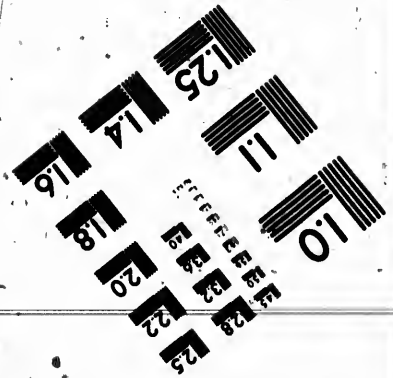
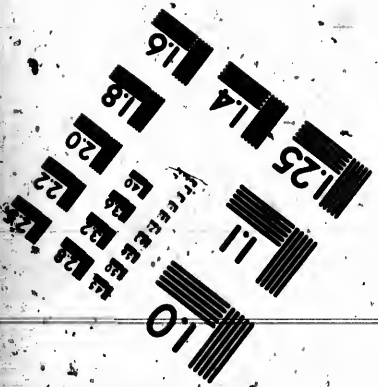
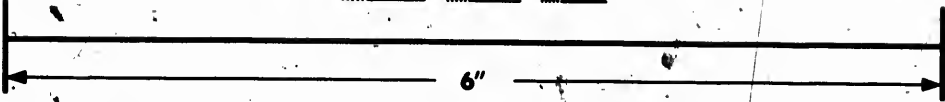
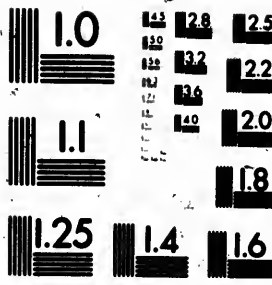


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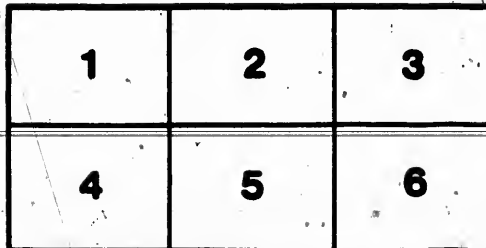
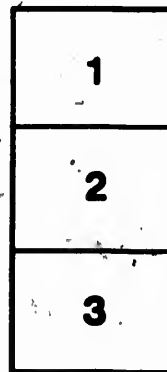
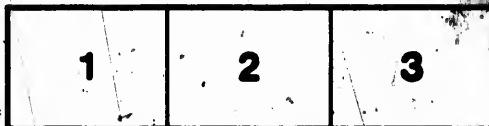
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CONSTRUCTION OF THE ONTARIO AND BERRI STREET SUBWAYS, BROCK STREET TUNNEL, AND NOTRE DAME STREET VIADUCT.

By STUART HOWARD, M. Can. Soc. C. E.

To be read Thursday, February 15th, 1900.

The writer, in describing in a general way the construction of the several works in this Paper, wishes to state that the structures differ very little from works built for the same purpose, but hopes that the drawings and contemplated and final completed costs may be of some use to his brother Engineers. The writer, who was fortunate enough to have charge of the designing and superintendence of the above mentioned works, wishes to thank Mr. P. W. St. George, M. Can. Soc. C. E., under whose supervision they were carried out, for his courtesy in allowing him to write this paper.

Concrete was used very extensively in all the foundations below ground, the masonry being all rock-faced Ashlar in regular courses, the backing being made up of large stones and concrete, well-bonded to the face stones; the cement was the best to be had in the market, and was mixed in the proportion of 1 of cement to 2 of coarse sand, for the Ashlar work and backing, and for the bridge seats and coping 1 to 1.

ONTARIO STREET SUBWAY.

This subway was constructed to permit of a roadway being built under the C. P. R. tracks at Hochelaga, which at this point numbered ten in all. The masonry retaining walls extend upon the south side, from the east side of the street in front of the Stock Yards hotel to the west side of Moreau street, and on the north side, from Moreau street to a point about 22 feet west of the west end of the subway proper, the walls being for a considerable distance on solid rock. The descending grade at each end is 1 in 20. The bridge carrying the tracks being 165 feet in length, by 40 feet in width, with a clear headway of 12 feet, it was impossible to give any more height, as the lower portion of the subway could not have

been properly drained. The total length of the retaining walls is as follows: upon the south side, 649 feet, and on the north, 378 feet, and are built according to the sections shown on plate 18, and stepped down so as to conform to the natural surface of the upper ground. The clear span between the perpendicular retaining walls is 40 feet; the copings being at the upper ends about 3 feet above the street surface and 16 feet at the subway, and surmounted by an iron fence composed of cast-iron posts placed every 10 feet, with 3 lines of 1 1/2 inch gas pipe, the fence being 3 feet 3 inches in height; this fence is returned across the bridge on the limit of the Railway Right-of-way, the posts being bolted to the trough plates, and to a plate holding in the concrete, in which the ties are bedded. The subway bridge is 156 feet long and 40 feet in width, with a central wall extending the entire length, on which are bolted 14 latticed channel columns, carrying plate girders of a depth of 2 feet, the ends of these girders resting upon the bridge seats of the abutment walls. At right angles to these plate-girders are bolted, iron trough plates, the ties being bedded in concrete in these troughs, and brought to the proper railway grade. The concrete for this work was composed of 1 of Portland cement, 1 of clean river sand and 4 parts of broken stone.

The excavation under the tracks was taken out without interrupting the railway traffic, piles having been driven close to the side of the rails in such a position as not to interfere with the masonry work; they were then cut off and capped, and stringers slipped in under the ties, the whole making a pile trestlework. The retaining wall at the west end was returned up the east side of the street in front of the Stock Yards hotel, a distance of 50 feet, the street being graded to give easy access to Ontario street. The subway from end to end has been paved in scoria blocks, 5 foot sidewalks laid, new drain put in, as also water and gas pipes, and gullies.

The estimated cost was \$85,000, and the actual cost as per details:

Earth excavation	11,970 cub. yds. at 29 1/2 cents	=	\$ 3,531.15
Rock excavation	52 " " 80 1/2 "	=	41.86
Rock faced Ashlar	3,061 " " \$8.57 1/2 "	=	26,248.07
Cut stone Masonry	206 " " \$10.25 1/2 "	=	2,051.00
Stone behind walls	663 " " \$3.00 "	=	1,989.00
Temporary trestle		=	3,500.00
Timber in same—price allowed for old		=	1,215.00
Paving		=	11,505.91
Fencing		=	1,200.00
Concrete		=	5,000.00
Iron superstructure and columns		=	16,400.00
Superintendence and sewers		=	10,476.00

\$83,557.99

The cost of the subway proper under the tracks, including excavation, masonry, temporary bridge, bridge and floor system, amounted to \$38,000.00; the cubic contents measured to the outside of the masonry walls were 169,000 cubic feet, equalling 22½ cents per cubic foot; \$243.00 per lineal foot of subway, or \$4.50 per square foot of area.

The contractors for the ironwork were the Dominion Bridge Co., and for all the other items Messrs. Laurier, Rheame & Desormeau.

BROCK STREET TUNNEL.

This tunnel was constructed, to open up a roadway from Craig street to the wharf, and is situated at Beaudry street, about eight-tenths of a mile east of the Post Office, and a third of a mile east of the Berri street subway, and has already proved its great use, the carters being able to take double the load they were formerly able to, the approach from the wharf being so heavy and the descending grade so steep by the ramps to Notre Dame street and down again to Craig street. The total length of the tunnel and approaches is 905 feet, measured from the south side of Craig street to the southerly limit of the Canadian Pacific Railway's cribwork on the wharf; the tunnel itself from portal to portal has a length of 666½ feet with a grade of 1 in 42.

The approach at the Craig street end is 200 ft. long and 40 ft. wide, with a 10 foot sidewalk on the west side, leaving a clear roadway of 30 feet. Upon the east side of this approach is a masonry retaining wall, which sustains an upper roadway leading from Craig street to Notre Dame, of a width of 35 feet. This roadway has a grade of 1 in 14½, the height at the north portal being 21 feet above the tunnel floor. The coping of this wall is stepped to suit the grade of the upper street, with an iron pipe fence similar in construction to that at the Ontario street subway.

The portals of the tunnel are of masonry, and extend a length of 8 feet, the arch stones being toothed so that the courses of brickwork are built into them exactly. The arch is a semi-circle with a radius of 15 feet, and springs from the floor of the tunnel, thereby giving a clear headway at the key stone of 15 feet. The brickwork at the haunches immediately above the masonry springing course is 4 feet 3 inches wide, and is stepped up until at the key it is 1 foot 5 inches in depth.

The intrados of the arch is of fire brick, 9 inches in thickness, the backing being of hard red bricks, the whole being laid in cement mortar, 1 of cement to 2 of sand; this brickwork has been most carefully laid, and thoroughly bonded, and all the courses kept perfectly straight throughout. On the top of the brickwork, and extending nearly to the haunches, is a thickness of 9 inches of concrete, com-

posed of 1 of cement, 2 of sand and 4 of stone, and over this concrete No. 20 galvanized corrugated iron; the stone filling to the underside of the tunnel roof planking being carefully laid in by hand and well consolidated. This stone filling acts as a drain, any water from above descending to the 6 inch open jointed pipe which is laid upon a bed of concrete, and on the same grade as the tunnel.

The north end of the tunnel for a distance of 103 feet was built in open cutting, as the depth over the crown would not admit of tunneling, and the excavation did not interfere with any traffic. After the brickwork, concrete and iron were completed, the excavated material was filled over, and again brought to the original surface. This work, as also the north east retaining wall, was completed December 15th, 1883.

The south approach consists of a bridge to carry the tracks of the Canadian Pacific Railway; the abutments are 36 feet apart with a mean length of 39 feet, and, in order not to interrupt the traffic of the railway, the tracks had to be carried by a temporary trestlework. As at the Ontario street subway, piles were driven from above and close to the track; they were then cut off below the surface, and timber caps put on; stringers were then slipped under the ties, forming a regular timber trestlework; the excavation was then proceeded with, and cross bracing put in wherever necessary. The piles were driven in such a position as not to interfere with the building of the abutments. This mode of procedure was most satisfactory, the entire work being done very expeditiously. The tracks are carried upon eight plate girders, 2 feet 6 inches deep, put in in pairs and braced sideways by latticed girders; the flooring is composed of 10 inches x 10 inches creosoted timbers laid close together, the joints being thoroughly caulked with oakum; this structure cost \$4,900 00. On the outside of the south portal hollow quoins were left in the recesses of the abutments, into which solid lock gates 12 inches thick and 14½ feet in height are fitted, the gates closing against a 12 inch timber, let into the mitre wall, and well bolted; this timber is put in after the close of navigation, a 6 inch plank taking its place during the summer season. This gate was to prevent the entrance of the water during any rise in the river, but the water finds its way from behind the abutments, and up into the tunnel by its pressure, and is of little use except to prevent ice entering the tunnel and injuring the walls. The difference of level between the wharf and Craig street is 21 feet, the highest freshet known being 13½ feet above the floor of the tunnel, at the south end.

The drifting of the tunnel was accomplished without any accident whatever, and the timbers were placed as shown on the section. A heading was first drifted from the south end about 10 x 11 feet, and timbered; the excavation for the tunnel itself was then carefully

done, the timbering being put in as soon as each section was excavated, until the whole area required was complete. The upper roof longitudinals as also the roof boarding were left in. When the masonry haunches were completed, the centering for the brickwork proper was put in, and the upright timbers cut out one by one as the work progressed, the roof timbers being supported from the brickwork. After the concrete over the arch was done, the corrugated iron was put in position and the space above filled in with large sized broken stone.

The tunnel was built from both ends, and when the walls met, no difference was found either in alignment or level. The key of the arch is of stone. When the walls met in working from each end, a shaft was sunk from the street above, and the brickwork completed, an inscription stone containing the city archives, coins of the realm, photographs, and plans in a copper box being placed in the side wall. In the tunnel there were used approximately 350,000 fire bricks, 1,300,000 hard red bricks, 1,450 cubic yards of masonry, 1,110 cubic yards of concrete, 50,000 pounds of corrugated iron, 3,600 cubic yards of stone filling, and 15,000 cubic yards of excavation. The north approach has been paved with scoria blocks, the tunnel and south approach with porphyry blocks. The roadway is 25 feet in width with a 5 foot elevated sidewalk on the west side only, protected by an iron pipe railing.

"Engineers' Estimate of Cost."

Excavation for walls and open built tunnel.....cys.	6,750 at 50c.	—	\$3,375 00
Filling over tunnel (open cut).....	2,200 " 25c.		550 00
Masonry in retaining walls.....	900 " \$9.00		8,100 00
do in north and south portals.....	390 " \$12.00		4,680 00
Cut stone copings, walls and portals.....	80 " 14.00		1,120 00
Excavation for Can. Pac. Ry. bridge.....	1,650 " 1.00		1,650 00
Pulling down and rebuilding old ramp wall.....	145 " 5.00		725 00
Stone behind walls.....	250 " 2.50		625 00
Temporary C. P. R. bridge.....			1 500 00
Open built tunnel.....	L. ft. 96 x	\$126.00 =	\$12,096 00
<i>Tunnel drifted (per lin. foot).</i>			
Excavation.....cys.	27 at \$ 1.50 =		\$40 50
Key stone.....	.055 " 12.00		0 66
Masonry foundation.....	1.54 " 10.00		15 40
Fire bricks.....in.	600 " 40.00		24 00
Red do.....	2,000 " 24.00		48 00
Concrete.....cys.	2 " 9.00		18 00
Corrugated iron.....lbs.	85 " 10.00		8 50
Stone behind wall.....cys.	1.7 " 3.00		5 10
Tile pipe, 6".....1 ft.	2 " 0.35		0 70
Centres and headings.....	1 " 9.00		9 00
Filling over arch.....cys.	4.25 " 1.00		4 25
Extras.....			0 89

\$176 00 x 557 feet = 98,032 00

\$132,463 00

The contractors' final estimate for this work, amounted to \$131,696 67.

The other items in the Engineers' Approximate Cost, not included in the contract for the tunnel proper, were as follows:—

Railings on Copings and in Tunnel, 942 lineal ft. at \$1.75	=	\$ 1,648.00
Iron Bridge to carry C. P. R. tracks	=	5,000.00
Flood gates at South Portal	=	400.00
Porphyry Paving in Tunnel.. 1,964 sq. yds. at \$4.50	=	8,838.00
Sidewalk in Tunnel.. 300 " " 3.50	=	1,050.00
Curb in Tunnel.. 667 lin. feet at 70c.	=	467.00
Curb at North End .. 200 " " \$1.00	=	200.00
Scoria Block Paving.. 1,092 sq. yds. at 3.50	=	3,822.00
Drains and Macadamizing..	=	4,200.00
Engineering and Contingencies..	=	17,000.00
		\$42,625.00

This work was completed for the sum of \$42,304.00, the Engineer's estimate for the total work being \$175,078.00; whereas the total cost when completed was \$174,000.00. This amount really covered many little items which were unforeseen.

The contractors for the tunnel portion of the work were Messrs. Lafontaine & Lemoine, and the iron bridge was put in by the Dominion Bridge Co.

BERRI STREET SUBWAY.

This subway was commenced at the end of May, 1893, and before the winter set in the whole work, with the exception of the paving, was completed. This subway was designed to give an easy approach from Craig to Commissioners' street, Berri Lane, or Barrack street being widened, and a new street opened up between St. Louis and Notre Dame streets. The subway proper extends from Champ de Mars street to the Canadian Pacific Railway freight shed, a total distance of 430 feet. The approach from Champ de Mars street has a descending grade of 1 in 39 to the arch under Notre Dame street a distance of 180 feet, the roadway under the arch and the eastern approach from Commissioners' street being practically level for a distance of 250 feet.

Between Champ de Mars and Notre Dame streets there is an upper roadway upon the south side of the subway, with a width of 20 feet, and upon the same side, extending from Notre Dame to Commissioners' street, a similar upper road of a width of 30 feet. Heavy retaining walls are built to sustain these roadways, the copings being stepped to suit the grades of the streets, and surmounted by an iron pipe fence similar to the other structures already described. The arch was originally designed with a clear span of 45 feet, as

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permission could not be obtained from the Hospice St. Charles to build the north westerly retaining wall upon their property, but, at a later period after nearly all the arch stones had been cut, and the centres made, permission by the Hospital authorities was granted and the span widened to 52 feet. Any engineer now viewing this arch would naturally say, what an extraordinary structure, an arch at one end with the abutment carried forward to carry an iron viaduct. Why was it not all carried out in iron? When the Berrill Street Subway was designed, no plans had been made, nor was the idea broached of any extension of the Canadian Pacific Railway into the present Place Viger Station, but, when the work was well under construction, the scheme matured in time to prevent the building of the north westerly retaining wall.

The arch centering was made very strong, the lagging only being carried down to the top of the third course above the springing; many centres are made so weak that the weight of the arch stones causes the haunches to settle, and the crown to spring up. Care was also taken to build the arch evenly from both sides, so as to distribute the weights carefully; all the stones being used were also loaded upon the centering, keeping it in place.

The change in the span of the arch necessitated a great deal of extra work; new centres had to be made, and about 8 feet in height of the northerly abutment torn down, and moved forward 7 feet. By referring to the drawing of the arch, you will see that it is formed by radii from seven centers, which were arranged so that the curve might conform as nearly as possible to a true ellipse. In order to utilize as many as possible of the old arch stones, only a few had to be thrown out, the same radii being kept, and a new central one of a larger radius or 46 feet 6 inches inserted, raising the key stone, only 6 inches. The arch stones were cut very truly to the radii, and the whole structure built most carefully, and when the centres were removed no settlement whatever could be measured. The section of the arch shows clearly the top crown line, which was formed of masonry whenever depth would allow, and concrete in the shallow portions, the whole being covered with a 3 inch thickness of asphalt, allowing any water to drop into the back stone filling, and out through the weepholes. The retaining walls were built according to the section shown, with a face batter of 1 in 12, the coping being laid on a perfectly straight line, and with an iron pipe fence on top. The old retaining wall on Barrack street which the writer had the pleasure of building some years formerly was demolished, the stone as far as possible being used in the new work, and the south end of the Dalhousie Square depot was underpinned, and reconstructed to correspond with the other faces of the building. An iron stair-

case was built opposite St. Paul street, for pedestrians to descend to the lower level or subway. The writer has given sections of two elliptical arches, one with a rise of 1-3rd of the span, the other rise being 1-4th of the span, together with a table showing, by letters, the spans, radii and dimensions, which he hopes will be of some practical use.

Engineers' Estimate for Subway with 45 Foot span Arch.

Excavation	cub. yds.	25,000	at	45c.	=	\$11,250.00
Filling over arch	"	900	"	30c.	=	270.00
Masonry in old wall torn down and rebuilt	"	800	"	\$6.00	=	4,800.00
Masonry in arch abutments	"	650	"	9.00	=	5,950.00
Masonry in arch stones and copings	"	267	"	14.00	=	3,738.00
Masonry in retaining walls	cub. yds.	3,410	"	9.00	=	30,690.00
Asphalt on arch	sq. yds.	400	"	2.50	=	1,000.00
Stone behind walls	cub. yds.	650	"	2.50	=	1,625.00
Cutting down wall at depot	"	360	"	4.00	=	1,440.00
Paving in scoria	sq. yds.	3,637	"	3.50	=	12,730.00
Engineering and contingencies						10,500.00
						<hr/> \$83,993.00
Deduct north-west wall, 922 cubic yards at \$9.00						8,298.00
						<hr/> \$75,695.00
Add additional cost of altering to 52' span						2,000.00
						<hr/> \$77,695.00

The 45 foot span according to these figures would amount to \$280 per foot in depth of arch, and for a 52 foot span \$310 per foot in depth of arch. The cost of the arch proper, according to contractors' figures amounted to \$281 per foot in depth. The total cost of the contractors' work, including paving, amounted to \$67,000, and the engineering and contingencies the sum of \$10,255, making a total of \$77,255. The contractors for the arch, paving and walls were Messrs. Madore and Frechette.

NOTRE DAME STREET VIADUCT.

This viaduct has been built on the lines of Notre Dame street, between the Berri street subway arch and the East side of La Croix street, for the accommodation of the Canadian Pacific Railway, their tracks leading to the new Viger Square Hotel Depot, passing beneath the structure. The northerly abutment of the Berri street

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street

arch had to be widened, not altogether for its additional strength, but in order to suit the spans of the bridge itself.

In addition to the two abutments, the northerly one of which was carried down Lacroix street on a curve, there are 21 pedestals with copings $3\frac{1}{2}$ feet x 12 feet, and 22 with copings $3\frac{1}{2}$ feet square. The pedestals as far as the north end of the old Dalhousie Square passenger depot are at right angles to the axis of the bridge, the remainder as far as the north abutment being placed at an angle of $54^{\circ} 41' 30''$, so as to suit the curves of the tracks approaching the depot at Viger square the north abutment being parallel to them. The total length of the bridge proper between the abutment-bridge seats being on the west side, $437' 3''$; on the centre line, $452' 10''$, and on the east side, $468' 5''$. The width of the bridge between the outside plates is $52' 3''$, the five lines of columns being placed 11 feet centre to centre. The columns are composed of 2 channel irons, and one eye beam, resting upon rocker bases, having also rockers at the top, to allow for the contraction and expansion of the steel. Upon these columns which are thoroughly braced transversely are placed the longitudinal plate girders. The spans of these girders are, 4 clear spans of $38' 3''$, 2 of $50' 2\frac{1}{2}''$, one of $40' 2\frac{1}{2}''$, and one of $59' 6''$, and one $54' 1\frac{1}{2}''$, beside the tower spans. The columns on the long pedestals are placed $7' 9\frac{1}{4}''$ centre to centre, which constitute the towers, the depth of the girders being $4' 3''$ deep for the short $38' 3''$ spans, and $5' 3''$ for the longer ones.

On the top these girders and at right angles to them are placed the iron floor beams, composed of $10\frac{1}{4}''$ eye-beams, extending the whole width of the bridge, and at 4 feet centres; upon these eye-beams, which are bolted to the girders, are placed the 3-16 inch buckled plates, the buckled portions being 4 ft. sq., and made in long lengths; these plates are riveted to the eye-beams and strengthened longitudinally by T. bars. The roadway is composed of concrete and wooden block paving, with a stone curb, and firmite sidewalk of a width of $8' 1\frac{1}{2}''$ upon each side, leaving a clear roadway between the curbs of 36 feet, a double electric car system of tracks being placed in the centre, the trolley poles which are of iron being bolted to the outside plates and bracketted to the columns. The buckled plates before the concrete was laid were painted with hot asphalt, which has had the desired effect of making the bridge almost perfectly water tight. The fence posts were of cast-iron 3 inches in diameter, with bosses; they were placed every 8 feet, and bolted to the outside plates; there are 4 lines of $1\frac{1}{2}$ inch gas-pipes passing through them, the top bar being $3' 4''$ above the sidewalk level at the outside of the bridge. The triangular portion of the bridge down Lacroix street has a length of curved abutment of 140 feet. And on the south side one column and 2-60' girder spans of

a depth of 6 feet, girders extend from these outside girders to the bridge seat of the abutment, of a depth of 3 feet, and at distances of 13' 3" parallel to the main bridge. At right angles to them are placed 12 inch eye-beams, at 4 feet centres; and on these the buckled plates and scoria block paving with concrete. During the construction of the bridge a temporary roadway was made upon trestlework, west of the structure, so that the traffic was not much interfered with, the cars being carried this way, and only stopped when the connections were made at the north end. The old wall along the east side of Notre Dame street, which the writer also constructed for the Canadian Pacific Railway, had to be torn down, a great quantity of the stone being used in the bridge abutments and pedestals.

It would be well to note here that this wall was built during the winter months, the thermometer being from 15° to 20° below zero for days together, the sand and cement were warmed, as also the water, and the stones subjected to a steam jet to thoroughly clear off any snow or ice, and yet we had great difficulty in pulling this wall apart, showing conclusively that masonry can, without any fear, be built during winter time, care being taken.

Engineers' Estimate of Cost.

Excavation..	cub. yds. 28,000	\$ 0.65	\$18,200.00
Tearing down old walls.. . . .	" 1,300	1.50	1,950.00
Temporary bridge and grading road..			3,000.00
Masonry in abutments..	cub. yds. 1,400	9.00	12,600.00
Paving and sidewalks..	sq. yds. 2,720	3.50	9,520.00
Masonry in pedestals..	cub. yds. 414	10.00	4,140.00
Cutstone on pedestals and bridge abutments..	" 180	14.00	2,520.00
Removal, etc., of water-pipes....			2,500.00
Stone-filing behind walls.. . . .	cub. yds. 100	4.00	400.00
Superintendence and contingencies			15,000.00
			<hr/>
			\$69,830.00

Iron Superstructure.

In columns..110,000 lbs.
 In girders..460,000 "
 Buckled plates & T beams 250,000 "
 Floor beams..165,000 "
 In cross bracing, etc.: 97,000 " 1,082,000 lbs. at 3½ cts., \$35,665
 which equals a total cost of \$105,495.00. The amounts paid were to the contractors, Madore & Fréchette, \$43,270.00; to the

Dominion Bridge Co., \$35,505.00; for blecks for roadway alteration of water pipes, superintendence and small contingencies, \$24,191.00, or a total of \$102,966.00; the amount of iron in the Bridge Co.'s tender was 1,090,000 pounds.

The Lacroix street portion was estimated at \$25,000.00; and the amounts paid were to the contractors, Madore & Frchette, \$16,521.00; to the Dominion Bridge Co., \$6,568.00, and for superintendence, \$1,600.00, a sum total of \$24,689.00.

Taking out the items in the bridge proper, namely, pedestals, steelwork and flooring; the structure being to back of bridge seats, a mean of 460 feet in length, a width of 52 feet, and an average depth of 30 feet, the cubic content would be 717,600 cubic feet, at a cost of \$40,425.00; or 5.63 cents per cubic foot, \$88.00 per lineal foot of bridge, or \$1.70 per square foot of area. The columns are 22 feet long, and any extra depth can be allowed up to 30 foot columns by adding \$1.25 per cubic foot to the above cost.

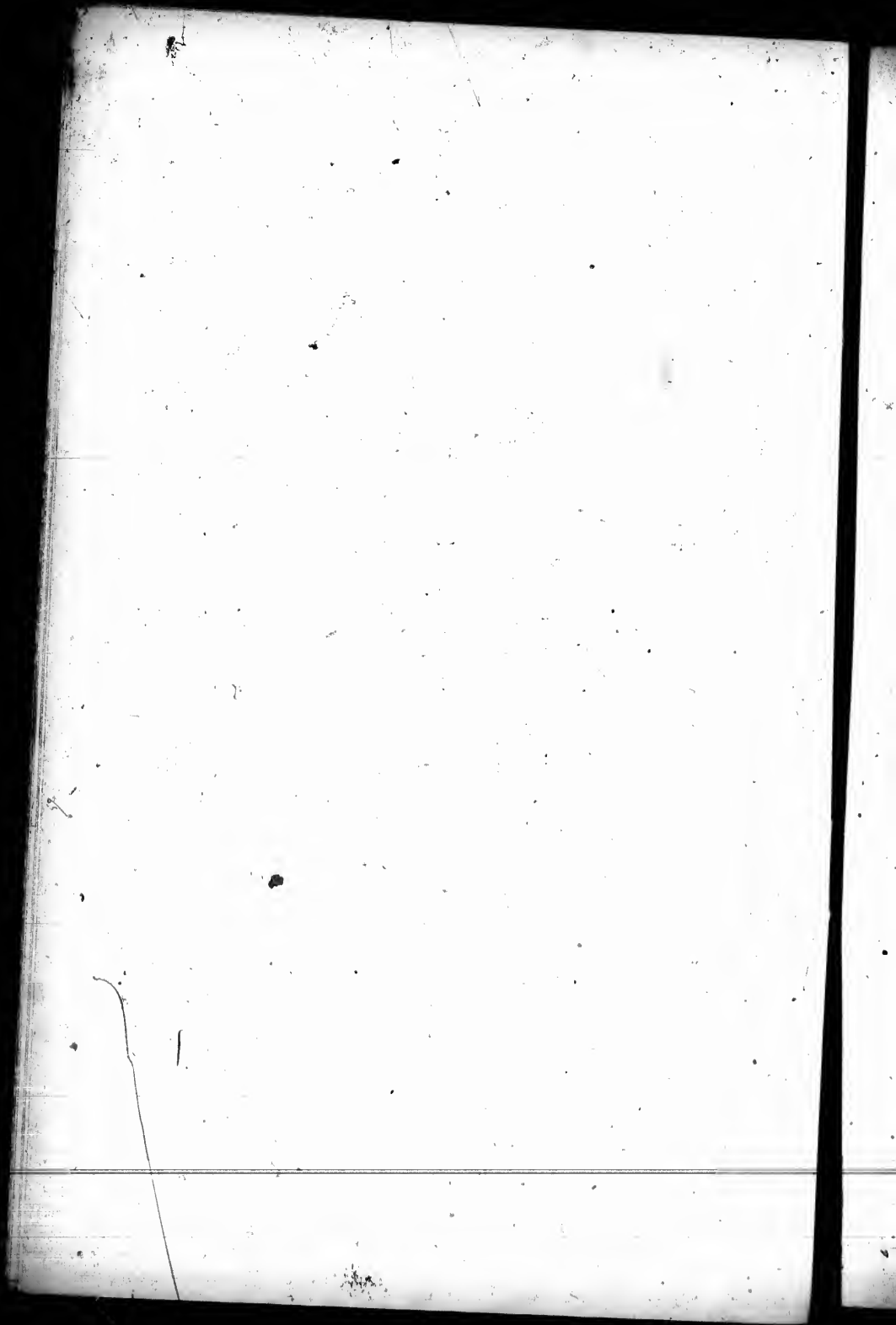
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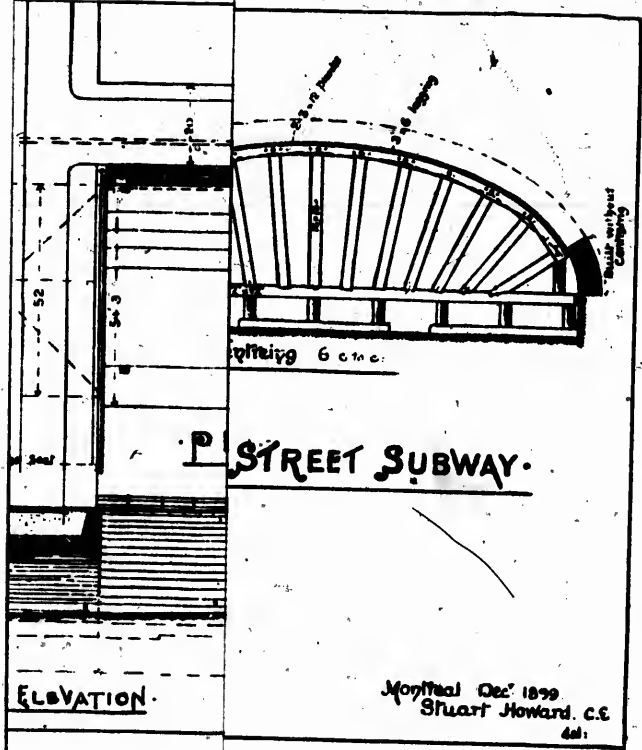
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5,665
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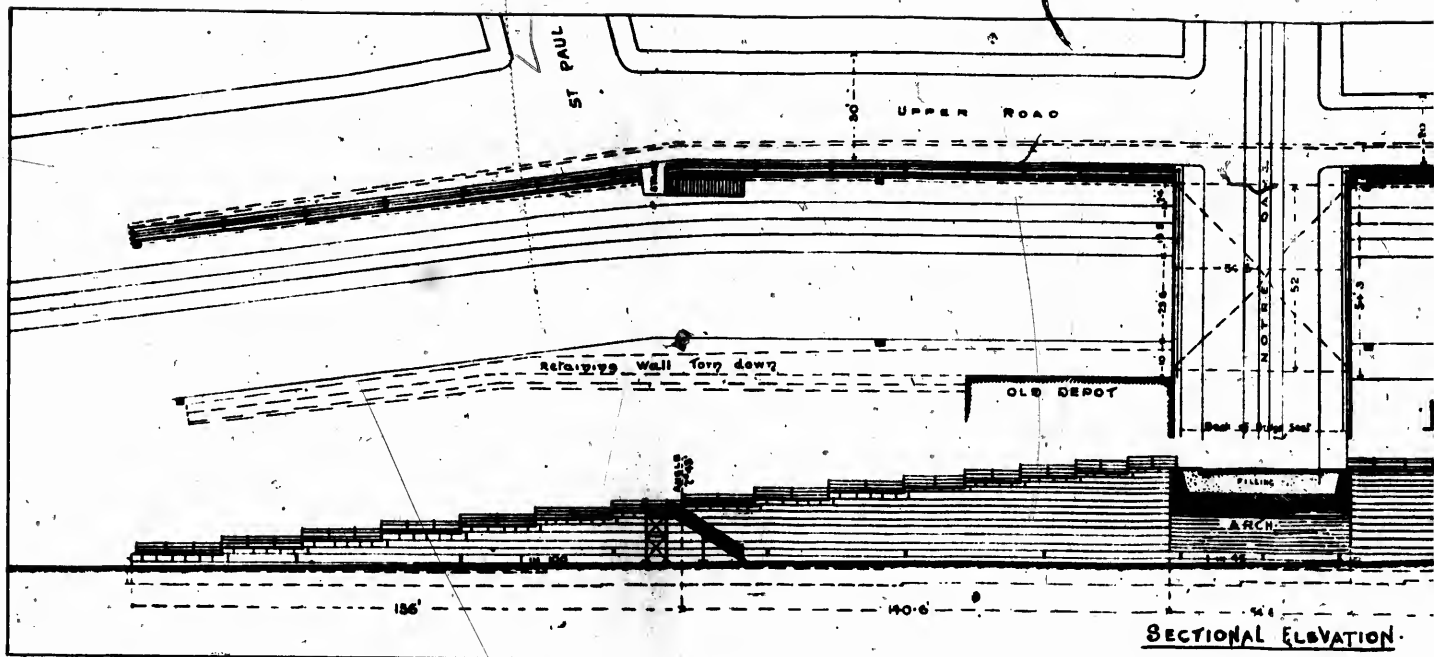


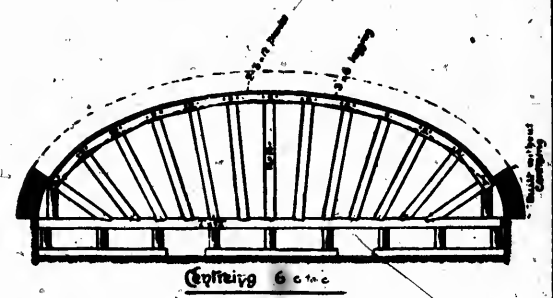
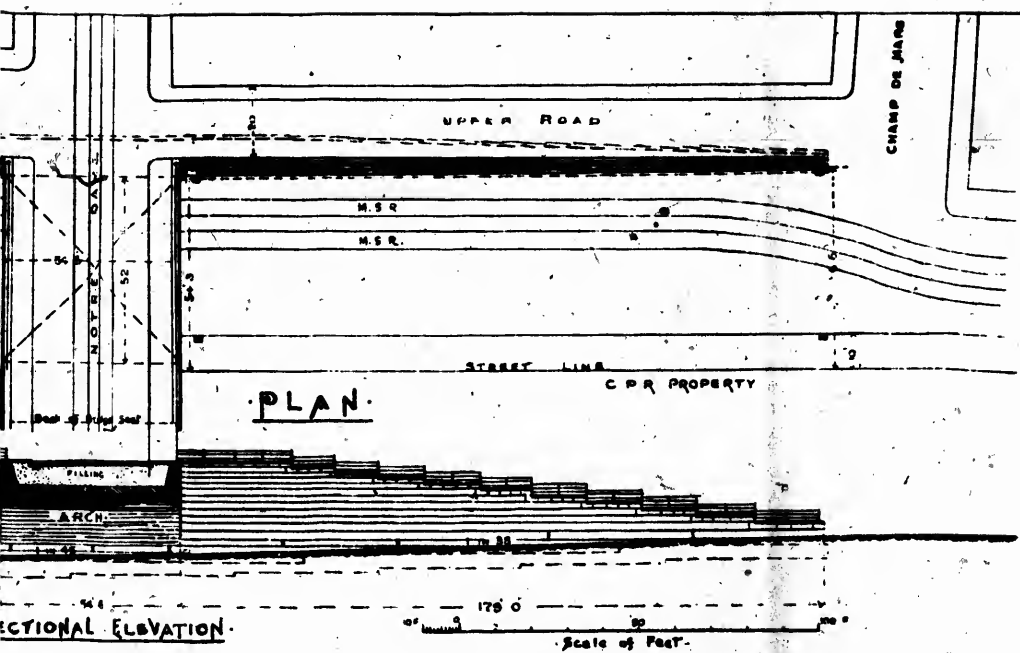


P STREET SUBWAY.

ELEVATION.

Montreal Dec. 1899.
Stuart Howard. C.E.
del.



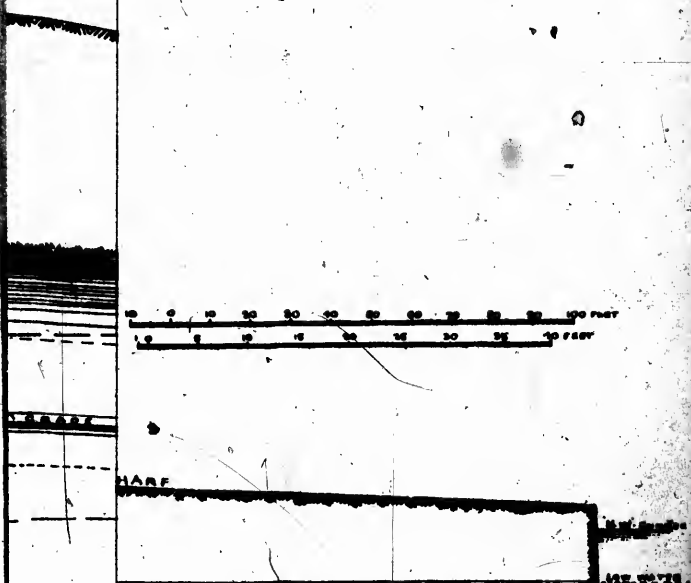


BERRI STREET SUBWAY.

Montreal Dec 1899
Stuart Howard, C.E.
441



TRANSACTIONS CAN. SOC. C. E.
VOL. XIII PLATE XVII

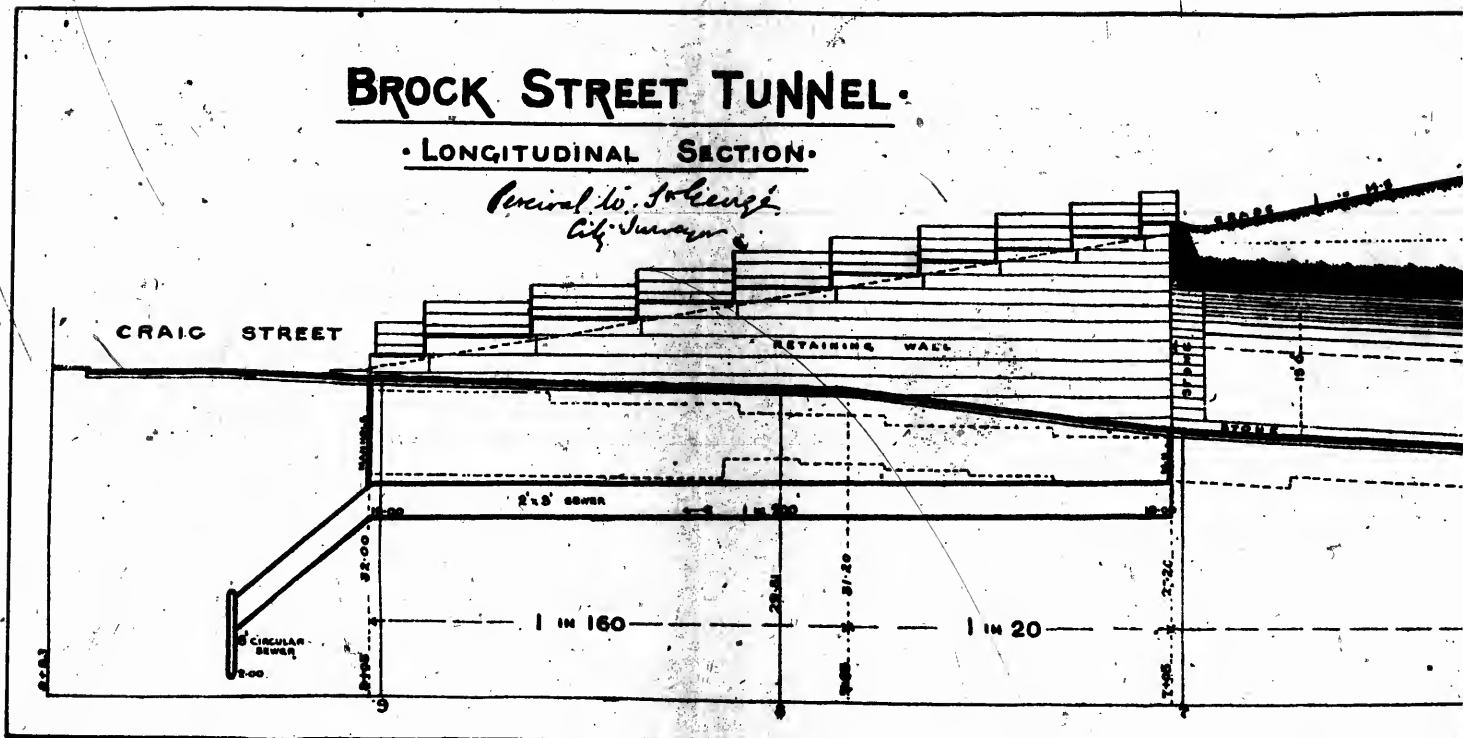


STUART HOWARD: C.E. del.

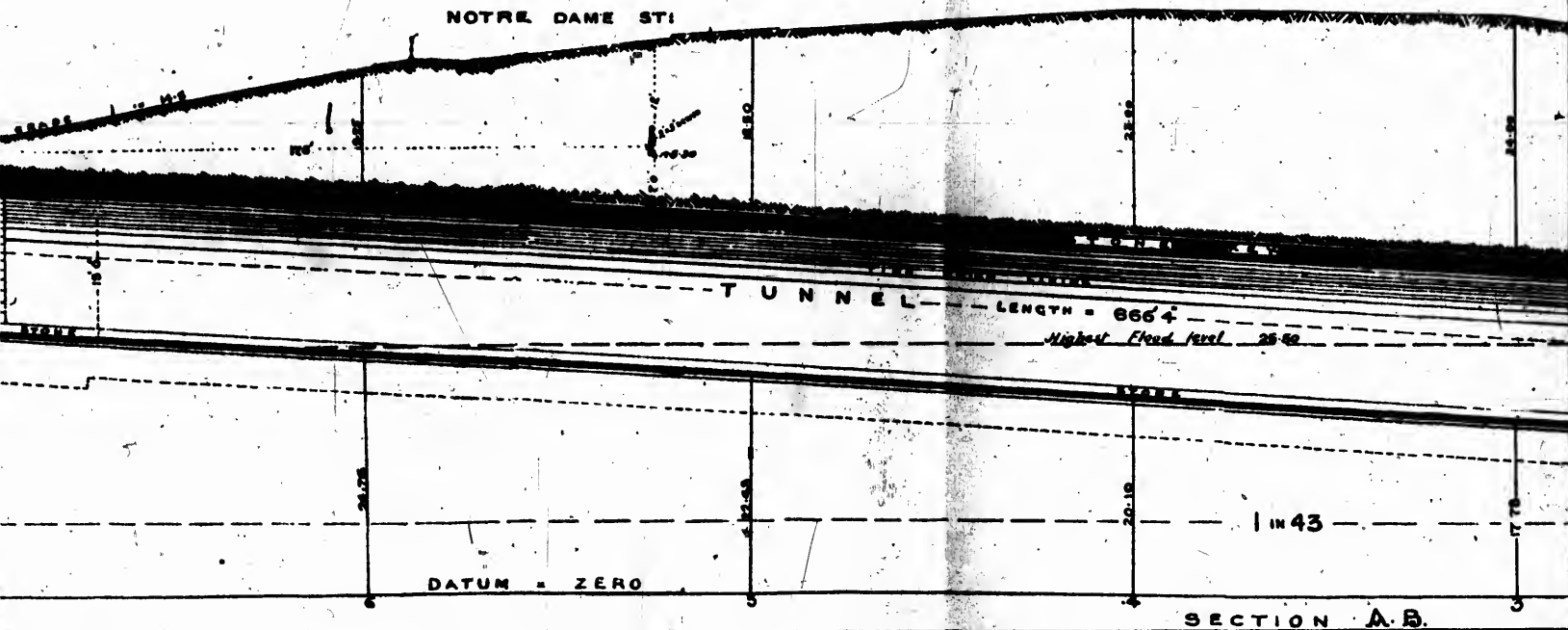
BROCK STREET TUNNEL.

LONGITUDINAL SECTION.

*Revised to follow
City Survey*

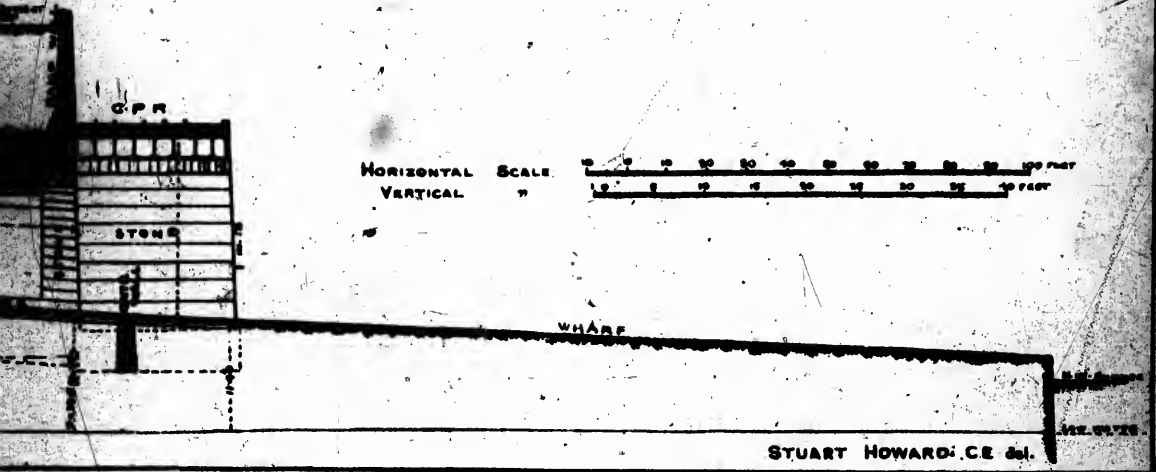


NOTRE DAME ST.

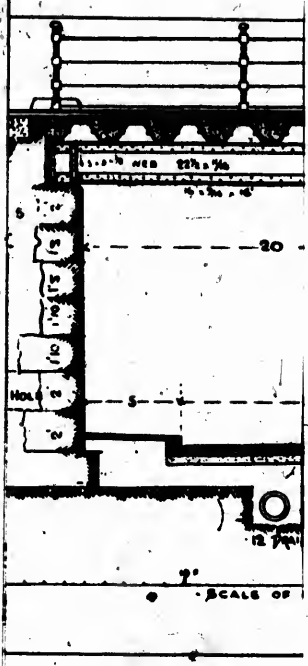


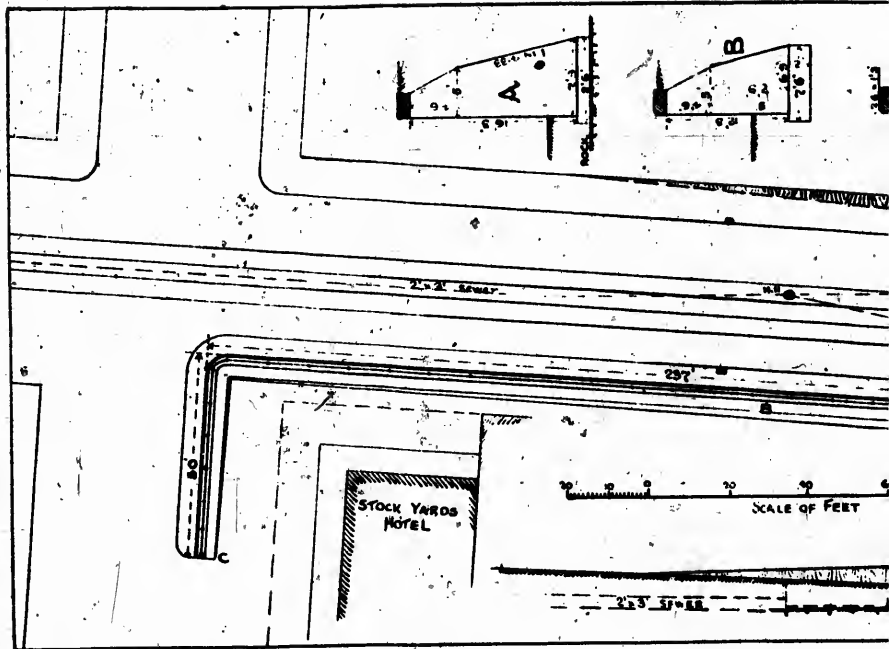


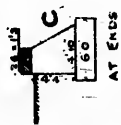
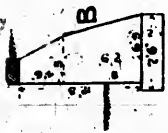
TRANSACTIONS CAN. SOC. C. E.
VOL. XIII PLATE XVII





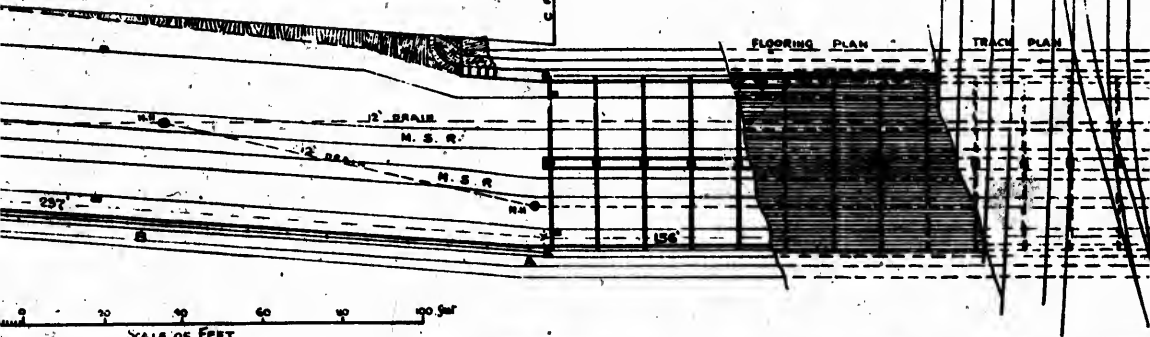






AT ENDS

C.P.O. FENCE

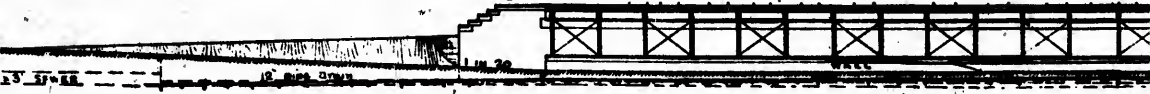


FLOORING PLAN

TRACK PLAN



SCALE OF FEET



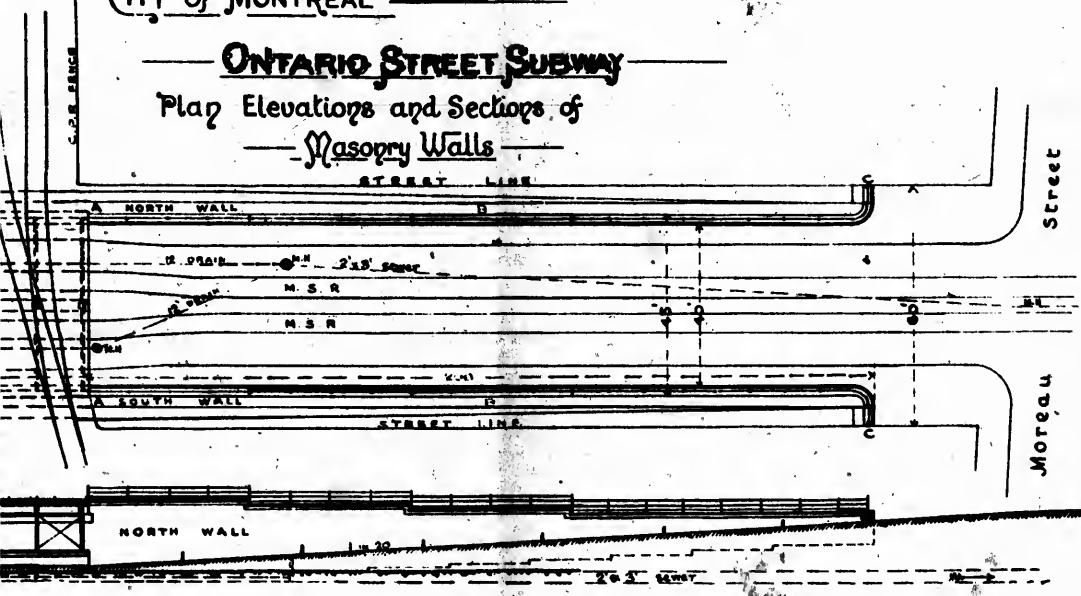
11' 20"

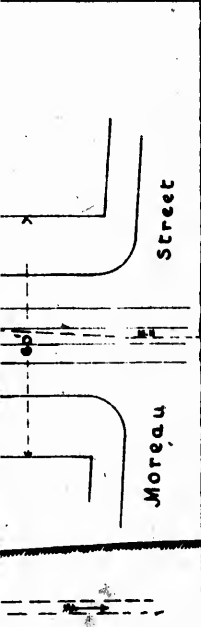
WALL

CITY OF MONTREAL

ONTARIO STREET SUBWAY

Plan Elevations and Sections of
Masonry Walls

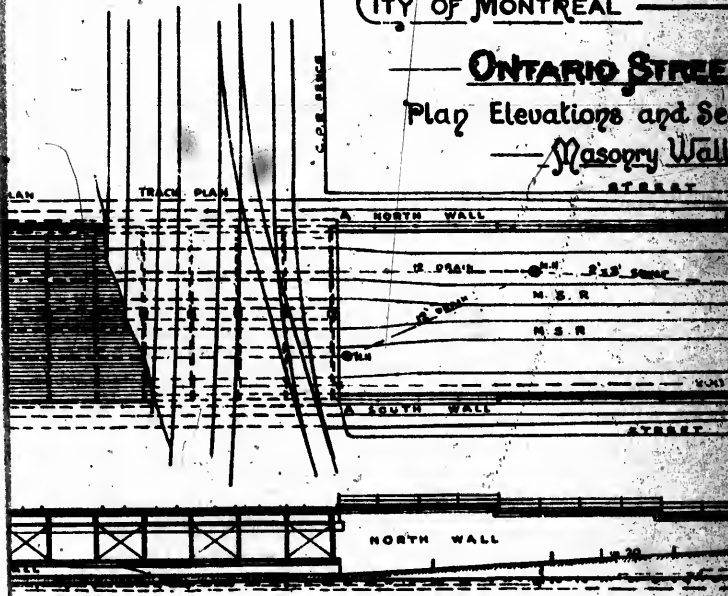




CITY OF MONTREAL

ONTARIO STREET

Plan Elevations and Section
 of
Masonry Wall



STREET SUBWAY

and Sections of Walls

ST LINE

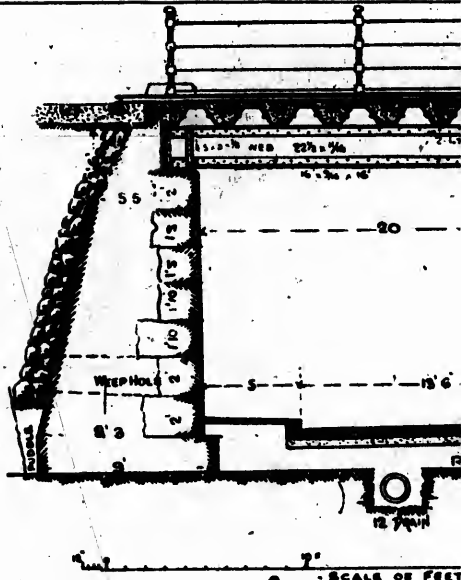
ST LINE

ST LINE

ST LINE

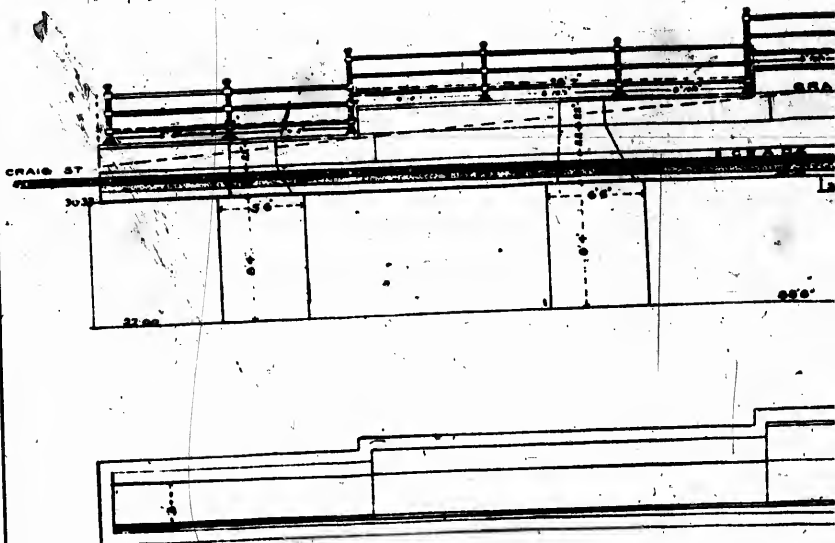
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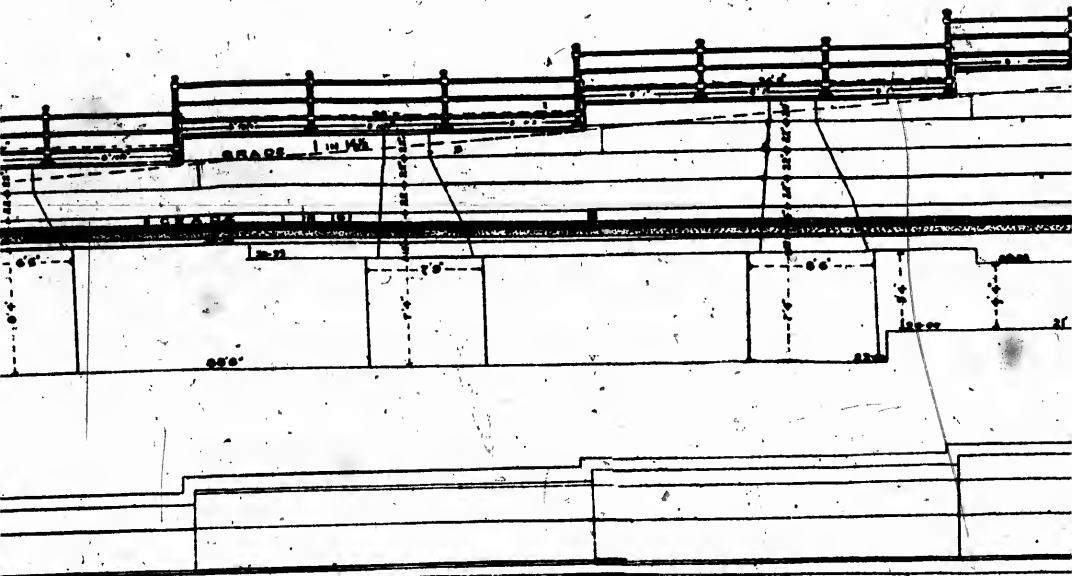
Moreau



SCALE OF FEET

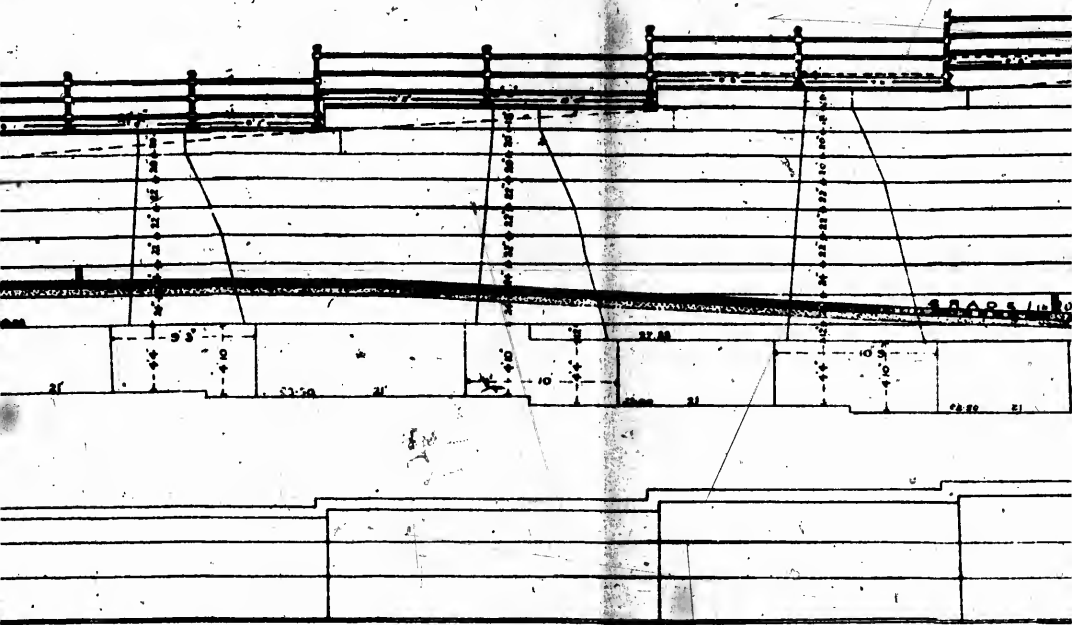
TRANSACTIONS CAN. SOC. C. E.
VOL. XIII PLATE XIX





BROCK

Dorth F

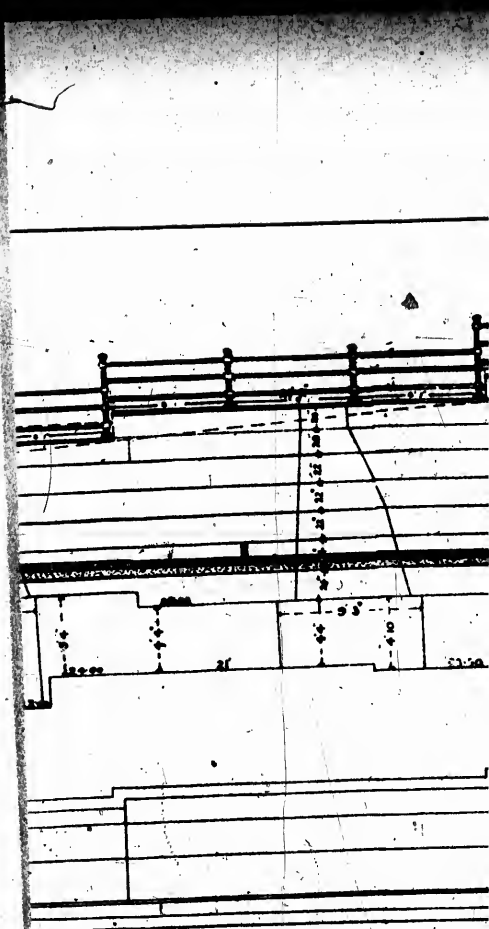
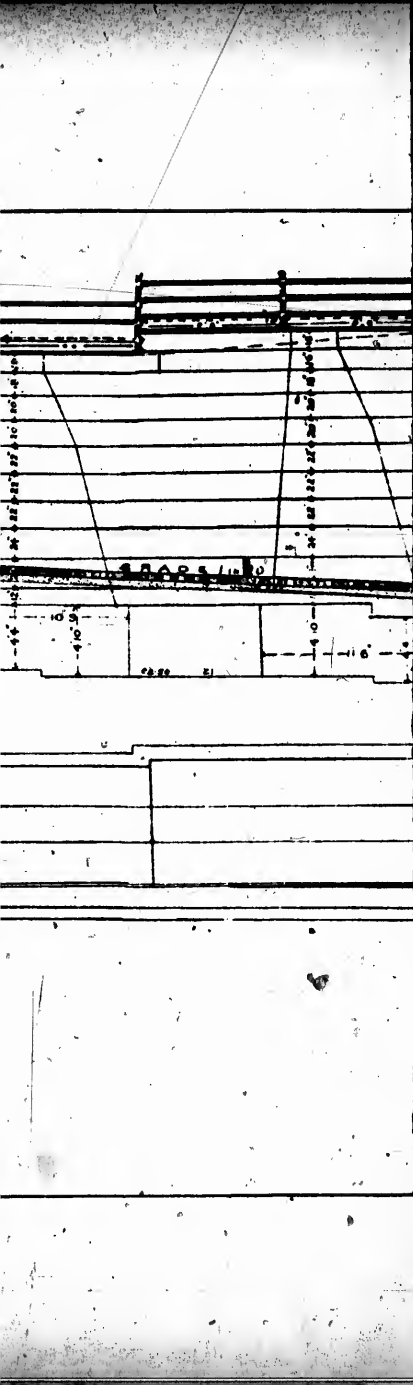


K STREET TUNNEL

th Portal and Retaining Wall.

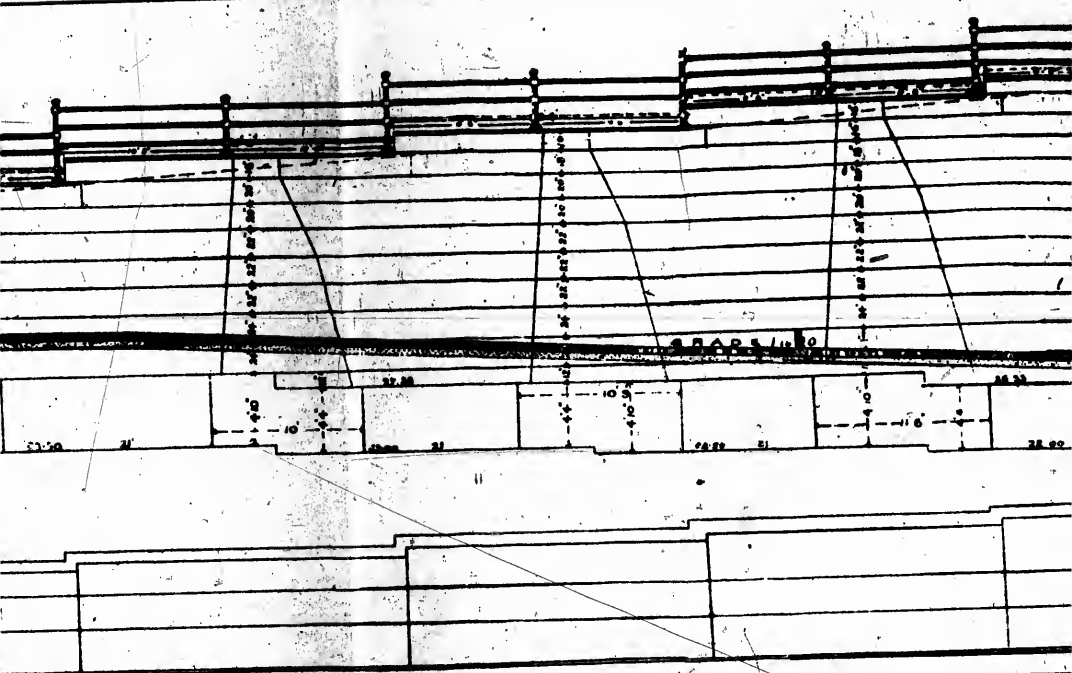
Grade of Foot.

*Revised. W. H. ...
by ...*



OCK STREET

North Portal and Retain
Scale of Feet

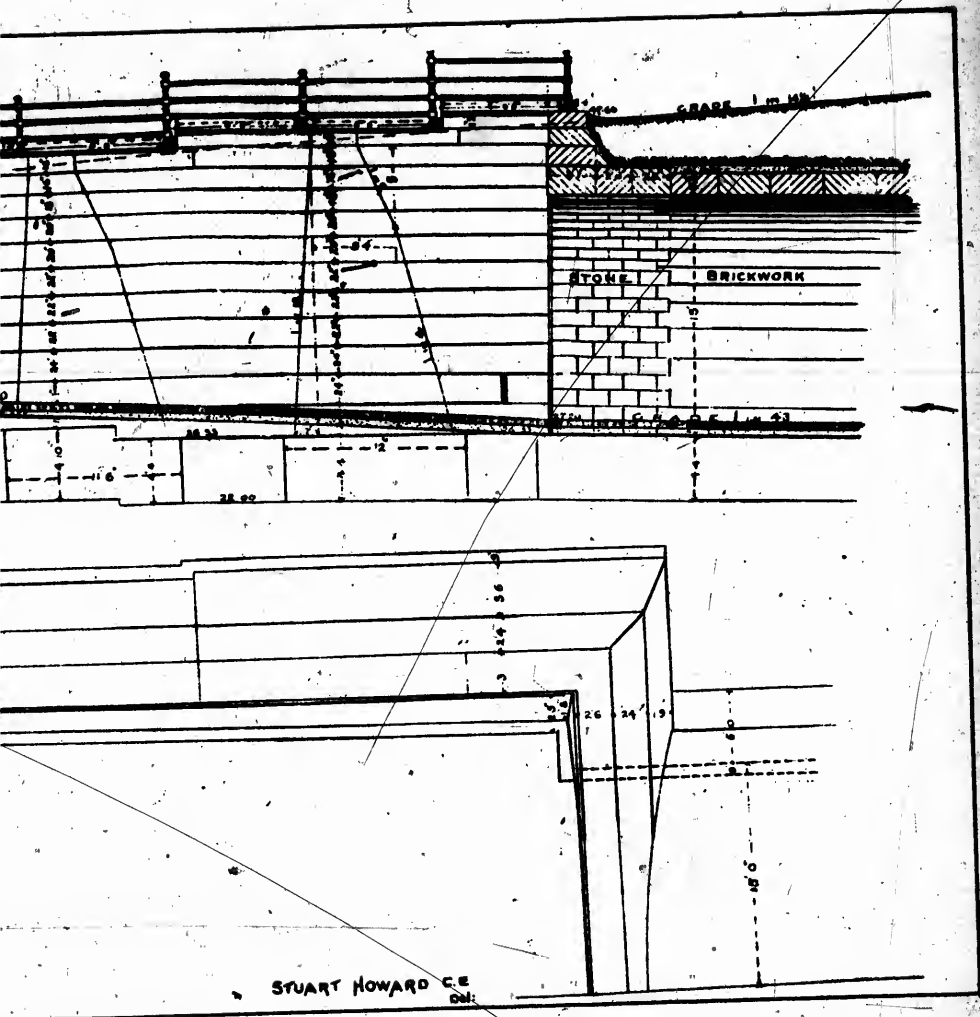


RET TUNNEL

Retaining Wall.

Feet

*Revised. Williams
by design*



STUART HOWARD C.E.
D.R.

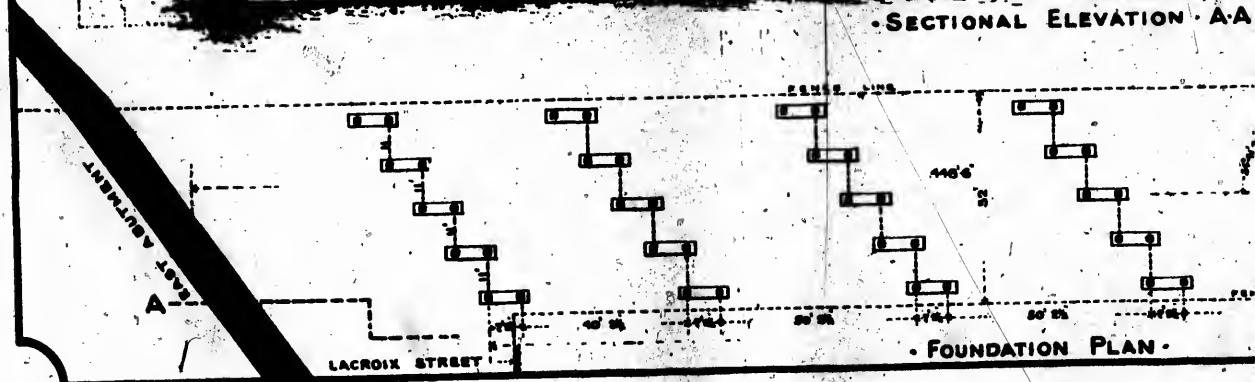
CITY OF MONTREAL
NOTRE DAME STREET VIADUCT

*Revised to Plans
by J. J. J.*

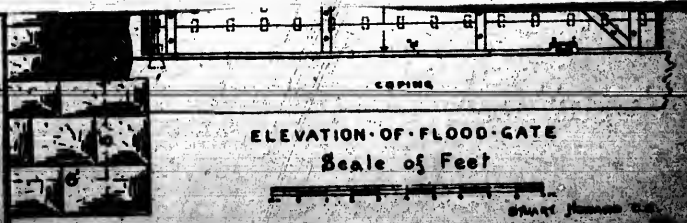
SCALE 40 FEET TO AN INCH



SECTIONAL ELEVATION - A-A



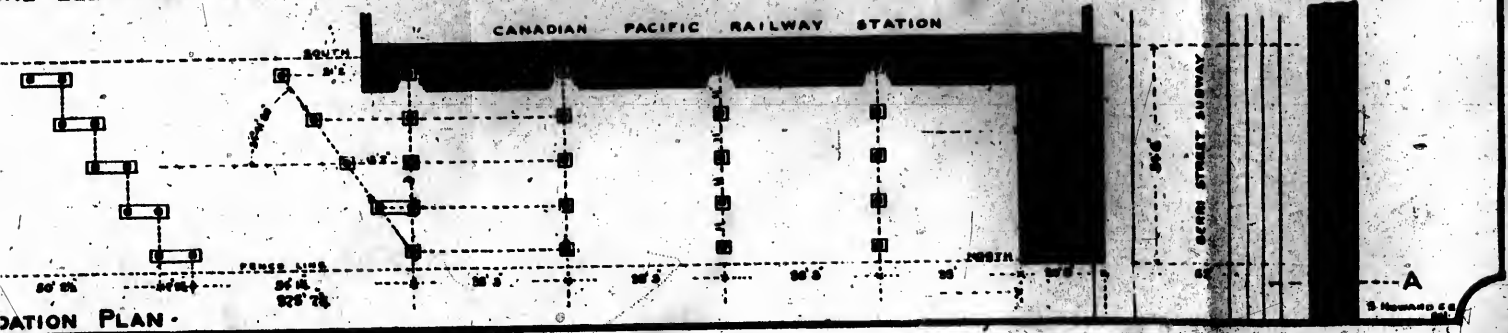
FOUNDATION PLAN



ELEVATION OF FLOOD-GATE
Scale of Feet

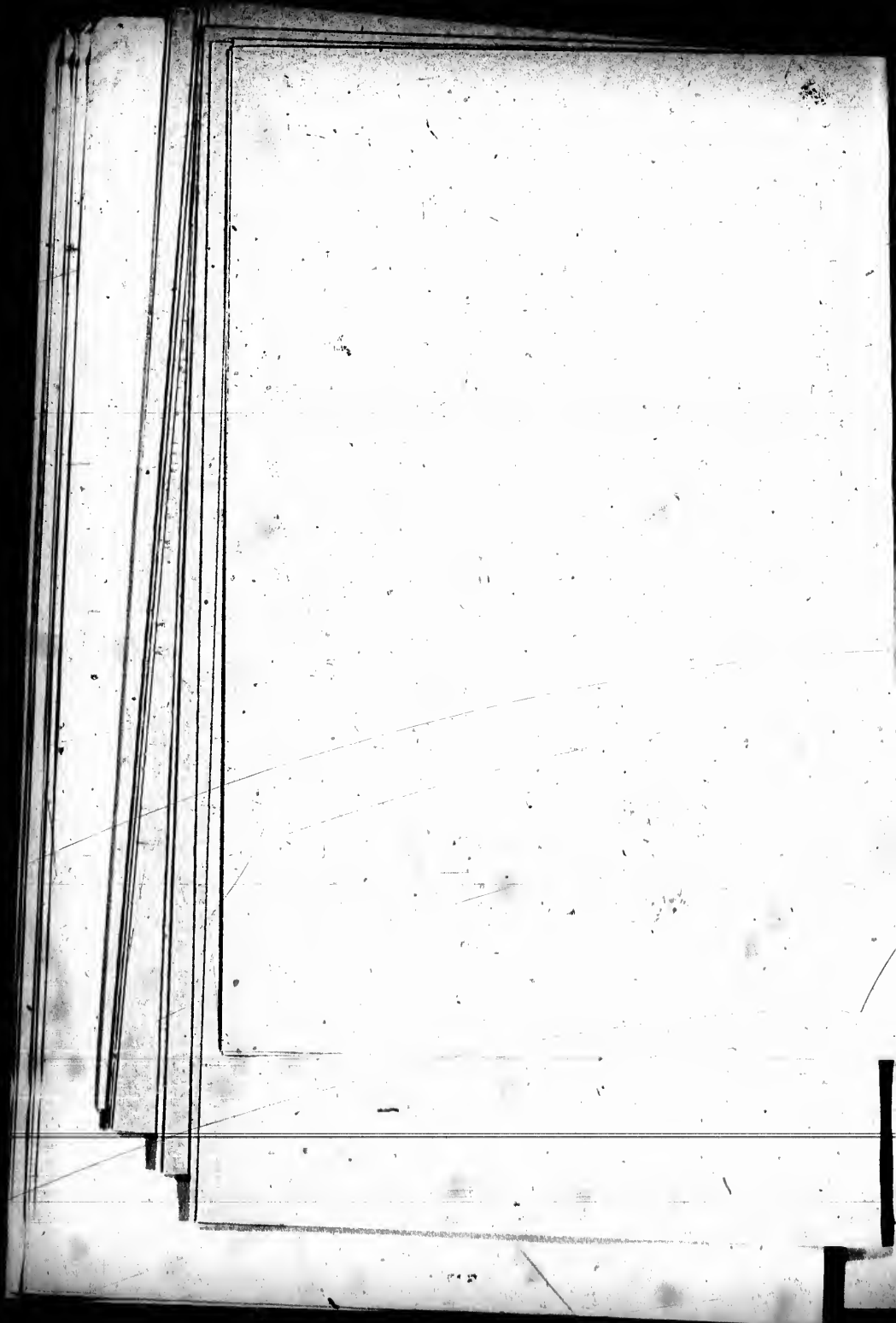


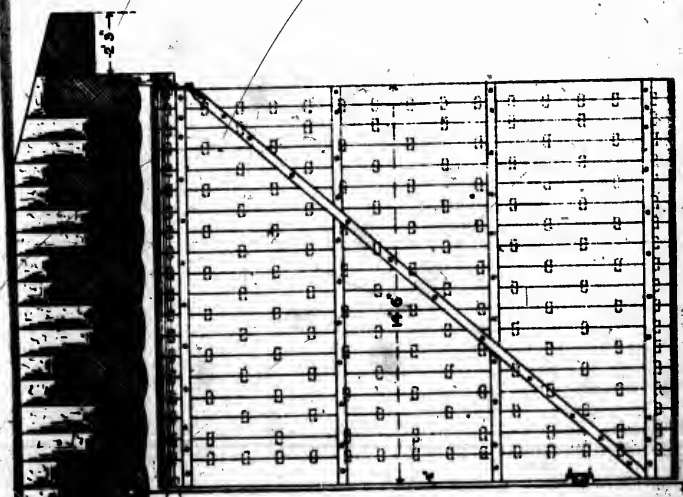
AL ELEVATION - A-A -



FOUNDATION PLAN -

A
S. HERRING & CO.





COPIING

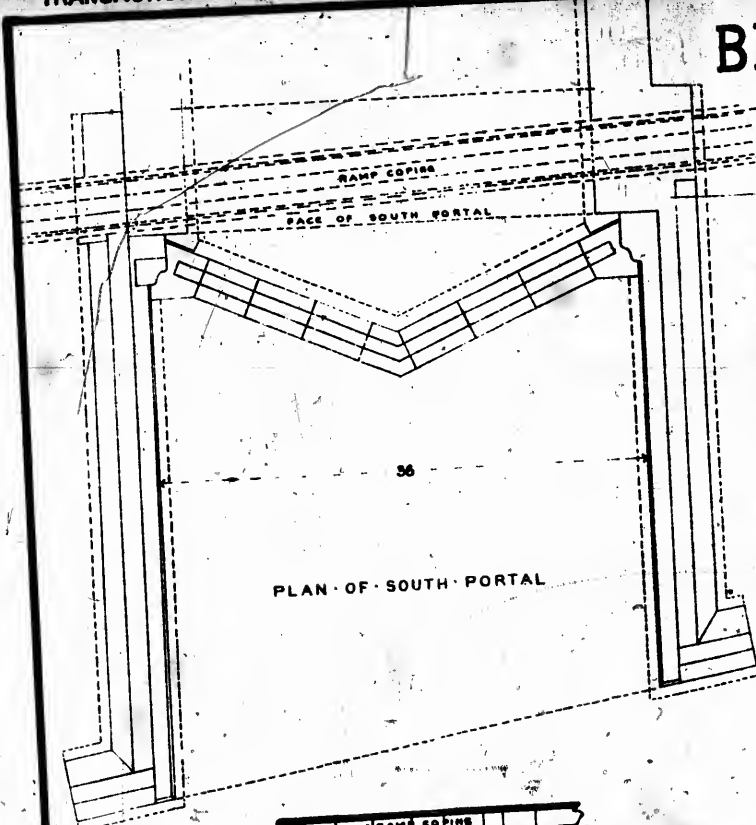
ELEVATION OF FLOOD-GATE
Scale of Feet



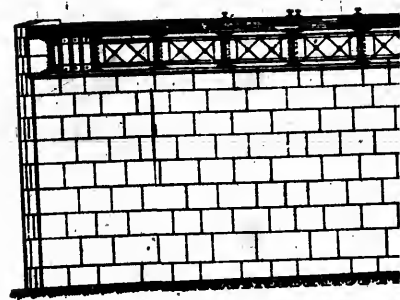
STUART HOWARD C.E.
Des.

BROCK STREET SOUTH PORT

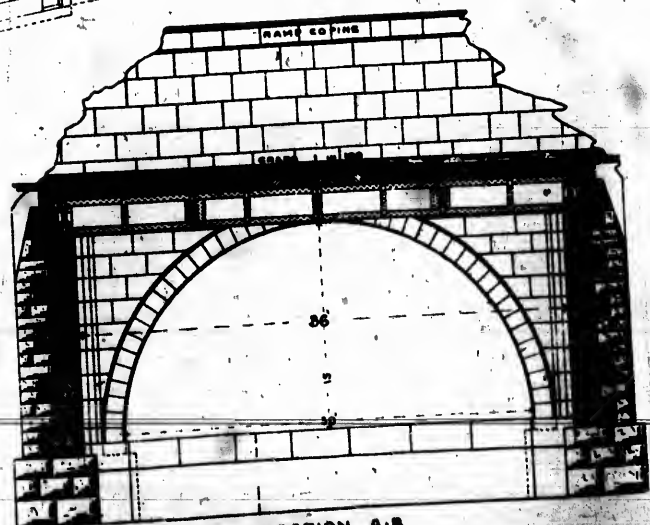
Proctor



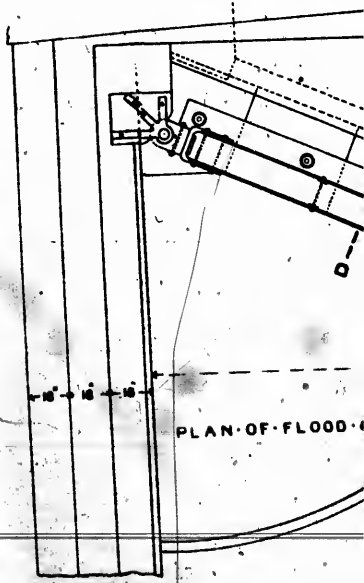
PLAN OF SOUTH PORTAL



Scale of Feet



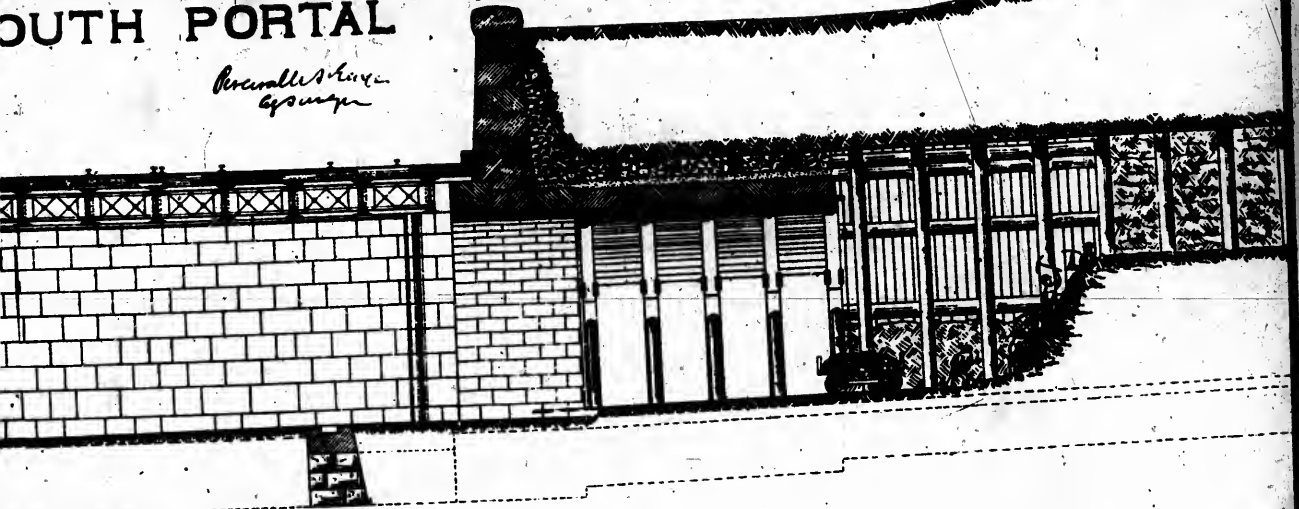
SECTION A-B



PLAN OF FLOOD

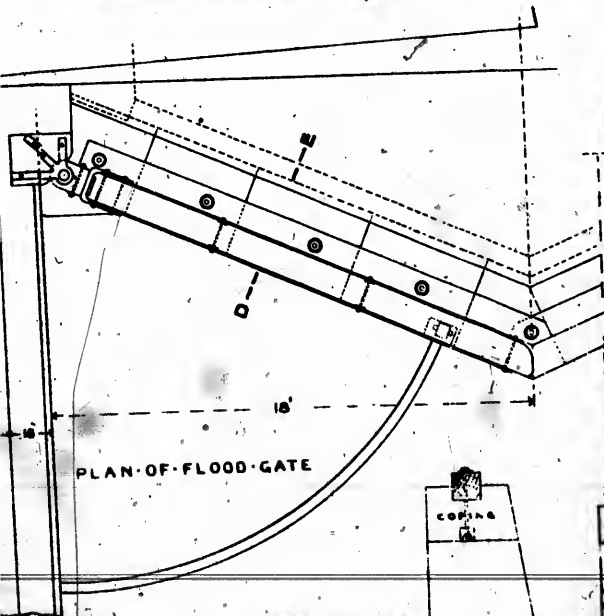
K STREET TUNNEL SOUTH PORTAL

*Revised March
1907*



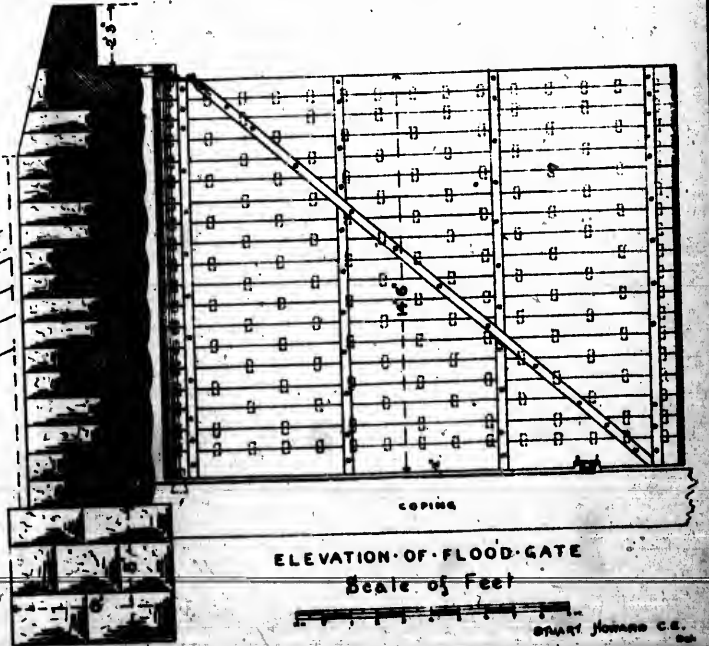
Scale of Feet

SECTION C-D



PLAN OF FLOOD-GATE

SECTION D-E



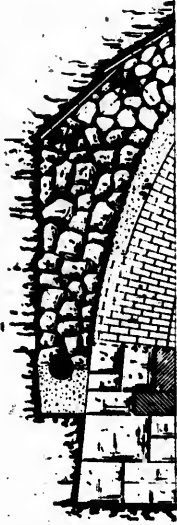
ELEVATION OF FLOOD-GATE

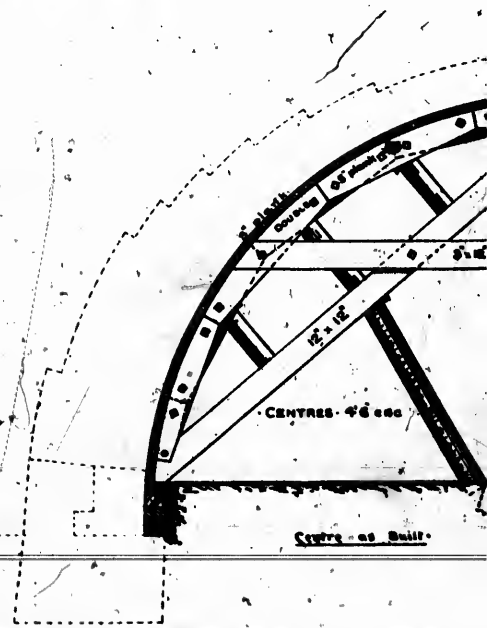
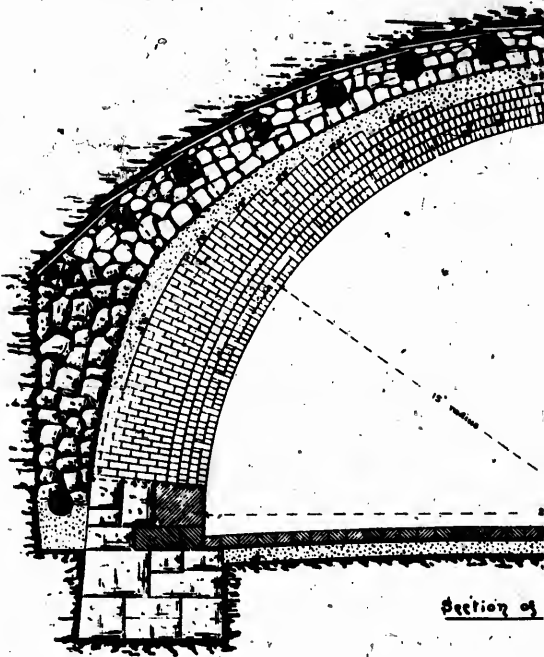
Scale of Feet

SMART HERRING C.E.



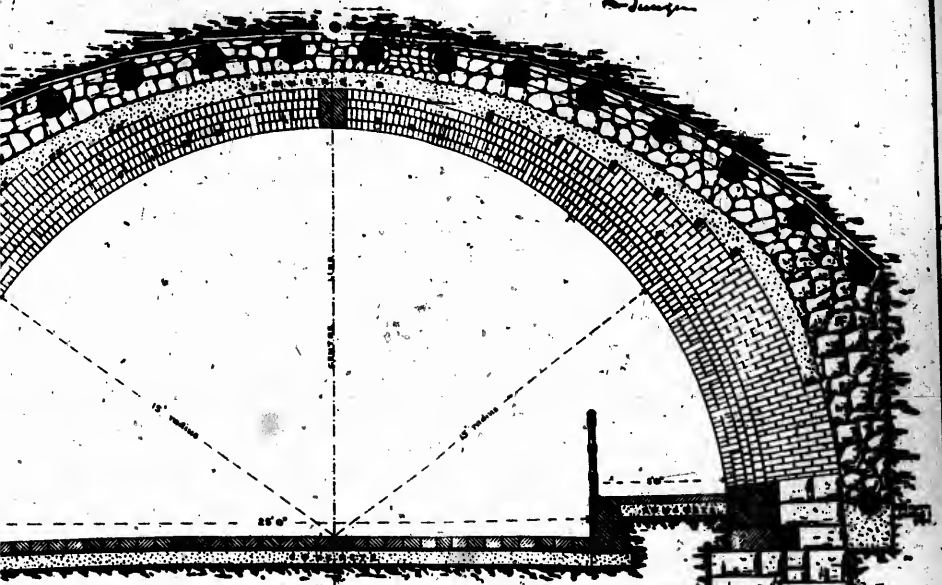
TRANSACTION
VOL. XIII



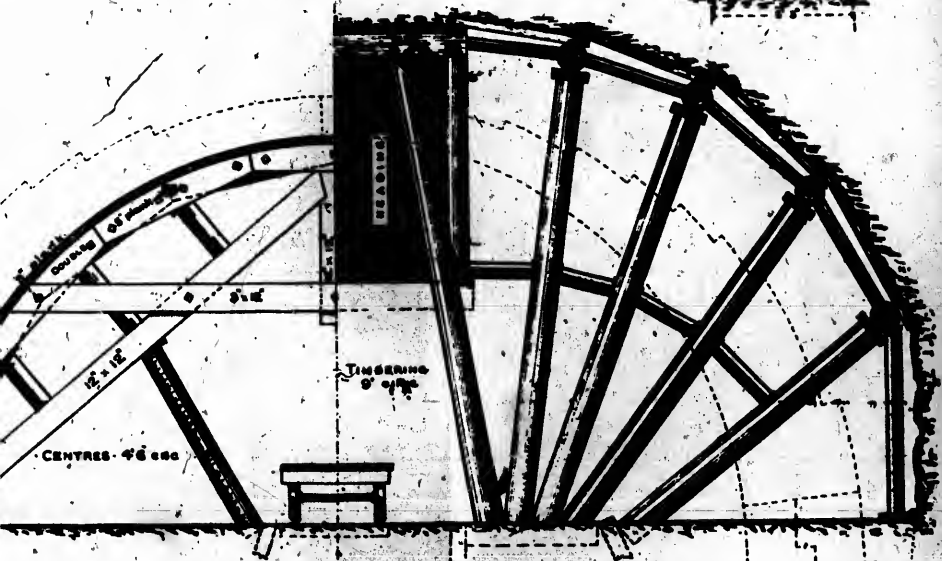


BROCK STREET TUNNEL

*From the
original*



Section of Tunnel - Contract Drawing



CENTRES - 46' 00"

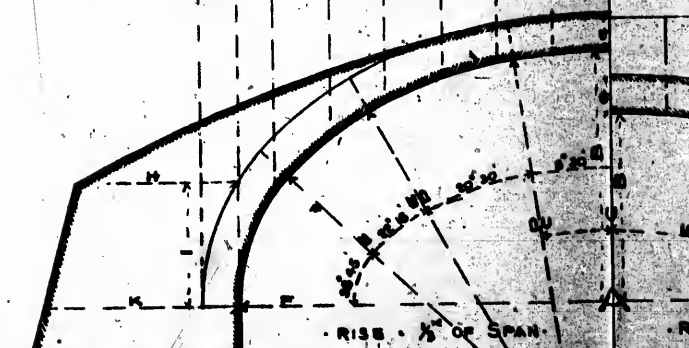
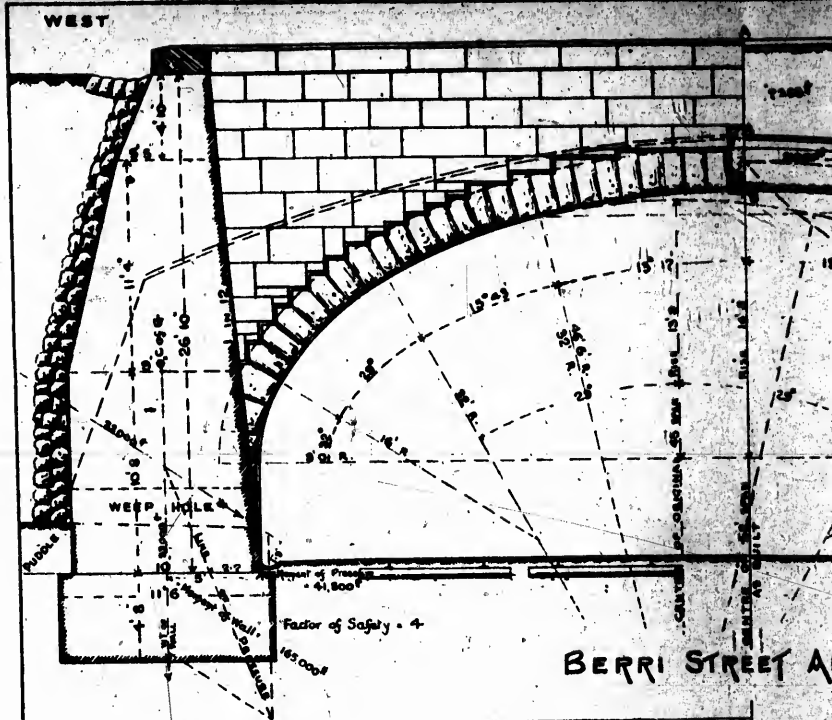
Centre as Built

Supporting - Timbering as Built

Scale of feet

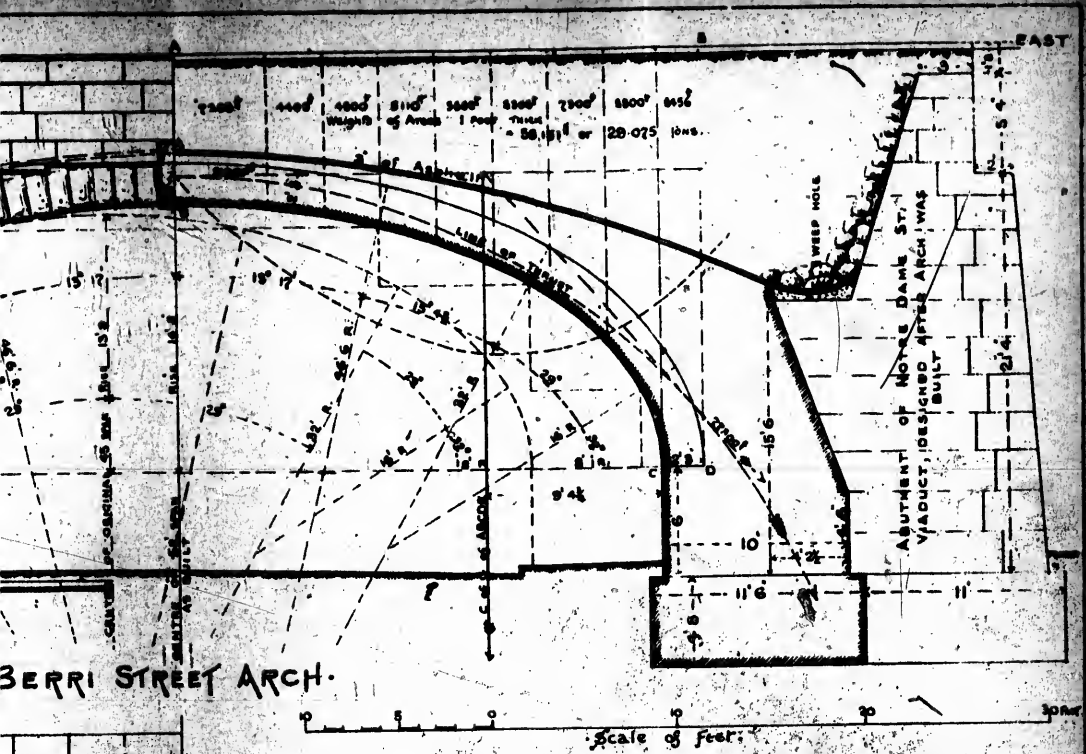




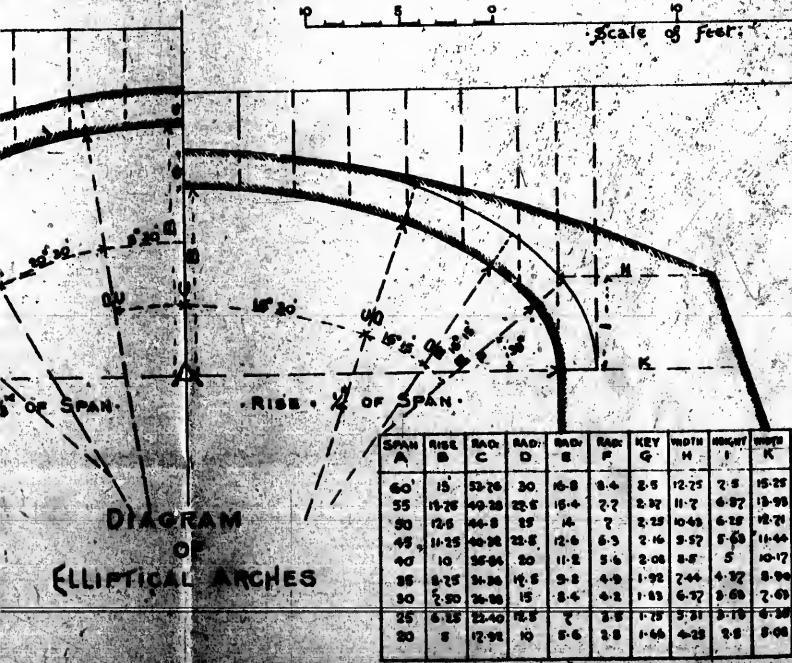


SPAN A	RISE B	CHORD C	CHORD D	CHORD E	CHORD F	KEY G	WIDTH H	HEIGHT I	WIDTH K
60	20	52.5	24.5	20.75	15	2.42	15.05	10	15.45
56	18.67	48.85	22.45	19.25	13.75	2.30	14.96	9.17	14.16
50	16.67	43.75	20.75	18.45	12.5	2.18	14.82	8.35	12.82
45	15	39.57	19.45	17.96	11.25	2.10	14.72	7.5	11.58
40	13.33	35	18	17.5	10	2.00	14.65	6.65	10.3
35	11.67	30.45	16.75	17.05	8.75	2	14.61	5.85	9
30	10	26.85	15.25	16.55	7.5	1.95	14.57	5	7.75
25	8.33	23.25	14.05	16.1	6.25	1.85	14.54	4.16	6.44
20	6.67	20	12.8	15.65	5	1.75	14.50	3	5.15

DIAGRAM OF ELLIPTICAL ARC



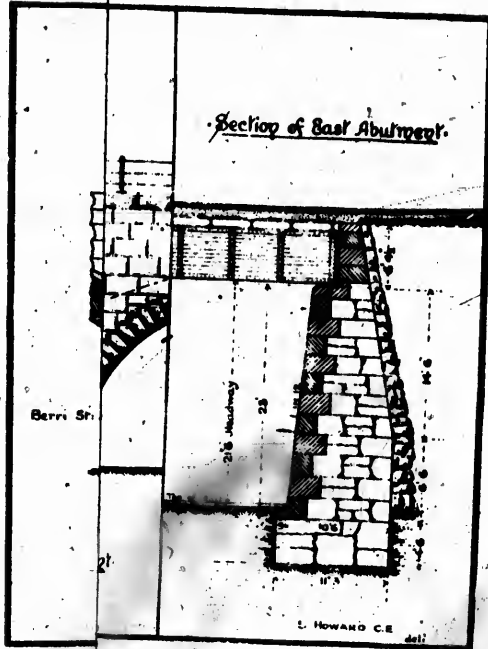
BERRI STREET ARCH.



Copyright, 1908
Stuart J. Hayward, C.E.
M.C.S.C.E.



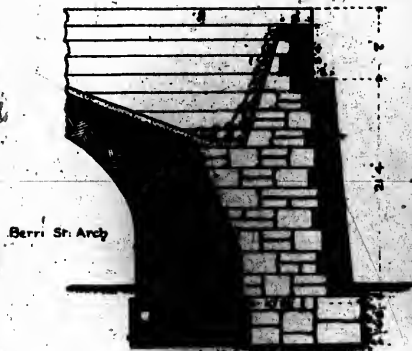
TRANSACTIONS CAN. SOC. C. E.
VOL. XIII PLATE XXIV





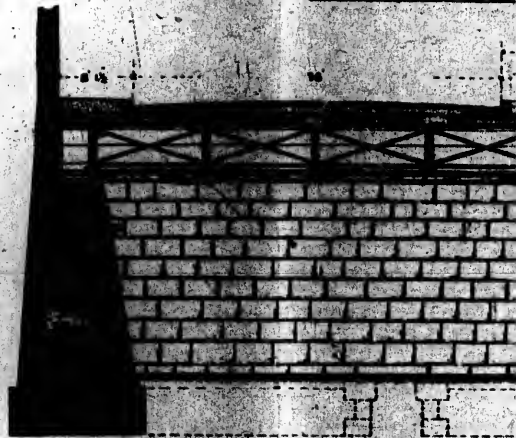
CITY OF MONTREAL
NOTRE DAME STREET

SCALE 1/4" = 10 FEET



Berri St. Arch

Section of West Abutment

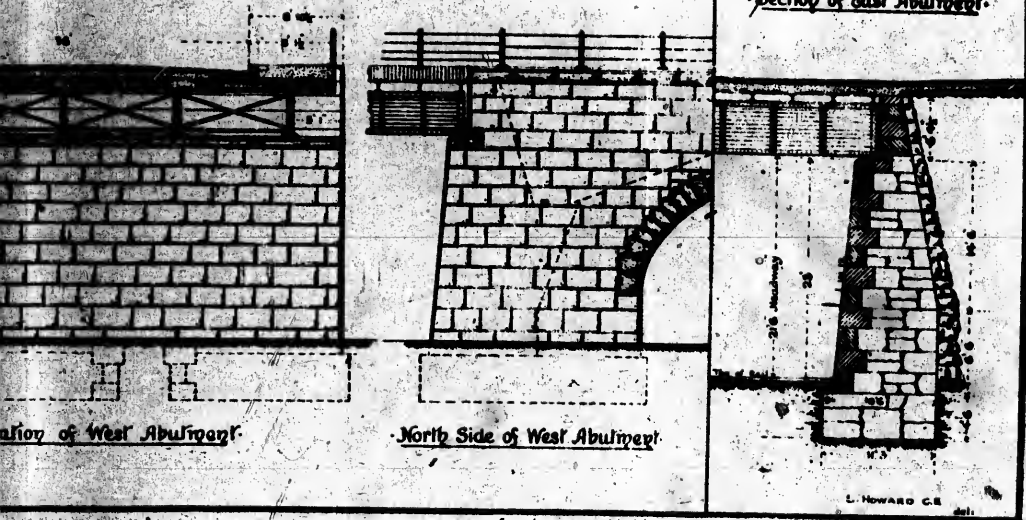


Front Elevation of West Abutment

CITY OF MONTREAL
RE DAME STREET VIADUCT

SCALE 16 FEET TO AN INCH

*General at level
of bridge*



Section of East Abutment

Section of West Abutment

North Side of West Abutment

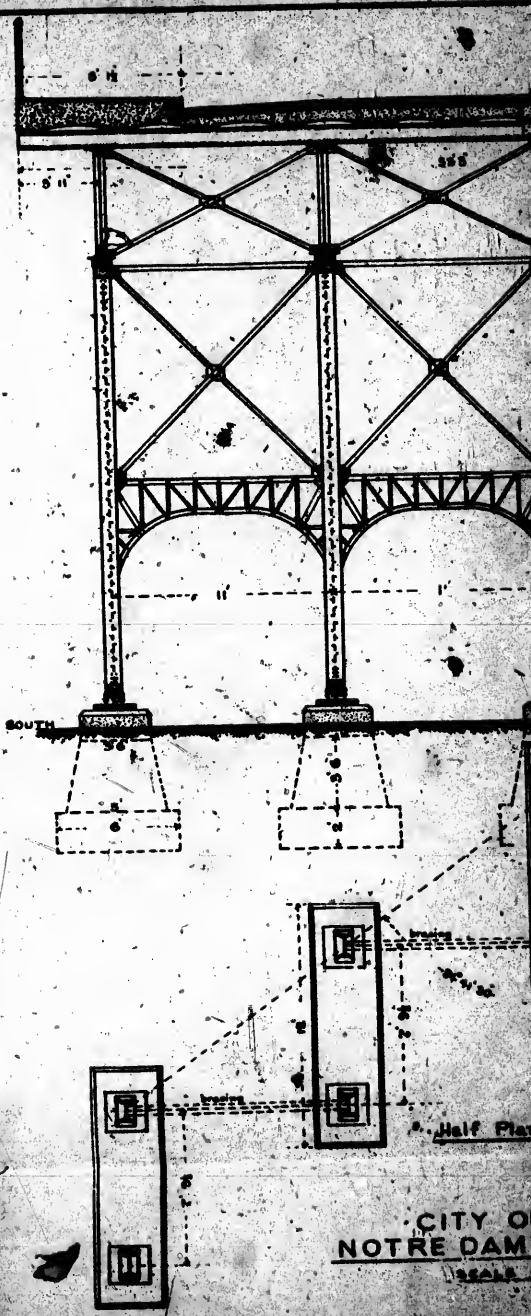
L. HOWARD C.E.

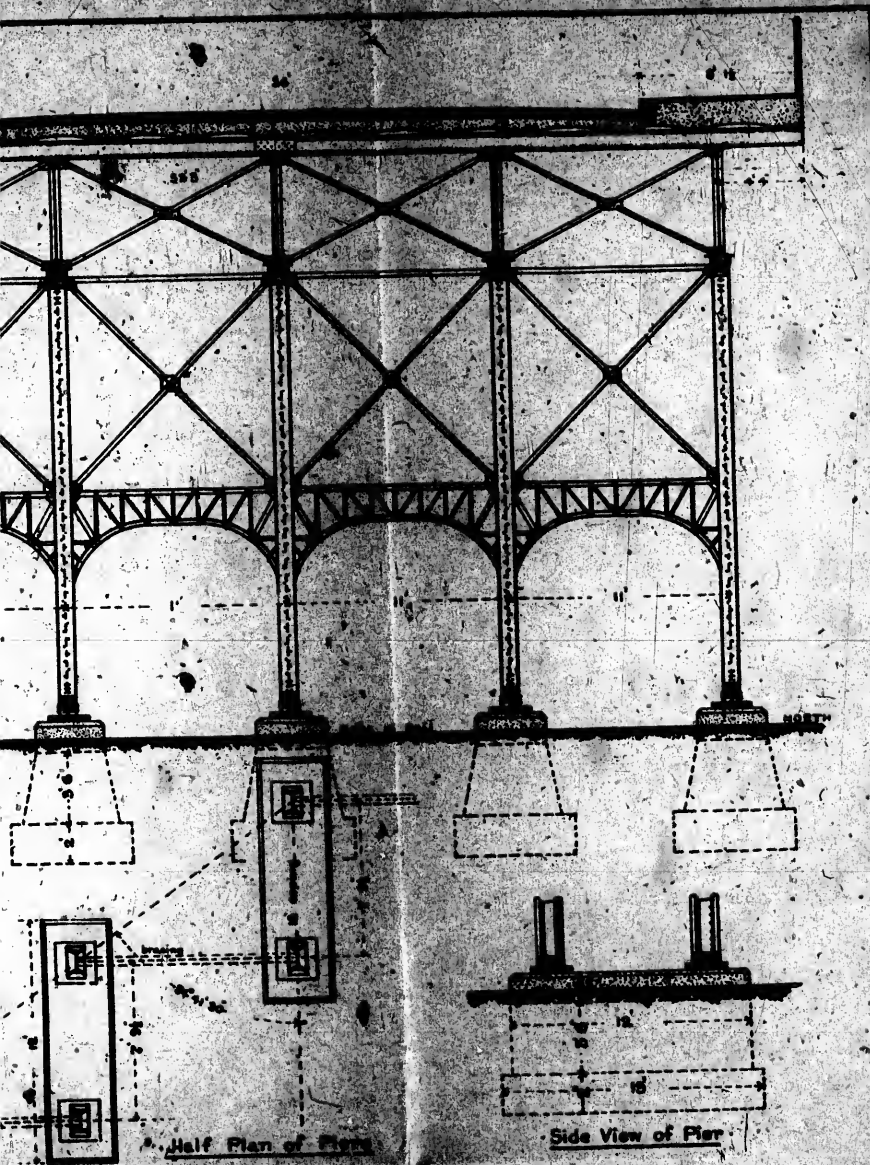




SOUTH







CITY OF MONTREAL
NOTRE DAME STREET BRIDGE

SCALE 1/4" = 1'-0"

W. H. ...
...

L

OCK STREET TU

North Portal and Retaining Wall

Scale of Feet



