel are not only displayed graphically, as outlined above, but are also stored in a data base associated with the map. This data base is an important feature of the Parcel Mapping facility, providing greater information capabilities. Each parcel has a data base entry. The data base is attached to the graphic file via an Intergraph facility, so that for any given graphic parcel, data base information may be retrieved and displayed. The data base capabilities may also be used without accessing the map itself.

The parcel is the basic entity of the data base. For each parcel the following information is accessible:

Parcel Address: This is the unique parcel address.

Street Name: The full name and quadrant of the street is indicated.

Parcel Coordinates: Coordinates of an interior 'text node'.

Roll Number: The roll number is obtained through a batch run matching parcel addresses to the assessment file.

Parcel Area: The area of all parcels is calculated at once in a batch run, and inserted in the data base.

Section Number: This may differ from the section on which the parcel appears.

Information relating the parcels to the street network of the City is also contained in the data base.

Any of these data may be retrieved for any given parcel. Different users of the Parcel map are interested in different data items. Therefore, various versions of the parcel map are distributed to users, each indicating different data items. These data items are retrieved and displayed for the creation of the particular map of interest only.

Creation of the Parcel Map

The Parcel Map is created using the Legal Base Map information supplied by the Engineering Department and legal ownership descriptions obtained from

Assessment. The basic operations involved in the creation of the Parcel Map are as follows:

- 1 The Legal Base Map files, which are metric sheet based, are merged to form sections, the basic area units used for City mapping functions.
- 2 Parcel boundaries are created by copying the surveyed lot lines to the parcel map file and editing the linework to form the parcel lines. The parcel boundaries are determined from legal descriptions obtained from the City Assessment Department and Land Titles Office.
- 3 Once the linework for the parcels has been completed, the parcels are converted to individual polygon entities and data base entries are created for these parcel polygons. The process of creating the polygons is done primarily from the mathematics of the linework by the system itself. The operator provides one point inside the area which is to become the parcel polygon. From this single point, the system finds the nearest side and follows the boundaries until the polygon is closed. This procedure is possible because of the precise placement of the lot corners (Mayhood, 1982). A data base entry for each parcel is automatically created at this time. Location information including street segment, block-face, section and coordinate information is picked up automatically and inserted in the data base along with the parcel address.
- 4 Other parcel attribute information is added to the data base later, including the assessment roll numbers and the parcel areas. Additional graphic data include municipal addresses, building names, road closures and plan numbers.

The production of this digital Parcel Map differs from the approaches taken by many other municipalities. The major difference involves the direct use of land title information constructed on a legal base. The creation of parcels in this manner is possible because the legal base is precise, having been created from calculated coordinates. This methodology for the creation of the Legal Base and Parcel Base maps involves capture of data at point of origin, thus resulting in accurate and precise base maps (Somers, 1982). Figure 1 is a portion of a completed composite base map, indicating selected legal and parcel base elements.

Site Map Information

An important aspect of address information maps is the depiction of sites consisting of multi-family residential, commercial and institutional developments. Such sites contain private roads and buildings with individual addresses, although the parcel containing the site may be large and have only a single address. The detail of these sites is not normally available on City maps. This information is quite important, however, to emergency services, taxi and courier services, utilities, other City departments and the general public.

The first problem involved in mapping such information is that of obtaining it. The Addressing Section of the City has gathered site map data from a variety of sources including utilities, developers and various institutions and developments.

Given the cartographic quality of these sources, mapping the information on

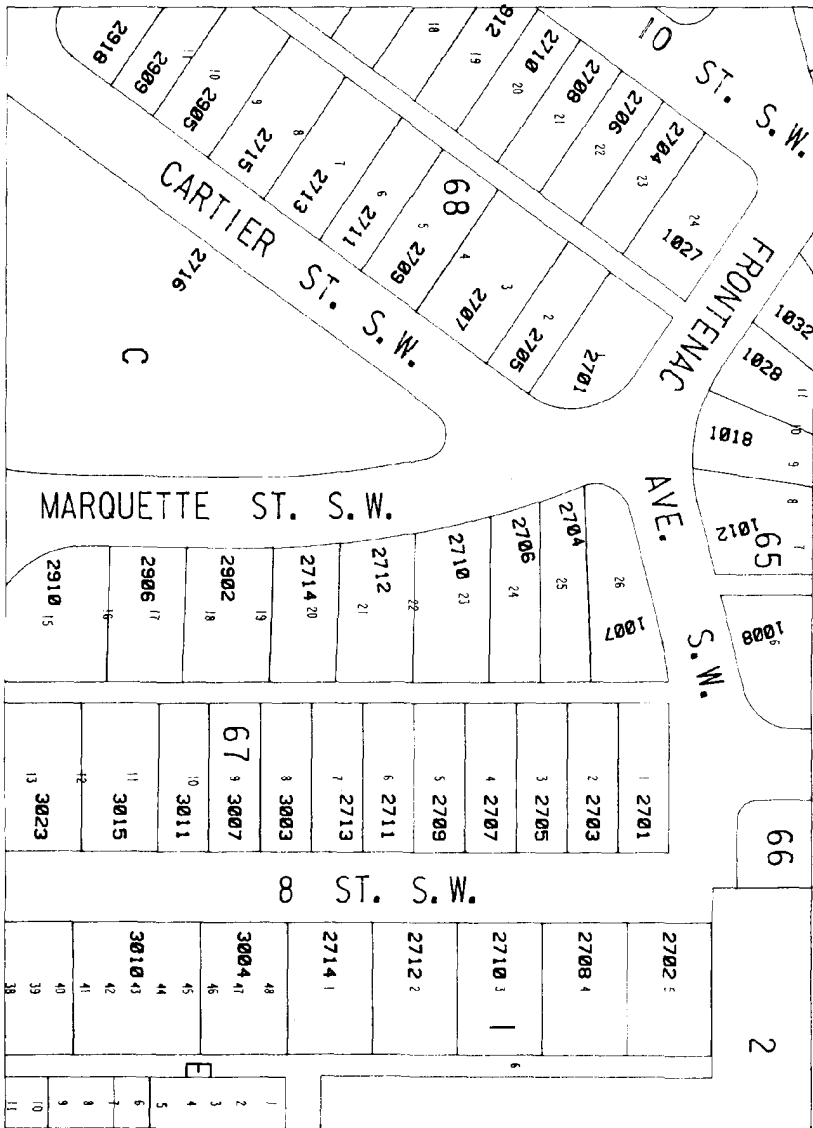


FIGURE 1. Base map indicating street names, lot numbers, parcel boundaries and parcel addresses.

an accurate base map presents a problem. The current methodology is to fit the boundary of the site into the precise boundary of its parcel and then to adjust the site contents according to relative location. The contents of the site are not expected to be highly accurate with respect to coordinate location. The major objective in the portrayal of sites is to position the roads and buildings relatively correctly with respect to location, orientation and size, and to show the addresses clearly.

A third problem arises in the production of hardcopy maps including such sites. Different users and output scales require different information to be displayed. A flexible product has been developed, utilizing the level features of Intergraph drawing files. Large scale maps can be produced using the building outline level with or without an overprinting of the complex name. Small scale maps can be produced using the complex name level only.

Data base extensions are being considered that would allow entry of individual condominium or multi-unit dwellings as entities related to the basic parcel.

APPLICATIONS MAPPING AND MAP USE

Many City departments, as well as outside parties, use the City base maps. Some City activities are parcel, or address based, and would use the Parcel Map as a resource, reference, or link to other address related data. This is accomplished via the street network and location information in the parcel data base. Many functions would add or overlay data to the Parcel Base, thus augmenting the parcel data bank. Such a situation would facilitate access to a variety of parcel related data.

Utilities

The utilities use a combined base map. The legal base information is required for their primary records, while the Parcel base data are necessary for drop lines and billing. A joint utility mapping effort is being coordinated by the Engineering Department. That department will distribute the composite base map in digital form to each of the utilities. Each utility will map its own records on this base according to its operational needs. Specific utility data will be fed back to the Engineering Department by each utility as a digital map file. The Engineering Department will then create and maintain a common utility map from this information. This procedure will make available a central utility map for use by the City, all utilities, and other parties concerned with utility locations.

The City Electric System was the first utility to begin records mapping. Primary underground, overhead, and communications are their first efforts.

Addressing Section

The Addressing Section of the City is a major user of full address information maps. That group currently maintains paper address maps manually but a full set of plots of the digital Parcel Map will replace their current map record system. Address maps are used as a resource for their work in maintaining and adjusting City addresses and for servicing the public. As the central authority on address information, the Addressing Section updates address and parcel information for input to the Computer Mapping Section.

Assessment

The most common and the largest revenue producing entity that the City Administration deals with is the taxation parcel. Thus, one major use of the Parcel Map will be in conjunction with functions dealing directly with the parcel for assessment purposes. The Assessment Department is interested in the

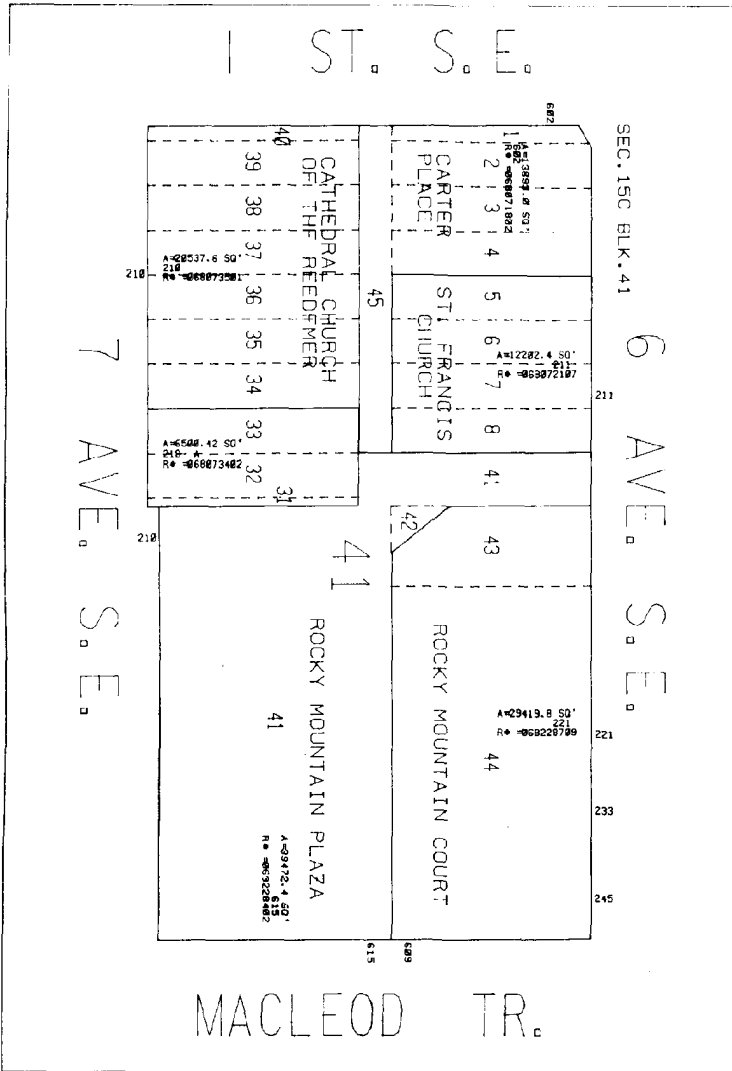


FIGURE 2. Assessment map showing roll numbers, areas, building names and municipal addresses in addition to lot lines and numbers, parcel boundaries and addresses, street names and block numbers.

graphic representation of their operational location data in a computerized format. Maps produced for this purpose display all address information including section, street name, block number, parcel address, municipal address and building name (see Figure 2). The development of area and roll number display was also developed largely for Assessment use.

Planning Land Use

The Planning Department is concerned with two types of land use mapping – Land Use Classification and Actual Land Use. When these map data are represented as polygons, polygon overlay operations can be performed. This operation would allow analysis of Land Use Classification vis-à-vis Actual Land Use.

Additional Applications

Many other City departments are becoming involved in the automation of their mapping activities. The benefits of such a conversion lie mainly in the maintenance of the map. The Transportation Department will be converting their bus stop and sign inventories to the computer mapping system. These maps will be linked to a data base containing inventory information currently maintained manually, such as bus stop equipment and characteristics. Bus routes will also be added to the system. Other current departmental applications include the mapping of ward and polling subdivision boundaries, census tracts, and police neighborhoods.

MULTIPURPOSE MAPS

The basic objectives of the computer mapping program are to centralize the maintenance of a city base map to a single source, thus eliminating duplication of effort and facilitating map maintenance, and to promote multipurpose use of digital map information. Different users have different needs, so the maps must be as flexible as possible.

A major feature of the Intergraph systems mapping facilities is the division of each graphic file into 63 separate levels. As many as 3 read-only reference files can also be displayed along with the primary file. This allows great flexibility in map design. The City has made use of these features by arranging for each Department to maintain its own separate files, while using other files, including the base maps, as reference files. This allows access to other Departments' data, but protects it from inadvertent damage. Each map itself is designed to make use of the level structure. In general, each type of data item is contained on a separate level, thus enabling display of selected information.

Digital map overlays created by one department may also be of use to others. The standardization of graphic data onto a single base makes data compatible between departments, and the centralization of the information on the computer makes it more readily accessible.

Different users require the display of different data elements from the data base. For example, Assessment needs roll number and area included on each parcel along with a small parcel address. The Addressing Section requires larger addresses to be printed, with no roll numbers and areas. Both groups use the same Parcel Base Map graphic but require the printing of different data elements. Separate maps are printed for each group, displaying the elements of interest to them and in a format suitable for their needs. The use of the system data base display capabilities, selective level display, and time of output options allows for this flexibility.

STATUS OF THE MAPPING PROGRAM

Many applications of computer mapping in the City are well underway. The legal base maps will be current on January 1, 1984. The Parcel Base will come fully on-line shortly after that. Planning has nearly finished its land use classification mapping activities and Electric has several record mapping series partially complete. Assessment, Addressing, Police and other departments are using various forms of the Parcel Map.

Future plans include augmentation and enhancement of the Parcel Map and Data Base. Other departments will begin adding their information to the system once the base maps are completely on-line.

CONCLUSION

The benefits of the automation of the City's mapping efforts include reduction of duplicated effort, simplified map maintenance, use of a single centralized base map and increased ease of access to data, among others. The Legal Base and Parcel Base mapping activities involve data capture at point of origin, resulting in accurate and precise base maps. The conversion of current mapping activities to an automated system will take quite a while, but once it is done, maintenance of the maps is more efficient. Automation also requires a great amount of initial funds, although the net savings are certain in the future. Current economic constraints may slow the implementation of computer mapping methodology in the City, due to high initial costs. The program has demonstrated, however, that the benefits are worth the costs in the long term.

REFERENCES

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