wheel to the outside of the paved part of the road way. Vehicles could always keep to their own side of the road without going off the paved portion, while it will always give a play of nearly two feet on each side, and of nearly four feet altogether in the width allowed to the vehicle to travel over, thus leaving space enough for vehicles to avoid always going in the same track, and wearing the roadway into ruts.

If any further addition is to be made to the width of the macadamised part, it should be enough to allow three vehicles to pass over it abreast i. e., sixteen feet and seven feet four inches, or twenty-two feet eight inches in all. This is a common width for the paved part of the roadway of this description, as the difference of one foot eight inches can be gained by reducing the two feet of spare width at the outsides by ten inches on each side; however the clear width between the ditches should not be less than twenty-four feet, while a thirty foot roadway will allow four vehicles to meet abreast, and thirty five feet is enough for a regular traffic of four vehicles.

In cuttings or embankments in ordinary loose earth or gravel, the side slopes should be made one and one half horizontal to one vertical; in rock one quarter to one is sufficient; for stiff clay two to one should be allowed and soft greasy clay requires a slope of three to one to be allowed. In the case of ordinary earth when cuttings or embankments are not more than five feet high, a slope of one to one is sufficient, and one half to one in stiff clay.

In the case of embankments, the surface of the ground when it has a transverse slope such as would cause the bank to slide latterally, should be cut into steps before the embankment is commenced. The necessity for this for any particular slope can only be determined by the conditions of the case ; water may get in between the original surface and the made ground and render the embankment very liable to slide. All stumps, brush and vegetable material should be cleared off the surface before the embankment is commenced.

Culverts.

The question as to what kind of material is best for culverts is important to municipal authorities. A large proportion of highway expenditure is for repairing and reconstruction of timber culverts. Timber does not last long in culverts where it is subjected to the varying conditions of wet and dry. Culverts must be maintained in the road grade, and where timber is used we must expect the annual outlay for reconstruction and repairs to be very large. This is not all. The stringers or covering decays so quickly, that accidents happen by a horse or load going through them before the authorities think that the timber in them has commenced to decay. Two or three times the value of a permanent culvert is often paid to settle the damage, or the law is invoked and invariably large damages are given against municipalities, this with the costs of suit which are always large enough, make timber culverts a very expensive part of road maintinance.

PIPE CULVERTS,

The construction of culverts in a permanent manner so as to get rid of the repeated demand for repairs and renewals must be settled.

The use of vitrified collar tile and cement pipe for road culverts has now ceased to be an experiment, and the old box culverts of timber are fast becoming a thing of the past. The cost of culvert pipe is usually a little more than timber, but is soon made up in saving the cost of repairs. Well made pipe of proper strength once laid needs no further repairs, and experience shows that it will last for years. It too frequently happens that when township councils order the construction of culverts under roadways the pipes are brought on the ground, the contract is let to the lowest bidder who invariably has no experience in such work, the ditch is dug-to the required depth to carry the water from the channel above, the workmen place the pipe, sometimes with the hub down grade, or in some cases with the centre of the ditch lower than the outlet, and in this slovenly way the results are unsatisfactory.

The bottom of the trench should be rounded out to fit as nearly as possible the curve of the pipe from the lower surface up to the horizontal centre line. When collar pipe are used depressions should be cut in the bottom of the trench to fit the sockets, so that when the pipe is laid its entire lower surface from end to end will rest solid. If the ground is soft or sandy this

cannot be done, but the same result may be obtained by carefully ramming the loose earth under and around the lower surface of each section of pipe up to its horizontal centre line after it is placed in position. When quicksand is encountered a concrete foundation should be laid in order to prevent the lodgement of debris or ice. A culvert should be built with a good fall. The pipe should be laid with the hub or flange up grade or towards the inlet. When this is done properly it is a matter of no consequence how high the bank is above the pipe, for it cannot be broken by the weight of the earth. If the bank is solid and not likely to cave or slide, the end of the pipes will not require to be protected. If the bank is soft an abutment of some sort should be made to receive the end of the tile, and the foundation of this should extened below the influence of the frost to prevent heaving and settling, which might throw the end of the pipe out of position. These abutments should extend high enough to protect the banks during high water. When stone or brick abutments are too expensive, a good and cheap substitute can be made of cedar plank and posts. These should be constructed with considerable inclination towards the road bed, to prevent the pressure of the embankment from crowding the planks outward. Where gravel is plentiful a concrete for this purpose will be found preferable to timber.

A pipe culvert should have a good fall, and be so constructed that it will drain itself, When required, two or three pipes may be laid side by side, and in case of altered circumstances the capacity of a culvert may be increased by laying additional pipes. In such cases they should be placed far enough apart to secure a solid bed for each. The best pipe should be used, and every care exercised in putting them in. It is a mistake to purchase second class or culled pipe for this purpose, as is sometimes done.

The following table shows the size, capacity and average price of vitrified pipe in car load lots at any railroad station in Ontario.

Diameter (in inches,)	Weight per foot (in pounds) Single Strength.	Price per foot.
6	10	15 cts.
8	16	17
9	23	20
10	34	22
12	44	29
15	63	41
18	84	60
	Double Strength.	
12	1½ " thick	75 cts.
15	1¾ " thick	$1.00
18	2 " thick	1.25
24	2⅝ " thick	1.75

PRICES OF CEMENT CULVERT PIPE AT FACTORY.

Diameter (in inches.)	Price per lineal foot.
4	10 cents
6	12½ "
8	20 "
10	25 "
12	35 "
14½	55 "
18	65 "
21	95 "
24	$1.25
30	$1.75
36	$2.50
43	$3.75

In determining the size of the culvert it is necessary to take into consideration the area to be drained. Statistics show the maximum rain fall to be about two inches per hour. One inch of rain fall gives 22,633 gallons per hour for each acre. Experience proves that owing to various obstructions not more than fifty per cent. of the rain fall will reach the drain or culvert within the same hour and due allowance must be made for this fact in determining the size of the pipe required. Severe storms are usually of short duration.

The following table shows the carrying capacity of pipe.

Size.	Three inch fall per 100 feet.	Six inch fall per 100 feet.	Nine inch fall per 100 feet.
6 inch.	129	183	224
8	265	375	460
9	355	503	617
10	463	655	803
12	730	1033	1273
15	1282	1818	2224
18	2022	2869	3508
24	4152	5871	7202

BRICK CULVERTS.

Where the current is rapid and the volume of water so great as to warrant the use of culvert pipe, brick culverts will be found to be economical. The life of the wooden culvert is from four to ten years, and that of a brick culvert from fifty to sixty. A solid foundation is required either natural or artificial but not necessarily a dry foundation, from the fact that good brick culverts have been built when it was found necessary to keep the water dipped out of the pits; a dry foundation is preferable. The material should be first class sewer brick. Any that show signs of softening should be rejected as they will soon crumble. Each brick should be dipped in water, or well saturated before being put in the wall. The sand should be clean and sharp, and be taken from the creek in preference to that from the bank which is liable to contain more or less clay, and will make the mortar soft. The bottom of the pit for the barrel of the culvert should be at least eighteen inches below the bed of the stream, but this would depend on the size of the culvert to be built, and the height of the road grade. Wing walls should be constructed, commencing at least twenty-four inches below the bottom of the culvert, in order that the water will have no chance to get under them, and ultimately undermine the whole structure. The mortar should be composed of two parts of good hydraulic cement and three parts sand. The bricks on the inside of the barrell of the culvert at their front edge should almost touch each other so that there will be very little mortar to wear or wash out, which in time would let the bricks become loose and drop out. The water should never be allowed to wear the bottom of the stream away from the lower end of the culvert. If a fall of the water over the end of the culvert exists it will wear the mortar from between the brick and ruin the masonry. The wing walls should be built three or four inches higher than the top of the barrell so as to hold the dirt overlying the culvert. The walls should be at least eight inches thick, and thicker in proportion to the amount of pressure which they have to withstand. A two inch oak plank should be placed on top of the wall, of a width equal to the thickness of the wall

(To be continued.