A REPORT

ON THE ESTABLISHMENT

OF PRECISE ASTRONOMICAL STATIONS

ALONG

THE BRITISH COLUMBIA - NORTHWEST TERRITORIES BOUNDARY

EAST OF THE LIARD RIVER

SEASON OF 1950

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In compliance with instructions received from the British Columbia-Yukon-Northwest Territories Boundary Commission,* the organization of an astronomical observation party to establish precise latitude stations at intervals along the 60th parallel of latitude east of the Liard River was undertaken in May, 1950.

From the meagre available information pertaining to the area adjacent to the theoretical boundary, it was apparent that the transportation problem would be difficult to solve. Whether or not the Petitot River, which crossed the boundary a number of times, was navigable for cances or flat-bottomed boats was most uncertain. However, the existance of a canyon and many rapids on the most northerly 40-mile stretch of the river was definitely established.

Questionnaires regarding the feasibility of landing on the Petitot River in summer with pontoon-equipped planes were sent out. Mr. R.M. Crowther, the former owner and operator of the Musqua Air Service at Fort Nelson, who had been operating in the Fort Nelson area for three years, reported that he had flown over the Petitot River a number of times. From his observations of the local conditions, he considered that summer aeroplane landings would be very hazardous or impossible.

The use of packhorses for transportation was given scant consideration due to the remoteness of the theatre of

*Composed of Mr. B.W. Waugh, Surveyor-General of Dominion Lands, Chairman, and Mr. N.C. Stewart, Director of Surveys and Mapping of the British Columbia Department of Lands and Forests. operations from Fort Nelson, the nearest possible base, and the prevalence of soft muskeg in the area along possible routes leading to the observation station sites.

In reply to an air mail letter sent out early in March, a radio telegram from Mr. R. Cunningham, Manager of the Hudson's Bay Company at Fort Liard, was received on April 6th. From this communication, it was learned that the Petitot River was navigable for shallow-draught, flat-bottomed boats or cances for three or four weeks following the spring break-up, provided that sufficient mechanical power was available for propulsion. With this definite and reliable information, it was decided to attempt water transportation for the first 60-mile stretch of boundary lying to the east of the Liard River, by descending the Fort Nelson and Liard Rivers by boat, and then ascending the tributary Petitot River from its mouth at Fort Liard, for about 90 miles to its most easterly crossing with the 60th parallel of latitude. For the remainder of the boundary line lying to the east of the last mentioned point, it was planned to use aerial transportation, provided that lakes suitable for plane landings could be found on or adjacent to the boundary.

On May 14th, I left Ottawa for Edmonton which was reached on the morning of May 17th. On the evening of the same day, I continued the journey to Dawson Creek which was reached on the evening of May 18th. The next day, a number of purchases were made locally and truck transportation arranged for the shipment of canoes, instruments and camp equipment, from Dawson Creek to Fort Nelson. For safe-keeping, the shipment was consigned to the Hudson's Bay Company, which has a storage warehouse on the west side of the Fort Nelson River, accessible by truck from the Alaska Highway.

At Fort Nelson, considerable difficulty was experienced in hiring suitable river men accustomed to handling

small boats and canoes in fast water. Most of the local trappers had already returned to the settlement from their trap lines, but the majority of them were, for the time being, so well supplied with money from their recent fur sales, that they were not disposed to accept employment on a survey party. Several suitable men refused offers of eight dollars per day.

After some delay, Chas. E. Jensen was engaged as river pilot and cook, and R.M. Crowther as labourer. With John G. Moffatt of Victoria, who had already been engaged as recorder, this completed the recruiting of help. It was decided that any additional men required might be secured at Fort Liard.

For transportation of personnel and equipment, a 35-foot, flat-bottomed river boat powered with a 25 H.P. marine engine was hired at Fort Nelson. Two 18-foot canvascovered, freight-model cances brought from Ottawa were taken along to supplement the boat transportation. While the Fort Nelson River is relatively safe for cances, the Liard River is very fast at high water. During the early summer, it may rise 5 or 6 feet in as many days. At such times, currentvelocities of 9 or 10 miles per hour may be encountered in certain stretches of the river. This makes the use of cances very hazardous, especially in going up stream.

As an alternative to canoes, there has been developed on some of the northern rivers, a flat-bottomed type of boat about 5 feet in width, 35 to 45 feet in length, and 3 to 4 feet in height. These boats, drawing one to one and a half feet of water, are usually powered with inboard marine engines of from 25 to 50 H.P. capacity. This year's experience goes to show that a 25 H.P. unit is inadequate to cope with the highvelocity currents sometimes encountered on some of the northern

rivers.

Supplies for the 600-mile boat trip, estimated to take 6 weeks, were purchased locally from the Hudson's Bay Company. Although prices are high at Fort Nelson, it would not be expedient for a surveyor to purchase supplies in Edmonton and pay train and truck transportation charges to Fort Nelson, unless the party was large and warehouse storage facilities available at Fort Nelson at low cost. By notifying the Hudson's Bay Company a couple of months in advance, a complete line of food supplies suitable for work in northern areas, could be secured without delay.

On Monday morning, May 29th, the party loaded the cances and boat, and set our for Fort Liard, 180 miles downstream. All the astronomical instruments and most of the camp equipment were stowed in the boat. The two cances were lightly loaded and towed behind the larger craft.

The trip down the Fort Nelson River to Nelson Forks, and thence down the Liard River passed without incident. The waters of the Liard were not yet swollen by excessive run-off in the mountainous region to the southwest. As a result the current-velocities encountered on the Liard seldom exceeded 7 miles per hour. However, particular care had to be exercised to avoid fouling the flotilla on "sweepers" or "dead-heads" - trees detached from the bank which had become grounded on the river bottom with one end projecting above the surface of the water.

Towards evening of the second day, we neared the vicinity of latitude 59°58'42", where the Dominion Observatory had established an astronomical station on the river bank in 1922. After considerable search, the old concrete pier (with bronze tablet) was located, and camp made near-by for the night. Commencing at the pier, a chain-and-compass traverse was

projected along the shore to the estimated position of the 60th parallel of latitude. At that place, a marker, visible from the river, was attached to a tree to indicate the approximate site of the astronomical station to be established on our return trip.

On May 31st, we reached Fort Liard where final preparations were made for the ascent of the tributary Petitot River. From local inhabitants we learned that only one of the Indians in this district attempted boat travel on the first 40 miles of the Petitot River. The one exception was Joe Donta, the Indian assistant to Clarence Shattuck, the Federal Government fire warden stationed at Fort Liard. As Mr. Shattuck was interested in inspecting this part of his domain, it was agreed that he and Donta should come along with us in his power boat. This boat, of shallow-draught design, was powered with two outboard engines - a 35 and a 15 H.P. Johnson. With both engines operating simultaneously, it could develop speeds up to 20 miles per hour. At the time when arrangements for the trip were being made, we didn't realize how lucky we were in securing such helpful travelling companions. Without their aid, we probably would never have been able to reach our objectives on the Petitot River.

On the morning of June 1st, we set out on the 90-mile trip. Donta and Shattuck led off in the fast power boat which soon outdistanced our slower craft. To speed up the latter, we put a light load in one of the towed cances and ran it as a separate unit. The 5 H.P. Johnson engine on the cance proved inadequate to cope with the fast current encountered later in the day. The other cance, we loaded upside down on Donta's boat. In spite of this attempt at equalization, our boat lagged behind the other. However, by running at partial throttle, Donta managed to keep the lead boat within our visual range, thus permitting us to follow

it through the winding channels of the river.

About three miles from Fort Liard, we encountered the first rapids, which we were able to ascend with throttle wide open. In the next 10-mile stretch, we passed through 7 rapids of a similar type, and about 15 miles upstream from the mouth, we entered the Petitot River canyon. This gorge, about 500 feet wide at the water surface, has precipitous walls estimated to be 500 to 800 feet in height cut through soft sedimentary rocks. The water, which varies from 2 to 10 feet in depth, attains velocities up to 12 miles per hour, with an average value of about 8 miles. In two or three placed, the water surface is a seething mass of whitecrested waves 2 to 21 feet high. These patches of rough water constitute real hazards to navigation for heavilyladen cances. For the flat-bottomed, shallow-draught type river boat, with 3-foot sides, such as we were using, the waves are not particularly dangerous, provided that the engine is sufficiently powerful to cope with the current.

Shortly before entering the 6-mile-long canyon, I had further lightened the Jensen boat by accepting a place with Shattuck and Donta in the leading craft. About three-quarters of the way through the chasm, we encountered a particularly fast stretch of white water created with turbulent waves. Donta's boat propelled by its two outboard motors had no trouble forging ahead. From it, we watched Jensen's boat strive futilely to breast the current. Realizing that it could advance no farther under its own power, we stopped at a narrow ledge of rock attached to the base of the canyon wall. To return and track them up the fast water was impossible, due to the height of the sheer, rocky cliffs on either side of the river. Finally, it was decided to try towing the boat up the rapids.

Leaving me seated on the ledge, with the empty cance held alongside, Donta and Shattuck turned the nose of their boat downstream, and a few moments later disappeared from view behind the nearest bend in the canyon wall. After a 20-minute wait, the two boats reappeared as if by magic through a hole in the rocky cliff. The towing effort was a huge success - so great, in fact, that before another 15 minutes had elapsed, the two boats had reached the upper end of the fast, turbulent water. As I watched anxiously from my narrow ledge. I saw the leading boat cast off the tow line. Flung high in the air, the coiled rope missed the deck and dived like an angry snake into the boiling water in front of Jensen's boat. The bowman of the boat, inexperienced in river transport, and quite unaware of the potential danger, failed to retrieve the tow line promptly. Then things began to happen. The rope. whipped astern by the current, was caught by the revolving blades of the propeller. In a few seconds, it was wound round and round the shaft in a tightly-drawn, tangled mesh which so restricted the rotation of the propeller that the engine sputtered and stopped. The boat, swept backwards through the foaming water, narrowly missed a huge boulder, and disappeared around the canyon wall. Then the tow boat turned and followed it downstream, and out of sight.

Seated on the rocky ledge of the canyon wall, I had plenty of time to ponder over the fate of the boat and its crew. Fifteen minutes passed - then a half an hour, and finally an hour with neither sight nor sound of my companions. The approach of night spurred me to action. Although the prospect of descending the white-water rapids alone in a canoe was anything but pleasant, I started the outboard motor and set out downstream. The navigation of the swift water and

the dodging of boulders and rocks was not too difficult. But when I reached the white-crested waves already described, the successive upward impacts lifted the unballasted bow high in the air and threatened to capsize the cance. At last, I passed through the rough water, rounded the bend and came upon the remainder of the party with the two boats tied up at the foot of the cliff, while the crew was busily engaged cutting free the snarled rope from the propeller. The story of their unpremediated descent of the rapids without oars or power was luridly described by Jensen in the expressive vernacular of the Northland. In one thing we all concurred that the safe passage of the boat was a near-miracle for which sincere thanks were due to that particular guardian angel charged with the safe-keeping of Government survey parties. Soon, we were ready again and with Donta towing, the flotilla progressed steadily upstream till late in the evening, when we emerged from the canyon and made camp for the night.

From the southeast end of the canyon to three miles beyond latitude 60°, there is a 12-mile stretch of river broken at fairly regular intervals by rapids. Some of these are nothing more than ripples; others are white water rapids that can only be ascended by shallow-draught craft equipped with powerful motors. On most of the rapids, the navigable channels are so far out from shore that tracking would not be feasible.

On the second day of our trip, Donta and Shattuck towed us up most of the rapids as far as the creek which has its origin near Maxhamish Lake and empties into the Petitot River about $2\frac{1}{2}$ miles southeast of astronomical station N 8. Knowing that we could navigate under our own steam from this point onward, our two friends bid us good-bye and set out on the return trip to Fort Liard.

On June 3rd, we voyaged along a delightful section

of the Petitot River. Only a few small rapids occur on this 50-mile stretch. In most places the river is about 600 feet wide with 10 to 50 foot banks. However, fairly recent bush fires have destroyed much of the forest cover in this part of the country. From time to time throughout the day, we encountered small flocks of Canada geese which were nesting along the river bank. Ducks, muskrat and beaver were also observed along the route.

From the 8-mile National Topographic Series map of the area, we chose a suitable camp site estimated to be close to the most easterly crossing of the Petitot River with the 60th parallel of latitude. A preliminary observation for latitude on the night of June 3rd showed that we were about 650 feet south of the desired position. The next morning station N 9 was established, the observatory tent and the precise astronomical equipment set up, and preparations for observational work completed. On the nights of June 6th, 7th, 9th and 10th, star observations were carried on as long as weather conditions permitted.

On Sunday, June 11th, we rose early, packed up all our equipment and made the return trip to the vicinity of the most westerly crossing of the Petitot River. A preliminary star observation that same night indicated that our latitude was 59°59'17". The next morning we ran a rough traverse down the river and selected an observation site for station N 8. In the afternoon, the astronomical equipment was set up and adjusted. At night, light clouds prevented us doing much work. However, we got one pair of latitude and a longitude determination.

On the morning of June 14th, the men commenced the construction of the survey monument, while I set out to connect the local river traverse with the newly established

astronomic station N 8. With 4 or 5 traverse pickets and an axe, I was working my way along the boulder-strewn edge of the river. In turning around after planting a picket, I caught my foot in a moss-covered hole and was thrown violently backward over a large boulder. In the fall, my full weight came down on my left hand which struck a second boulder. In this accident, the outer bone in the finger was fractured and the knuckle joint completely dislocated.

To descend the river at once for medical attention meant that it would be impossible to return to the station till next year. Accordingly, it was decided to get as many latitude observations as possible that night and leave for Fort Liard the following morning. Fortunately the sky was clear so that another longitude set and 21 pairs of latitude stars were observed. This work, however, was accomplished under very trying conditions due to the pain and swelling of the left hand. After a sleepless night, the local survey work was completed and the instruments and equipment packed up.

About noon June 15th, we commenced the trip downstream but soon ran into trouble. In the interval since coming up the river, the general water level had dropped 15 or 18 inches, greatly increasing the difficulty of negotiating the rapids. Where formerly there was 3 feet of water, there was then only a foot and a half. No clear channel could be found down many of the rapids. In running the first three or four, we struck rock after rock but managed to scrape over them. On the fifth rapids, the one inch planking on the bottom of Jensen's boat was broken in three places. This meant a serious delay as most of the load had to be taken ashore in the cances, so that extensive repairs could be made to the boat's bottom. For the remainder of the day, the men

waded through the rapids holding on to the boat which had to be pulled, showed, and pried over the shallow places. At times, one or two men went ahead with pike poles to clear away boulders from the river bottom, so that a passage could be made for the boat. More than a half a day was required to advance 5 miles under these conditions.

On June 16th, we made better progress. Some of the rapids were descended under power with the engine at quarter throttle; other rapids were so dangerous that the crew was obliged to go overboard and manhandle the boat through the most likely-looking channels. The passage through the canyon was without incident. Although the current was fast, there was a greater depth of water in most places than in the section of river we had just passed over.

At this stage, we commenced to congratulate ourselves on the success of our voyage. The worst rapids of the river lay behind us. Fort Liard lay only a few miles ahead and only two rapids intervened. We started down the first one. The rays of the setting sun were in the pilot's eyes and he didn't see his nemesis ahead. Suddenly, we landed squarely on a large submerged boulder and the boat turned sideways in the current. One of the canoes we were towing was swept against us - swamped and capsized. To avoid further trouble we cut it loose. Leaving Jensen, the only experienced river man in the crew, in charge of the stranded boat, I set out alone down the rapids in the second cance to chase the upturned craft. Three-quarters of a mile downstream, I was able to tow it ashore and salvage much of its light load of tents and camp equipment. The list of material lost in the accident included :-

1 paddle

- 1 tool kit for Johnston engine
- l funnel
- 1 pair pliers

- 2 rock drills
- l screwdriver
- l shovel
- 2 carborundum stones
- 2 fly sprayers

Assorted food supply, probably worth \$70.00 Realizing that the three men left in the stranded

boat would not be able to get it off the rocks, I paddled on to Fort Liard and engaged a power boat and two men for salvage operations. Returning at once to the scene of the accident, we unloaded all the astronomical instruments and other assorted gear from Jensen's boat. After being lightened in this manner, it was possible to pry it off the rocks with no further casualties. The party finally reached Fort Liard about 10 p.m. tired and wet.

The next morning I sent a radio message for a plane to come from Fort Nelson to take me to the hospital operated by the Royal Canadian Air Force at that point. On arriving at Fort Nelson, it was found that the resident doctor had left for "outside" two days previously. However, the nurse superintendent of the hospital took an X-ray of the injured hand, which showed a fracture and complete dislocation of the finger joint. As a general anaesthetic would be required before reducing the dislocation, the nurse refused to attempt the operation. Accordingly, it was necessary to seek the services of the nearest doctor at Fort St. John, where the dislocation was reduced and the hand and lower arm put in a plaster cast.

Returning by air to Fort Liard as soon as possible, my party made ready for the trip upstream to latitude 60° , where we were to establish station N 7, - the third of the season's series.

On June 24th, we reached the desired latitude and set up our camp and observatory tent close to the marker located on our trip downstream, over three weeks previously. By July 1st, the station was completed together with a local triangulation joining our N 7 station with the Dominion Observatory astronomical pier established one and a half miles distant in 1922.

Four days were required to ascend the Liard and Fort Nelson Rivers. On our arrival at Fort Nelson, the river pilot was paid off. The other two members of the party were retained for work on the eastern section of the boundary, using aeroplane transportation.

Associated Airways Limited of Edmonton had, at that time, a Bellanco Skyrocket pontoon-equipped plane stationed at Fort Nelson for the use of small geological survey parties engaged on oil exploration in the area. On July 7th, this plane was chartered for a reconnaissance trip of the western section of the boundary line. After flying a straight course to our station N 7 at the intersection of the Liard River with the 60th parallel, we took some pictures of the station site from the air. The white cotton ground strip, 6'x 9', which we had placed in position before leaving the station, showed up plainly from the plane which circled around at 2500 feet.

After completing the photography, we flew westward along the line for about 15 miles to get an idea of the nature of the country. In general, the area west of the Liard River is heavily-timbered, rolling terrain which rises in elevation as one proceeds westward. No open soft muskegs were observed along this section of the boundary line. Information received from trappers who are familiar with the region, indicates that there are no extensive muskegs and that horse feed should be found without too much difficulty. Twenty-four miles west of the Liard River is the valley of the Beaver River which cuts through mountainous country. According to one trapper, the valley is deep and precipitous in most places. To take packhorses across the river, it would be necessary to detour several miles to the north of the boundary line.

Before reaching the Beaver River, we turned around and flew back eastward - recrossed the Liard River and continued along the 60th parallel past station N 8, and on to station N 9. East of the Liard River lies an area of vast muskegs, through which there flows numerous streams. Adjacent to the Liard and the tributary Petitot River, there is a strip of timbered terrain probably two to five miles wide. Elsewhere, it is mostly open muskeg, some of which appeared to be very wet. While we were camped at station N 7 on the Liard River, one of the crew was sent on a ground reconnaissance to the eastward. On his return, he reported that the 4-mile strip of terrain adjacent to the river was composed of heavily wooded muskeg that was reasonably firm. Although feed would not be available early in the season, till new grass and vegetation had sprung up, packhorses would find the footing reasonably good. From the air, however, it was seen that the timbered strip did not extend far to the east of the Liard. Instead, vast stretches of open muskeg dotted here and there by ponds and small lakes were to be seen. North of Maxhamish Lake, a particularly wet-looking area was observed. As we flew along towards the east, the sun's rays were reflected from the stagnant water lying below us in the many slimy, green pools which merged into an uninviting looking emsemble. How soft this muskeg is, we do not know. From our superficial inspection from the air, it was concluded that it would not support the weight of packhorses. However, by detouring several miles to the north, horses might be taken through to the Petitot River.

From station N 8 to station N 9 in longitudes 122°58' and 122°11' respectively, the area adjacent to the boundary is well drained by the Petitot River. Either packhorses or canoes could be used along this section of line. In two places marked "X" and "Y", there are possible landing places for pontoon-equipped planes. At these places, the river is sufficiently straight and deep to afford reasonable landing facilities for 5-passenger aircraft. In June 1950, landing stretch "X" had from 3 to 4 feet of water, while "Y" was found to have between 3 and 5 feet. By making use of these landing places, the demarcation party could be supplied by aerial transportation. Medium-sized canoes might also be flown in and made available for the line-cutting party. Later in the season, however, if the general water level of the river dropped appreciably, the two landing stretches would become too hazardous for anything but very light two-passenger aircraft.

Next, it was planned to fly along the boundary and land at one, or both, of the small lakes A and B shown astride the boundary in longitudes 121°17' and 120°58' respectively on the 8-mile Topographic map. With light instrumental equipment and sufficient food supply for about a week, we took off on July 9th and flew directly to station N 9. At this point, we turned and flew eastward along the boundary to locate the above-mentioned lakes. Several miles east of N 9, we crossed the bull-dozed winter tractor road that was opened up by the U.S. Army Engineers in 1942-43. From information received at Fort Nelson, this road was used only once in 1945 by the Department of National Defence on Operation Muskox. It crosses areas of soft muskeg unsuitable for the use of packhorses in the summer time and is known to be obstructed by windfall in certain sections.

Along the boundary east of the tractor road, lies an extensive stretch of soft muskeg. This vast swamp is approximately 100 miles from west to east and probably as great a distance from north to south. Around some of the larger lakes in the area, there are marginal strips of terrain that appear to be composed of fairly dry muskeg. The smaller lakes and rivers appear to have no solid ground adjacent to their shores or banks. Shallow, muddy, slimecovered ponds and small lakes are numerous. In places, where no ponds, streams or lakes exist, the presence of stagnant surface water was indicated by the reflection of the sun's rays from the ground below.

Lakes A and B proved to be too shallow and small for safe landings with pontoon-equipped planes. From the air, mud bars relatively close to the surface could be plainly seen. In all probability, the water is no more than two feet deep in both of these bodies of water.

We then flew north 5 miles to the nearest lake where a landing was made near the centre of the southern bay (marked C on the map). Soundings at various points showed only 4 feet of water. The plane was taxied successively towards the shore in four different places and, in each case, was grounded 200 - 300 yards from the muskeg banks. Finally we waded ashore carrying the light astronomical equipment on our backs.

Although no real solid terrain could be found along the shore, we set up the instrument in preparation for the observation of the meridian transit of the sun at noon. The instrumental set-up was not all that could be desired, but an observation of reasonable accuracy was secured. The ensuing computation showed that the occupied point (on the easterly side, and about one mile from the southern tip of the lake)

is in latitude $60^{\circ}06' \pm 30''$. From this observation, it is apparent that the lakes shown on the map of the local area are depicted about 2 miles too far south.

The relatively well-drained muskeg, close to the shore of the lake, was much too soft to provide a stable support for a pier for precise astronomical observations. In fact, no terrain suitable for a camp site could be found. In the much wetter, badly-drained area near the boundary line, 6 miles to the south, the taking of precise astronomical observations would be out of the question, unless the ground was frozen to a depth of several feet. Accordingly, plans for establishing one or more points in this vicinity were temporarily abandoned.

Due to previous commitments with other organizations, Associated Airways could not prolong the trip on July 9th, so we returned to Fort Nelson immediately after making the latitude determination on the sun.

On the afternoon of July 10th, we set out on the final flight to investigate the terrain from lake B eastward along the boundary to the northeast corner of the province of British Columbia. This 40-mile stretch of territory also was found to be composed of very wet, open muskeg. No "islands" of solid terrain were observed anywhere close to the line. The 60th parallel of latitude will most certainly intersect the 120th meridian of longitude in a particularly wet area. The nearest lake (marked D), which is 6 miles to the northeast of the intersection, appeared to be only a foot or two in depth and scarcely a mile in length. No landing should be attempted there, except with skiis in the winter time. As we circled around over the locale of the intersection, we could see for 30 or 40 miles. To the limit of visibility, the same flat monotonous, greenish-yellow muskeg, dotted here and there with ponds and small lakes, extended in all directions.

On the return that evening to Fort Nelson, a telegram was sent to the Chairman of the Boundary Commission, advising him of the impossibility of establishing precise astronomical stations on the boundary line east of the Petitot River during the summer months. A reply received the next day approved the disbanding of the party, preparatory to my return to Ottawa. Accordingly, the instruments and equipment were shipped on July 12th to Dawson Creek, where they were re-consigned to Ottawa.

On July 14th, Moffatt and I left Fort Nelson by bus for Dawson Creek. At 6.10 a.m. July 19th, I arrived back in Ottawa.

The establishment of a precise astronomical station at the northeast corner of British Columbia, and another on the boundary near longitude 121°17', must of necessity be undertaken when the muskegs and lakes are frozen. Two methods of carrying on the project are suggested.

The easiest way of doing the job would involve the use of a tractor trailer combination. By leaving the Mackenzie Highway, which extends from Grimshaw to Hay River, at latitude 60°, and following the tractor road bull-dozed through the bush in connection with the Topographical Survey project of 1949-50, the northeast corner of the Province of British Columbia could be readily reached. From the northeast corner of the province to longitude 121°17', the muskeg is so open, that little or no bull-dozing would be necessary to open a road. An alternative route would be possible from Fort Nelson northward along the old tractor road to Fort Simpson. On reaching latitude 60°, a road could be bulldozed eastward along the boundary with very little effort.

The second method would involve some hardship for the personnel of the observation party. The plan of operation, very similar to the 1947-48 demarcation of the Ontario-Manitoba boundary, terminating on the Hudson Bay coast, would involve aeroplane transportation supplemented by dog team.

According to information acquired at Fort Nelson, aeroplane landings may be made on the ice surface of local lakes and rivers up till the middle of April. From the second week of March onward, the temperature may be expected to remain above zero. In the three-week-and-a-half period from March 21st to April 15th, two or three precise astronomic stations could be established without too much personal discomfort to the observers.

Judging from the latitude observation taken at lake C, it is probable that the boundary will be found to pass about 2 miles south of lake B. Using plane transportation out of Fort Nelson, a camp could be established on lake B. A dog team could then be flown to the lake to transport the instruments and equipment 2 miles south to the locale of the precise station. No trail cutting would be required through the open muskeg. The northeast corner of the Province of British Columbia could be established in a similar manner using lake D, 6 miles to the northeast, as a landing field.

West of the Liard River, two astronomic stations are required. One of these could be reached with comparative ease by ascending the Beaver River soon after spring breakup. By leaving Fort Nelson shortly before June 1st with a suitable flat-bottomed boat equipped with a 40 H.P. motor, no special difficulty should be encountered. Arrangements for boat transportation could probably be made through the

Hudson's Bay Company, or directly with Ed. Cooper, or C.E. Jensen of Fort Nelson. An astronomic station, established at the intersection of the 60th parallel with the Beaver River, would give suitable spacing with N 7, N 8, and N 9 established in 1950.

To establish the second station about longitude 125°28', midway between station N 6, north of Smith airport, and the Beaver River, it would be necessary to resort to packhorses. A suitable packhorse train could be rented at Fort Nelson from Collison Brothers, who are equipped with facilities to transport them by truck to Smith airport. From the airport, there is a tractor road leading northward to Tobally Lake. This road was used in 1944 for tractor transportation to the site of station N 6.

Mr. L. Larsen, with headquarters at Fort Nelson, has had years of trapping experience in the area east of Smith River Airport and Tobally Lake. Larsen Lake, close to the headwaters of the Beaver River, bears his name. During a conversation at Fort Nelson this year, Larsen stated that there is a packhorse trail joining Tobally and Larsen Lakes. However, the trail is poorly defined, requiring a guide with local experience to follow it from point to point.

According to Larsen's report, the terrain adjacent to the boundary east of Smith River is rolling country which becomes more hilly in the neighbourhood of the Beaver River. The forest cover in this area is not extremely dense, so that the cutting of horse trails would not be very difficult. Early in the season, before the new plant growth has developed, horse feed would be hard to find. Supplementary feeding of oats would be required at this season of the year. Taking into consideration the various factors involved, it is considered that it would be more advantageous to cut a new horse trail eastward along the boundary from station N 6, than to use the old trapper's trail 10 miles to the north.

In general, survey operations between the Smith and Liard Rivers should involve no great difficulty. Supplementary air transport could be made available by making aeroplane landings on Larsen Lake eight miles north of the boundary line. From the lake, an old horse trail is known to lead southward along the Crow River. Horses and horse wranglers may be hired during the summer months at Fort Nelson, Lower Post, and at other points on the Canada-Alaska Highway.



Rock cliffs along the Fort Nelson River



Push-pull method of ascending the Petitot River Rapids

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Supper time on the banks of the Petitot River. The entrance to the canyon is seen in the background.



1273 A-6

Cliffs along the Petitot River



View along the Petitot River



View along the Petitot River



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127319-9

Flotilla moored on the banks of the Petitot River



1273 A-19

Flotilla moored on the Petitot River



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1273 A-11

Scene along Petitot River



Rock cliffs on Petitot River



1273 R-14

Canyon, Petitot River



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1273 A-15

Cliffs along Petitot River



View near end of Petitot River Canyon



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12732 - 17

Taking soundings in the Petitot River



1223 1-18

Remains of forest cover, destroyed several years previously by fire, Petitot River



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1273A-19

Observatory tent and camp set up at station N 7 on the Liard River.



1273 A-20

Concrete pier for astronomical instrument at station N 7 on the Liard River.



Diesel-powered river boat pushing a flatbottomed scow up the Liard River. Taken from station N 7, at latitude 60°.



1273 A-22

Diesel-powered river boat pushing a flatbottomed scow up the Liard River. Taken from station N 7, at latitude 60°.



View from station N 7, looking westward across Liard River. Distant hills in background.



Diesel-powered river boat pushing a flatbottomed scow up the Liard River. Taken from station N 7, at latitude 60°.

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Camp site at station N 9, on the upper reaches of the Petitot River.



1273 A - 26

Observatory tent at station N 9 on the upper reaches of the Petitot River. * 1



1273 A -27

White ground strip set out at station N 9 for the identification of the site in the aerial photographs.


APPENDIX

Station N 7

Description of Station. Tabulation of observations. Blue print showing local topography. R.C.A.F. aerial photograph of adjacent area. Aerial photograph taken with small camera showing white ground marker.

Station N 8

Description of Station. Tabulation of observations. Blue print showing local topography. R.C.A.F. aerial photograph of adjacent area. Aerial photograph taken with small camera showing white ground marker.

Station N 9

Description of Station. Tabulation of observations. Blue print showing local topography. R.C.A.F. aerial photograph of adjacent area. Aerial photograph taken with small camera showing white ground marker.

12

Daily Diary

STATION N 7

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Description, Astronomic Station N 7

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The station monument is an iron post marked $\frac{N}{1930}$, mound, and 4 pits situated in the heavy timber 1930 feet east of the high water mark on the east bank of the Liard River.

Twelve feet from the river bank, there is a concrete pier with a bronze tablet marked "Geodetic Survey - Triangulation Station". The pier marks the site of the temporary observatory. The iron post is 38.2 feet north and 106.4 feet east of the bronze tablet in the concrete pier.

The station site which is 15 feet above the high water mark is almost directly across from the mouth of a narrow channel leading to the westward of an island near the west side of the river.

Two bearing trees were established as follows :-

Designation			tion		Magnetic Bearing from Iron Post	Distance in feet	
B.T.	1	-	16"	Balm of 0	liload	1550	36.0
B.T.	2		8"	Birch		840	19.5

Final Values

Latitude 59°59'58.42 ± 0.11 Longitude 125 47 30.52

TABULATION OF OBSERVATIONS AT STATION N 7

Latitude

Dat	te	Latitude	<u></u>	VZ
June 27,	, 1950	59 ⁰ 59 ['] 58 ["] 03	.03	.00
		57.67	.39	.15
		56.87	1.19	1.42
		58.99	.93	.86
		59.98	1.92	3.69
		56.85	1.21	1.46
		57.38	.68	.46
		58.92	.86	.74
		60.13	2.07	4.28
		59.96	1.90	3.61
		57.19	.89	.76
		57.15	.91	.83
		57.09	.97	.94
		58.19	.13	.02
June 28	3, 1950	57.42	.64	.41
		57.44	.62	.38
		56.92	1.14	1.30
		58.34	.28	.08
		57.29	.77	.59
		58.99	.93	.86
		56.87	1.19	1.42
		59.04	.98	.96
June 30	0, 1950	57.55	.51	.26
		57.27	.79	.62
		57.70	.36	.13
		57.58	.48	.23
		57.09	.97	.94
		57.28	.78	.61
		57.54	.52	.27

Latitude			
Date	Latitude	<u></u>	2
June 30, 1950 (continued)	59 59 57 50	.56	.31
	57.20	.86	.74
	56.90	1.16	1.35
	59.61	1.55	2.40
	59.40	1.34	1.80
	58.28	.23	.05
	60.03	1.97	3.88
	59.57	1.51	2.28
	59.33	1.27	1.61
	56.12	1.94	3.76
	57.71	.35	.12
	58.75	.69	.48
	58.62	.56	.31
	58.51	.45	.20
	58.59	.53	.28
Mean of 44 pairs	59 ⁰ 59 ['] 58 ["] 06	£v².	. 47.85
Reduction to site of monument	+ 0.38	-	
Reduction to sea level	- 0.02		
Latitude of Post <u>N 7</u> 1950	59 ⁰ 59 ¹ 58.42 +	0.11	

TABULATION OF OBSERVATIONS AT STATION N 7 (Continued)

TABULATION OF OBSERVATIONS AT STATION N 7

Longitude

Date	
June 27, 1950	123 47 33.40
June 28, 1950	32.41
June 30, 1950	32.01
Mean value	123°47'32.61
Reduction to site of monument	-2.09
Longitude of Post <u>N7</u> 1950	123 ⁰ 47 ['] 3052



AD N 7 Astronomical Station Iron post marked $\frac{N7}{1950}$, mound, and 4 pits $\phi = 59^{\circ} 59' 57' 4' 58.42$ $\lambda = 123 47 3/1 30.52$

PLAN

Showing topography adjacent to N7 ASTRONOMIC STATION British Columbia - North West Territories

Boundary Survey

Scale - Inch = 400 feet

Plan # 794

June 30th, 1950 C H Ney

Dominion Land Surveyor

S

DOB Dominion Observatory Astronomical pier established in 1922

0 0

N7 Astronomical Station

1271.

<u>Scale : 1 in = 3160 ft.</u>

N

N.T. Astro Station - I Post, mound, pits.

8

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60 th Parallel 0

of Latitude.

Dominion Observatory pier established 1922.

ASTRONOMIC PT. N 7 B.C.-N.W.T. Boundary



ASTRONOMIC PT. N 7 B.C.-N.W.T. Boundary



North



STATION N 8

Description, Astronomic Station N 8

The station monument is an iron post marked <u>N.8.</u>, mound, and 4 pits situated on a level stretch 1950 of land in a burnt-over area 195 feet from the south shore of the Petitot River and directly opposite a out bank 500 feet high. Between the station monument and the river, along the meridian line, there is a 180-foot stretch of heavy spruce. About 800 feet to the east of the station, the Petitot River turns sharply towards the south.

A piece of board marked N 8 was mailed to a blazed spruce tree on the river bank to mark the site. A good camp site may be found in the spruce area.

Two bearing trees were established as follows :-

Designation			ati	on	Magnetic Bearing from Iron Post	Distance in feet	
B.T.	1		10"	Spruce	8070	83.0	
B.T.	2	-	10"	Spruce	00	47.5	

Final Values

Latitude 59°59'56"49 ± 0"12 Longitude 122 59 05.06

TABULATION OF OBSERVATIONS AT STATION N 8

Latitude

.

Date		Latitude	<u></u>	VZ
June 14, 1950		59 ⁰ 59 [*] 57 ^{**} 08	.28	.08
		57.44	.14	.02
		57.90	.60	.36
		57.58	.28	.08
		59.51	2.21	4.90
		58.17	.87	.76
		58.22	.92	.84
		56.11	1.19	1.42
		57.01	.29	.09
		56.51	.79	.62
		56.90	.40	.16
		56.91	.39	.16
		56.71	.59	.35
		57.13	.17	.03
		57.41	.11	.01
		57.45	.15	.02
		58.24	.94	.90
		56.82	.48	.23
		55.46	1.84	3.40
		56.49	.81	.65
		57.39	.09	.01
		58.08	.78	.61
Mean value of 22 pairs	11	59 ⁰ 59 [°] 57 ^{°°} 30	$Z \nabla^2$	= 15.70
Reduction to site of monument	11	-0.77		
Reduction to sea level		04	_	
Latitude of Post <u>N8</u> 1950	in .	59 ⁰ 59 ¹ 56 ["] 49 ±	. 0.12	

TABULATION OF OBSERVATIONS AT STATION N 8

Longitude

July 12th, 1950	122°59'08.08	weight	1*
l4th	122 59 04.05	99	3
Weighted mean	122 59 05.06		
Reduction to site of monument	0.00		
Longitude of Post <u>N8</u> 50	= 122 ⁰ 59'05"06		

Approximate value for rough check.

Soth Parallel of Latitude

N8 Astronomical Station Heavily Iron post marked $\frac{N8}{1950}$ 4 pits and mound $\phi = 59^{\circ} 59^{\circ}$ 56.49 $\lambda = 122 59$ 55.05

Petitot

950.0

C

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PLAN

200 4194

Showing topography adjacent to N 8 ASTRONOMIC STATION British Columbia - North West Territories Boundary Survey

Scale I inch = 400 feet

A

AZ = 294°41' 1274'4

В

June 15 1950

C H Ney Dominion Land Surveyor

Plan # 195 File # 1272

Astronomical Station

60 th Parallel of Latitude

0

E

A

Scale : 1in = 3120 ft.

N 8 Astro Station

I. Post, mound, pits

ASTRONOMIC POINT N 8 B.C.-N.W.T. Boundary

North



ASTRONOMIC POINT N 8 B.C.-N.W.T. Boundary







STATION N 9

Description, Astronomic Station N 9

The station monument is an iron post marked <u>N9</u>, mound, and 4 pits situated on a bench 40 feet in 1950 elevation and 60 feet east of the high-water mark on the east bank of the Petitot River.

A piece of board marked N 9 was nailed to a 16" poplar tree on the bank of the river which flows almost northwest from the marker. A camp site may be found 600 feet to the south, on the same side of the river.

Three bearing trees were established as follows:-

	E	n	Igna	tion	Magnetic Bearing from Iron Post	Distance in feet
B.T.	1	-	10"	Poplar	1520	45.6
B.T.	2	-	6"	Balm of Gilead	2870	63.7
B.T.	3	-	6"	Poplar	34 ⁰	62.6

Final Values

Latitude 59°59'58.80 ± 0.09 Longitude 122 12 59.71 TABULATION OF OBSERVATIONS AT STATICN N 9

Lati tude

1

Date	Latitude	<u></u>	<u>v</u> e
June 6th, 1950	59°59 *60"38	1.45	2.10
	59.07	.14	.02
June 7th, 1950	59,65	.78	.52
	58.61	. 32	.10
	59.15	.22	.05
	58.26	.67	.45
	59.95	1.02	1.04
	58.96	.03	.00
	57.04	1.89	3.57
	58.57	.36	.13
	59.22	.29	.08
	58.58	.35	.12
	58.71	.22	• 05
	61.10	2.17	4.71
June 9th, 1950	57.56	1.37	1.88
	58.72	.21	.04
	57.37	1.56	2,43
	59.94	1.01	1.08
	59.33	.40	.16
	58,33	.60	. 56
	58.69	.24	•06
	57.84	1.09	1.19
	56.04	.69	.79
	58.71	.22	.05
	59.65	.72	.52
	58.87	.06	.00
	58.43	.50	.25
	61.42	2.49	6.20
	60.42	1.49	8,22
	59.07	.14	.02

Latitude			
Date	Latitude	<u>v</u>	<u>v²</u>
June 9th, 1980	59 ⁰ 59 [*] 57 [*] 50	1.43	2.04
	59.38	.45	.20
	58,27	.66	66
June 10th, 1950	58.97	.04	
	58,35	.58	.34
	59.35	.42	.18
	58.57	.36	.13
	58.39	.54	.29
	58.86	.07	.00
	59.02	•09	.01
	58.92	.01	.00
	59.73	.80	.04
		.05	.00
Mean value of 43 pairs	59 ⁰ 59 [°] 58 [°] 93	E, v2	34.40
Reduction to site of monument	-0.08		
Reduction to sea level	-0.05		
Latitude of Fost N 9 50	59 ⁰ 59 [*] 58 [*] 80 ±	0*09	

TABULATION OF OBSERVATIONS AT STATION N 9 (Continued)

TABULATION OF OBSERVATIONS AT STATION N 9

Longitude

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	DBDB					
June	6th,	195	0			122012 60 50
	7th,	195	0			60.20
	9th,	195	io			59.36
Nean	valu	8				122012 60.02
Redu	stion	to	site	of	monument	31
Longi	ltude	20	Post	NO		182012 59.71



Petitot

River

120

D N9 Astro Station Monument $\phi = 59^{\circ} 59^{\circ} 59^{\circ} 58^{\circ} 80$ $\lambda = 122 12 593 59.71$ Iron post marked $\frac{N9}{1950}$ mound and 4 pits

PLAN

Showing topography adjacent to

N 9 ASTRONOMIC STATION

British Columbia - North West Territories

Boundary Survey

Scale - / Inch = 400 feet

Plan # 796 File 1273

Creek 10'Wide 1' deep 671' 10

J

646'

H

June 10th, 1950

C. H. Ney Dominion Land Surveyor



N9 Astronomical Station Scale : 1 in = 4130 ft <u>UPH</u> 173/ LINE 3 + N LINE 2 + S LINE 2 + S 1 60 th Parallel of Latitude N 9 Astro. Station I. Post, mound, pits.

ASTRONOMIC PT. N 9 B.C.-N.W.T. Boundary

North





File No. 1273

ASTRONOMIC Pt. N 9 B.C.-N.W.T. Boundary



North



DAILY DIARY

1950

- May 14 Left Ottawa at 10.45 p.m. H.D.T. for Dawson Creek.
 - 16 Arrived Winnipeg 9.55 a.m. at height of 1950 spring flood.
 - 17 Arrived Edmonton about 7.40 a.m. Contacted J.G. Moffatt, recorder from Victoria. Left for Dawgon Creek by train at 5.30 p.m.
 - 18 After delay en route, arrived at Dawson Creek about midnight.
 - 19 Arranged with the American Trucking and Distributing Company to transport the astronomical instruments and camp equipment to Fort Nelson. No bus available for passenger travel till May 22nd.
 - 20 Made purchases locally of necessary camp equipment, principally dishes and cooking outfit.
 - 21 Sunday.
 - 22 Loft Dawson Creek 9.45 a.m. on British Yukon Navigation Company bus for Fort Nelson which we reached about 10.20 p.m. En route, we passed through snowstorm between Fort St. John and Fort Nelson.
 - 23 In the morning, went by taxi 10 miles to the Nelson River. Grossed by small boat to the old settlement on the east side of river. Arranged with Manager of the Hudson's Bay Company for rental of space in storage warehouse for a week. Moved over to settlement in evening. Accommodation for the travelling public almost impossible to find at the old settlement. Finally secured improvised accomodation with Mr. C. Greagan.
 - 24 Brought some of the radio equipment from the Hudson's Bay Company warehouse on the west side to our quarters on the east side in order to sheek and test receiver and transmitter.
 - 25 Had broken thwart on cance repaired. Arranged with Mr. Davis, efficer-in-sharge Department of Transport radio station at Fort Nelson Air Port, for daily radio schedule during our work along the 60th parallel. Schedule as follows:-

Time - 7 p.m. to 7.05 Pacific Standard Time.

My transmitter XLI 32 on a frequency of 4455 Kc. Continuous wave transmission (code only).

D.C.T. Radio Station VFDT - frequency 4885 Kc. Telephone transmission only.

At night made first test of intercommunication over a 2-mile distance, and found everything satisfactory.

28

May 26 Purchasing supplies for trip. At night made final test of radio communication with VFDT. Messages were interchanged without any trouble.

27 All equipment packed for trip. Made out accounts to date and attended to correspondence.

Sunday. Had visit from Socony Vacuum Oil Company, geologists, who expected to fly into the area adjacent to the upper stretches of the Petitot River.

- Although it was drizzling rain, we left Fort Nelson at 10.10 a.m. The two lightly-loaded canoes were 29 towed behind the larger craft. Operating at a throttle, we made about 10 miles per hour. Some large ice cakes were observed along the river bank. In spite of heavy clothing, the cold penetrated quickly, making the personnel very uncomfortable. Camped for night about 30 miles upstream from Nelson Forks.
- Left camp at 5.45 a.m. after a good sleep. 30 Passed Nelson Forks about noon where we lunched on the river bank. On entering the Liard River we found the current much faster. However, the pilot managed to avoid the numerous sand bars. We passed Francois Indian village about 4 p.m. At 5 p.m. we arrived at the locale of the Dominion Observatory astronomical pier established in 1922, about 1g miles south of the 60th parallel of latitude. After supper, a chain-and-compass traverse was extended northward from the pier to find the approximate locale of the 60th parallel.
- After a 22-hour trip, we arrived at Fort Liard about 10 a.m. The rest of the day was spent in sorting 31 and rearranging our equipment. Arrangements were also made whereby Mr. C. Shattuck, Dominion Fire Warden, and an Indian, named Joe Donta, should accompany us up the Petitot River in their fast power boat.
- June 1 Left Fort Liard at 7.15 a.a. to establish two points on the Petitot River at its most easterly and westerly crossing of the 60th parallel. Had a great deal of trouble getting up the rapids due to the inadequate power plant in Jensen's boat. About 15 miles upstream from the mouth, we entered the 6 mile canyon. About three quarters of the way through, we narrowly avoided an accident due to the fouling of the propeller by a tow rope. Quite late in the evening we emerged from the canyon and camped on the river bank for the night.
- Shortly after leaving camp at 5.45 a.m. we encountered June 2 rapids after rapids at fairly regular intervals. With the aid of Donta and his boat we were able to make slow but steady progress against the current. By midafternoon, we were about 2 miles upstream from the

June 2 - (continued)

first crossing of the 60th parallel. As the current velocities in the Petitot River beyond this place are known to be fairly moderate, Shattuck and Donta said good-bye to us and headed back downstream to Fort Liard. Camp was made that night near longitude 122°45.

5 - Left camp at 6.30 a.m. and after 6¹/₂ hours steady progress with three motors operating at full capacity, we reached the locale of the most easterly crossing of the river with the 60th parallel. From the 8-mile-to-the-inch map, National Topographic Series, we identified a site which appeared to be close to the desired latitude. A camp was made nearby and, at night, a preliminary observation for latitude showed the point of observation to be in latitude 59°59'53".5.

- 4 Sunday. Chained 650 feet northward along river bank and set up observatory tent and the precise astronomical equipment. Overcast with rain at night.
 - 5 Cut the large trees adjacent to the observatory in order to make white ground strip markers visible from the air. Started construction of mound and pits. At night, overcast with rain.
 - 6 Before breakfast, saw 6 Canada geese, one beaver, and a black bear all on the river. Spent some time tracing an open circuit in the electrical system of the accessory equipment. Located and measured bearings and distances to bearing trees. At night had trouble getting started on the star observations due to the brightness of the night sky. Worked till 2 a.m. when it was broad daylight again. Got a longitude determination and 2 pair of latitude stars.
 - 7 A black bear swam across river close to our camp. In afternoon, I measured the angles of the local triangulation scheme. At night, we got a longitude determination and 12 pairs of latitude stars. Clouds obscured sky at 12.40 a.m.
 - 8 Bright and clear during day when we did some computing. At 8 p.m. it clouded over completely for the night.
 - 9 Overcast all day. Mosquitoes bad. In the afternoon, finished the local triangulation scheme with ties to the mouths of tributary creeks. Clear at night. Observed a longitude set and 21 pair of latitude stars.
- 10 Bright and clear at night. Observed 10 more pairs of latitude stars, completing the station with a total of 3 longitude sets and 43 pairs of latitude stars. Before going to bed, we packed up most of the astronomical equipment.

June 11 - Sunday.

Packed up camp and left station N 9 at 9.10 a.m. for the return trip downstream to establish N 8 at the most westerly crossing of the Petitot River with the 60th parallel of latitude. Arrived at the general locale at 1.25 p.m. At night took an observation to determine the approximate latitude which turned out to be 59°59'13". The mosquitoes very bad.

12 - Commencing at the observation station, we ran a traverse down the river bank to determine the locale of the 60th parallel. A new camp was established near the indicated position. In the afternoon, we set up the observatory tent. At night there were light clouds. However, we got a good determination of longitude and one pair of latitude stars.

- 13 Commenced the construction of the survey monument consisting of iron post, mound and pits. Readjusted precise equipment to ensure better operation. At night rain and clouds. No observing. Set up radio transmitter and contacted Hudson Bay Co. station XKA 30 at Fort Lierd.
- 14 While the men were digging the pits and building the mound, I set out with a number of pickets for use in extending the local traverse along the river bank. In turning around after planting the first picket, I caught my foot in a moss-covered hole and fell backward over a large boulder. The first finger of my left hand struck another large boulder, and the impact fractured the bone between the knuckle and first joint and in addition completely dislocated the first joint. The finger was also badly lacerated by the violent contact with the rough boulder.

As all attempts to pull the finger back into joint proved futile, it was realized that it was necessary to get medical attention as soon as possible. It was also realized that the general water level of the river had lowered about 16 inches since our journey upstream two weeks previously. This meant that if we descended the Petitot River to Fort Liard, it would be practically impossible to return upstream till the high water period the following spring.

Although the pain and swelling rendered my left hand almost useless, it was decided to try to carry on that night with the observational program and then leave the next day for Fort Liard. The final objective was Fort Nelson where the R.C.A.F. had a medical officer and a small hospital. Fortunately the night was clear so that we were able to observe a second longitude set and 22 pairs of latitude stars. Although this number of latitude observations fell far short of the 40 pairs prescribed by the Commission, it was realized that the mean value of the latitude so determined would not be expected to differ very much (no more than 0.10) from the mean of 40 pairs. Under the cir-

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June 14 - (continued)

cumstances, the Boundary Commission might be disposed to accept the mean value of the 22 pairs without fear of introducing any serious inaccuracy in the demarcation of the boundary line.

15 -

After a sleepless night, we completed the local survey, finished the monument and established two bearing trees. By this time the left hand was almost purple and the swelling extended up the arm.

At 12.30 p.m. we were packed up and ready to start the trip to Fort Liard. Three or four rapids were descended at 2 throttle. The descent in each case was most hazardous due to the low water. Rock after rock was hit by Jensen's boat. For a while the one-inch planking was able to withstand the battering. On the next rapids, one of the bottom planks was broken in three places.

After a long delay to make repairs, we started again. To avoid complete disaster, we "walked" the boat down the rapids. Two men clung to the stern and one to the bow in order to keep it straight in the current and to retard its velocity. In some places the water was deep; in others too shallow to permit our passage without lifting, pulling and prying. The two lightlyloaded cances were dragged behind.

16 - Continued man-handling boat down rapids for most of morning. Later in the day, the conditions improved permitting us to travel under partial engine power. We passed through the canyon without incident but farther down we got stranded on a submerged boulder where the adjacent water was fast and quite deep. One of the towed cances swamped and capsized with the loss of some food and tools. By following the upturned cance down the rapids in the second cance, I managed to retrieve several tents. Paddled on to Fort Liard and secured power boat and men to help refloat the stranded boat. Arrived at the post about 10 p.m.

17 -

Set up cook tent and hung out the wet tents and tarpaulins to dry. The instruments and other equipment were stored in the Fire Warden's warehouse for safe-keeping. At 9 a.m. I sent a radio message to Fort Nelson for a plane to come and take me to the hospital at that point. Associated Airways plane arrived at 4 p.m. and flew me to Fort Nelson. On arrival at the hospital, I found that the resident doctor was away on holidays. As no anaesthetic could be given without a qualified doctor, I was obliged to go to Fort St. John. The next southbound plane or bus was due to leave Fort Nelson on June 19th.

June 18 - Sunday. The weather very hot and sultry. The air temperature during the middle of the day about 98° F.

- 19 Left at 4.55 a.m. on C.P. Airlines plane for Fort St. John. About 8 a.m. contacted Dr. Leon Komar who took me to local hospital, administered general anaesthetic and put finger back into shape. Plaster cast was put on almost half way to elbow.
- 20 Got reservation on next plane back to Fort Nelson. Very hot weather.
- 21 Met an old friend, Mr. MacLeod, Manager of the Hudson's Bay Company local store. Mr. and Mrs. MacLeod had been at Lower Post during work in that area in 1942.
- 22 Left for Fort Nelson about 3 a.m. Arrived at 5.30 a.m. After attending to some business, I left Fort Nelson at 11.11 a.m. in Associated Airways plane and arrived at Fort Liard shortly after noon.
- 23 Up early; packed up and left at 9.45 a.m. to ascend the Liard River as far as latitude 60°. The river now 5 feet higher than it was a month earlier. The current was so fast that we only made 2 miles per hour upstream. Arrived at 9 p.m. in rain at our objective.
- 24 Cleared site for observatory along the bank of the river where the tree growth was very high. We then discovered that the angle irons and bolts for assembling the observation pier had been lost in the accident on the Petitot River. Jensen and Crowther were sent back to Fort Liard for two bags of cement and some boards for the construction of a concrete pier. Clouds and rain at night. No stars.
- 25 Sunday. Boat back from Fort Liard at 2 p.m. We then crossed the river to a sand bar and freighted over gravel and stones for a concrete pier 12"x 24"x 48" imbedded 18" in the ground. We then built the form, made the necessary excavation and carried the sand and stones to the pier site. At night got a good azimuth observation after which it clouded over and rained.
- 26 In the morning we mixed and poured the concrete. In the afternoon the observatory tent and the instruments were set up and adjusted. Later in the night, we got a number of stars for the determination of the instrumental constants.
- 27 Commenced the construction of the mound and pits. At night it was clear. Observed a good longitude set and 15 pairs of latitude stars.

1

June 28

- In the morning, observed local triangulation to connect station N 7 with Dominion Observatory pier 12 miles to south which was established in 1922. Weather very hot and mosquitoes bad. At night it was partially clear. Observed another longitude set and 8 pairs of latitude stars. In the evening a diesel-powered boat and scow owned by Ed. Cooper, Fort Nelson, passed upstream. To lighten our load for the forthcoming trip to Fort Nelson, we got Cooper to take one cance and an empty gas drum on his soow.
- 29 Dull and cloudy. Worked out several pairs of latitude stars which proved to be about 59°59'58"0. At night, heavy rain. No stars.
- 30 The weather cleared during the day. Sent Jensen on foot eastward for 4 miles to report on the country. At night clear and bright. Observed a 10 star longitude set and 24 pairs of latitude stars.
- Bright and hot. Powerful diezel boat owned by Barney Streeper, Fort Nelson, passed upstream. At night, cloudy with no stars visible. As we already had about 45 pairs of latitude stars and July 1 three good longitude sets, I decided to wait no longer.
 - Bright and clear. Up early. Packed up and left 2 for Fort Nelson at 9 a.m. Due to the adverse current, we only made 3 miles per hour upstream. At night, camped on a flat island where we found the mosquitoes very bad.
 - Passed Hudson's Bay Company Post, Nelson Forks, about noon. Camped near Ollie Low trapper's cabin 3 for the night.
 - Hot burning sun. Temperature about 90° F. At night, camped on sand bar one mile upstream from 4 "Broken Arm"
 - Up at 5.15 a.m. Left campsite at 4.50 a.m. 5 Passed Snake River Indian settlement at 9.30 a.m. Arrived at Fort Nelson about 3 p.m. in heavy rain. Stored the equipment at Mr. A.F. George's warehouse. Paid off C.E. Jensen, river pilot and cook.
 - Ready to make reconnaissance flight over boundary 6 line, but weather cloudy and rainy - no flying. Working on accounts and correspondence.
 - 7 Made reconnaissance - aerial photographic flight over western part of 60th parallel of latitude. Flew from Fort Nelson to station N 7 where we took some pictures of the adjacent terrain. We then flew about 12 miles westerly almost to the Beaver River. Turning again, we flew eastward, recrossed the Liard River and continued to station N 8. Large areas of very wet muskeg north of Maxhamish Lake. We took pictures of terrain adjacent to N 8

July 7 - (continued)

and then flew on to N 9 which was photographed from 2500 feet. The white ground strip markers previously placed at each station site showed up well from the air. Mr. Slavin, Sunoco Vacuum Oil Company geologist was camped at our station N 9. Arrived back at Fort Nelson at 1.28 p.m.

8 - In the morning, Associated Airways plane went out with an oil company party. We sorted out camp equipment, food and instruments for possible landing and an observation on Lakes "A" or "B". In the evening, we loaded the plane ready for an early start next morning.

9 - Sunday.

Took off at 8.00 a.m. and flew to Lake "A" which proved to be too small for pontoon-plane take off. Moreover mud bars could be seen just below water surface. We then flew on to Lake "B", where the same conditions obtained. To get a better idea of the country from the ground, we flew 6 miles north and landed on Lake "C". The shore of the lake proved to be soft and spongy. Set up the small transit and observed the noon transit of the sun for latitude, which proved to be 60°06'16". Took off from Lake "A" at 1.00 p.m. and arrived back in Fort Nelson one hour later.

- 10 We made the final reconnaissance of the 60th parallel from Lake "B" to the northeast corner of the Province of British Columbia. Along this section of the boundary line, there was an unbroken stretch of muskeg which appeared to be soft. Lake "D" which is 6 miles N.E. of the provincial corner was too small and shallow for a landing. Sent telegram to Surveyor General in Ottawa, informing him of the impossibility of carrying on further with the work during the summer months.
- 11 Packing up equipment and crating instruments.
- 12 Took cances for storage in Hudson's Bay Company warehouse, Fort Nelson. Paid off R.M. Crowther.
- 13 Waiting for bi-weekly bus to Dawson Creek.
- 14 Left Fort Nelson at 8.30 a.m. by bus for Dawson Creek. Arrived about 7 p.m.
- 15 Left Dawson Greek at 8.50 a.m. on N. Alberta Ry. for Edmonton.
- 16 Sunday. Arrived Edmonton at 7 a.m. and waited till 9.00 p.m. for train to Winnipeg.
- 17 En route to Ottawa; passed through Winnipeg about 6 p.m.

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July 18 - En route Winnipeg to Ottawa.

- 19 Wednesday. Arrived Ottawa 6.10 a.m. E.S.T.