

1978

GORE & STORRIE LIMITED  
CONSULTING ENGINEERS

CITY OF BROCKVILLE

REPORT ON  
CPR - BROCKVILLE TUNNEL

Douglas M. Grant

# GORE & STORRIE LIMITED

CONSULTING ENGINEERS

ESTABLISHED 1919

MEMBER C.E.O.-A.C.E.C.

SUITE 700, 331 COOPER STREET

OTTAWA, ONTARIO K2P 0G5

TELEPHONE (613) 238-7702

1978 10 18

103.19

City of Brockville  
Victoria Building  
Brockville, Ontario  
K6V 5V1

Attention: Mr. T. H. Dobbin, P.Eng.  
City Engineer

Gentlemen:

Re: CPR - Brockville Tunnel

In accordance with your letter of authorization dated 1978 09 05, we are pleased to submit herewith, our report on the CPR Brockville Tunnel.

A site visit was made to review the condition of the existing tunnel, the results of which indicate that the present tunnel is in a reasonably good state of repair. As noted in the report, there are localized areas of the tunnel lining which are in varying states of disrepair, and which do require some immediate attention in order to prevent further deterioration and possible collapse. Estimated costs for the repair work recommended to be undertaken immediately are in the order of approximately \$30,000 to \$50,000. In addition, it is recommended that continuing annual maintenance be provided and a budget allowance for this work of \$5,000 per year is suggested.

Possible future uses for the railway tunnel suggested in the report include:

- a) a diversion conduit for all or part of the Buells' and Butlers' Creeks
- b) a diversion route for the sanitary trunk sewer facility
- c) a museum of early Canadian engineering and heavy construction works
- d) a storage facility for light equipment and supplies.

.../2

Of all of the above options, it appears from our initial review, that diversion of the present drainage courses to relieve downstream flooding does appear to be the most viable alternative worthy of further consideration.

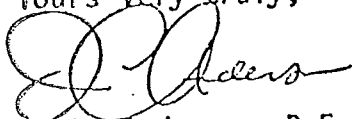
Depending on future long-term use of the tunnel, a more permanent maintenance-free type of permanent lining may be more desirable, such as a corrugated steel liner plate for the walls and roof and a cast in place concrete floor slab. Such a lining would be considered appropriate for either a storage facility or for a conduit for diversion of excess peak flow rates from the Buells' and Butlers' Creeks. The estimated cost for such work is in the order of approximately \$750,000.

If diversion of the entire creek discharge is found desirable, then additional channelization and tunnel deepening will also be required. Although this cost is difficult to accurately assess without more detailed geotechnical information, it is estimated that additional costs may be in the order of approximately \$500,000 for a total estimated cost of approximately \$1,250,000.

It is noted that the scope of this study was not meant to be in such depth as to provide concrete conclusions and definite recommendations, but rather to provide some additional data and assistance for the City in their continuing deliberations with respect to this matter. Proper and detailed assessment of alternatives suggested in the report, will require further study, including an in-depth geotechnical investigation to assist in the analysis and in the preparation of proper and realistic estimated costs.

We trust that the report is satisfactory and in accordance with the terms of reference provided. We are honoured to be of assistance to the City in reviewing this very interesting and important facility and we would be most pleased to provide any additional information or to discuss the matter further with you as you may desire.

Yours very truly,



J. C. Anderson, P.Eng.  
Branch Manager

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## CITY OF BROCKVILLE

### REPORT ON CPR - BROCKVILLE TUNNEL

#### BACKGROUND

The Brockville tunnel was constructed by the Brockville and Ottawa Railway Company during the period 1853 - 1859 and was opened for traffic in 1860, thus initiating rail service between Almonte and Brockville. The Brockville and Ottawa Railway Company subsequently amalgamated with the Canadian Central Railway Company in 1878 and finally became part of the Canadian Pacific Railway Company by amalgamation in 1881.

One of the many interesting and important distinctions of the Brockville tunnel is that it is probably the oldest work of its kind in Canada.

The Canadian Pacific Railway Company, the present owners of the tunnel, have requested the City of Brockville to assume ownership of the tunnel, along with the liabilities that would accrue thereto. The City of Brockville has in turn, expressed some reservations and concerns with respect to assuming ownership of the tunnel, which concerns relate to both:

- structural competence of the tunnel
- possible uses available for the tunnel structure.

In consideration of these concerns, City Council at its meeting of August 30, 1978, authorized Gore & Storrie Limited to undertake a structural study and report on the railway tunnel. By letter dated 1978 09 05, from Mr. T. H. Dobbin, P.Eng., City Engineer, Gore & Storrie Limited were advised of Council's authorization and specifically, that the report should include:

- the condition of the structure
- the groundwater and its effect on the structure
- the possible uses of the tunnel.

- a) the age of the tunnel structure which is in the order of 127 years.
- b) the limited maintenance which the structure has received, particularly over the period of the recent years.

The stone masonry lining through the clay sections appears to be in good condition, with some isolated areas which are in varying states of disrepair. The cement mortar grouting between the storework has deteriorated in a number of areas and should be repaired. In addition, there are two or three isolated areas of deterioration of the masonry wherein portions of the tunnel wall have partially collapsed and these should be repaired immediately. These locations of deterioration are generally limited to about 2 to 3 square feet in area.

The unlined section of the tunnel through the rock also appears to be in a reasonably good state of repair. Visual inspection through this area revealed, however, one isolated area where rock spalling from the tunnel roof has occurred within the recent years. This area should be given some immediate attention.

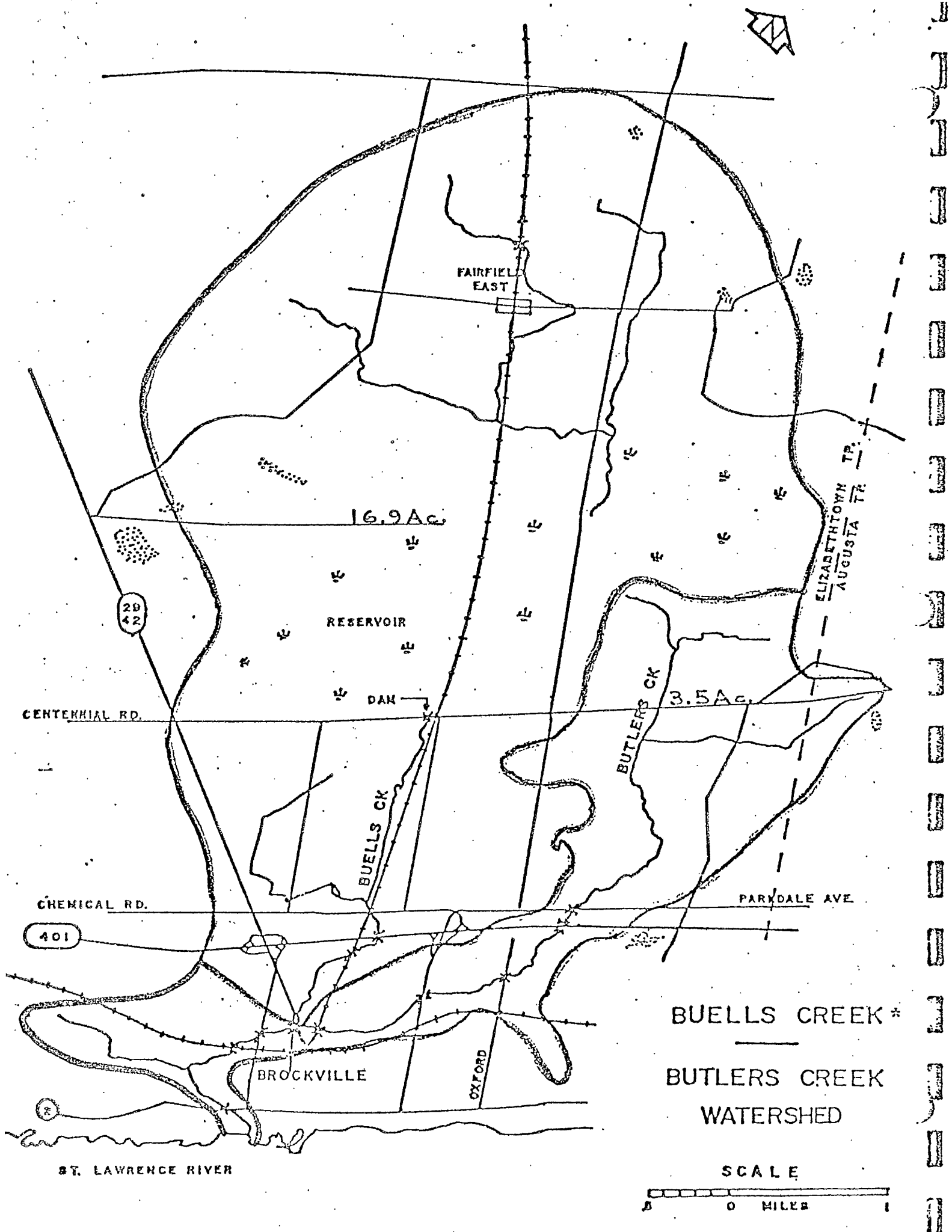
Other than the few isolated instances referred to above, the tunnel does not appear to be under any undue structural stress, which would place the integrity of the tunnel in any immediate jeopardy. However, if the tunnel is to be maintained in its present form, with the stone masonry and natural rock lining, then significantly more attention must be given to continued maintenance of the tunnel lining in order to protect against future deterioration and possible failure.

### Groundwater

The site inspection on September 26, 1978, revealed a varying influence of the groundwater penetration into the tunnel.

The southerly section of the tunnel through the stone masonry lined section and along part of the unlined rock section, is relatively dry, showing little groundwater infiltration. Along the northerly section of the unlined rock tunnel and more particularly along the stone masonry lined north end of the tunnel, groundwater infiltration increases quite significantly.

For the limited extent of the investigation undertaken, it was not possible to determine the height of groundwater exerting pressures on the tunnel. However,



29  
42

CENTENNIAL RD.

CHEMICAL RD.

401

2

FAIRFIELD  
EAST

16.9 Ac.

RESERVOIR

DAN

BUELLS CK

BROCKVILLE

OXFORD

BUTLERS CK

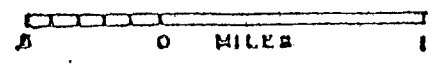
3.5 Ac.

ELIZABETHTOWN TR.  
AUGUSTA TR.

PARKDALE AVE.

BUELLS CREEK  
BUTLERS CREEK  
WATERSHED

SCALE



ST. LAWRENCE RIVER

the groundwater throughout the length of the tunnel does not appear to be exerting any undue or excess stresses on the tunnel lining.

The calcification build up in some areas is extensive and indicates that groundwater infiltration has been occurring for a long period of time, probably since completion of construction. There are no apparent adverse effects of the groundwater infiltration evident, other than the slow deterioration of the cement mortar for the stone masonry.

#### CONSIDERATIONS FOR FUTURE USE

The terms of reference for the study ask for specific suggestions relating to possible future uses for the railway tunnel. Although the scope of the study does not permit detailed analysis of alternatives, some consideration has been given to various options, which are described following:

#### Buell's and Butlers' Creeks Diversion

The City of Brockville experiences flooding problems on a relatively frequent basis along the Buell's and Butlers' Creeks, particularly downstream from their confluence at Front Avenue and Stewart Boulevard to the St. Lawrence River.

A flood plain mapping study was carried out through the City of Brockville by the Cataraqui Conservation Authority, defining the limits of such flooding and flood flows for design purposes, considering a design storm with a recurrence interval of once in 100 years.

Figure No. 1 opposite, is extracted from the above referenced report and shows the watershed areas for both the Buell's and Butlers' Creeks.

The drainage area of the Buell's Creek tributary to the confluence is approximately 16.9 square miles and of the Butlers' Creek tributary to the confluence, is approximately 3.5 square miles, for a total watershed area of approximately 20.4 square miles, as shown on Figure No. 1. The design flood flow downstream of the confluence is 2,750 cubic feet per second, which figure was developed for and reported in the flood plain mapping study and report, prepared for the Cataraqui Conservation Authority by Crysler and Lathem Limited, Consulting Engineers.



With the assistance of the City of Brockville Engineering Department, we have checked the relative elevations of the creek beds and the tunnel inverts to investigate the feasibility of diverting all or part of the creek flows southerly through the railway tunnel.

Figure No. 2 is a profile through the railway tunnel and northerly along the old railway bed to the intersection of the Butlers' Creek.

It is noted on the profile, that in order to provide adequate grade for diversion of the entire creek discharge, southerly through the tunnel, a substantial amount of excavation is required both along the old railway bed and through the tunnel, as well. This will be a very difficult and costly undertaking, which is most difficult to properly assess in any detail at this time. A proper assessment will require more detailed knowledge of the soils stratigraphy along the railway diversion and also an investigation of flooding occurrences and associated downstream damages for benefit analysis.

A second alternative which may also be possible and realistic, is a diversion of peak or excess flow rates only, above a predetermined level in the Butlers' and Buells' Creeks. Adopting this approach would allow present normal base flows to continue southerly along the existing creek channel with high level flows being diverted southerly through the tunnel. Some channelization and deepening of the existing tunnel will also be required for this alternative approach, but to a much lesser extent.

The profiles for both alternatives described are illustrated on Figure No. 2 and the approximate extent of channelization and tunnel deepening required for each is shown.

#### Sanitary Sewer Drainage

The sanitary trunk sewer servicing the major areas of the City follows a route along the Butlers' and Buells' Creeks, southerly to Water Street and then easterly along Water Street to the main sewage pumping station.

CITY OF BROCKVILLE  
 PROFILE THROUGH  
 EXISTING C.P.R. TUNNEL

SCALE: VERT. - 1" = 10'  
 HORIZ. - 1" = 500'

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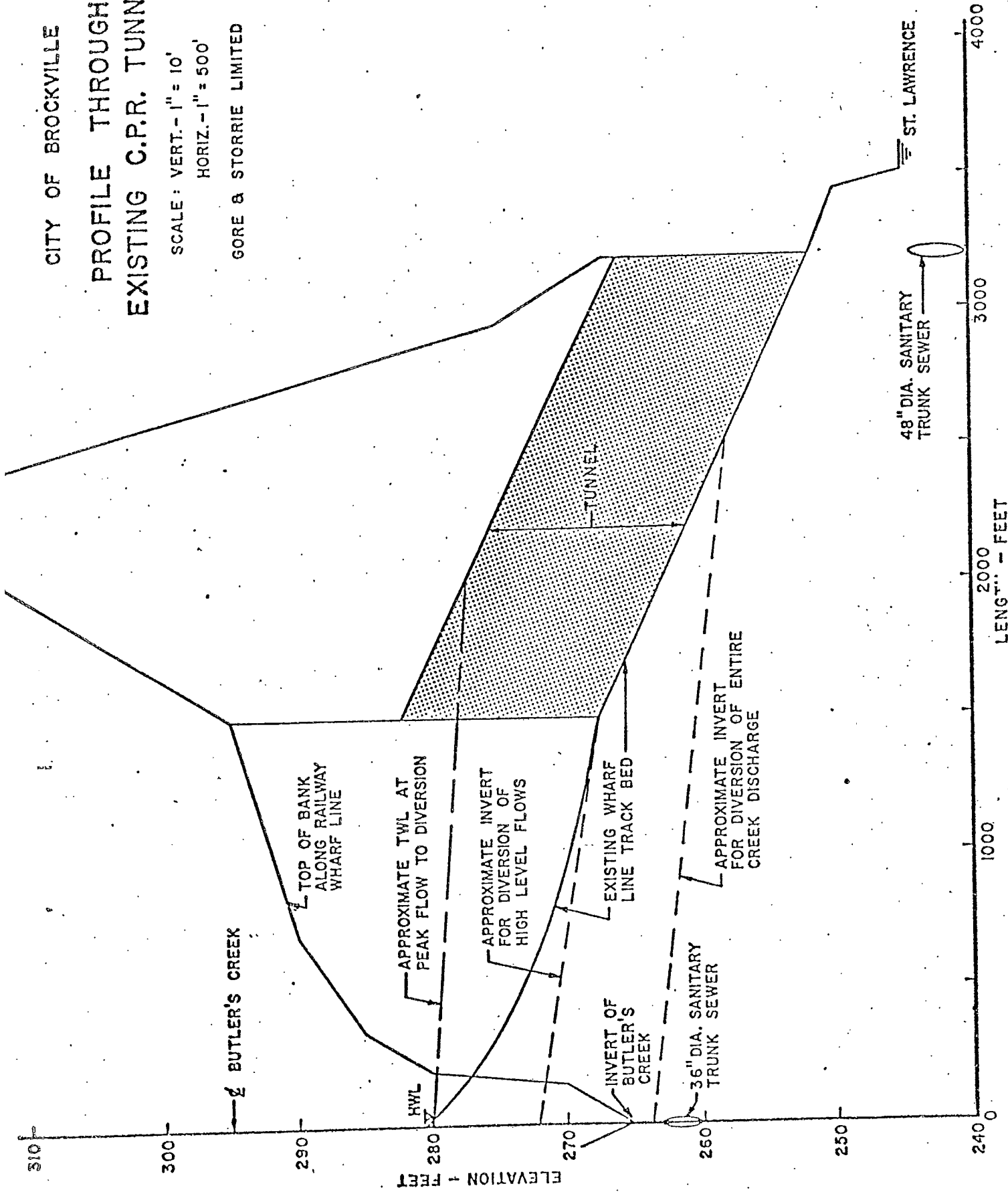


FIG. 2

We have reviewed the possibility of diverting the sanitary trunk sewer through the railway tunnel, connecting into the trunk at Water Street. This diversion could relieve that portion of the present trunk downstream from Park Street and eliminate a number of the sanitary overflow situations into the present creek. In addition, adequate capacity would be made available in the existing sewer downstream for servicing the presently undeveloped areas in the west and northwest sectors of the City.

The elevations of the existing sanitary sewers are such that the trunk sanitary sewer diversion would be below the present railway tunnel invert. Construction of such a sewer diversion under these conditions would be very difficult and costly. The feasibility of this approach will require a more detailed assessment, including a thorough geotechnical investigation before any definite costs or recommendations can be established.

#### Other Uses

Other possible uses for the tunnel which have been suggested include:

##### (a) Museum

As mentioned earlier, the Brockville Railway Tunnel is probably one of the oldest works of this kind displaying early Canadian engineering and heavy construction expertise. It may be possible to develop the tunnel into a museum facility, to display the works and their history.

Such an undertaking would require substantial funding and perhaps the support of the engineering fraternity, the heavy construction industry and higher levels of government, as well.

##### (b) Storage Facility

Another consideration for use of the tunnel which has been discussed, is storage space for light equipment and perhaps other supplies as well. However, it is considered that the limited width of the tunnel available and the presence of excess groundwater infiltration makes this approach somewhat impractical.

## MAINTENANCE CONSIDERATIONS AND ESTIMATED COSTS

### Present Condition

If the City of Brockville decides to assume ownership of the tunnel, and without a definite plan for early or long term utilization, then some immediate consideration must be given to either:

- rehabilitation and continuing maintenance of the existing tunnel lining
- filling the tunnel with consolidated earth fill material and abandon it.

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Rehabilitation of the present tunnel lining would involve the repair of the stone masonry lining where deterioration has occurred. In addition, repointing of the mortar work should be undertaken along the entire length of the tunnel. Through those areas of unlined rock tunnel, the rock should be carefully and thoroughly inspected and any loose rock scaled and removed. It may be necessary in addition, to install rock bolt supports and possibly gunnite localized areas of deterioration.

The existing doors at both ends of the tunnel should also be repaired for proper security and ready access for maintenance personnel.

~~Although the scope of such work is difficult to project,~~ <sup>It is</sup> we estimate that the cost of the repairs may be in the order of approximately ~~\$30,000~~ to \$50,000.

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Additional maintenance should then be undertaken on an annual basis to maintain the mortar work and inspect the condition of the tunnel in general. It is suggested that a budget allowance of approximately \$5,000 per year should be satisfactory for this purpose.

In the event it is deemed desirable to fill the entire tunnel with consolidated earth fill material, and abandon the facility, it is estimated that approximately 15,000 cubic yards of material will be required at a total cost of approximately \$250,000.

### Permanent Lining

If the City adopts to utilize the tunnel for any permanent long-term facility, such as a creek diversion or a storage area, then a permanent and relatively maintenance free tunnel lining will be required.

In this respect, we have investigated the possibility of installing a concrete floor slab and corrugated steel liner plate for the walls and roof. Such a structure can readily be manufactured to suit and match the present tunnel cross-section. The estimated cost for supply and installation of such a permanent lining is in the order of approximately \$750,000.

Alternatively, monolithic cast in situ full circle concrete lining may also be considered.

This estimated cost is considered appropriate for creek diversion of high level or peak flow rates only where minimum channelization and tunnel deepening, if any, is required. If it is found practical and desirable to deepen the tunnel and approach channel for diversion of the entire flow of the Buells' and Butlers' Creeks, then there will be an additional cost associated with this work. This cost is very difficult to properly assess at this time, without a more detailed knowledge of the geotechnical aspects of the work. It is considered, however, that deepening of the approach channel and the tunnel may add an additional \$500,000 for a total estimated cost of approximately \$1,250,000 for the diversion.