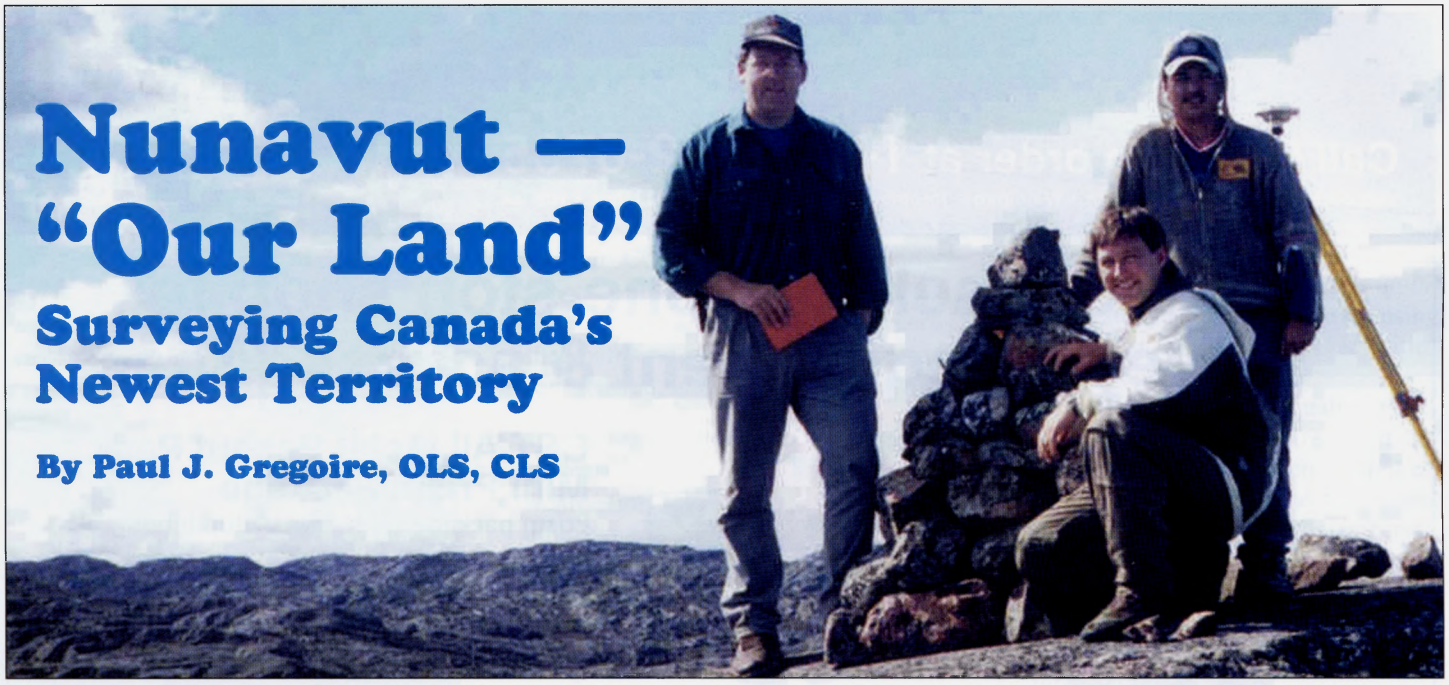
Nunavut — "Our Land"

Surveying Canada's Newest Territory

By Paul J. Gregoire, OLS, CLS



Nunavut is Canada's newest territory comprising an area of approximately 350,000 sq. km in Canada's Eastern Arctic region. It was established in 1999 after the successful negotiation and ratification of the Tunngavik Federation of Nunavut (TFN) Land Claim Agreement. This agreement is the largest land claim treaty in the history of our nation to have ever been concluded.

The establishment of the boundary of the settlement area commenced in the summer of 1994 with the first field surveys to locate, monument and measure the rectilinear boundaries of the Inuit-owned land parcels. At the tenth anniversary of these first surveys, through this article we will revisit our firm's (Marshall Macklin Monaghan Limited) involvement in the first surveys of the land claim parcels in Nunavut.

Historical Background

Prior to the establishment of the Nunavut territory, the Northwest Territories (NWT) comprised approximately one third of Canada's landmass and its boundaries were established in the early 1900s. The federal government administered NWT until the 1950s at which time representatives to the legislative assembly were first elected by the region's population.

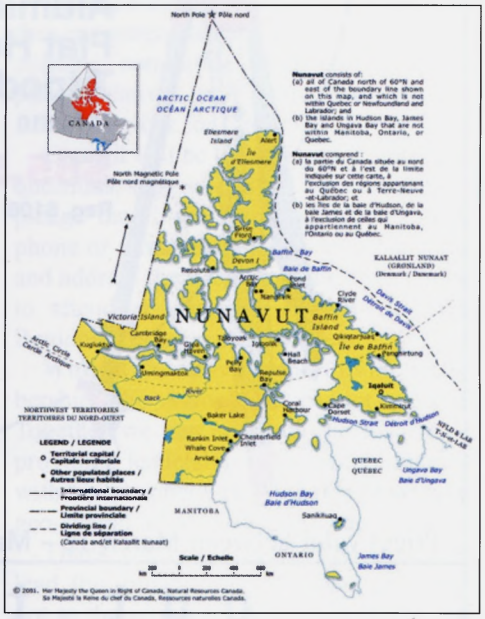
The native residents of the region subsequently became more and more interested in the administration of the north and in 1976 the Dene/Metis and the Inuit came before the federal government and proposed that the division of the NWT become an integral part of the Inuit land claim settlement in the eastern arctic. At that time they proposed that the tree line become the natural line of division between the eastern and western regions of the NWT. This concept of a division of the territory was first put to a plebiscite in the north in 1982.

Negotiations in 1987 proposed a division such that the Nunavut boundary would be based on the Inuit land claim settlement areas and in 1990 a single line boundary between the claim settlement areas of the Dene/Metis (Western Arctic) and the Inuit (Eastern Arctic) was proposed.

Negotiations continued and discussions of the Nunavut Accord began in December 1991 between the Government of Canada, the TFN and the Government of the Northwest Territories (GNWT). Approvals for the Accord were subsequently obtained by each party and in May of 1999, the residents of NWT voted on a boundary plebiscite to divide the NWT into the regions of the Eastern Arctic (Nunavut) and the Western Arctic (NWT).

The approved Accord made provisions for the Nunavut Act, the establishment of a local Government and support for a Legislative Assembly, an implementation process and a transition period as well as a funding mechanism for the transfer of capital payments over an extended period of time.

All sections of the Nunavut Act came into force on April 1, 1999 providing the Inuit with rights and title to the settlement lands including an interest in the natural resources and wildlife.



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Survey of Inuit Owned Land Parcels

The first field survey for the demarcation of the rectilinear boundaries of the Inuit-owned Parcels within the Nunavut Settlement Area in the District of Kitikmeot, NWT commenced in July of 1994. Survey contracts were awarded to successful proponents on the basis of best value to the Crown after the evaluation of extensive technical and financial proposals by numerous competing firms. A consortium of Marshall Macklin Monaghan Limited, Usher Canada Limited and Underhill & Associates submitted proposals and were successful in 1994 in contracting work to undertake the initial surveys in two remote areas adjacent to communities in the eastern arctic. These communities were Rankin Inlet and Arviat (formerly known as Eskimo Point).

In subsequent years the firm, in partnership with Usher Canada, was awarded additional contracts to complete similar land claim parcel surveys adjacent to the communities of Coppermine, and Bathurst Inlet, and inland parcels to the south of these communities.

Other survey contracts have been undertaken by numerous firms in remote communities such as Baker Lake, Pelly Bay, Repulse Bay, Bay Chimo as well as many other communities on Baffin Island, Victoria Island, Ellesmere Island and Cornwallis Island.

In all there were 1155 land claim parcels to be surveyed, comprising 33,000 km of artificial boundaries to be established. It was anticipated initially that this work was to be completed over an 8 to 10 year period.

Initial Proposal Preparation

Preparation of a detailed technical and financial proposal is an onerous task and requires several months to complete. A significant effort was made at the proposal stage to address important issues key to the successful award of a survey contract.

These key project issues include:

A stone Inukshuk 3-storeys high overlooks the community of Rankin Inlet on the western shore of Hudson Bay.

- Establishing an association with the local Inuit Association and making provisions for significant native involvement in each survey contract.
- Consultations with the Project Authority, through the Regional Surveyor's office in Yellowknife, on survey specifications and with Supply and Services Canada for clarification with respect to the survey contract.
- Enquiries about land use licence requirements from local Inuit Associations (for use of Inuit-owned lands).
- Enquiries about permit requirements with Regional Land Managers and/or District Managers of Indian and Northern Affairs Canada (for use of Canada Lands).
- Enquiries and obtaining pricing for helicopters and the fixed wing aircraft required for crew mobilization, scheduled supply shipments and fuel caches.
- Enquiries to locate and obtain use of existing camp facilities or for the establishment of remote camps.
- Enquiries and estimating the cost to mobilize drummed fuel via winter road to a project staging area.
- Establishing a working relationship with local suppliers for procurement and expediting of gear, leases and/or equipment rental for camps (i.e. codan radio, satellite phones and camp generators).

Project preparation

Project preparations to be made after the award of the survey contract include:

- Securing all necessary land use permits for campsites or fuel caches that are to be positioned on Inuit-owned lands.
- Notification to District Manager and confirmation that all activities are conducted within the spirit of the Territorial Land Use Regulations.
- Securing and finalizing of employment of local Inuit assistants from within the respective remote communities.
- Confirming logistics and ensuring availability and schedule of expediting firm and fuel supplier.
- Completing arrangements for radio communications between crews, camps, and aircraft and/or between camp and outside communities.

Survey specific tasks to be undertaken prior to mobilization include:

- A review of Official Survey Instructions and the requirements of the Canada Lands Surveys Act and the Manual of Instructions for the Survey of Canada Lands.
- Obtaining and reviewing existing aerial photography for each parcel corner in the project area.
- Investigating and obtaining data for all existing horizontal control stations within and in close proximity to the land claim parcels.

- Review of the 1:250,000 NTS map sheets indicating the intention and location of each isolated boundary corner.
- Review of the Descriptive Map Plans, which depict the nature and location of each proposed parcel corner and cross check with 1:250,000 maps for consistency.
- Transfer of parcel corners to multiple sets of the 1:50,000 map sheets for field use by the Canada Lands Surveyor.
- Investigate and obtain all mineral claim survey plans in close proximity to the subject parcels.
- Generate provisional coordinates for each parcel corner and prepare a Control Network design sketch indicating all baselines and control ties to be measured by GPS.

Field Mobilization

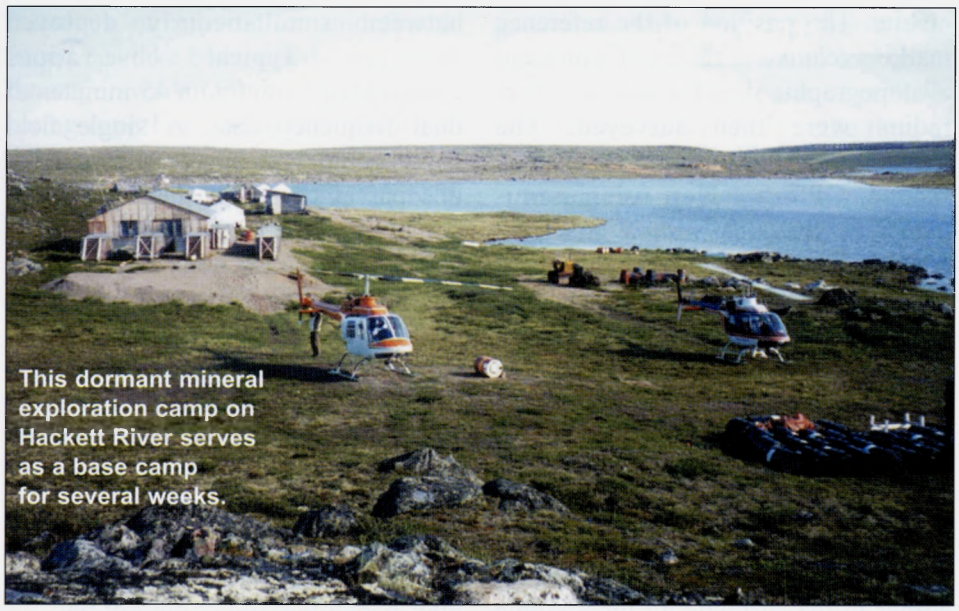
Logistics for the actual mobilization to the project camps can become a daunting task. In total, the mobilization to the field camp typically takes three full days. The first day is committed to mobilizing staff, survey equipment and related gear from Toronto to Yellowknife.

The second day is typically set aside to schedule a project initiation meeting with the Project Authority. Other meetings are scheduled with the expediter and representatives of the helicopter company. As well last minute supplies such as grout, jerry cans for water and gas for the rock drills and generators are purchased, monuments (including tablets, carsonite markers and reference monuments) are secured from the client and everything is transported to the airport staging area. The helicopters (typically two are used per contract) are mobilized to the remote community.

The third day involves mobilization from Yellowknife to the remote community or to several communities depending on the proximity of the community to where the base camp is being established and the number of crews being utilized.

With the passenger seats removed, this 737 aircraft transports camp gear, fuel and survey monuments from Yellowknife to Rankin Inlet.

Local Inuit help is typically secured for the duration of the project once the survey team arrives in the local community. If the opportunity for training is available prior to mobilization to field camp, it is scheduled at this time,



This dormant mineral exploration camp on Hackett River serves as a base camp for several weeks.

otherwise the most enthusiastic and capable helpers are selected and the on-the-job training commences once the field survey is underway in camp. A two-week technical training session in a classroom environment was provided in the winter of 1995 and subsequent projects benefited from the availability of these more experienced individuals.

Field Camp

Typical base camp facilities may include a temporary camp site on the Tundra, a vacant mineral exploration camp, seasonal camps established for hunting, fishing and eco-tourism programs, or a dormant mine site. If survey operations are close to a settlement or small community, the field crews may find accommodation at a local residence, in a church basement or a commercial facility.

The remote field camp for the 1994 project was located on Kaminak Lake, a several-hour flight by helicopter, west of Rankin Inlet. The camp had temporary provisions for a cook tent, computations tent, and sleeping accommodations, as well as a makeshift shower and an outhouse. Gas generators provided electrical power for the computations tent to run computers and to charge batteries for the GPS receivers and radios.

Camps like these are supplied every three to four days with barrels of jet fuel, groceries and necessary camp supplies. To survey the remote parcel corners, which can be in excess of 100 km from camp, it becomes necessary to establish fuel caches for the helicopters.

Fuel Cache

The strategic placement of fuel caches becomes critical during field operations. Helicopters frequently require additional fuel during the course of the day and cannot make lengthy return trips to base camp as this would result in significant downtime for crews. Caches containing 4 to 6 barrels of jet fuel and survey monuments are positioned such that refueling may be done en-route to remote parcels or at the end of the day on return to base camp. Fuel is positioned in advance of the crews and is usually done by fixed wing aircraft (Twin Otter or DC3). All barrels must be removed from the caches at the completion of the project.

Field Survey

The project requirement was to survey and prepare "Official Plans" under Section 29 of the Canada Lands Surveys Act in the form of Plan and Field Notes of Survey of rectilinear boundaries of Inuit-owned lands in the Nunavut Settlement Area. The nature and approximate location of the boundary corners had been pre-selected and agreed upon during prior negotiation between the various stakeholders.

The descriptions of the parcel corners are depicted on a 1:250,000 NTS map sheet and each parcel corner was transcribed onto 1:100,000 plans called Descriptive Map Plans (DMPs). These DMPs have been deposited on title in the Land Titles Office in Yellowknife and form the basis of the survey instructions from the client. Each DMP describes numerous Inuit-owned lands (IOL) parcels and details the nature and intended location of each of the parcel corners. The corners were identified as one of the following:

RWM — Right Water Meeting is that point where the ordinary high water mark (OHWM) at the right bank of a stream or river meets a lake or the sea.

LWM — Left Water Meeting is that point where the OHWM at the left bank of a stream or river meets a lake or the sea.

RTM — Right Tributary Meeting is that point where the right bank of a tributary meets the OHWM of a stream or river.

LTM — Left Tributary Meeting is that point where the left bank of a tributary meets the OHWM of a stream or river.

HL — Height of Land is that point higher than its surroundings.

Having transcribed the water meeting or height of land point onto the respective 1:50,000 NTS map, the field crew could navigate to the governing physical feature by using provisional coordinates, which were scaled for each corner and uploaded daily to the on-board GPS unit in the helicopter. Corner selection was completed by the Canada Lands Surveyor (CLS) on approach to the corner or by closer field examination in instances where it is difficult to determine the point of water meeting, or the physical height of land.

The main corner monument consisted of a brass tablet, which was threaded onto a steel rod and driven into the ground to refusal. In the case of bedrock, it was drilled and grouted

This parcel corner in the Eastern Arctic has been established where a small creek bed and a dry lake bed meet. The stone mound, carsonite marker and three reference monuments witness the main marker.

into place. Tablets were identified with unique numbering as well as parcel number identification and suitable markings to indicate the direction of the surveyed lines. Three reference markers (CLS 77) and a carsonite marker were installed at each corner and a one metre high stone mound was constructed from available boulders on-site. The position of the reference markers relative to the main tablet and all topographic detail within a 200 m radius were then surveyed. The topographic detail was picked up by a second GPS receiver using semi-kinematic methods with a 5 second data rate. In the initial field surveys of 1994, the topographic survey was completed by total station survey methods and the orientation of the site survey was governed by completing several sets of solar observations. Each parcel corner was photographed from ground level and from an oblique angle from the helicopter. These photographs document the relationship of the parcel corner to the surrounding topographic features. The position of the parcel corner was pinpricked on each of the relative aerial photographs, which were then signed and dated by the CLS.

The spatial relationship between respective IOL parcel corners, connections between adjacent parcels and the geodetic control stations, were made by static GPS observation techniques between simultaneously deployed receivers. Typical observations consisted of a minimum 45 minutes of dual frequency data. A single field crew would typically leap frog from one parcel corner to the next parcel corner. By the time the referencing and topographic survey was completed at a new corner, the helicopter and crew could return to the previous corner to collect the receiver and move ahead to the next parcel corner thereby creating a closed traverse around each parcel. Maximum efficiency is obtained when two crews work in relative close proximity to each other (i.e. an adjoining parcel) and can thereby obtain "free" inter-parcel ties and/or control ties.

Difficulties in establishing parcel corners were encountered on several occasions where the physical height of land was significantly distant from the provisional coordinates as generated from the map sheets (from several hundred metres up to 1 or 2 km) or there was no hill, esker or knoll at all. In the case of water meetings, there were

instances of missing or undefinable (dried up) lake beds, dried up seasonal drainage swails, areas flooded due to spring runoff or even rivers flowing in the opposite direction than assumed based on the DMP or 1:50,000 NTS sheet. In all of these instances it is the role of the CLS to position the parcel corner such that the integrity of the parcel configuration is maintained. Witness monuments for a parcel corner were established only in the rare instance where it was physically impossible to set (i.e. a cliff or other rugged terrain).

Computations

All GPS field observations were downloaded and processed in the base camp on a daily basis. Files were backed up on a second laptop for all data sets. Parcel networks and control tie networks were built from the baselines observed, such that a simultaneous network adjustment could be completed. Each network was within specification, passing second order tolerances as defined by the Geodetic Survey of Canada.

Final coordinates of parcel boundary monuments were derived from a fully constrained least squares adjustment that met second order horizontal accuracy at the 95% confidence level. The internal accuracy of each parcel survey, based on a minimally constrained least squares adjustment, met first order horizontal accuracy standards at the 95% confidence level.

There were several instances where baselines needed to be re-measured because of initial poor quality data that was caused by either ionospheric activity, equipment problems with cables, batteries, GPS sensors, or operator error (length of simultaneous data was insufficient to properly resolve the baselines).

By the end of the field survey, summary tables that listed fully constrained coordinate values (NAD83, UTM and geographic values), together with ellipsoid elevations, point scale factor and convergence had been generated. This data, together with a field report and daily camp log of all activities, formed the basis of preliminary returns to the client at the time of demobilization from camp.

In addition to completing computations in camp, the computations technician coordinates fuel caches, arranges for camp supplies, tracks flying time for each helicopter and approves trip tickets, assists in necessary repairs, supervises the fuelling of camp generators, maintains a daily project log, and hopefully has enough time to catch some Arctic Char for dinner.

Plan Preparation

Final plan preparation was undertaken back in the office. Due to the size of most of the land claim parcels, the plans were prepared at a scale of 1:50,000 or 1:100,000. A detail inset of each parcel corner (usually at 1:2,000 scale) illustrated the position of the parcel corner monument, the ancillary monumentation and line work for the topographic detail. Ties from the main marker to the topography were listed in tabular form. Final plan mylars are typically 2 to 3 metres long.

Tables for the geodetic control marker data, ties to control from parcel corners as well as a coordinate table of each parcel corner are also provided on each plan.

A digital backdrop of the topographic detail (based on the 1:250,000 National Topographic database produced by Natural Resources Canada) was compiled for each parcel plan. It is this digital data that is used to compile the natural boundary positions of each parcel.

All plans were certified by the CLS and will be approved under Section 29 of the Canada Lands Surveys Act. In addition, the plans were approved by the representatives from the respective Inuit Association and Nunavut Tunngavik Inc. The plans were then recorded in the Canada Land Surveys Records as well as in the Land Titles Office in Yellowknife, NWT.

Summary

The Nunavut territory will continue to grow and prosper as it develops the necessary infrastructure to manage its future. Recent approval has been given for the establishment of the first diamond mine and recent reports indicate that a record number of prospecting permits, covering an area of 64 million acres, have been awarded.

From the survey perspective, participating in the initial field surveys of the land claim parcels for the Nunavut territory was a challenging and ultimately, a satisfying experience. The opportunity to travel to this region of the country, to meet and work with the local Inuit, to experience their views, attitude and culture was very unique. Having to experience the hardships of extended periods of work in remote camps and to endure the challenges of the terrain and weather conditions proved to be trying at times. However, encounters with wildlife such as caribou, musk ox, wolf, arctic fox and grizzly bears (from a safe distance) were among the most memorable and rewarding experiences. Ten years have passed since the original surveys began, but like most unique and challenging projects surveyors find themselves involved in, this one will be remembered for a long time.

The Geomatics Division of Marshall Macklin Monaghan Limited provides a full range of professional surveying and mapping services, including digital mapping and information services to its national and international clients, from offices in Markham and Mississauga, Ontario and through Usher Canada Limited offices in Calgary, Edmonton, Fort McMurray and Bonnyville, Alberta. Websites: www.mmm.ca and www.ushercan.com

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