British Columbia

Indian Reserve Commission

Reports

on

Irrigation

1878

Interior Division

Indian Reserve Commission
Survey Branch

Fort Hope
23rd October 1878

Sir,

I have the honour to submit for the confirmation of the Hon[ble] the Superintendent General of Indian Affairs, the following remarks on the subject of Irrigation as connected with the Indian Reserves, east of the Cascade Mountains in this Province.

In carrying out your instructions on this subject, it was found necessary to endeavour to ascertain how much water is on an average required per acre of cultivable land, and how much is unavoidably wasted, with the ultimate vision of teaching the Indians its most economical use a section of country where thousands of acres may be profitably cultivated, provided that the natural water supply be utilized to its utmost extent.

Irrigation abroad

In connection with this question it may be well to consider the quantities estimated to be necessary in various parts of the world where irrigation on an extensive scale is carried out and Mr Burnell gives the following results which shew how widely difficult are the quantities required for different soils and different crops.

G. M. Sproat, Esq.
[illegible word] Indian Reserve Commissioner

[illegible]	932 cubic feet per acre per day.
[illegible]	622 --- “ --- “ --- --- “ --- --- “ ---
[illegible]	244 --- “ --- “ --- --- “ --- --- “ ---
[illegible]	205 --- “ --- “ --- --- “ --- --- “ ---
East [illegible]	405 --- “ --- “ --- --- “ --- --- “ ---
South of [illegible]	1200 --- “ --- “ --- --- “ --- --- “ ---

The first and last of these quantities Mr Burnell considers excessive.

He also states that the successful cultivation of rice is estimated to demand a supply equivalent to 1440 cubic feet per acre per day.

But as rice is an essentially aquatic plant and requires to be constantly immersed in water during its growth, while it cannot be cultivated with success north of the 46th parallel it will hardly be argued that as large a supply of water is needed for grain crops in British Columbia.

In California where irrigation under somewhat similar conditions of climate and soil, to those which [illegible word] in this Province, has proved most successful, it is stated that it is customary among the Ditch Companies to charge the farmer for one cubic foot per second for each one hundred and sixty acres under cultivation, equivalent to 540 cubic feet per acre per day, throughout the year, on 59 inches of rainfall per [illegible], of which amount it is estimated that not more in all probability than one third is actually absorbed.

The managing director of a company engaged in extensive irrigating operations in California kindly writes me. In the San Joaquin Valley at the beginning of the farming season

a furrow is turned up all round the tract, thus forming a check and the water is turned on until the land is so thoroughly saturated that it will absorb no more. That with the few inches of rain that fall in the spring is often enough to mature a crop of wheat, barley [illegible word]. If not, then as the heads begin to fill out, that is six weeks or two months before maturity, the necessary amount of Irrigation has to be applied.

It may be also remarked that there is no special irrigation season in that State, the climate permitting the irrigation of grass lands at any point of the year.

In California, the extensive tracts of land which can be cultivated by the aid of irrigation encourage the construction by joint stock companies of irrigation canals, on too large a scale and of too expensive a character to be undertaken by individuals. Among these canals may be mentioned. 1. The Rhodes ditch length ten miles, cost about $10,000. 2. Lowes Ring's River ditch, length thirteen miles, cost about $28,000,--3. Last Chance ditch length about twenty miles cost about $60,000. 4. Mussel Slough ditch length about sixty miles, cost estimated at $60,000.--5. The Peoples ditch length about forty five miles, cost about $100,000,-- 6. Settlers ditch length about twenty miles, cost about $50,000,--7. Lakeside ditch length about thirty miles cost about $50,000.

In California in addition to the supply obtained from lakes and streams, artesian wells have in many places been bored during the last year or two, and with satisfactory results. The average cost appears to be about $4.25 per foot to a depth not exceeding two hundred feet, and it is believed that

[illegible words] have been sunk to a greater depth.

Soil Irrigating Districts B.C.

In the region east of the Cascade Mountains, the sail of the benches and terraces and irregular slopes of some of the valleys, which once probably were the bed of a great lake, is extremely fertile when irrigated, and has been described as composed of modified or redistributed drift, modern [illegible word], [illegible words] chiefly the product of the disintegration and re-arrangement of the boulder clay, though mixed also with the detritus from [illegible] rocks since the glacial period, which has been carried down by rivers when flowing at a higher level, as they seem here to have flowed in the past. (See Geological Survey of Canada Report.)

The subsoil is generally of a gravelly character, and is so porous that it is not a very uncommon event to find what are known in California as sinks, where a good rigid stream will suddenly disappear, and perhaps break out again after a subterranean passage of two or three inches.

In places however there is a subsoil of stiff clay, and it is on such land that water can be most economically used.

Elevation of Cultivable Lands.

From such information as I have been able to acquire, it may I think be laid down as a general rule that land at a much greater altitude than two thousand feet above the sea is unfit for cultivation owning to the prevalence of excessive frosts. There are however exceptions to this

rule, and the Pavillion Mountain may be cited as a notable one, where owing to local conditions, cultivation has been and may be to some extent successful.

Irrigation Essential

It must be understood that Irrigation is essential to cultivation in nearly all places throughout this section of the country, and that hither no authentic information has been placed on record as to the quantities of water required for different sails and different crops.

To obtain this information numerous enquiries were made of the settlers as to the amount of water estimated to be necessary per area, but from the fact that, as a rule, the main conductors had neither been constructed to carry any particular quantity, nor measured with accuracy, enquiry failed to furnish the details required upon which to found a general estimate.

Under these circumstances, the plan was adopted of measuring the contents of the ditch, and then obtaining from the proprietor an estimate of the number of acres such an amount of water would in his opinion irrigate.

In this Province it is considered necessary to irrigate from three to four times at intervals of from twenty to thirty days, during the irrigation season commencing about April.

Sources of Supply

The main streams of the Fraser and Thompson Rivers, lie too far below the fertile benches in their valleys to permit of any idea being

entertained of procuring supplies from their boundless resources, at all events at present.

The main supplies for irrigation are found from the smaller mountain streams, which generally attain their greatest volume in May, the month in the commencement of which the largest quantity is required. They however fall very rapidly in the two succeeding months and in some seasons there is in many places a scarcity towards the latter and of the period during which irrigation is carried on.

When it is practicable to select from different sources of supply, which is rarely the case in British Columbia, the broad rule is that the water which has been longest exposed to the air is the best for irrigation purposes; and it is on this ground, that particularly where the sources of supply consists of springs, or short [illegible word] streams, it is considered advisable to construct the main conductors wide and shallow; and it may be remarked in this connection, that although this form of ditch offers a far larger area of surface subject to evaporation than a deep and narrow one, it on the other had by considerably reducing the lateral pressure, also diminishes to an appreciable extent the risk of breaking the banks.

It must not however be assumed that in all instances the water can be utilized during the whole of the twenty four hours continuously Water from lakes and large streams can usually be permitted to run without cessation, but in some cases, where the supply is derived from cold springs, and short [illegible word] streams, it is found necessary, in the absence of reservoirs, or where the main [illegible word] are not of sufficient length to allow of

its temperature being raised by exposure to the air, to shut it off during the night; and of course in such cases a proportionately larger quantity will be required during the day. Where however the main conductor is of considerable length, it is believed that the water will in its passage be sufficiently raised in temperature to avoid ill effects.

I am not aware of the opinion of the gentleman in charge of the Geological Survey in this Province as to the practicability of obtaining a supply from artesian wells. In any case I would respectfully submit that the time has not arrived for its trial, at least as far as the Indian Department is concerned, and for the reason that the construction of ditches can be accomplished by the Indians themselves with but a small outlay while the construction of artesian wells would require the purchase of expensive plant, involving heavy freight charges, and necessitate the employment of skilled labor.

It must not be assumed from the foregoing that the portion of British Columbia now under consideration is badly watered for purposes other than those of irrigation. On the contrary the whole surface of the country is dotted with lakes, and traversed by streams varying in size from the Fraser to the tiniest [illegible word], though sometimes from these positions, and sometimes from the large outlay which would be incurred in utilizing their waters, they are practically excluded from being classed, in most cases, among the available sources of supply for irrigation.

Systems of irrigations

With regard to irrigation as practiced in

[illegible words] may be remarked, that it
[illegible words] practicable, in all instances.
[illegible words] to the high rate of wages, to properly
[illegible words] the surface of the land to be irrigated for
[illegible words] of the water, and it is apparent that
[illegible words] such preparation made a much smaller
quantity of water, than is now in such cases used,
would be required as we more nearly approached to
its most economical distribution.

In this Province neither the bed
work nor catchwater systems of irrigation appear to
have been adopted in their integrity, but rather
what may perhaps be best described as a
combination of the two.

In the former system it is usual
in Europe for the feeders to [illegible word] the [illegible word]
and to shed their water by gravity over the sides
of the edges. This formation is only applicable to
grass crops, and is not adapted for the
cultivation of cereals and roots, with the exception
of rice. For cereals and roots, the feeders must
be in the furrows between the ridges; and of
course the upper portions of the ridges are only
reached by the water, through the action of
capillary attraction, a much less efficacious process
as far as the economical consumption of the water
is concerned.

In the case of canals irrigated by
overflow, the roads would be in danger of being
[illegible word] of their covering of soil which, as already
has been stated, is in that portion of British
Columbia now under consideration, of a remarkably
light character, while grass would not incur the
[illegible word] risk, the surface soil being an efficient
[illegible word] to this soil.

It has been remarked very frequently, in [illegible word] the method of irrigating here, that the [illegible word] or collecting ditches, have been cut with a fall instead of level, and in consequence the water is [illegible word] off from the higher ground which remains comparatively dry, while the lower receives an undue quantity.

The Miner's Inch.

It has been customary in British Columbia to record for irrigation purposes one miners inch per cultivable acre. The following extract from the Rules and Regulations, Gold Fields Act, 1859 gives the rule for its measurement.

"The water taken into a ditch shall be"
"measured at the ditch head. No water shall be taken"
"into a ditch except in a trough, whose top and floor"
"shall be horizontal planes, and sides parallel vertical"
"planes; such trough to be continued for six times its"
"breadth in a horizontal direction from the point at"
"which the water enters the trough. The top of the trough"
"to be not more than seven inches, and the bottom of"
"the trough to be not more than seventeen inches below"
"the surface of the water in the reservoir, all measurements"
"being taken inside the trough and in the low water"
"or dry season. The area of a vertical transverse"
"section of the trough shall be considered as the measure"
"of the quantity of water taken by the ditch."

"The Ordinance to amend the Laws relating to Gold Mining, 2nd April, 1867." Clause 133, states

"In measuring water^in any ditch or sluice the following rules shall be observed. The water taken into a ditch shall be measured at the ditch head with a pressure of seven inches. No water shall be taken into a ditch except in a trough placed horizontally at the

[Citation Note]
RG 10, Vol. 3663, File 6425-3,
Reel C-10111

“plane at which the water enters it, the aperture
“through which the water passes shall not be more
“than ten inches high.”

In California a miner’s inch represents the quantity of water which will pass through an orifice one inch square with a constant head of six inches.

In the Californian measure adopting the formula, $Q = \sqrt{gh} \times a \times 0.6$, where Q = cubic feet discharged per second, --2g = 64.3 the effect of gravity, h = the head above the water of the orifice in feet, and a = the area in square feet, we obtain $Q = \sqrt{64.3} \times 0.542 \times 0.0069 \times 0.6$, thus Q=0.02444. And one miners inch is equivalent to $0.02444 \times 60 \times 60 \times 24$ per day at 2,112 cubic feet per day of twenty four hours.

The same formula gives 2,868 cubic feet per day of twenty four hours with a head of seven inches and an aperture of ten inches in depth as the British Columbian inch.

Rainfall

The following Table of the results of observations in several Districts of British Columbia shews that rainfall during what may be termed the irrigation months of April, May, June, and July, 1877 in inches.

Irrigating Districts					
Plan	April	May	June	July	Total
Spence's Bridge	0.38	1.41	0.75	1.25	3.77
Cache Creek	1.03	1.10	1.35	1.22	4.70
Kamloops	0.78	1.42	1.67	0.59	4.46
Okanagan	0.11	1.75	2.15	1.42	5.54
Non Irrigating Districts					
Plan	April	May	June	July	Total
Spallumcheen	1.38	1.84.	1.65	1.82	6.69
Hope	1.71	1.84	2.20	1.38	7.13
New Westminster	1.55	1.62	2.65	1.03	6.85

The above Table shews an average in the Irrigating Districts of 137, and in the Non Irrigating Districts of 205 cubic feet per acre per [illegible word], or half as much again in the latter case as in the former.

It should however be mentioned that the year 1877 was exceptional as regards the unusual quantity of rain which fell in the interior of British Columbia.

During the month of May 1878, at Kamloops the rainfall was 1.85 inches, equivalent to 216 cubic feet per acre per day. And it appeared to be the general opinion that with a similar rainfall during the season, irrigation might, at all events to a very great extent, be dispensed with.

It must be remembered however that as art cannot compete with nature in the [illegible word] distribution of water, a far larger quantity is required for artificial irrigation than would constitute an

abundant rainfall of which every drop would perform its destined function.

In the [illegible word] connection it may be observed that the rainfall which would abundantly water the more retentive soils of the non irrigating districts would probably prove an inadequate supply for the porous soils for which irrigation is principally required.

In the districts requiring irrigation, a considerable proportion of the rainfall is the result of sudden and heavy storms, the effect of which is sometimes more injurious than beneficial. A notable instance of this occurred on the 20th July of the present year, when a sudden storm burst on the Bonaparte Valley and washed over several acres of cultivated land a sufficient quantity of gravel to completely bury and destroy the crop. It is obvious that the results of such a storm will be to largely increase the registered rainfalls, though the effects are simply disastrous.

In the non irrigating districts storms of this description are rare; the rain falling more frequently and less violently and with a corresponding increase of beneficial effect.

In order to bring out more clearly a comparison between the enormous amount of water supposed to be required for irrigation and that which would form an abundant rainfall, let us assume that we have one hundred acres of land to be irrigated with one hundred inches (BC measure) of water at the ditch head, that the loss in transit by leakage and evaporation amounts to fifty per [illegible word], that the season is a dry one, and that the land [illegible word] to be irrigated four times at intervals of twenty days. We shall then find that the quantity

actually delivered on the land is equivalent to 1,434 cubic feet per acre per day throughout the season, or what is the same thing that at each period of irrigation five acres will be irrigated with 143,400 cubic feet, or a quantity sufficient to cover that area to a depth of 8 inches, or a depth during the season of eighty days of 2 feet eight inches; or a depth of 1 foot per thirty day month.

Take the following case as an example; The ditch which irrigates a certain piece of land in the Valley of the Thompson has immediately above the land to be irrigated, a mean velocity of 2.35 feet per second, and a mean area of 1.25 square feet, equivalent to a total discharge of 253,800 cubic feet per day, or 88 miner's inches (B.C. measure). It is stated that the season lasts ninety days; that the areas to be irrigated comprises about fifty acres of grass, and thirty acres of grain, that during [illegible word] days of the season this volume of water is directed over the grass, and during thirty days over the grain. We have then the result, that through the entire season, the grass receives 3,384, and the grain 2,828 cubic feet per acre per day; or a quantity sufficient during the season to convert the entire area into a lake 6.55 feet deep.

Compared with the rainfall necessary to do away with irrigation, and the quantities used in the irrigating countries, these figures certainly appear excessive.

Loss from various causes

Before dealing with the question of the quantity of water required for irrigating grain and grass crops in the region east of the Cascade Mountains in this Province, it is necessary to consider the loss

arising from the following causes; firstly, loss by evaporation, secondly, loss in transit by leakage; and thirdly loss in distribution by water. These sources of loss form important [illegible words] during the irrigation months, and in a section of country in which the soil is generally light and porous.

Loss by Evaporation

Regarding the loss arising from this source, it is to be regretted that there are no data derived from experiment in this country upon which trustworthy conclusions can be based.

The loss by evaporation is not taken into account in California; and probably for the reason that, the canals usually loading from a water supply of considerable volume, it has not been found necessary to economize to the same extent as would be required in British Columbia where the easily available sources of supply are [illegible word].

In discussing this question Mr Burnell states that in England "the experiences derived from the uses of reservoirs on canals, appears to indicate that during the summer months, it is necessary to allow for an evaporation ranging between 1/6 and 1/8 of an inch per day."

Assuming this statement to be correct, it would appear that in the eastern part of British Columbia, under similar conditions, namely in a reservoir where the water is at rest, the rate of evaporation would be higher owing to the increase of temperature, which is occasionally as high as 104^{o} Fah. in the shade, and on the other hand it must be remembered that the rate of evaporation is lower for water in motion than for water at rest.

Assuming the rate of evaporation to

be double that in England, we have to provide against a loss arising from this source of from 1/3 to 1/4 of an inch per day, equal to form 1210 to 907 cubic feet per acre per day.

Loss in transit by leakage.

Since this depends to a great extent on the proper formation of the main conductors, and increases directly with their length, it is observed that this loss can only be reduced to a minimum by the construction of ditches with substantial banks and overfalls, sluices and waste weirs where necessary, and with proper areas and falls to conduct the quantity of water required, while the loss by filtration into the subsoil may be partially reduced by the construction of timber flumes where the soil is porous, and by throwing into the ditch at intervals small quantities of clay or loam, which being first carried along in suspension by the water, and then gradually deposited, assist to consolidate the porous soil through which the ditch passes.

Loss in distribution by waste

This may be reduced to a minimum by preparing the surface for the reception, and providing adequate labor power to supervise the distribution of the water.

Quantity of Water required

Regarding the quantity of water required for irrigation, it may be remarked that, one cubic foot per second will in twenty four hours cover an area of four acres to a depth of six inches, which certainly appears to be a not unreasonably low estimate of the quantity required at each period of irrigation.

On this assumption and supposing that the land requires irrigating once in twenty four days for grain, one cubic foot per second (or 30 miners inches, B.C. measure) will irrigate one hundred acres of grains land.

And one cubic foot per second to four acres is equivalent to 21,600 cubic feet per acre per day. The question of the unavoidable loss in distribution has now to be considered. It has been stated by irrigating enquiries that of the whole quantity delivered upon the land, only from one half to one third can be estimated to be actually absorbed.

Assuming that two thirds of the above amount are wasted, and that the evaporation amounts to 1210 cubic feet per acre as above, we have 5.990 cubic feet left for absorption, equivalent to a depth of 1.56 inches at each period of irrigation on an average throughout the season of 264 cubic feet per acre per day, of which amount 240 cubic feet are estimated to be actually absorbed equivalent to a monthly rainfall of 1.98 inches.

If this water unabsorbed at first be utilized on other lower lying land, calculation will show that the result of the utilization of this waste will give a very close [illegible word] to the Californian standard of one cubic foot per second to each one hundred and sixty acres.

The above is the estimate of the quantity of water required for grain crops. The next question that demands consideration is that of the quantity of water required for grass.

It is stated that the German irrigators who have large quantities of water at their disposal, have a popular proverb to the effect that "he who has water has grass" and it is equally

true in British Columbia that he who ~~has~~ would have good cultivated grass must have water.

Here as before we are not with a want of data on which to base our conclusions, the one definite statement with which all agree is that grass can hardly have too much water.

It appears that, as already stated, rice which during its growth is constantly immersed in water is estimated to required 1440 cubic feet per acre per day, and we have already estimated grain to required 864; probably then it may be assumed that grass will required an amount approximating the mean of these two quantities, say 1150 cubic feet per acre per day, or 40 miners cinches, B.C. measure.

The quantities above mentioned are the quantities required to be delivered upon the land. The quantity required to be appropriated form the sources of supply is another question. There is a considerable loss in transit. We may estimate the^loss by evaporation at from 1/3 to 1/4 of an inch per day; but that which arises from leakage in transit must vary with the varying conditions of soil and construction to such an extent, that no general rule can be laid down. Each case must be treated on its individual merits. It may however be mentioned that loss in transit from these sources has been estimated as high as fifty per cent in some instances in British Columbia. But it can hardly be doubted that the proper construction of the main conductors would materially reduce this enormous percentage. Unfortunately however, the high price of lumber and the expense of transport have hitherto effectually

prevented most settlers from building flumes in any places where it was possible to do without them.

Drainage.

Up to the present times but little has been done, and indeed in many cases, from the natural contour of the land, and the character of the subsoil, but little is required to be done in the way of artificial drainage to carry off the surplus water from the irrigated lands. But the best authorities on irrigation are unanimous in their opinion that the removal of the water is nearly as essential as its original introduction.

Hall of Main Conductors

It being apparent in many instances both among white settlers and Indians that the main conductors have been constructed with far too heavy grades to the grate detriment of their banks, the gentleman in charge of Survey Party, Interior Division, has been instructed to endeavour when staking out main ditches to obtain grades of not more than 1 in 700, or less than 1 in 1500, since at these inclinations ditches will not be liable to [illegible word] on the one hand, or slit^silt up on the other.

In staking out these ditches, a practised difficulty has arisen, and it is this, that whereas after levelling a ditch for a white man, he would be furnished with a section shewing the depth of cutting of each stake, in dealing with [illegible word] Indians it is necessary to place the stakes only on those positions, in which the depths of cuttings will be uniform, and this in some

instances involves a too rigid adherence to the natural contour of the ground.

This difficulty however with others would probably disappear with the appointment of local agents who would be able to advise and help the Indians.

Though not perhaps a matter coming strictly within the limits of this Report, I may perhaps be pardoned for suggesting, that, as it appears inevitable that the bunch grass should gradually disappear before the advance of stock it would be well to consider what grass is the best adapted to replace it.

It is necessary that its substitute should be capable of flourishing in dry soils, without the aid of irrigation, at considerable altitudes and should be sufficiently handy to defy the effects of frost in early spring.

From what I can gather, Alfalfa alone partially fulfils these requirements. That it will flourish at considerable altitudes without the aid of irrigation is a fact already ascertained. The main danger arises at the time when the snow disappears; then as it first vigorously [illegible word] the early spring frosts may prove destructive.

As its character there are not two opinions on the subject it is first class land for stock and makes equally good hay.

It is with some diffidence that I beg to submit these remarks, and I have felt compelled to enter into the subject at some length in order to explain the grounds on which I base my conclusions. For as before stated there is no authentic information on the subject of irrigation in this Province on record, and I

[illegible words] it was to grope my way from
[illegible words] to another amidst a [illegible word] of my
[illegible words] in the field.

I have [illegible word]

(signed) E. Mohun
Surveyor to Ind. Res. Comm.