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Tests made to ascertain where conditions were most suitable for the 72-inch Reflector

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TESTS MADE TO ASCERTAIN WHERE CONDITIONS WERE THE MOST SUITABLE FOR THE 72-INCH REFLECTOR.*

BY W. E. HARPER, M.A.

The proposal to instal a powerful reflecting telescope six feet in diameter necessitated testing where the atmospheric conditions were most suitable, as such an instrument would require the very best conditions attainable. The following report treats of the tests made at different stations in Canada with that end in view.

It seemed natural that the meteorological reports which give the general climatic conditions such as temperature, precipitation, amount of clear sky, etc., would be of first importance in selecting in a general way where such favourable places might be found. What was desired of course was the place having the greatest percentage of clear nights and the best conditions of seeing on these nights. Naturally the greatest number of clear nights might be expected where the precipitation was not excessive; the transparency would depend in a measure upon the altitude above sea-level, while steadiness would depend upon many things. Upon the degree to which these conditions were fulfilled would depend the suitability of the place, considered from an astronomical standpoint. Proximity or easy access to a large city and suitable conditions for living would also be important considerations and should have due weight.

INFORMATION FROM METEOROLOGICAL REPORTS.

A compilation of meteorological data from places all over Canada was accordingly made. The available data were much more comprehensive from some places than from others, but the following table contains all that there is valuable in this connection. The preliminary table compiled

*Somewhat abridged from a report to the Director in January, 1914.

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included a number of other places, but from the data they were so inferior that this second limited number only was considered. In the table the days are reckoned as clear if there is less than 30 per cent. of cloud, partly cloudy if from 30 per cent. to 70 per cent., while excess of this percentage ranks a day as cloudy. The column headed "cloudiness" sums up these results and gives a fairly reliable index of the character of the day even though the personal equation of the observer must enter into it. Of recent years sunshine recorders have been introduced at a great many stations which do away with this personal equation. The results for the places given in the table bear out the estimates of the observers. Now, while the "day clearness" is not strictly the "night clearness," and local conditions can be imagined which would make the two differ, yet it is the consensus of opinion that in the long run the two will average up about the same and hence the percentage of cloudiness for the day may be taken as representative of the night as well. Later on mention will be made of special work having in view the determination of the "quantity" of seeing at some of the stations selected.

METEOROLOGICAL DATA 14 YEARS (1895–1908).

	Altitude.	Temperature.				Days.					Mean Total Precipitation.	Mean Total Precipitation 20 years.	Humidity.	Cloudiness.	Days Completely Clouded.	Wind Velocity.	Remarks.
		Highest.	Lowest.	Mean Daily Range.	Mean Yearly.	Clear.	Partly Cloudy.	Cloudy.	Precipitation .01 in. or over	Snow.							
	Feet.	°	°	°	°						inches.	inches.					
Ottawa	296	93·2	−23·3	18·2	43·0	93	137	135	126	57	32·98	33·40	83	58	62	6·7	
Gravenhurst	770	91·3	−31·7	20·2	....	126	129	110	105	60	35·85	.....	..	50	..	5·8	1908 missing.
Winnipeg	760	92·1	−39·2	22·8	34·9	117	135	113	103	53	20·95	20·81	81	53	94	13·9	
Battleford	1620	92·0	−40·8	22·3	34·4	127	136	103	99	49	14·64	13·79	78	50	41	7·9	
Medicine Hat	2161	98·9	−35·3	24·6	41·3	111	150	104	75	40	14·60	13·11	70	53	56	7·5	
Calgary	3389	89·5	−32·7	24·0	37·4	110	164	92	79	35	19·02	16·30	78	50	..	8·5	
Banff	4542	85·8	−35·7	21·7	35·6	103	156	106	138	73	21·09	21·11	70	52	..	4·1	
*Okanagan	1200	94·3	−11·2	21·1	....	....	....	....	70	27	12·58	.....	....	....	....	....	Years 1903-11 inclusive.
Kamloops	1193	98·5	− 8·6	19·1	47·7	94	149	122	71	17	9·86	10·62	71	56	55	3·8	1895, 6, 7 missing.
Victoria	85	84·7	+20·3	12·4	50·3	91	107	168	152	8	26·51	27·83	80	63	73	8·3	1895, 6, 7 missing.

*Years 1909–11 inclusive from Kelowna 10 miles northeast.

Since this table was compiled other data have come to hand, which bear upon the question and may be tabulated here. Most of this was secured when the writer visited the different stations and through the kindness of the observers had access to the detailed meteorological records at these places.

BANFF (SULPHUR MOUNTAIN, ALTITUDE 7484 FEET).

MEAN WIND VELOCITY FOR 1910.

Miles per Hour.

January	24·3	July	17·6
February	18·8	August	14·2
March	21·5	September	15·8
April	19·0	October	23·2
May	18·0	November	17·0
June	15·4	December	24·5

This is a typical year and the average is 19·1 miles per hour. The observer, Mr. S. B. Sanson, says velocities as high as 100 miles per hour have been recorded and the total movement for one continuous hour has been as high as 72 miles.

VICTORIA, B.C.

Month.	1899 to 1912 Inclusive.		Hours sunshine in 1913.
	Mean total movement of wind in miles.	Mean number of hours sunshine.	
January	6704	53	50
February	5848	86	81
March	6330	143	121
April	6100	188	127
May	6248	202	166
June	6524	225	167
July	6252	296	274
August	5474	255	237
September	4280	190	198
October	4662	116	91
November	5927	56	56
December	6377	38	34

VICTORIA, B.C.

WIND VELOCITY 1899 TO 1912 INCLUSIVE.

Direction.	Total movement miles.	Number of hours.
S-W	322,459	26,472
N	120,774	22,100
W	164,434	16,586
S	106,469	15,374
N-E	78,909	11,153
E	72,512	10,682
S-E	101,332	9,240
N-W	23,264	4,633

In the general table the mean daily range for Okanagan is given as 21° F. As mentioned later Penticton, at the southern end of the Okanagan valley, was selected as one of the places to be tested. While there, the readings of the thermometer for 1910 and 1912 were given me by the observer, and from these the mean daily range for the years in question was 20° F. so that, although the place is about 30 miles from the Okanagan station, the data compiled for Okanagan will serve for Penticton.

No data as to the character of the days in the Okanagan were available for the years tabulated. However the sunshine recorder at Summerland, though installed only within recent years, shows the amount of clear sky to be about the average and thus from the table no one place has a commanding superiority in this regard. The low daily range of temperature at Victoria would lead one to expect fairly steady seeing at that place. The range there for the year is just one-half what it is at Ottawa.

PLACES SELECTED FOR INVESTIGATION.

Keeping in mind that preference be given to stations of southerly latitude, so that more stars could be reached in the southern hemisphere, the stations were simmered down to four which were thought to be typical of the various sections. The prairie section should produce uniform atmospheric conditions, particularly if an elevated plateau were available, and of the places on the prairie, Medicine Hat was deemed the most

promising. The Rocky Mountain section, where high altitudes are possible, was deemed worth testing and Banff was selected as typical. The dry belts of British Columbia were considered promising also, and the Okanagan valley, Penticton district, was selected as the particular place, while Victoria with its exceedingly small diurnal range of temperature seemed promising as regards steady seeing, and it made up the fourth station outside of Ottawa where specific tests were to be made. Incidentally during the progress of the work, a cursory examination of a number of other places was made.

NATURE OF THE TESTS.

Something of the nature of the tests at these five places will now be given. The principal instrument used was a Cooke $4\frac{1}{2}$-inch telescope, equatorially mounted. This photo-visual telescope was equipped with eye-pieces of magnifying powers 60, 120, 180 and 320, and a camera taking plates of cabinet size. While the programme was almost wholly planned for visual work, yet it was felt advisable to make some photographic tests which might serve as a check upon the visual work. The camera, belonging to the telescope, can be quickly attached and takes plates covering a field about 3° in diameter. Two fields were selected near the pole containing stars of various degrees of brightness. On the majority of the nights on which work was done, one or both fields were photographed by allowing the stars to trail across the plate for six or eight minutes. If care is taken to insure uniformity, particularly in the development of the plates, a comparison of the intensities of the star trails impressed upon the plates should give an indication of the relative transparency of the atmosphere from night to night. The photographic work was not considered of primary importance; it was intended to serve merely as a check upon the visual work upon which almost entire dependence was to be placed.

A list of close double stars was selected as was also a number of faint stars about the limit for the telescope. The steadier the seeing the smaller the star discs would be, and these would be the conditions most favourable to the resolution of close doubles. The theoretical limit for the size of

star disc for this telescope is approximately 1″·0 of arc but, owing to unfavourable conditions of seeing, it is not often that this theoretical limit of a telescope is attained. As will appear later, however, there were several nights experienced so favourable that this theoretical limit was reached. Thus the examination of close doubles, with a view to learning the minimum amount of separation that could be detected, formed the bulk of the observational work. The steadiness of the diffraction rings of bright stars would also give a clue to the seeing conditions and note was to be made of these. The transparency of the atmosphere could be arrived at, in a sense, from naked eye observations of objects about the limit in brightness for the eye and also in a certain measure from the ease with which faint stars could be picked up in the telescope. Caution would have to be exercised in this latter procedure, as it would be hard to dissociate transparency from steadiness. The theoretical limit of visibility for the telescope lies between 12·0 and 12·5 magnitudes.

Besides the telescope a few other instruments, mostly for meteorological purposes, were taken along. A thermograph was deemed useful to note the range in temperature, particularly during the night, as this is quite important in the case of large reflectors. A wet and dry bulb thermometer to note the humidity of the atmosphere, an aneroid barometer for use where no barometric readings were kept, and an anemometer for registration of wind movement completed the outfit.

The following table includes some of the more important objects used in the work. They are mostly double stars taken from Burnham's catalogue. The co-ordinates of position are only approximate.

PARTIAL LIST OF TEST OBJECTS.

Star No.	α	δ	Separation.	Magnitudes.	Remarks.
	h m	° ′	″		
6243	12 37	− 0 58	6·0	3·0 3·0	103″ distant is 11·6^m
6993	14 41	+27 30	2·3	3·0 6·3	
7031	14 46	+49 06	3·5	5·8 6·5	
7120	15 01	+48 00	3·7	5·2 6·1	
7127	15 03	+ 9 34	4·2	7·0 7·0	
7259	15 21	+37 39	1·4	6·7 7·3	
7563	16 11	+34 06	4·6	5·0 6·1	
			65·0	10·5	
7705	16 35	+20 38	3·7	7·2 10·1	
7739	16 40	+23 40	1·6	7·3 7·6	
			25·3	11·0	
7914	17 10	+14 30	4·6	3·0 6·1	
			84·8	10·6	
8243	17 52	+18 20	2·6	7·0 7·0	
8398	18 06	+16 23	1·2	6·0 7·1	
8692	18 34	+38 42	55·0	1·0 10·5	
8783	18 41	+39 45	3·0	4·6 6·3	Two stars fainter than 11·0^m lying between ϵ^1 and ϵ^2 designated *3* and *5*.
			46·7	10·1	
8785	18 41	+39 43	2·4	4·9 5·2	
9982	20 08	+ 0 37	3·2	7·1 7·4	
10437	20 38	+32 00	2·8	6·0 8·1	
10605	20 51	+ 4 10	2·0	6·2 7·7	
10713	21 00	+56 10	1·7	6·0 7·0	
12196	23 07	+74 54	0·9	5·2 7·5	
12675	23 55	+33 04	2·0	6·0 6·0	
1438	2 43	+60 01	2·1	7·1 9·0	
1568	3 03	+71 17	1·7	7·5 7·5	
1952	3 52	+80 30	0·9	5·2 6·1	
2178	4 20	+22 00	5·4	9·2 9·3	Between κ^1 and κ^2 Tauri.

The highest power was used wherever possible. The use of this power, which is about 70 to the inch, would give a fairly severe test of the seeing and would compensate to a certain extent for the small aperture used. Certainly any tendency to unsteadiness of the air would be at once apparent from its use, and it would be only on nights of the very best seeing when it could be used at all.

GENERAL ITINERARY OF TRIP.

Having in mind the four places just mentioned as being typical of the conditions in their respective districts, I left Ottawa on June 13th to examine more specifically the quality of the seeing at each of these places. While

some thought was to be given casually to the day seeing, the main consideration was to be the night seeing and the suitability of the place for research with a large reflecting telescope. It may be readily understood, that as my stay would necessarily be limited at each place, that unusual weather conditions might prevail which would result in a false impression of the place being gained, consequently it was thought best to visit the places both going and returning, so that different seasons of the year be experienced, and thus average conditions the more likely to be assured. The wisdom of this was apparent from my first stay in Medicine Hat, the latter part of June. Previous to my visit the weather for some considerable time had been fine but during my stay it was mostly wet and cloudy. The same thing was true, though not to so marked an extent, on my return trip to Penticton.

I arrived in Medicine Hat June 16th and left for Banff July 1st, reaching there on the morning of July 2nd. During my stay at the latter place the weather was about normal, about two-thirds of the nights being wholly or partially clear. I left Banff for Penticton July 14th, arriving there the evening of the 15th. During my stay here this time, the weather was very favourable as both days and nights were in general clear. Incidentally the days were hot too, the thermometer being in the nineties nearly every day. Leaving Penticton July 28th I proceeded to Victoria, arriving on the morning of July 30th. I remained until Aug. 13th when I left for mount Hamilton, Cal., to visit the Lick Observatory and make some comparisons with conditions there, of which I shall speak later.

Returning to Victoria Aug. 23rd I remained until Aug. 30th. During my stay both periods in Victoria the weather was favourable, only three cloudy nights being experienced. From Victoria I returned to Penticton on Sept. 1st. Here I encountered some cloudy weather which caused me to prolong my stay until Sept. 23rd. It seems to be the rule that a break in the weather occurs about this season of the year, and from reports it was pretty general over the west. Conditions at Banff during my first visit warranted its omission on the return trip, so I returned directly to Medicine Hat,

arriving the morning of Sept. 25th. From reports the weather for three weeks previous to my coming was very beautiful and certainly during the first seven or eight days of my stay it was all that could be desired, hardly a cloud being seen in the sky. After ten days or so the weather broke and I left for Ottawa on Oct. 6th. Snow had begun to fall.

During the latter part of October and the first half of November, I continued similar work at Ottawa and a preliminary relative value of the places was arrived at. As will be shown later, Victoria, of the outside places, was the most favourable and another visit was made there during the month of December to ascertain the quality of the seeing during its worst weather. Returning to Ottawa the beginning of 1914, a couple of weeks more were similarly spent before the available data was considered sufficient to decide the question.

I shall now treat more in detail of the seeing conditions found in the various places outside of Ottawa, taking them in the order visited.

MEDICINE HAT.

Medicine Hat is situated in the dry belt of Southern Alberta, 650 miles west of Winnipeg on the main line of the C.P.R. The city of something less than 15,000 people, lying in the valley of the South Saskatchewan, is noted for its immense resources in natural gas. In view of the cheap power thus afforded it is claimed that here will be the manufacturing centre of western Canada. This would be aside from our discussion were it not that the vicinity of a manufacturing city is usually considered a poor place to locate an astronomical observatory. As there is, however, no smoke from the use of gas it would seem that no drawback would thereby result. Apart from the railway trains, which use coal, it is a smokeless city.

In looking over the place for a suitable location for my telescope I decided upon the tableland to the north of the city. Its elevation above the city is about 135 feet and hence above sea level 2,300 feet. To the north and east and west stretches the plateau, while immediately to the

south lies the valley about a mile wide, through which the river runs; and beyond the valley the plateau is continued. There was no noticeable difference of seeing in the various directions for altitude of 25° and greater, but for lower than 25° altitude the seeing over the river seemed a little more unsteady.

As intimated above, unfavourable weather greeted me here. The average total precipitation for the year is 14·6 inches, and during the two weeks I was here about one-sixth of that amount of rain fell. In all, there were 9 nights on which no work of any account could be done, 5 nights which were more or less cloudy permitting some work to be done and only one which could be called clear.

No rapid changes of the barometer were noted; the maximum range during the two weeks visit was only 0·55 inches. The average velocity of the wind was 10·8 miles per hour. As a rule the wind dropped in the evening, though this rule was not without exception. I have noted it calm in the evening on commencing work and during the night the wind would rise and attain a velocity of 10 or 12 miles an hour. In such cases it was necessary to use a wind shield to prevent undue jarring of the telescope. The general direction of the wind is east and west following the valley of the river. Sometimes for short periods of the day it attained a velocity of from 50 to 60 miles an hour.

The following remarks describe the conditions on the nights upon which work was done.

June 20.—Worked until midnight on clear spaces. Clouded then. Considerable unsteadiness. Magnitude 10·1 about the limit. 6^m stars have 1″·3 disc. Rate, what seeing there was, 2·5.

June 23.—From 8.30 to 9.30 seeing very steady. Remarkably so considering the broken sky. At 9.30 haze and clouds thickened over and steadiness vanished. At 10.20 a heavy dew started to fall and object glass coated as fast as it could be cleaned. Transparency the first hour not on a par with steadiness, which was 4·5 for stars near zenith.

June 24.—Just a few clear patches. Steadiness again very good. Clouded completely at 10.20. Rate, the little seeing obtained, 3·0.

June 28.—Cloudy and hazy in places and seeing very variable. Star discs from 1″·3 to 1″·7 in diameter in best seeing. Worked till midnight; no further use. Seeing varied from 2 to 4 but most of the former.

June 29.—With the exception of an hour at the beginning and an hour at midnight, the night was clear. A twelve mile breeze blew most of the night. After the haze of early hours of night lifted, the transparency was good. Both *3* and *5* in ϵ Lyræ seen, the former persisting while the star was within 2 or 3 hours of the meridian. In rare moments 7^m stars had discs 1″ in diameter, in general they were 1″·3 and 1″·4, and doubles of this separation could be nicely identified. There was no such thing as uniform seeing throughout the night; the steadiness at best was easily 4 or better but at times it was less than 2, especially for the lower altitudes. The night might be rated 3.

June 30.—The first hour after sundown was remarkably steady. Haze was overspreading most of the sky. About 9 o'clock the haze thickened and steadiness vanished. Clouded completely at 11 o'clock, so dismounted. While examined, seeing decreased from 4·5 rapidly to 2.

BANFF.

Banff is a small town in the heart of the Canadian Rockies, about eighty miles west of Calgary. It is a famous resort for tourists, its sulphur baths attracting many visitors. Its elevation above sea level is 4521 feet, which is considerable to start with. It was my intention to locate on some of the surrounding mountains, but on looking them over, only two, Tunnel and Sulphur, seemed at all practicable. On the summit of the latter is located the meteorological station, to which trips are made every second week by the observer. Its altitude is 7484 feet. The western slope, as well as considerable of the eastern slope, is devoid of vegetation and in other respects it did not appear, upon further examination, suitable even for my preliminary testing much less as the location of a permanent

observatory. The wind averages 19 miles per hour and gales of 100 miles an hour have been recorded. I went up Tunnel mountain, altitude 5540 feet, but it too is quite rocky and barren near the top, and has such a limited area on its summit that no permanent building would be advisable even were conditions of seeing suitable. In the valley at an altitude of about 4800 feet, where some rising ground gave air drainage, it was decided to locate. Considerable hesitancy was felt in adopting this course but it seemed the only feasible one.

Below is given in some detail the conditions existing on the nights on which work could be done.

July 2.—Considerable number of floating clouds. Worked on bright stars in openings in clouds. There was no such thing as steadiness. Doubles of 3″ and 4″ separation just identified as elongated blur. The brilliancy of the sky struck me as good. The $10 \cdot 1^m$ in system of ϵ Lyræ shone like a 9^m star. I rated the night 2, but this may not give much of an idea. The transparency was good in spite of the utter lack of steadiness.

July 4.—Slightly steadier than July 2nd but very poor yet, could barely detect companion in ϵ Boötis. Star 7120, about $3'' \cdot 7$ separation, could no more than be suspected double from the blurred image. Vega when right on meridian presented a very diffuse image. The night was clear except for some floating clouds. There seemed to be no difference in steadiness depending upon direction. Seeing noted as 2.

July 5.—The day was calm and practically clear. The night was calm also with not a cloud. Hence better seeing expected. About sundown and at odd intervals during the night there was some semblance of steadiness but on the whole there was not a great improvement. For example, Arcturus when 2 hours west of meridian gave a fairly steady image. Fifteen minutes later, in looking at it a second time, the seeing had become exceedingly bad. To the unaided eye the night seemed brilliant, the Milky Way standing out conspicuously, yet, probably from the lack of steadiness, faint stars could not be picked up. The word "flux" seems to best describe the star images. The night rated 2.

July 7.—For an hour or so in the twilight hours the seeing was fair. Star discs, in the case of stars of 6th and 7th magnitudes, had diameters as small as 1″·5 and seeing was noted as from 2·5 to 3·5. This did not last very long. The images assumed their usual flux. The transparency was not good as the 10·1 in ε Lyræ was by no means brilliant. Summing up the night it would not rate over 2.

July 8.—Slight haze till 9 o'clock, otherwise all clear. Again no such thing as steadiness, even near zenith. With power 320 it was all one could do to detect double stars of 3″·5 separation like 7031, 7120, etc. Power 180 was better of course but even this could not be used. All images in state of flux. No wind whatever. Rated night 1·5.

July 10.—Conditions similar to previous nights. Clouded at 10 o'clock and rained.

July 11.—The amount of sky clear at start was 20 per cent. This increased but the night was never perfectly cloudless. The seeing was more steady than usual. The images were not always in that state of flux which characterized almost every night; the diffraction rings in the cases of bright stars could be seen. Star discs not over 1″·3 and 1″·2 were noted, and in the zenith for a short while the seeing was as good as 4 but this did not last over a few minutes. Lateral displacements of the images to the extent of 1″·4 noted. The night rated between 2 and 2·5.

The nights of July 12th and 13th were cloudy and on 14th I left for Penticton. During my stay at Banff no rapid change in the barometer took place; in fact during the first week not over 0·1 inch variation was noted. There were successive days and nights clear and calm so that if steadiness existed at all, it might be expected to show up on such nights. It was never seriously the case; in fact unsteadiness to a marked degree was the feature of every night.

PENTICTON.

Penticton lies at the south end of Okanagan lake, which is about ninety miles long and from one to three miles wide. It is reached by rail from

Sicamous on the main line to Okanagan Landing 50 miles, thence 90 by boat to Penticton. The Okanagan valley especially the southern end is one of the dry belts of B.C., the total average precipitation according to best available data being about 12 inches per year. It is the centre of a great fruit raising district, the orchards being located on the benches which rise about 200 feet above the level of the lake. These benches extend from the lake shore on either side back from 1 to 2 miles before the base of the mountains is reached, and this is the stretch of land which has been irrigated and turned into fruit lands. The land itself is of fine volcanic silt and owing to the dry climate considerable dust is experienced. South of the town is Dog lake. The winds which attain considerable velocity here are mostly in a north-south direction between the two lakes.

The morning after my arrival I went up the mountain which Dr. Plaskett had previously looked over. It lies to the east of the town about two miles in an air line. In shape it is long and narrow with its ridge running in a northeasterly, southwesterly direction. The highest point, subsequently determined by an aneroid, is approximately 1600 feet above lake level. Thus its elevation is 2730 feet above sea level. This point is about due east of the wharf. To the northeast it slopes off quite gradually for some distance and then rises to a higher mountain; to the southwest it falls off in a succession of terraces, of which there are two extensive ones, until it reaches the Penticton creek. I came down these southern slopes and decided to set up on the middle one, but failure to get the instruments up on pack horses necessitated my setting up at an elevation of about 1630 feet where there was a sufficient commanding sweep of the sky. While the place was suitable enough, the higher altitude would have been preferable and it was a disappointment not to have succeeded in getting there. During my stay here I went up the mountain from the north and saw that the equipment could be got up from that side. On the return trip, therefore, I was able to locate on the crest. The tests at the two levels have an additional advantage of furnishing a comparison of the seeing at different altitudes.

Owing to unavoidable delays I did not get set up on the 16th, which was a beautiful clear night. Before my arrival the weather had been quite wet and disagreeable, but almost coincident with my coming it cleared up and remained so while I was there.

July 17.—At the start the wind affected the instrument somewhat as the wind shield was not perfectly satisfactory. However this was allowed for. There seemed to be smoke in the air as if from forest fires, though none in immediate neighbourhood. The distinctness with which double stars showed up was a change from what I had been accustomed to at Banff, though much to be desired yet. In lulls, estimated star discs to have diameters 1″·2 and 1″·3. Could not get *3* and *5* in ε Lyræ. Rated the night 3·5.

July 18.—The day was clear and calm, the smoke of previous day seemingly gone. The early part of the night up to 11.30 was fair, both as regards steadiness and transparency. From that time till 3 o'clock the seeing was almost perfect, star discs having approximately their theoretical diameters of 1″·0. About 3.30 a.m. humidity began to increase and seeing became somewhat unsteady. The night rated 4.

July 19.—Not quite as good as previous night though very fair. Star discs more like 1″·3 diameter. Picked up different ones of that separation, 7259 in Burnham's catalogue, separation 1″·4, a case in point. The night rated 3.6.

July 20.—A broken night. Clouded about 4 o'clock in day, cleared at 9 o'clock, clouded again 1 o'clock. What seeing there was, was unsteady and rated 2.

July 21.—A very hot day. While the southern half of the sky was always clear, an electric storm was raging to the north. This may have had something to do with the seeing which was exceedingly bad. No attempt was made to estimate diameters of discs from close doubles, as all in a state of flux. True there were moments when this could be done but they were fleeting. The night rated 2.

July 22.—The night was broken by fleeting clouds. It was transparent enough, but the steadiness was not the best. It varied from 2 to 4 depending upon the altitude. Continued watching, showed flashes of *3* in ϵ Lyræ. Rated 2·5.

July 23.—The night was peculiar in that the seeing was very variable. It would be almost perfect for a while and almost the next instant be absolutely useless so far as steadiness is concerned. Changed from 4·5 to 1·5 in few moments. An electric storm to the east may have had some connection with such variable seeing conditions. Rated the night 3 which is sufficiently high.

July 24.—There was considerable floating haze throughout the night as seen by temporary extinction of 10^m stars. No 11^m stars seen. The steadiness varied from 4 in the zenith to 2·5 for altitudes of 25° to 30°. 7^m pairs of $1''\cdot4$ separation could not be identified. Outside of the little haziness, which could be noted with the unaided eye, the night was very fair though and was rated 3.

July 25.—Day clear and somewhat cooler. Sky deep blue early part of night. Later a whitish haze crept up from horizon. Could see indications of faint stars in ϵ Lyræ though they were not striking. Could pick up doubles of $1''\cdot3$ separation. The steadiness was not so good as on the best night (18th) but everything taken into account the night would be rated 4.

VICTORIA.

Victoria was reached on July 30. That day was spent in looking over possible places for my preliminary testing. Beacon hill, Gonzales point and the sight of the new meteorological station were visited in the forenoon. In the afternoon, I have to thank Mr. A. S. Barton, who, being interested in scientific work, placed his automobile at my disposal and directed me to several of the elevations in the vicinity which I wished to look over. Mount Tolmie, mount Douglas, Strawberry hill, Knockan hills and other elevations were examined. The prevailing southwest winds would strongly militate against elevations to north or east of the city, and I decided to locate on a

rocky eminence in the midst of a considerable block of timber in the Hudson's Bay Company's reserve near Esquimalt. There I was not affected by the smoke from the city.

July 31.—First glance showed surprising steadiness. Star discs down to theoretical 1″ diameter, and seemed like steel engravings so steady and beautiful was the diffraction pattern. Transparency good, as 11^m and 12^m stars in ϵ Lyræ persisted. Only for a few moments was there anything but perfect seeing. Rated 4·6 so as to leave a margin for the theoretically unattainable.

August 1.—The day became hazy and the night was more or less cloudy. Extensive forest fires in the state of Washington and southwest wind carried smoke this way. Worked on the brighter stars as they only were available. Rated the night 1.

August 2.—Was cloudy until near evening when it cleared. As somewhat smoky and atmosphere very humid, good seeing not expected. The stars *3* and *5* in ϵ Lyræ persisted *at times*, which was better than the average transparency at other places. Aside from this little lack of transparency it was a perfect night. The steadiness fine; the close doubles stood out with clear cut definition, diffraction pattern of bright stars very steady. Rated night 3·5.

August 3.—The night was apparently similar to preceding. Somewhat indisposed and did not go out.

August 4.—This night the first appearance of unsteadiness was noted. It was by no means bad but, being the first noted here, attention was directed to it. The night seemed somewhat foggy to the naked eye, though the humidity of 74 per cent. is less than some nights when good seeing existed. Lack of definition was the nature of the defect in seeing; star discs were about 1″·5 diameter in the case of 6^m stars. Seeing valued at 2·7.

August 6.—Up to 11 o'clock the night was very good. Double stars of 1″·3 and 1″·4 separation easily detected. Below 40° altitude it was

very thick. After 11 o'clock all stars more or less milky. However, flashes of *3* (11^m) in ϵ Lyræ seen. Just a poor to fair night and rated 2·5.

August 7.—Mostly clear but high wind prevented work, as telescope could not be properly protected from wind which at times reached 50 miles an hour.

August 8.—In the first three hours or so, up to 10 o'clock, the seeing was excellent, rating about 4·5. Then some unsteadiness crept in and images not perfectly defined, though about this time one could see stars as faint as 11^m. Later the seeing could not be rated more than 3·5 when averaged over the working regions of the sky, *i.e.*, above 30° altitude. This at Ottawa we would rank, I think, as an exceptionally good night. Rated 4·0.

August 9—This was practically a perfect night, and the best yet. Before twilight ceased many close doubles examined and star discs for 6^m and 7^m stars averaged 1″·1 in diameter. Doubles as close as 1″·2 nicely separated and defined. Star 8398 in Burnham's catalogue a case in point. Fainter companion nicely dissociated from brighter. Excellent definition and night rated 4·3.

August 10.—A few "floaters" in the sky with horizon hazy in the southeast, which seems to be customary. The night otherwise apparently fine to the naked eye, yet it was by no means good. True, doubles of 1″·4, 1″·3 and even 1″·2 separation could be suspected but no definition. Magnitude 10·5 was lowest reached. The night described as "Banff flux on small scale" and rated 2·4.

August 12.—Quite cloudy in evening but cleared, and mostly clear during night, though "lanes" of haze at times spread over clear spaces. The humidity stayed about 82 all night. Transparency fair, 10·5^m about limit. *3* in ϵ Lyræ seen occasionally, *5* quite rarely. 10·5 magnitudes quite distinct. The steadiness was very good, diameters of discs slightly over limiting value. Rated night 3·9.

August 23.—At start, 6.30 p.m., 80 per cent. clouds. They broke and night remained clear. Humidity very high, around 90 most of night.

Transparency noted as not the best, yet 11^m stars seen. *3* in ϵ Lyræ did not persist, *5* was not seen. Slight fuzziness or lack of definition of image in early evening but this wore off as night progressed. Lateral displacements not greater than 0″·5. Star discs had diameters from 1″·3 to 1″·0. In zenith, seeing 5, lower down less; on the whole the night worth 4.

August 24.—Clear and calm all day; night similar and exceptionally good. Transparency the poorest factor, *3* and *5* in ϵ Lyræ showed at times but did not persist. The 11^m in α Herculis glimpsed at times. On other hand definition was perfect, the diameters of star discs not much exceeding 1″·0 on the average. An example may be noted: star 7259 Burnham's catalogue, separation 1″·4. There was a clear line of separation between the 6·7^m and 7·3^m stars equalling one-third of diameter of brighter. Hence 7^m star has disc 1″ diameter, which indicates perfect conditions of instrument and steadiness. The steadiness might be said to run from 3·5 for altitudes of 25°, rapidly increasing up to 4·8 for stars in the zenith. The night rated 4·3.

August 25.—Night clear but strong wind, so much the case that I had to discontinue work. The horizon was the clearest of any night yet, the Olympian mountains standing out clear cut in the early evening, yet there was considerable unsteadiness apart from the vibrations due to the wind.

August 26.—While the steadiness was in general good, there were bodily displacements of the images ranging from 0″·3 to 0″·5. Got a glimpse of the 11^m ± in α Herculis, but on the whole it was not easy to pick up faint stars. *3* and *5* could be known to be present from a certain milkiness surrounding their position, but they were by no means prominent. Considering that it just cleared entirely about 8 o'clock I think the seeing was exceptional. Rated 4.

August 27.—Day clear and calm and good night expected. Did not quite come up to expectations. Images lacked clear cut definition experienced on previous nights. Also small bodily displacements of 0″·3.

Yet 11^m stars showed quite bright, almost the equal of the best experienced so far. Got glimpses also of 12^m stars. Worked only till midnight. Rated 3·7.

August 29.—The night was not the best for transparency. A haze extended up 20° in the east, in other directions noticeable but not marked. Fluctuations in brightness of faint objects showed better transparency possible. Were I rating this factor alone it would run 3·5 to 3·8 on scale of 5. On the other hand the steadiness was excellent. I marked it 4·8 in very many cases which means as good as ever seen. If this had *always* been the state of the seeing and *in all positions*, the night would be rated thus but it was poorer than the maximum for low altitudes, say those around 25°. Possibly 4·3 would sum up the seeing in all particulars for the night.

PENTICTON (SECOND TRIP).

As stated previously, after spending a short time at Victoria on my return from mount Hamilton, details of which have already been given, I returned for a second visit to Penticton. This time I was located on the crest of the mountain, altitude 2,730 feet.

September 4.—Cleared about 5 o'clock. While not expecting the best of seeing, I thought it would gradually improve as the night wore on but it did not. The wind dropped early at night and it was calm, and to the unaided eye a good night but there was absolutely no such thing as steadiness. Star images were nebulous and fully 3″ or 4″ in diameter. With power 180 could distinguish some doubles of 3″·0 separation but that about the limit. Humidity ran from 70 in the early evening to 90 at daylight. Could not rate the night, as had not experienced such previously.

September 5.—Cleared completely about sundown. The first hour after sundown was good, about 4·0. Then a north wind arose, it got cold, and seeing became exceedingly bad. For an hour it was no good, then it gradually improved and remained about 3·5. Doubles of 2″·0 were nicely measurable though they jumped considerably. Night rated 3·5.

September 6.—Clear calm day and good night followed. The humidity was quite low, around 40 all night. The unfavourable criticism was in regard to transparency caused by a veil of haze, which seemed to prevent faint stars from being detected or rather from persisting in vision. While not perfect, the steadiness was so nearly so that nothing unfavourable need be said. Night rated 4·4.

September 8.—Clouded in day. Cleared at 7.30 in evening but unsteady and shortly afterwards clouded over.

September 9.—Seeing first three hours after sundown absolutely no good. Then it improved slightly so that some semblance of an image was given. Doubles of 3″·0 could be detected by elongation but that was about the limit. Seeing like this till midnight. Humidity around 60. Night rated 1·5.

September 10.—The night up to midnight was fair for steadiness, a great improvement on the past few nights but not quite equalling September 6. A film of haze hung over most of the sky till midnight when it disappeared. The transparency was much improved though the steadiness remained about the same. To the unaided eye the 10th and 11th stars in the Pleiades showed up better than I had ever seen before in Canada though not so good as at mount Hamilton. Rated the night 4.

September 11.—The night one of the best. All close doubles clearly defined. A marked feature was the greater steadiness in the south and west caused by haze which persisted in that part of the sky. In the west the stars of low altitudes were remarkably steady. The transparency of course was not the best, *3* and *5* in ϵ Lyræ persisted only about 10 per cent. of the time. The definition best factor—the steadiness would have been 4·6 save for the northeast—the transparency not over 4·0. The night rated 4·3.

September 16.—Cleared at 5 o'clock but broken by clouds most of the night. Up to 9.30 p.m. considerable ill definition and bodily displacements

of 1″·0. Transparency poor. It was with difficulty that 10m stars were seen. Some improvement 9.30 to 11 o'clock. Best hour around midnight, when seeing much steadier though transparency not improved much. The feature of poor seeing in eastern heavens was again noticeable. Rated night 3·0.

September 18.—Night brilliant but quite unsteady. Power 320 entirely out of question. It kept improving particularly after 9 o'clock, when wind dropped completely, and at 1.30 in the zenith it could be rated 4·2 but deteriorated very rapidly with decreasing altitudes. Same characteristic of poorer seeing to east than in other directions. Early evening, doubles of 2″·0 was the limit. This improved so that 1″·2 could be detected, though far from being definite. Night valued at 3·3.

September 19.—The best all round night experienced here. Doubles of 1″·0 could be immediately identified. Diffraction rings steady and similar to steel engraving effect noted in best seeing at Victoria. Slight lack of transparency, but night worth 4·6.

MEDICINE HAT (SECOND TRIP).

September 25.—Part of night devoted to setting up and adjusting instrument but conditions noted from 9.30 on till near daylight. The diffraction pattern was fairly steady. I should say steadiness on the whole about 3·4. Towards morning dew began to form on object glass and by 3.30 formed as fast as could be cleaned off. Rated night 3·4.

September 26.—Day and night clear. Wind first from south then dropped entirely for few hours, then rose from north and later again shifted to south. Seeing was almost useless at any time so far as steadiness was concerned. This night and September 4 at Penticton were very much alike. Images extremely diffuse. No rating.

September 27.—The night started off fine. For an hour after sundown the seeing was excellent, but after that time the definition began to deteriorate. Bodily displacements crept in and general unsteadiness the rule. From 8.30 the seeing practically useless. Doubles of 2″·0 could be

suspected but that the limit. Power 120 highest usuable. Night rated 2·5.

September 28.—Here was a night of which one might expect the best. Clear at least for four successive days and nights, with a steady barometer all day and no wind. It was woefully disappointing. Star images nebulous, being 3″ or 4″ in diameter. Night not worth over 2.

September 29.—Clear till 9.30 p.m., partly cloudy rest of night. North wind which however dropped completely. Seeing a marked improvement on former nights. Could detect doubles down to 1″·2 though they were not well defined. Transparency only fair when perfectly clear, as *3* and *5* in ε Lyræ did not persist. Rated night 3·5.

September 30.—With the exception of some hazy clouds in south and west which lasted till 9 o'clock, the night clear. Fairly transparent, as *3* and *5* in ε Lyræ and others similar persisted half time. Bodily displacements were not large; star discs improved from 1″·6 to 1″·3 diameter. Seeing rated 3·3.

October 1.—Sky perfectly clear down to horizon. Some wind from west which died down. Great unsteadiness. Neither 320 nor 180 nor 120 powers any use. Images must be 5″ or 6″ in diameter. Rated 1·3.

October 2.—Clouded in afternoon and turned quite cold. Cleared at 7 o'clock. Seeing absolutely useless, but on account of sudden cold change in weather there is some excuse for it tonight which there was not on previous nights. As an illustration of poor seeing one case may be noted. Star 7120, 3″·7 separation with powers 320 or 180 just one elongated blur, with 120 can note some form of images. Clouded quickly at 8.30. Rated 1·0.

As the nights of 3rd and 4th were cloudy and snow was falling on the 5th, and further as I considered I had sufficient information regarding this place, I decided on the 5th to pack up and leave next day for the east.

OTTAWA (SUMMER AND AUTUMN).

Here will be given a summary at least of the work done at Ottawa. The instrument was partly set up on May 14th, but repairs and alterations occupied some time and, further, considerable trouble was experienced in getting a perfectly uniform image. Some time was spent in arranging a programme of test objects, fields for photographic purposes, etc., but conditions of seeing were noted at the same time. The following summary is sufficient to indicate the general conditions experienced. The rating assigned in the early summer has been lowered to that given in the table in view of my standard being raised, as will be mentioned later.

SEEING CONDITIONS AT OTTAWA.

Date.	Remarks.	Rating.
1913		
May 14	Cirrus clouds, some haziness and unsteadiness	2·0
" 20	Images lack definition	2·3
" 24	Floating clouds, steadier than previous night (20th)	2·4
" 29	Steadiness and transparency fair, best yet	2·8
" 30	Fair; diameters of star discs 1″·8 and up	2·6
June 4	Diameters of star discs 1″·7 or more	2·6
" 5	Poor night	2·0
" 7	Transparency 3·8; steadiness 3·3	3·4
" 9	Transparency 4·0; steadiness 3·6	3·7
" 10	Very hazy and unsteady	1·0

SEEING CONDITIONS AT OTTAWA—*Continued.*

Date.	Remarks.	Transparency.	Steadiness.
1913.			
Oct. 14	Doubles of 2″·5 separation barely distinguished	3·7	1·2
" 16	What little seeing there was, was very fair	2·0	3·0
" 30	Steadiness fair in view of two weeks previous broken weather	2·4	3·0
" 31	Reverse of last night; transparency better than steadiness	3·6	2·7
Nov. 2	Cleared at 10 o'clock; seeing improved to 2·30	3·0	2·7
" 4	Transparency seemingly good, but fluctuations of faint stars	3·8	2·4
" 5	Indian Summer day; images very nebulous	3·2	2·2
" 6	Second Indian Summer day; images at times as much as 5″·0	2·4	1·8

PRELIMINARY COMPARISON OF THE PLACES VISITED.

SUMMARY OF THE VISUAL WORK.

Place.	Nights.	Transparency.	Steadiness.
Medicine Hat*	14	3·5	2·3
Banff	6	3·2	1·3
Penticton	18	3·6	3·1
Victoria	14	3·7	3·8
Ottawa	18	3·0	2·4

As stated previously in this publication, the seeing experienced at Banff, under what should have been good conditions, was so poor as to render it unsuitable as a site for a large reflector and consequently it was omitted on the return trip. While the first visit at Medicine Hat was made at a season of broken weather when the best seeing could not be hoped for, yet during the bulk of my second stay the weather was all that could be desired. Hardly a cloud was seen for 6 days and 6 nights, and report stated that such conditions had existed for two or three weeks previous to my coming. The average wind velocity was below the normal, the barometer was fairly steady, and in these settled conditions the best seeing that the place could produce might be looked for. It was very disappointing that the seeing experienced fell away below expectations. From what little seeing had been experienced the first visit, together with other observers' experiences at similar places, particularly in the plateau regions of South America, I had been led to expect much from it in favourable weather, but from whatever cause the poor seeing resulted—and local conditions can not be blamed for it—the place may be rejected as unsuitable.

Before treating of Penticton and Victoria—both of which have points in their favour—and comparing them with Ottawa, the statement should be made that in the writer's opinion the figures given in the above table for Ottawa seeing are lower than they should be, for the reason that much poorer conditions than the average existed during my work here. For the

*Most weight given to second visit; few nights on first visit would be classed as workable.

past 5 years we have kept a record of the seeing experienced while making spectrograms, rating it on the customary scale of 5 for the best seeing. The observers were Plaskett, Parker, Cannon and the writer. The three last mentioned, by whom the bulk of the rating was done, agreed fairly closely in the number assigned the seeing,—there being ample opportunity to compare estimates. Dr. Plaskett usually rated lower: his standard was naturally higher owing to his having experienced better seeing while visiting other observatories. The following table will give the average value assigned the nights on which the spectrograph was in use, for the years 1909 to 1913 inclusive.

OTTAWA SEEING (RECORD OF SPECTROGRAMS).

July	50 nights	3·5	
Aug.	49 "	3·5	
Sept.	63 "	3·6	Average = 3·46.
Oct.	55 "	3·4	
Nov.	27 "	3·3	

Now, to bring these estimates into conformity with the writer's ratings for this special work, they would have to be lowered by about 25 per cent., for my standard of what constitutes perfect seeing has, during my visits to Penticton, Victoria and mount Hamilton, been correspondingly raised. Thus we may put down Ottawa seeing as averaging 2·6. The transparency may be denoted by 3·3 and steadiness 2·6. These numbers are better indices of the seeing here than those in the above table. They may be high or they may be low, but what is vital they represent Ottawa seeing according to the present standard of the writer, by whom of course the comparisons at the other places were made. The three places then still under consideration would rate as follows:—

RELATIVE SEEING VALUES.

Place.	Transparency.	Steadiness.
Penticton	3·6	3·1
Victoria	3·7	3·8
Ottawa	3·3	2·6

Photographic Tests.—Mention has been made of the photographic work. Twenty plates were made at Penticton and fifteen at Victoria of the selected star fields and developed under uniform conditions after my return to Ottawa. While the plates in general bore out the relative ratings for steadiness—the Victoria plates showing trails much sharper than those at Penticton—yet, owing to possible slight changes in focus, too much dependence ought not to be placed upon them when considering this factor. In comparing the intensities of the trails on the plates other members of the staff were kind enough to give their estimates so as to check my own.

The result of this photographic work shows that Penticton excels Victoria in transparency about 20 per cent. Now, as it happens, the visual rating for the two places is about the same. But there is no doubt about the superiority of Penticton over Victoria in the matter of transparency. One could almost say as much from knowing the altitudes above sea-level: Penticton, first visit, 1630 feet, second visit, 2730 feet; Victoria about 200 feet. From general unaided eye observations I had judged that Penticton was superior in this regard and the photographic plates indicate such to be the case. The explanation of my apparently high rating for Victoria in this regard is the following: Two things were taken into account in assigning a number to represent the transparency; (1) the general appearance of the sky and the faint objects reached with the naked eye; (2) the ease with which faint objects could be picked up with the telescope. Now in regard to (2) Victoria excelled Penticton considerably. The theoretical limiting magnitude for the telescope lies between 12·0 and 12·5. Stars of 11·5 magnitude could be picked up and persisted more or less in vision almost every night at Victoria, while such was not possible at Penticton on more than half the nights. Now the reason for this is no doubt the greater steadiness experienced at the former place. The light from the faint objects was concentrated into small compass making a distinct impression on the eye, which could not be the case where the image was not perfectly defined and steady. Transparency, in so far as faint objects to be reached is concerned, cannot be dissociated from steadiness.

The conclusion that seems to be warranted from a consideration of both visual and photographic work is that whereas Penticton excels Victoria in transparency, yet where steadiness is concerned Victoria is vastly superior to Penticton. The ratings of 3·6 for Penticton and 3·4 for Victoria in the matter of transparency would not be far astray.

Clear Sky.—As no specific data regarding the amount of clear sky at Penticton were available, arrangements were made for a resident of that place to photograph the northern heavens each night by simply directing a camera to the pole star and allowing the stars to trail across the sensitive film. For comparison a similar arrangement was effected at Medicine Hat. For obvious reasons these latter films have not been fully worked up. Between March 19 and October 7, 204 records had come in from Penticton and of these 177 have been considered. Comparison with the record of September 19, which was my best night at that place, has been made and the result shows that the nights averaged at least 46 per cent. as good as that night. At Summerland, about five or six miles distant, a sunshine recorder has been in operation for a few years and from it the percentage of bright sunshine is 45. We may thus assume that the percentage of clear sky at Penticton is in the neighbourhood of 46. There is the additional suggestion in these figures that the day and night amounts of clear sky are interchangeable.

Wind.—No records for wind at Penticton were available. Considerable wind movement was experienced during my stay, the prevailing winds being north and south between Okanagan lake and lake Skaha. Some idea of the average wind velocity may be gained from a comparison of the anemometer records during my stay at each place. At Medicine Hat the instrument was fully exposed to the wind, while at Penticton and Victoria it was sheltered to some extent by trees, slightly less so at the latter place.

Medicine Hat	11·2	miles per hour.
Penticton	4·6	" "
Victoria	5·7	" "

From my short stay at each place the best I could say would be that the wind velocity at Penticton would be similar to that at Victoria, which in exposed places is about 8 miles per hour.

Temperature Range.—As a further aid in arriving at the relative values of the places the temperature gradients will be given here. In the table at the beginning, the average diurnal range was given, but what is of more specific importance is the range in temperature during the time the reflector is in actual operation, because at other times protection can be given it. The range in temperature between sundown and the time of minimum value during the night, usually just before sunrise, was noted from the thermograph sheets. The clear nights only were considered, the range being greater in general on clear than on cloudy nights. The figures for Ottawa are for all the clear nights during the four months' work.

MEAN NIGHT RANGE.

	°		°
Banff	9·2 C	Victoria	3·8 C
Medicine Hat	7·5 C	Ottawa	7·6 C
Penticton	7·2 C		

Victoria's superiority in this regard is very pronounced.

Summary.—Considering the two most favourable places outside of Ottawa, the data bearing directly upon the question of a site may be crystallized into the following table:—

Place.	Wind.	Clear Sky.	Range of Night Temperature.	Transparency.	Steadiness.
		Per cent.	°		
Penticton	Approximately 7 or 8 miles per hour	46 ±	7·2 C	3·6	3·1
Victoria	" "	37	3·8 C	3·4	3·8
Ottawa	" "	42	7·6 C	3·3	2·6

The main columns in the above table are the amount of clear sky, transparency, range of night temperature and steadiness. I am not prepared

to say what the relative importance of these factors is, but I think it will be admitted that the last mentioned—the steadiness— is by far the most important, and in this regard Victoria leads, being about 50 per cent. superior to Ottawa. In conversation with different astronomers during the summer, at the Lick Observatory and at the Yerkes, the emphasis in making a selection of a site for a large reflector was laid upon (1) the steadiness and (2) a low range in temperature. The consensus of opinion seemed to be that these qualifications were of paramount importance, "Better far to work one night with good seeing than two with seeing only fair."

As regards the amount of clear sky there is no marked difference. What advantage there is lies with Penticton, with Ottawa second.

Preference should again be given Victoria when the temperature range is considered. Those who have experienced the changes produced in reflectors by rapid changes in temperature would heartily favour the place where low range is to be found, and Victoria's range is only half that of Ottawa's.

Thus of the two places, Penticton and Victoria, the latter is the more desirable if removal from Ottawa be decided upon. As the observations at Victoria extended over the month of August, which is probably one of the best months of the year, it was felt advisable before deciding such an important question to make further investigation at Victoria and see what conditions were like there at other seasons of the year.

WINTER VISIT TO VICTORIA.

With the object then of ascertaining the seeing conditions at Victoria during the winter months, as referred to above, I made a second visit there, arriving on November 28.

In addition to the continuation of specific tests, general local conditions which might have a bearing upon the question were to be considered. The percentage of clear nights at this season of the year is very small and my stay extended over four weeks before I felt that sufficient data had been secured. I left Christmas Day and arrived in Ottawa on December 30.

During this stay at Victoria I worked on 14 nights or parts of nights, though on many of these only a few hours' seeing could be had. Other nights I had made ready to work but did not get sufficient seeing to be worth recording. Out of these 14 nights it is doubtful if more than six could be called workable; the rest were so broken that were we on regular work with a telescope we would probably discontinue work unless something especially was desired.

December 1.—Images jumping somewhat but fair definition. Diffraction pattern nicely formed. Transparency about 3·0, steadiness about 3·0.

December 2.—Transparency not quite the equal of last night, but the steadiness somewhat better. Some jumping of images still, but not over $\frac{1}{2}''$. The definition slightly better also. Rated steadiness 3·2.

December 7.—Just few open spaces and worked on bright stars. Diffraction pattern nicely formed. Worst feature was the short quick jumps of image amounting to $\frac{3}{4}''$. Rated seeing at 3·0.

December 8.—The stars were fluctuating in brightness considerably and transparency not over 2·8. Seeing improved from sundown to 8 p.m. and then remained about constant. Doubles of $1''·5$ were noted easily. A marked feature was the rapid decrease in the quality of the seeing with decreasing altitudes. Never so marked before. The seeing averaged 2·5.

December 9.—First glimpse at sundown was rated 4. This lasted for 15 minutes then the seeing decreased in quality rapidly and by 7 p.m. was not over 1. The images became nebulous first and then lateral displacements crept in. Temperature began to rise about this time. The few hours' observing not worth over 1·3.

December 12.—Just a few openings in sky and seeing not over 1·0.

December 13.—Five hours partly clear and the seeing varied from 1·2 to 2·5. Averaged up would be worth about 1·5.

December 15.—Less than one hour's seeing but it was very fair. Star discs about 1·3 diameter. The definition fair but short quick jumps again a feature. Rated as 2·4.

December 17.—Uncertain in evening as to whether it would be clear or not. The seeing surprisingly good. Entered in my notes as "a night that got lost in the summer and strayed in now," as the quality of the seeing was so good. Two examples may be given: Star 1952 of Burnham's catalogue, a double, magnitudes 5·2 and 6·1, 1″·0 apart, at altitudes 45° had components separated and discs just touching each other. Stars 2712 (η Orionis) magnitudes 4 and 5, separation 1″·0 also, at altitude 33° though jumping had components separated also and discs just touching, power 320 easily usuable. Down as low as 15° altitude the diffraction pattern was continuous and seeing better than 3. This is not usually the case for such low altitudes. While sky not perfectly clear yet, the first half of the night was workable. Seeing rated 4·0.

December 18.—No marked criticism could be made of the steadiness for the two hours clear. Lack of definition was the most noticeable feature. Transparency not over 2·5 and very humid. Seeing rated as 3·6.

December 19.—Perfectly clear day and clear night. Early evening floating haze kept extinguishing faint stars like Celæno and Sterope. Later this haze disappeared and the average transparency for the night was given as 3·8. There was considerable shimmering of the diffraction pattern and also short quick jumps of the star disc but the seeing was worth 3·6.

December 20.—Wholly clear all day. Workable first half of night but latter half broken. The seeing best from 5 to 7 o'clock when it averaged 4·0. Later it was worth only 3·4. Averaged up for the 5 hours workable as 3·7.

December 22.—Clouded in afternoon but cleared up in evening. Five hours work, transparency 3·6, steadiness 3·9.

December 23.—Fancy mostly cloudy during the day but all clear on return to city at 6.30 p.m. Night clear till 1.30 a.m. Transparency rated as 3·6 but steadiness poor and not worth over 2·2.

Taking into consideration the 14 nights on which more or less work was done the average seeing was 3·0. As mentioned above, a great many of the nights were so broken that under ordinary circumstances work would be discontinued unless some special observation were required. There were, however, 6 nights which could be said to be workable and they are as follows:—

WORKABLE NIGHTS.

Date.	Transparency.	Steadiness.	Date.	Transparency.	Steadiness.
December 8.....	2·8	2·5	December 20.....	2·6	3·7
" 17.....	2·8	4·0	" 22.....	3·0	3·9
" 19.....	3·8	3·6	" 23.....	3·6	2·2

Average transparency..... 3·1
Average steadiness..... 3·3

These two numbers sum up the result of the visual work.

WORK AT OTTAWA (WINTER).

December 31, 1913.—Returning to Ottawa on the 30th I began working on the night of the 31st. It was clear till 10.45 when it hazed over. While clear the transparency was as good as 3·3 but steadiness very poor and rated 2·0. Temperature −8°F.

January 1, 1914.—Neither transparency nor steadiness were the equal of preceding night. The images were jumping badly. Rated transparency 3·0 and steadiness 1·8. Temperature −9°F.

January 4.—Afternoon clear but clouds hanging around horizon at night and somewhat hazy; night warmer (25°F.) than preceding two nights, and steadiness considerably better. Rated it 2·5 and transparency 3·0.

January 5.—Day mostly clear but considerable haze over sky at night. Thickened over at 10.30. The steadiness was quite variable, ranging from 1·3 to 2·6 but averaged up for the part night as 2·0. Transparency 2·5.

January 10.—Cleared in evening and quite cold (−14°F). The transparency was very good, being rated 3·6, and the steadiness was considerably better than expected. There were short quick jumps of the image and some lack of definition but the seeing was worth 2·8.

January 12.—Clear and cold all day. The seeing was the best here since returning. The lateral displacements were not over $\frac{3}{4}''$. The first four hours rated 3·0 which is the outside limit. Toward midnight it got poorer. Transparency 3·4. Night minimum −30°F.

January 13.—Up to 10.30 there was considerable jumping of image though the nucleus was fairly distinct. It became more diffuse however. Transparency rated as 3·4, steadiness 2·0. Night minimum −31°F.

The mean rating for seeing conditions at Ottawa for these seven nights is 2·3, which is just the same as that for the nights I worked in October and November. As the time of my visit to Victoria in December falls in between these two dates we may compare the seeing conditions at the two places as follows, the rating being on the customary scale of 5:—

	Summer Seeing.	Winter Seeing.
Ottawa	2·6	2·3
Victoria	3·8	3·3

VICTORIA, B.C.

Climate and other Data.

During my stay in December at Victoria, I took the opportunity of looking over the local conditions tending to produce the climate which it enjoys, and a few brief remarks on these conditions may not be out

of place. The city is situated on the southeast point of Vancouver island. Its mean temperature varies from 40° F. in winter to 60° F. in summer, so that extremes of temperature are not met with. The absence of low temperatures is likely to be welcomed by observers, who often work in temperatures much below zero. The mean yearly precipitation taken over a period of 24 years is 27·8 inches. Some winters there is a fall of snow of a foot or so but it quickly disappears.

The reasons suggested for this low range in temperature and moderate rainfall are the presence of the warm ocean currents—winter temperature 45°F., summer temperature 65°F.—and the fact that Victoria, and a limited area adjoining, is practically surrounded by mountain ranges which extract the moisture from the ocean winds. To the south of the strait of Juan de Fuca rise the majestic Olympians 7,000 to 8,000 feet. The range circles to the east and culminates in mount Baker (11,000 feet). To the north again are snow capped mountains, while to the west extend ranges sufficiently high to cut off the bulk of the precipitation that comes from the ocean winds. The precipitation along the western coast varies in localities from 100 to 140 inches per year, then this relatively dry belt is reached. Crossing the Gulf the winds again become charged with moisture which is precipitated on the mainland, where it amounts to about 70 inches per year.

Wind.—Through the gap to the southwest—the entrance to the strait—come the prevailing winds. Every month in the year this is the prevailing direction, though during the winter a greater proportion than usual comes from a northerly direction. This was especially the case during my winter visit. Whether this abnormality of direction had any effect on the seeing or not I cannot say. The average wind velocity as previously given is 8·3 miles per hour. In a somewhat sheltered position the wind movement, according to my anemometer, averaged 5·5 miles per hour during my stay so that conditions in this regard were about normal.

Temperature.—Considering the clear nights alone during my winter visit to Victoria, the average range in temperature from sundown to the minimum for the night was 3°·8 C. This value is identical with that of

the summer visit. The night range at Ottawa on the clear nights in December, 1913, and on those worked in January, 1914, was 8°·1 C., so that whether summer or winter the range at Ottawa is about double that at Victoria.

As this data was for such a limited number of nights, I was led to examine the thermograph sheets kept at the Meteorological Office, Victoria, and those at our own observatory. The table shows the range from sundown to the minimum for the night for two years sufficiently typical of the two places in regard to sunshine to make the comparison fair.

RANGE IN NIGHT TEMPERATURE.

—	Ottawa, 1911.	Victoria, 1906.	—	Ottawa, 1911.	Victoria, 1906.
	°	°		°	°
January	7·2 C	2·4 C	July	5·3 C	3·9 C
February	6·5	3·9	August	5·9	4·9
March	7·0	4·8	September	6·3	4·0
April	6·6	4·5	October	6·9	3·5
May	6·8	3·8	November	4·7	3·1
June	4·1	3·2	December	4·1	2·8

The means of these are: Ottawa 6°·0 C., Victoria 3°·7 C. Thus when all the nights, regardless of whether they were clear or not, are considered, the range at Ottawa is about 60 per cent. greater than the range at Victoria. Just which of these two relative values is best to take may be a matter of opinion. It might be thought that more weight should be given to the greater number of observations, but on the other hand as we cannot tell just how the range varies from cloudy to clear nights and the latter only are concerned, it may be best to adhere to the figures obtained for the nights which were known to be clear. One thing struck me forcibly in looking over the Victoria thermograms and that was the rapid drop in temperature just at sundown. It was much more marked on the Victoria than on the Ottawa sheets. Now as the observational work does not strictly start at sundown, though it is considered advisable to open up

about that time, the range during the working hours at Victoria would be reduced in a greater proportion than at Ottawa. I think we may with safety conclude that the range during the working hours of clear nights is at least 75 per cent. greater at Ottawa than at Victoria.

The altitudes above sea level of Ottawa and the observing station at Victoria are 278 and 230 feet respectively. If a site of greater elevation were taken it would probably be found that the range in temperature would be lessened. In the selection of a site for the D. O. Mills' expedition to the southern hemisphere some evidence was obtained bearing on this question. The site selected was about 1,000 feet above the National Observatory and quoting from the report* "The ratio of the range in temperature during the night on the hill to that of the lower country is about 1 to 3 in summer, and less in winter." There are in the vicinity of Victoria, elevations of from 700 to 1000 feet, well wooded,—which is important—so that if one of these were chosen the range of 3°·8 C. would probably be lessened, though it could hardly be hoped to reduce it in such a marked degree as in the case at Santiago.

In the general table of meteorological data at the beginning of this publication, the amount of clear sky was put down as Ottawa 42 per cent., Victoria 37 per cent. Since then, through the kindness of the director of the Meteorological Service, Mr. R. F. Stupart, to whom we are indebted for much valuable information, I have secured the data from sunshine recorders at each place. The data for Ottawa is for the years 1898 to 1912 inclusive, that for Victoria covers the years 1899 to 1912 inclusive.

PERCENTAGE OF BRIGHT SUNSHINE.

—	Ottawa.	Victoria.	—	Ottawa.	Victoria.
	%	%		%	%
January	31	19	July	54	61
February	38	30	August	54	57
March	41	39	September	44	50
April	45	46	October	40	34
May	47	43	November	28	20
June	51	46	December	33	15

*Publications Lick Observatory, vol. IX, page 19.

The mean percentages, Ottawa 44, Victoria 41, are in good agreement with the eye estimates mentioned above. These numbers require some explanation. They represent the percentage of *bright* sunshine only, and consequently the amount of clear sky is greater than indicated by these numbers. As there is no information available, I can not state just what altitude the sun has to be before its rays are strong enough to burn the paper, but it has to be considerable, especially if the horizon is hazy, and hence the numbers fall short of the actual clear sky. These positive corrections should be applied to every month in the year, though they should be largest in the winter months when the sun's altitude is always low. The corrections added to both would not change the relative amounts of clear sky at the two places. Local conditions however do affect the records. The recorder at Ottawa is situated at the Experimental Farm about three miles from the centre of the city, while that at Victoria is on the top of the Post Office block in the heart of the city, where volumes of smoke from the soft coal used are pouring out in winter and thus cutting off the strength of the sun's rays. I have in mind a particular instance which I shall give, though probably it is an extreme case. Intending to examine the recorder one day about the middle of December I kept note of the condition of the sky before going to see it. The sun had been up two hours and a half, and though the horizon was thick I should have classed the sky as 90 per cent. clear. The record showed 20 minutes bright sunshine. The effect on the record of the smoke from neighbouring chimneys and a hazy horizon was impressed upon me upon that occasion. This was probably, as I have said, an extreme case, but it goes to show that when the two places are compared in regard to amount of clear sky a special allowance in the case of Victoria should be made.

I have thought well to consider these percentages further. It will be noticed that the percentages for Victoria during the winter are lower than those for Ottawa. Part of this, though by no means all, can be ascribed to Victoria's higher latitude taken in connection with local conditions previously referred to. I have taken the average time interval from sunset to sunrise, less one hour, for each month in connection with the percentages

given above and I find a weighted mean amount of observational time for Ottawa as 40 per cent., Victoria 35 per cent. These figures would be better indices than those previously given if we could free them from the errors caused by the circumstances mentioned. There should be a positive correction applied to each; it should be greater for Victoria than Ottawa; but any correction that I might suggest would be more in the nature of a guess than otherwise, so I shall refrain from changing them.

Precipitation. — The precipitation at Victoria is confined principally to the winter months, there being less than 3 inches altogether during the four summer months. The following figures are based on 32 years' records:—

PRECIPITATION AT VICTORIA.

January	4·3 inches	July	0·4 inches
February	3·2 "	August	0·6 "
March	2·5 "	September	1·6 "
April	1·5 "	October	2·5 "
May	1·0 "	November	4·4 "
June	0·8 "	December	5·1 "

If curves for the precipitation and cloudiness were plotted they would, using a suitable scale, coincide completely excepting for the months of April, May and June, when the cloudiness is considerably in excess of that suggested by the precipitation. The total precipitation at Ottawa is about 5 inches greater per year than at Victoria.

Humidity.—Though we speak of the vicinity of Victoria as a relatively dry belt, yet intense humidity is a marked feature. The summer months are slightly less so in this respect than the winter but only slightly. A summary of the hygrographic sheets* from June to November inclusive shows that the humidity is least about 2 o'clock in the afternoon, when it is 68, that it rises gradually to 94 about 2 o'clock in the morning and continues thus until about 6 a.m. when it falls somewhat more rapidly than it rose to 70 about noon. Were this district selected, it would be necessary to adopt some scheme to prevent the mirror from being affected, but this should not prove difficult.

*This hygrograph was 200 feet from ocean and 20 feet above its level.

Some mention has been made earlier in this publication of the scarcity of suitable sites close to the city, as the prevailing southwest winds carry the smoke over the elevations to the north and east of the city. It was felt that possibly in the Highland district about 10 to 15 miles northwest of the city, where there are elevations of 1,200 to 1,500 feet, that a site could be had free not only from the present city's smoke but from any ill effects of the future development of the city, particularly in the Esquimalt district. The only doubt in my mind was as to whether climatic conditions were similar there. No weather stations were there, hence no data were available from the Meteorological Bureau. However, the city six years ago thought of tapping this district for a water supply and records were taken of the precipitation at three places in the district. Mr. Reed, the meteorological agent, secured these for me. For 7 months the precipitation totalled 44 inches and the yearly precipitation would probably be in the neighbourhood of 60 inches. West of here in the mountains proper the precipitation increases markedly, so it is probable that the precipitation diminishes rapidly as we come from the west to the eastern edge of the Highland district. Quite frequently during my winter stay I had noticed it raining over the whole western range and Highland district while the sun was shining at Victoria, and I could not but feel that the precipitation and corresponding cloudiness would be such as to render inadvisable selecting a site anywhere in the Highland district west of meridian 123° 27′. This restricted the suitable area to the immediate vicinity of Victoria and the Saanich peninsula. The general climatic conditions of this peninsula are similar to that of Victoria. Furthermore, as intimated previously, there are in this Saanich district elevations from 700 to 1,000 feet free from the city's smoke and lights, and suitable for an observatory.

Fogs.—When Victoria was suggested I had the impression that fog might prove a drawback, and in compiling the data from the meteorological reports I kept glancing at the column of days on which there was fog. As there was nothing to alarm one, no note was made of it. I do not think that there is any cause for uneasiness on this score now, but a word on the subject may be in order. From the reports, there are on the average about 10 days

a year on which fog occurs. For Ottawa the average is given as 6. At Victoria these fogs may be expected from September to February inclusive, the greatest number occurring in the months of September and October. If there were any data giving the height to which they extend it would be valuable but there is none such. This can be said though, that I was never bothered with fogs any night during either visit. I have watched them in the day time on several occasions from various points,—mount Douglas (725 ft.), mount Newton (1,000 ft.), mount Wark (1,420 ft.), mount Malahat (2,000 ft.), and others — and my opinion is that they only rarely exceed 300 to 500 feet. There are times when they do exceed 1,000 feet but these are rare and are in cloudy weather, when no observing could be done anyway. No objection to the place can be taken because of fogs.

The question of earthquakes was considered also but no alarm was felt on that score.

GENERAL SUMMARY.

1. From the meteorological reports a number of localities in western Canada, deemed most promising as a site for the proposed 72-inch reflecting telescope, were selected where special tests of the seeing conditions were to be made and compared with conditions at Ottawa.

2. Observations were carried on from June to October, visits being made going and coming.

3. Of the places outside of Ottawa, Victoria showed up the best in regard to the conditions desired and it alone had to be considered if removal from Ottawa were contemplated.

4. A return visit to Victoria in December was made to ascertain the conditions during the early winter which is naturally the poorest season.

5. The number of clear nights at Victoria and Ottawa is about the same, the latter having any advantage there is. The transparency of the sky is in general the same. Suitable selection of site at Victoria would make that

place slightly better in this regard. The wind velocity at the two places is practically the same. The two most important items in the case of a large reflector are the low range in night temperature and the seeing conditions, *i.e.*, steadiness of image, sharpness of definition, etc. The range of temperature on working nights at Ottawa is at least 75 per cent. greater than at Victoria. The summer seeing conditions at Victoria are 50 per cent. better than at Ottawa, in winter they are 43 per cent. better.

6. The limited duration of the tests made one hesitate to pronounce authoritatively on the relative merits of the two places, but in view of the decided advantages which Victoria possesses in regard to low range of temperature and steady conditions—factors without which a large reflector would be next to useless—it could hardly be gainsaid that the extra cost and inconvenience ought to be overlooked and the telescope located at Victoria.

ADDENDA.

TRIP TO LICK OBSERVATORY.

It was deemed expedient to make some comparisons with the seeing on mount Hamilton, California, where is located the great 36-inch refractor of the Lick Observatory. Accordingly I left Victoria on Aug. 13, arriving at mount Hamilton at noon of Aug. 16, and remained until noon of Aug. 20 when I returned to Victoria.

The nearest point of railroad connection with mount Hamilton is San Jose, 50 miles south of San Francisco. Mount Hamilton, by the highway, is 26 miles from San Jose, nearly east, and is reached by auto-stage over a fairly good road constructed by the Santa Clara county. The country is rolling in character and mount Hamilton is the climax of a succession of rising slopes. Its altitude is 4,209 feet. This place was selected as the site for the telescope after investigations of the seeing conditions on the site had been carried on in 1879 by Mr. S. W. Burnham, now connected with the Yerkes Observatory. It enjoys the reputation of being one of the most suitable sites in the world for stellar research. The weather, during

the entire summer and well on into the winter, is practically unbroken and the observers count upon a succession of clear nights during that time. Less dependence is placed upon the winter season, which is however short.

While there I looked over their weather records, which at that time had not been published; part of the data is here summarized and may be of interest. The data given are the means for the $12\frac{1}{2}$ years from July 1st, 1888, to Dec. 31st, 1900.

Maximum temperature	74°·2 F.
Minimum temperature	32°·2 F.
Daily range	12°·7 F.
Temperature	52°·1
Humidity	61·3 per cent.
Total precipitation yearly	29·9 inches
Wind velocity	12·9 miles per hour.
Clear days	214 per year.

The following additional items are of interest:

Highest barometer	26·269 inches.
Lowest barometer	25·055 inches.
Highest temperature	94° F.
Lowest temperature	13° F.
Greatest rainfall in 24 hours	4·36 inches.
Lowest humidity	1 per cent.
Highest wind velocity recorded	80 miles per hour.

In connection with the daily range in temperature, which is extremely low, it must further be stated that the range during the observing hours of the night is very low indeed. There is a sharp drop in the temperature in the early hours of the evening and then it remains almost constant for the rest of the night, not over 2° or 3° difference in temperature being the rule. This is most favourable and accounts in some measure for the uniform seeing throughout the night which is experienced on mount Hamilton.

The director, Dr. Campbell, was absent in Europe but Mr. R. H. Tucker, the acting director, and in fact every member of the staff did

everything possible to make the four days which I spent as their guest both pleasant and profitable. Somewhat unusual unsteadiness prevailed on the four nights I spent there. The summer had been quite out of the ordinary as the number of nights of good seeing had been much more limited than all past records showed. The first night, Saturday, after the visitors were dismissed, I spent with Dr. Aitken with the 36-inch. I had previously noted conditions with the 12-inch. The seeing was very unsteady. The evening was very cold for August and the fog, which had all evening been lying in the valley, rose and covered the mountain putting an end to all work. On Sunday the weather became warmer and it was hoped that the steadiness would thereby be improved, but though some improvement was noted it was far from perfect, not being over 2 on a scale of 5. On Monday evening conditions were again noted with the 12-inch both before and after midnight, but on the scale of 5 for perfect seeing, 2·5 would be the maximum assignable. The humidity ran from 45 per cent. to 35 per cent. during the interval examined. The appearance of the star image in the 36-inch, to which the spectroscope was attached, confirmed my estimate of 2·5. On Tuesday night I used the 12-inch for a short time and afterwards, with Dr. Aitken, the 36-inch and 6-inch finder. The latter is comparable to the Cooke telescope I used at the selected sites. Thus a comparison of the same seeing using different apertures was possible and this was extremely helpful. Several doubles were examined and though separations as low as $0''\cdot25$ are measurable with the 36-inch on good nights, nothing under six times that distance could that night be measured. The night was not better than 2.

Naturally it was disappointing to the members of the staff of the Lick Observatory, as well as to myself, that such unusually poor seeing conditions had been experienced during my stay. Nevertheless, from a comparison of our estimates of the quality of the seeing on various occasions, I think that our conceptions of what constitutes perfect seeing are probably about the same, and, that being so, I believe we have sites in Canada where seeing conditions, in so far as steadiness is concerned, are as good as those enjoyed by the observers on mount Hamilton.

There is one characteristic of the seeing on mount Hamilton which impressed me very much and that is the transparency. I am bound to admit that it is superior to that found at any of the sites tested as well as at Ottawa. I can illustrate by a reference to the well known group of stars, the Pleiades. On good nights at Ottawa nine stars are easily seen by me with the unaided eye, I have occasionally picked up eleven but with considerable straining of the eyes. At the Lick Observatory, when the cluster had about the same altitude, the first glance was sufficient to show the eleven, the two faintest ones standing out quite conspicuously. At one other place, Penticton, the eleven could be seen much more readily than at Ottawa but not nearly so easily as at the Lick Observatory, so as regards this feature of the seeing the sites tested show up somewhat less favourable than mount Hamilton.

Apart from this particular investigation, my visit to mount Hamilton was helpful to me in other respects and I wish here to record my appreciation of the many kindnesses shown me while there.

PHOTOGRAPHS OF NORTHERN SKY AT VICTORIA.

During the occasion of my last visit to Victoria it was arranged to have photographs made of the northern heavens by simply exposing a camera to the sky for a number of hours each night. The work has been very carefully done by Mr. James Pearce, and we thus have records of the night sky from December, 1913, to the end of May, 1915, when the work was discontinued.

For the year 1914, which in the matter of bright sunshine is about normal, an inspection shows the following:—

Number of nights perfectly clear	70
Number of nights clear (less than 20 per cent. clouded)	43
Number of nights partly clear (broken sky)	28
Number of nights perfectly clear at start	21

Probably on all these 162 nights, work would be attempted at least. At Ottawa during the same year, which was away above normal for observing, we started work on 181 nights. Thus while the quality of the seeing at Victoria is much superior to Ottawa, we cannot hope for very much improvement in the quantity.

DOMINION OBSERVATORY,
OTTAWA,
June, 1915.