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A DESCRIPTION OF THE BELGO-CANADIAN FRUIT LANDS COMPANIES' IRRIGATION WORKS, NEAR KELOWNA, B.C.

BY C. A. STOESS, M. CAN. SOC. C.E.

(To be read before the General Section)

The Belgo-Canadian fruit lands are situated 10 miles east of Kelowna at the foot of Black Mountain and include an area of 9,000 acres of which only 6,000 acres are available for irrigation. The general map shows the location, part being shaded in the morning from the east by Black Mountain and part from the north. The top of Black Mountain is about 4,000 feet above the sea and the extremes of altitude on the irrigable land are 1,525 feet above the sea at Mission Creek at the southwest corner and 3,305 feet at the northeast corner of the company's property. The land is generally very rolling with many deep pot holes and hills and has good slopes and benches with good soil. It was necessary to make a 10 foot contour survey in order to design the subdivision, distribution of irrigation water, roads, etc. The only data that had previously been taken was a barometer survey of which no marks were found on the ground, so that all necessary surveys had to be made before construction work could be commenced. The time available for such surveys was very limited as it was urgently insisted upon that the water should be turned on as soon as possible.

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It is very much to be regretted that proper Government supervision does not yet exist to prevent real estate men bringing undue influence to bear on these irrigation enterprises for which, in some cases, they have advocated Government ownership in order to remove the burden of failure from their own shoulders.

As there is a moderate precipitation of 14 inches a year on these lands, and usually a good rainfall during June, the quantity of irrigation water decided upon was one cubic foot per second to every 150 acres, or the equivalent of 1.32 feet depth, and this was arranged for as follows:—for 6,000 acres during

May and June	62 days	0.82 ft. deep	= 4,920 ac. feet.
July and August ..	38 "	.50 " "	= 3,000 " "
Total	100 "	1.32 " "	= 7,920 " "

of this 4,920 ac. feet will be supplied from streams in flood and the 3,000 ac. feet from reserved water. These figures were derived from the following calculations:—

Total water supply 1 c.f.s. per 150 ac. for 100 days = 1.32 ft. deep.
7,920 ac. ft. = 3,450,000 c.f.s. in 1 day = 40 c.f.s.
add for loss 25% 10

to be provided for 50 c.f.s.

and this gives an allowance of $0.00\dot{6}\dot{6}\dot{6}$ c.f.s. per acre,

or $0.04\dot{6}\dot{6}\dot{6}$ c.f.s. for watering once a week.

The reservoir is at the head of the North Fork of Mission Creek where there are two small lakes. The water area will be 272 acres at the water surface formed by the dams and will hold 3,070 acre feet. About one mile below the dams an eastern branch of the North Fork of Mission Creek joins the west branch, and this eastern branch can be run into the reservoir by a ditch or flume of about 2 miles length. Within half a mile of each other there are 3 dams on this reservoir site.

Dam No. 1 has a length of 445 feet with a maximum depth of 31 feet, or 24 feet above the surface of the ground. The foundation is in granitoid rock; at the west end the dip is 75 degrees with a strike almost at right angles to the line of the dam, dipping into a water-tight hardpan below about 10 feet of wet gravel for a distance of 95 feet beyond which is hard gneiss for a distance of

350 feet and beyond. The dam is built of a concrete core 1½ feet wide at its top, which is 7 feet below the top of the dam, and 3 feet wide at the surface of the ground. The trench below the surface of the ground averages 6 feet wide and is filled with concrete and fillers of rock. The water surface will be 3 feet below the top of the dam, with a top width of 10 feet. On either side of the core wall there is a cushion of earth 3 feet thick that is carried up to the top of the dam, and beyond this is a heavy rock fill having slopes of 1½ to 1 on the water side, and 2 to 1 on the lower side. The water side is protected by hand laid rip rap. There is a concrete culvert through the dam in solid rock with a sluice gate built of 3 thicknesses of 2" plank set in heavy wooden frames anchored to the concrete, and operated from a gate house set on a heavy tower. The gate rod enters a cast iron standard, having a brass nut and ball bearings. All woodwork is coated with carbolineum and tar.

Total excavation in rock	9,177	cu. yds.
Earth filling around wall	1,471	" "
Riprapping, hand laid	1,471	sq. "
Concrete wall (6 to 1)	581	cu. "

The concrete in place cost $12.00 per cu. yd., and the cost of the rock in place varies from about $1.00 to $0.42 per cu. yd. The spillway is 40 feet long.

Dam No. 2 is situated about half a mile east of Dam No. 1, and is similar in construction. Its length is 255 ft. with a maximum depth of 41 ft., or 25 feet above the ground surface. The foundation is all in solid rock, except for a length of about 30 feet where the foundation was placed in hardpan at a depth of 14 feet below the ground surface. The rock fill being very heavy and large no riprapping was done.

Total excavation in rock	8,555	cu. yds.
Earth filling around wall	850	" "
Concrete core wall	290	" "

As a precaution, a 12-inch concrete pipe, set in a concrete bed, was built provided with a 12-inch gate, gate tower and house. All the rock for the dam had to be blasted and hauled to the dam, using 3 sets of track and cars and derricks.

Dam No. 3 is across a slight depression 250 feet long and 4 feet deep and formed of rock and earth.

At one mile below Dam No. 1, where the creek bed is in solid rock, a concrete weir is built to gauge the flow.

Between the reservoir and the intake several small streams add to the flow of the North Fork of Mission Creek. The intake is located at the junction of the ditch and the North Fork of Mission Creek, about 11 miles below the reservoir. A training wall of cribwork, 180 feet long, filled with rock, is built on the west side of the stream bed; the stream bed straightened and a crib abutment built on the east side and filled with rock. Between these cribs there is a bear trap dam having 4 leaves or traps each 5 feet wide. These leaves are worked by a winch and running tackle. In the training crib, on the west side, is an opening provided with drop logs through which the water can be diverted at low water, with the leaves raised, into a forebay or canal 10 feet wide at the bottom and 500 feet long leading to the headgate of the main ditch. Along the east side of this forebay are 6 spillways of concrete as a provision against the drop logs at the bear trap dam being accidentally left open.

Immediately above the headgate 4th Creek comes in,—a creek that rises very quickly in the spring, discharging about 300 c.f.s. In the spring of 1912 this creek brought down a large quantity of gravel that filled up part of the forebay 3½ feet deep, and to avoid a recurrence of this a flume has been built 10 feet wide and 2½ feet deep on a 5 per cent. grade across the forebay and the channel of the creek paved for 300 feet up above the forebay. At low water this creek can be turned into the forebay.

The headgate is built of two thicknesses of 2-inch fir with a heavy fir frame anchored to and set in the concrete, all well coated with carbolineum and tarred. The gearing is on ball bearings.

From the headgate the ditch runs through a very sandy and gravelly side hill having a natural slope of 2 to 1, requiring a concrete lining for a distance of half a mile. The section of the ditch is given on a plan of the concrete inlet at the headgate.

On account of an adjustment of grade, and to provide a water cushion at the lower end of the concrete lining, the grade is broken and is partly 0.14 per cent., and partly 0.37 per cent.

At the lower end of the concrete lining is a concrete tank into which the water drops and stills before entering the ditch. The grade of the ditch is 0.14 per cent., or about 7½ feet per mile, the ditch being 5 feet wide at the bottom with 1½ to 1 side slopes, and calculated to run slightly less than 3 feet per second, and to carry 60 c.f.s. with a depth of 2½ feet of water. At rock excavations where steeper slopes occur, the width is 7 feet across the bottom, and at sharp bends compensation in width is allowed for.

The quantities of excavation are as follows:—

1st mile	32,223	cu.	yds.
2nd "	15,407	"	"
3rd "	8,509	"	"
4th "	7,623	"	"
5th "	9,536	"	"
6th "	14,079	"	"
7th "	15,398	"	"
8th "	6,334	"	"
9th "	6,983	"	"
10th "	10,842	"	"
11th "	4,739	"	"
Total	131,673	"	"

Near the end of the first mile a particularly bad spot was found, the earth at this place being of a friable nature and consisting partly of volcanic ash. The natural slope of the ground was 1½ to 1, a difficult place to build a ditch, but with patience and careful selection of material, by lining the ditch with 2 feet of selected material for a length of about 300 feet and by letting the water in very carefully the difficulties were successfully overcome.

With the exception of Dry Gulch (5 miles below the intake) where the ditch makes a very sharp bend round a steep gully, and where the excavation was nearly all sand and gravel, requiring 600 lin. feet of concrete lining, the ditch has given no trouble. A few minor leaks occurred in rock or in strata of gravel, but these were closed by simple treatment.

The ditch was tested throughout by dams at short distances apart and for sufficient time to ensure safety.

From experience in this ditch, as well as from other experience, location and treatment are found to govern the safety of the ditch and a moderate sized ditch may be placed on a slope of even 40 degrees inclination of the natural surface of the ground, provided the material is suitable, and it is not necessary to have a 1 in 4 slope for the line between the bottom of the ditch and the natural surface of the ground on the low side as is generally supposed.

The flumes consist of continuous wood staves set up similarly to a continuous wood stave pipe. This design occurred to the writer about 13 years ago, and only after very careful investigation was it adopted for this ditch. A similar design was once tried on the Santa Anna Canal in California with a boat-shaped section, but was found to leak and to let sand and grit into the joints, the cause being that the rods were 2′ 8″ centres, much too far apart to support the wood properly. The spacing of rods in continuous wood stave pipe and wire in wire-bound pipe frequently does not receive careful attention, with the consequence that the pipes usually leak more under the lesser heads than under the greater heads. Bearing this in mind the flume adopted is grooved and tongued, dressed to curve or radius and treated with carbolineum before erection. The rods are ⅜-inch diameter and the nuts 50 per cent. longer than the standard size to avoid stripping in tightening up especially under the strain in rounding curves. The ties across the top are of 3″ x 4″, set flat and one foot centre to centre. The flume is supported by wooden yokes cut to fit the flume out of 3″ x 12″ fir, and set to 6 foot centres. The ties and yokes were dipped in liquid asphalt.

The total length of the flume erected is:—

Flume on grade	6,720 lin. ft.
" " trestles	1,969 " "
Total	8,689 " "

The diameter of the flume is 5½ feet; the weight per mile is 199 tons; the staves are 1⅝ inches thick and cut out of 2″ x 6″ fir. Turning curves of less than 200 feet radius was found to be difficult, and staves of less width are recommended. The continuous wood stave flume gives even curvature, very much facilitating the flow of water. The flume was tested to a depth of 2 feet of water with very satisfactory results.

The ends of the flumes are set in concrete structures or headwalls where expansion and contraction is provided for by caulking the joint between the flume and the concrete with tarred unravelled rope or oakum.

At convenient places along the line of the ditch waste gates are provided for use in the event of a washout or accident, and these were usually placed at the entrance to flumes and sometimes in the bank of the ditch. The waste water is led away through a wooden flume to the nearest creek or gully.

At 8 miles from the headgate is 8 Mile Creek, across which the water is carried by an inverted siphon. This is a 27-inch inside diameter rivetted steel pipe 1,220 feet long, with a maximum dynamic head of 200 feet, the thickness of the plate being No. 9 I.S.G., or 0.144 inches. The joints are of the Matheson type and leaded.

The grades are generally very steep (in one place 40 degrees) and heavy anchorages of concrete with holding down rods and shape steel were placed at each bend. The inlets and outlets are concrete tanks provided with gratings and flushing gates.

The difference in elevation between the inlet and outlet is 60 feet.

At 10½ miles below the intake a throwaway is built to keep the ditch clear of a rock slide on Black Mountain and to reduce the unnecessary elevation at this location. The throwaway is 2,000 feet long and drops 300 feet to a tank where part of the water continues northwards through a siphon across a gully to the continuation of the main ditch, that will eventually irrigate to the northern boundary of the company's property in a distance of 7 miles. The balance of the water goes through a siphon 8,879 feet long of various diameters proportional to the water conveyed, the diameters being 18, 14, 12 and 10 inches. The difference in elevation between the inlet and outlet is 230 feet with a maximum dynamic head of 450 feet. This siphon, as well as 8 Mile Creek siphon, was tested to the full static head.

The pipe is lap-welded steel, made by Stewarts and Lloyds, with leaded joints for pressures up to 350 feet head, and with Drees bolted expansion joints for pressures over 350 feet.

The 18-inch pipe is 6 mm. thick, and the rest of the pipe 5 mm. thick.

This siphon will deliver water to a large area of land on Hepburn Hill. The main delivery from this siphon is from the low point to irrigate about 1,000 acres. In this siphon, as in 8 Mile Creek siphon, concrete anchorages were placed at the bends on the steeper ground.

The laterals are of various types and have still to be built, these will be in concrete where imbedded in the ground. Semi-circular flumes are of wood or galvanized iron or steel where trestle work is necessary, and the siphons are of continuous wood stave pipe.

The works were begun in 1910, and by October, 1912, the water was running all along the ditch. Letting the water down the 11 miles of ditch took about 3 months.

In addition to the above works a domestic water supply has been laid taking excellent water from 8 Mile Creek, where a small reservoir is formed by a circular concrete dam. This system has about 6 miles of 6-inch pipe and several miles of 3-inch, 2-inch and 1-inch pipe to supply residents.

Fig 1.—Flume.

Fig. 2.—Intake Headgate.

Fig. 3.—Flume Trestle.

Fig. 4.—Inlet to Flume and Waste Gate.

Fig. 5.—Intake to 8-Mile-Creek Siphon.

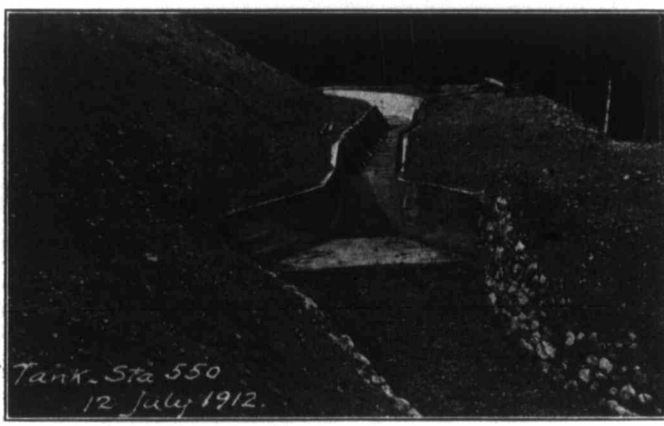

Fig. 6.—Tank at Entrance to Ditch.


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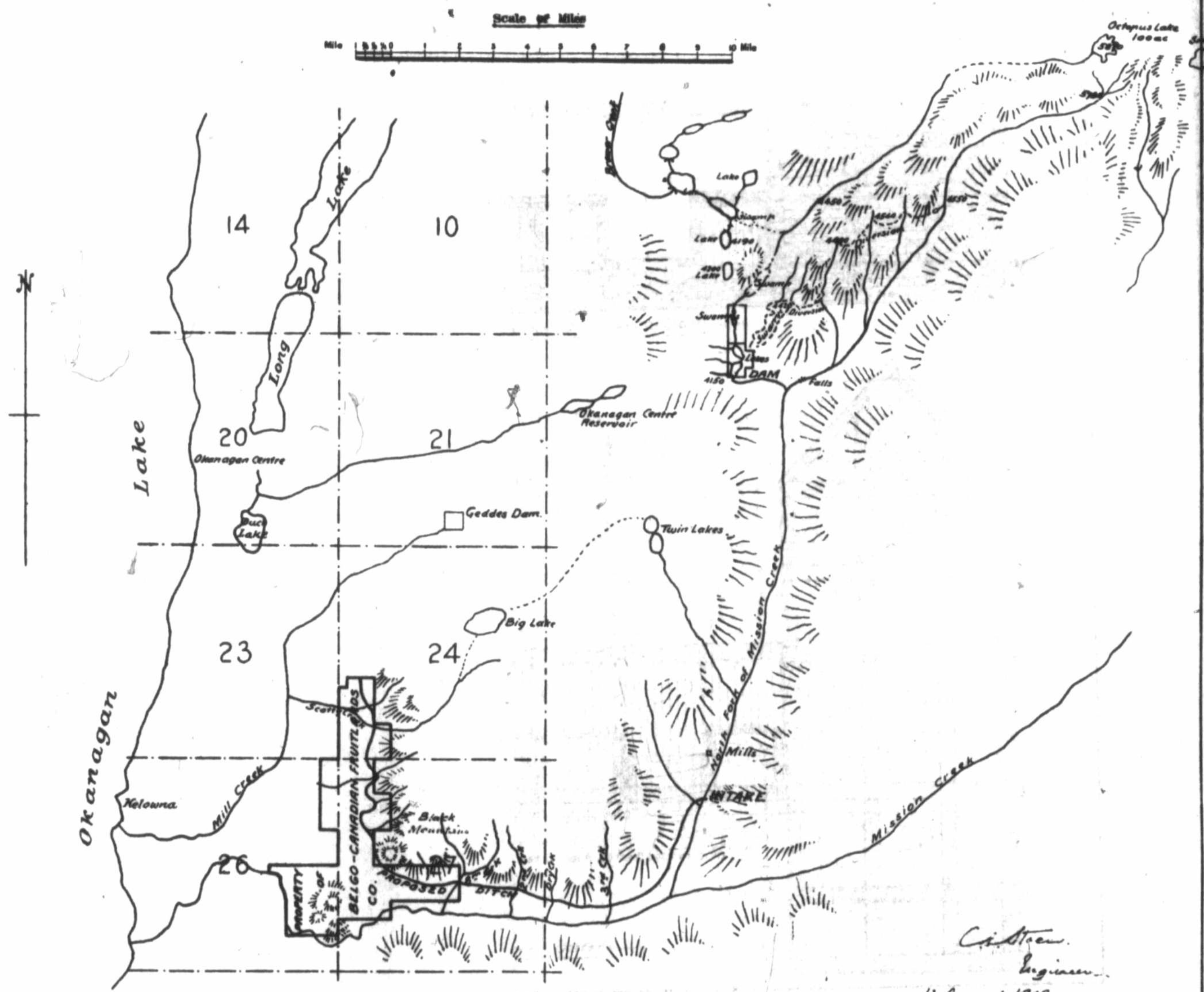
PLATE 1

BELGO CANADIAN FRUITLANDS CO

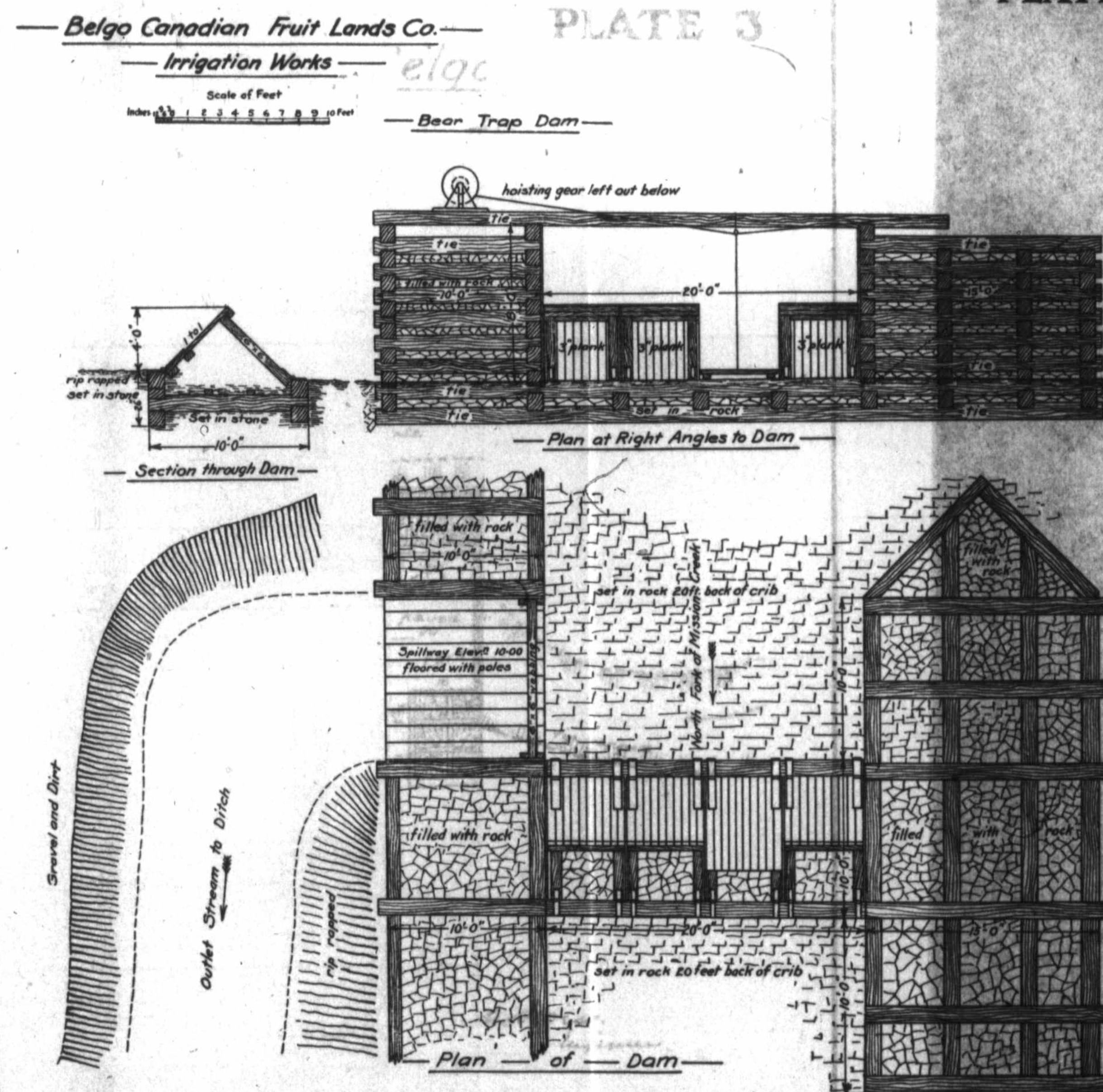
MAP SHEWING POSITION OF
LANDS, PROPOSED DITCH, INTAKE, DAM & WATER SOURCES



Engineer

13 August 1909.

PLATE 2



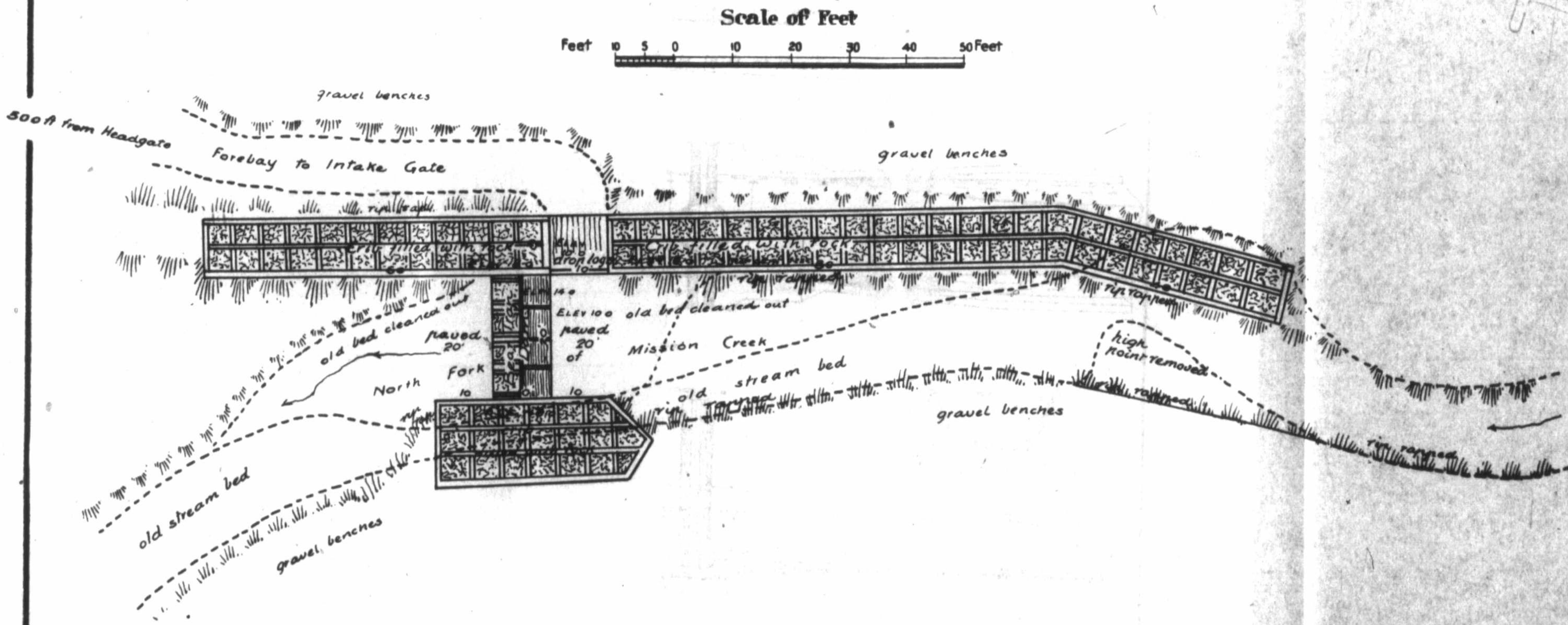
Belgo Canadian Fruit Lands Co.
Irrigation Works
Scale of Feet
Bear Trap Dam
hoisting gear left out below
20'-0"
Section through Dam
rip rapped
set in stone
Set in stone
10'-0"
Plan at Right Angles to Dam
filled with rock
Spillway Elev. 10.00 floored with poles
set in rock 20ft. back of crib
North Fork of Mission Creek
Gravel and Dirt
Outlet Stream to Ditch
rip rapped
set in rock 20 feet back of crib
filled with rock
Plan of Dam

PLATE 3

Belgo Canadian Fruit Lands Co

Irrigation Works

Plan of Arrangement at Bear Trap Dam



C.A. Sirois.
Engineer.

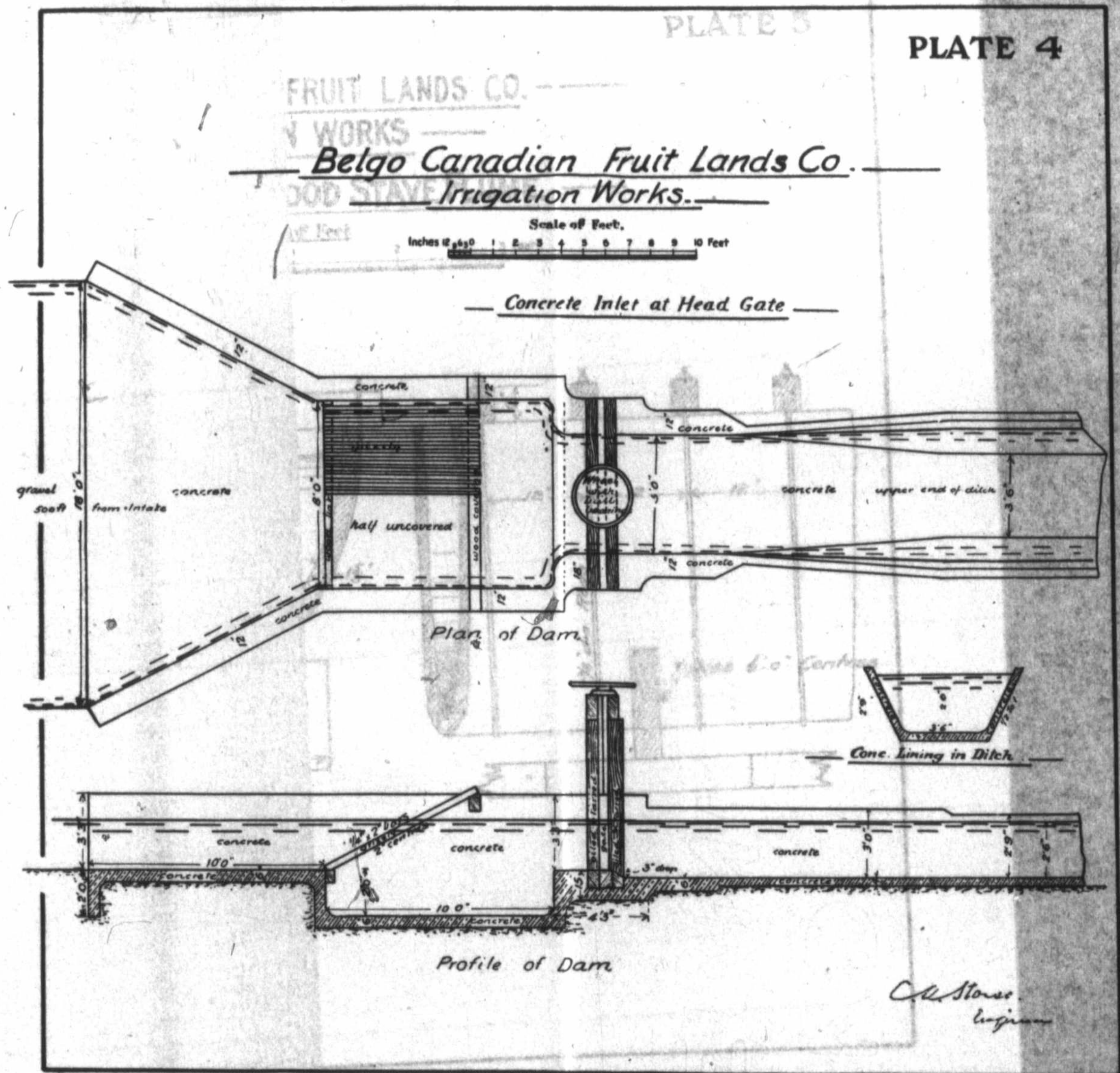


PLATE 4
Belgo Canadian Fruit Lands Co.
Irrigation Works.
Scale of Feet.
Inches 12 6 3 0 1 2 3 4 5 6 7 8 9 10 Feet
Concrete Inlet at Head Gate
gravel
50 ft
18'0"
from intake
concrete
8'0"
half uncovered
wood
5'0"
3'6"
12"
18"
upper end of ditch
Plan of Dam
Cone. Lining in Ditch
2'0"
3'6"
3'3"
10'0"
Profile of Dam
3" drop
4'3"
3'0"
2'9"
2'6"
C. A. Stoess
Engineer

PLATE 5

BELGO CANADIAN FRUIT LANDS CO.

IRRIGATION WORKS

CONTINUOUS WOOD STAVE FLUME