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A NEW 24" WATERMAIN CROSSING UNDER THE RED RIVER AT REDWOOD AVENUE

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I would like to begin my paper on a day back in the spring of 1952, when I arrived at the Waterworks Office one morning, to learn that the 12 inch watermain crossing the Red River at Rover Avenue had failed, leaving the Elmwood Area dependent on a single 10 inch supply main. There was great concern over the situation, because the 10 inch main located at Redwood Avenue had been in service since 1908, and had given trouble in May, 1934, in May, 1937, and again in May, 1945.

It was readily apparent on that morning of May 1st, that with the Red River still at its spring level, there would be virtually no hope of making a repair for several weeks, and possibly not for months. By eleven o'clock on that morning, a decision was reached to install a temporary ten inch main on the Louise Street Traffic Bridge. Full resources of the City Engineering Department were directed to the task of providing the temporary crossing. Crews worked around the clock, and by three o'clock of the following afternoon, the new main was put in service. This was no small accomplishment, for in less than 28 hours, 665 feet of 10 inch asbestos cement water pipe was installed and anchored to the bridge. In addition, close to 550 feet of cast iron water pipe was installed on the bridge approaches, to make connection with the existing distribution system on either side of the river. As an immediate emergency measure, three temporary fire hose lines were laid across the bridge by noon of the first day. It was a major effort on the part of all who worked on the project.

The repair was completed during the latter part of July, with the assistance of a local diver. A barge was rented and anchored at the location of the break, which was approximately at mid-stream. Repair operations were carried out from a platform constructed at the rear of the barge, using oil drums as floats. This was the third river main repair on which the services of a diver were used.

The technique followed in making such a repair is for the diver to investigate the conditions of the break. After deciding where the pipe is to be cut, the diver places the pipe cutter on the pipe, and the cutter is rotated from the surface by means of a rope attached to the handle of the cutter. The diver back-cuts, and tightens the cutter for the next stroke. The cutting operation is naturally much slower than making a cut on the surface. Nevertheless, the method is quite practicable, and as long as the cutting wheels are in good condition, cutting time is not excessive. Most of the failures have been caused from "cramping" of the ball and socket joint, to the point where the socket splits. Two cuts are generally required, the location being determined by the length of the filler section. Most of the original crossings were laid on the bed of the river, in such a manner as to be bowed up stream.

When a failure occurs, mis-alignment of the pipe usually takes place, and it is necessary to locate the relative positions of the two sections and lay out a system of bends and straight pipe to make the reconnection. Universal Pipe has been used on several recent repairs, and adjustable couplings installed at the new joints. A great amount of coordination is required between the diver and the surface crew in lining up and handling the pipe under water. This particular repair required several days to complete, and was carried out in about 15 feet of water.

Due to the growth in recent years of the Municipalities east of the Red River, it was proposed in an overall Plan to add a third crossing in this vicinity in the relatively near future. In view of the seriousness of the situation, it was decided to leave the temporary crossing on the Louise Street Bridge until arrangements could be completed for an additional permanent crossing. Plans were made to construct a new 14 inch steel watermain across the Red River at the foot of Disraeli Street during the winter of 1953-1954. The decision to leave the temporary main in place, proved to be a sound one, because on December 14, 1953, a joint leak developed on the Rover Avenue crossing in the north bank. This was repaired only to have another break occur further up the bank. When this repair was completed, it became evident that a major break existed in the river portion. It was then decided to abandon this crossing, which was installed in 1925, as being uneconomical to maintain.

In recent years there has been a change of thinking, regarding the placing of the pipe on the bed of rivers. In both the Disraeli Crossing and the new Redwood Crossing, the pipe is installed in a trench excavated in the river bed, and backfilled with sand. With four river main failures between 1950 and 1953, it is quite understandable that the City Engineering Department should give consideration to supplementing its crossings, both on the Red and Assiniboine Rivers. At the present time, there are two of eight crossings out of service on the Assiniboine River. The 10 inch Harrow Street Crossing, which was installed in 1913, and last repaired in 1950, is shut off and the leak not yet located. In all probability this crossing will be abandoned. The 18 inch Middlegate Crossing serving the south section of the City, has been out of service since late spring. Attempted repairs have proved unsuccessful, and at present a 16 inch welded steel pipe, approximately 500 feet long, has been installed in the Assiniboine River, and is being connected temporarily to the existing crossing by means of risers half way up the banks. Consideration is being given to the possibility of a permanent bridge-type crossing, either on the Maryland Street Bridge, or some other form of supporting structure. Experience gained through the operation of the temporary crossing on the Louise Street Bridge, dispels any great concern over the danger of freezing. While the pipe was insulated as a precaution against freezing, it was concluded that even during the low flow periods at night, a feeder main is unlikely to give trouble.

It might be of interest to note at this time, that the Department is proposing to install a 36 inch watermain across the Assiniboine

River, in the vicinity of Arlington Street, initially to take care of the supply to South Winnipeg, and ultimately to provide a tie-main between a new proposed Pumping Station at the South City Limits, and the existing McPhillips Street Station.

The 10 inch river crossing at the Redwood Bridge, is out of service as a result of being damaged during the construction of the new crossing which is located only a few yards down stream. Unfortunately, the bucket of the excavating machine picked up a timber, which was lodged under the watermain, lifting the main to the point where a lead joint pulled out. The main was subsequently lifted by chain blocks to the surface of the ice, and repaired. However, the repair proved unsuccessful, and finally it was decided to install a 10 inch temporary line on the ice, until the new main was completed. When spring break-up was imminent, and it was evident that the new crossing would not be ready in time, a 12 inch temporary line was installed on the Redwood Avenue Bridge. Both the Redwood Avenue and the Louise Street Bridge are classed as being on a navigable stream, and at times are subject to being opened to allow passage of large boats. In the case of the Louise Street Bridge, permission was obtained to leave the bridge closed to navigation during the period the temporary main was in place. Such has not been the case with the Redwood Avenue Bridge, which has had to remain open to navigation during the past summer. To open the bridge, it is necessary to shut off the watermain, and to disconnect the pipe temporarily. This problem would not be present with bridges on the Assiniboine River, or on the southern section of the Red River.

I have digressed somewhat from the main topic, in order to provide some background as to the importance of adequate river crossing facilities, and also to indicate some of the problems that are presently being encountered here in Winnipeg.

The new 24" watermain crossing at Redwood Avenue now under construction, is rather interesting from the point of view of design, and also as to the method of construction, and most certainly from the difficulties that are being encountered, and which are preventing its completion. Redwood Avenue is in North Winnipeg, about fifteen blocks or approximately one mile north of the Royal Alexandra Hotel. It is the logical location for a major crossing to serve the Elmwood Area, including North and East Kildonan.

One of the problems encountered in the design of this crossing was the unstable condition of the West river bank. A short distance below the proposed location, the bank of the Red River has moved considerably during recent years. The Engineering Department engaged a local Soils Consultant to carry out an investigation of this bank and to submit a recommendation as to its stability, relative to the proposed installation. From the Consultant's Report, it was evident that this bank would be subject to slippage, making it inadvisable to install a main unless it was kept below the probable line of failure.

Considerable experience had been gained in constructing sewers in tunnel, so it was decided to construct a vertical shaft some 70 feet back from the edge of the bank, and to install a horizontal tunnel supported on the boulder clay. The shaft is rectangular in shape, 5 1/2 feet x 9 feet inside measurement, and approximately 55 feet in depth. The tunnel section is 66 inch circular, having a wall thickness of 10 inches, and is 188 feet long. The tunnel was made large enough to allow working room for installing and servicing the 24" steel pipe. The watermain is supported by concrete pipe saddles, on approximately 20 foot centres. The tunnel section slopes to a sump located at the bottom of the shaft. A 3 inch cast iron airline extends to the end of the tunnel for ventilating purposes. Victaulic couplings are located at every third joint in the tunnel section to compensate for expansion and contraction. The lengths of pipe in the tunnel section were limited to 15 feet because of turning the angle at the bottom of the shaft. Copper strips 6 inches wide, 20 gauge, were used for water stop at construction joints in the shaft. Z-Rib Labyrinth water stops were used for construction joints on the tunnel section.

The pipe under the river was installed in a trench excavated so as to be approximately four feet below the existing bed. The pipe is resting on a strata of boulder clay a few feet above the surface of the rock. On the East bank, the pipe terminates in a valve chamber. The depth of fill over the pipe in the East bank varies from 10 to 16 feet. The length of the entire main from the shaft to the point of termination on the East bank is approximately 750 feet.

The 24 inch steel pipe meets A.W.W.A. Standard Specifications 7A.4-1949 for steel water pipe for sizes up to but not including 30 inches. The thickness of the spiral welded pipe is 0.3125 inches, fitted with flanged joints, coupled together with stainless steel bolts. Coal tar enamelled coatings are provided both inside and out, with an added protective felt wrapping on the outside, meeting A.W.W.A. Standard Specifications, 7A6 for Coal Tar Enamel Protective Coating for Steel Water Pipe, for sizes up to 30 inches.

Special connections had to be designed at both terminals so as to tie in with the existing facilities leaving provision for additional supply connections to develop the full capacity of the crossing. On the West bank, a new 14 inch asbestos cement line connects between the vertical shaft and a new 7' x 7' valve chamber on the existing 10 inch supply mains. A 24" blank flange is available for future connection. On the East side the 24" pipe is blank flanged in the 9' x 9' valve chamber, with a 12" connection to the existing system.

It might be interesting at this time to discuss the question of the size of the crossing. Originally, it was planned to install a 14" crossing, the same size as installed on the Disraeli Street main. Considering future requirements, it was decided to increase the size to 18 inches. Steel mains in the smaller size, with coal tar coating, present a problem in regard to joints being field welded. To overcome this problem, flanged joints were used with stainless steel bolts on the Disraeli Street Crossing. The Greater Winnipeg Sanitary District had recently installed 24" steel pipe with welded field joints, and with this size it was possible to repair the lining at the joints from the inside of the pipe. On comparing the economy of the proposed 18 inch size with flanged joints and stainless steel bolts, as against the 24" with welded joints, it was considered advisable to select the larger size, and take advantage of the greater capacity for future requirements. However, in the final design, flange joints with stainless steel bolts were used in preference to welded joints.

From a construction point of view, it was anticipated that the most critical section would be the junction between the tunnel section and the open pipe in the river bed. At this point, the pipe drops at an angle, a distance of approximately 5 feet. A dresser coupling was specified for the connection, and the entire section was to be encased in concrete. The profile indicated that this section of the pipe would be about 20 feet below winter ice level, and it was proposed that the connection would be made by means of a coffer dam.

Contract for the construction of this crossing was awarded to Prairie Construction Company Limited in October of 1954. It was hoped that the river portion would be completed by December 20th, 1954; the West shaft and tunnel by March 1st of this year. The contractor requested permission to construct the shaft by sinking it in eight foot sections. A special type of cutting head was to be installed on the first section. There was some concern as to whether it would be possible to maintain a vertical shaft, using this method. Permission was granted, however, providing the vertical alignment was maintained within a tolerance of 2 inches. Actually, the alignment was maintained well within this figure. The contractor is to be commended on the method he used to construct the vertical shaft. Work was commenced on October 18th, 1954, when the first section measuring

2.5 feet in depth, was completed. Subsequent sections were 7.5 feet in depth, and required approximately 12 cubic yards of concrete per section. By November 2nd, sinking of the fourth section had been completed, and, by November 13th, two additional sections were in place. The sinking operation of the shaft was virtually completed by November 23rd. At this time small testholes were placed in the bottom of the shaft to determine the depth to hard pan, and also to ascertain whether water might be encountered. As a result of the testholes, it was decided to sink the shaft a further 20 inches so as to be properly bedded on the hard pan strata. By December 2nd, the shaft had been sunk to its final grade, which was almost 55 feet below the surface. On December 8th, 12 1/2 cu. yds. of concrete were poured completing the bottom section of footing and floor.

Construction of the tunnel section was started immediately, and also, at this time, work commenced on the construction of a temporary pile bridge across the river to carry the excavating machines for digging the trench in the river bed.

By the end of December, the contractor had completed the shaft, about 50 feet of tunnel, the temporary bridge, and three sides of the Coffer Dam. Progress on the tunnel section continued satisfactorily, and by January 12th, approximately 90 feet had been completed. However, considerable trouble was being encountered in trying to seal off the coffer dam. January 24th was an unfortunate day for the contractor, because, on that date he broke the existing 10 inch watermain. This appeared to be the turning point in the construction schedule. From this date to February 10th, crews were engaged trying to repair this 10 inch watermain and, finally, it was necessary to install a temporary main on the ice. It was not until February 24th that the 24" main was tested and ready for placing. The method used on both the Disraeli Main and the Redwood crossing was to support the pipe in its entire length by means of chain blocks fastened to A-frames. While in this position, the pipe coating was tested for breaks by means of a Holliday tester, which measures the resistance of the coating to an electrical current. After the river section was installed and backfilled with sand, work commenced on removing the temporary bridge. In the meantime, the tunnel crew had proceeded to within 20 feet of the end of the tunnel section. On March 19th, the ground pressure in the tunnel became too great, and the tunnel excavation had to be stopped.

It was subsequently decided to try installing a tunnel liner inside of "four poling". This latter method consists of driving four 16 inch interlocking poling sections alternatively forward at the top of the excavation for support during the installation of the tunnel liner. This method proved to be unsuccessful because of the presence of large boulders which prevented the penetration of the poling sections.

Next it was decided to install a culvert, 28 feet long, inside the existing tunnel. The culvert was 62 inches in diameter, just small enough to clear inside the 66 inch tunnel. The culvert was jacked-in a distance of approximately five feet. However, at this point, the face blew in a distance of close to 20 feet, due to the excessive ground pressure. The next operation was to build up a face of shoring with in the culvert, and proceed with moving the face back to the extreme edge of the culvert. At this stage the situation was reviewed, and because of the high spring level of the river, it was concluded that the only hope was to freeze the surrounding ground. A 7 1/2 ton Freezing Plant was procured, and a series of twenty pipes driven in to a penetration of 5 to 15 feet around the section to be frozen. It took three weeks to freeze an eleven foot section solid enough to allow work to proceed. Tests indicated that a frozen cover of at least 2 1/2 feet existed at the top of the tunnel. Using this method, work proceeded to 17 feet beyond the face of the culvert. As progress was made 1" test holes were inserted to determine the depth of frost. At this point, a 1" test hole was driven 4 feet ahead of the excavation and as no water was encountered, it was decided to drive a larger hole through to the same depth. Unfortunately, this hole must have penetrated the frost face, because inside of a couple of hours a considerable quantity of water was flowing through the face and in a relatively short time the entire freezing effect was lost. The tunnel was then flooded in an attempt to prevent a complete collapse. In spite of this precaution the excavated section did collapse. It was necessary to pump the tunnel dry, recover the original freezing points and install a complete new system. At the same time approximately 2000 cubic yards of fill was deposited in the river to form a peninsula to cover the entire working area. It has been possible to install the new freezing points to a penetration varying from 15 to 25 feet ahead of the edge of the culvert because of having removed many boulders that had prevented penetration in the orignal installation. The freezing operation has now been underway for ten days, and excavation is expected to begin in approximately one week. It is to be hoped that the Contractor will be successful in this attempt to complete the juction between the river section and that portion in tunnel. The river section is presently anchored with a huge block of concrete to prevent movement of the pipe through floating.

In conclusion, I would like to acknowledge the valuable assistance received from Mr. Gordon Denson, Engineer of Water Works and Sewerage, City of Winnipeg; Mr. Gordon Laurie, Inspector, Water Works and Sewerage Branch, City of Winnipeg Engineering Department; Mr. Ian Stuart, Resident Engineer for the Contractor; and Mr. Mike May, President, Prairie Construction Co. Ltd. in providing information for this paper.