CANADA-NEWFOUNDLAND
FLOOD DAMAGE REDUCTION PROGRAM

ENVIRONMENT CANADA

DEPARTMENT OF ENVIRONMENT

REPORT ON ASSESSMENT OF THE EFFECTS OF DEVELOPMENT IN THE BRULEY AREA OF PLACENTIA

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1. Introduction

This report was authorized by the Department of Environment on behalf of the Canada-Newfoundland Flood Damage Reduction Program on 1986-12-02 based on the Department's request for proposal of 1986-06-19, ShawMont's proposal dated 1986-07-14, and the subsequent update letter dated 1986-11-26.

The scope of the study was to assess surface and subsurface drainage and the feasibility of landfilling the Bruley area (identified as Area 3 in the Canada-Newfoundland Flood Damage Reduction Program Report entitled "Hydrotechnical Study of the Placentia Area Flood Plain").

The four major items of study were as follows:

1. Assessment of the effect that landfill in the Bruley area would have on the water level in the Placentia flood risk area.
2. Assessment of the effect of landfill on the surface drainage system of the area and its impact on existing development in the area.
3. Brief assessment of landfill on subsurface drainage.
4. Comment on feasibility of landfilling.

The Hydrotechnical Study pointed out that flooding in the Bruley area of Placentia has occurred when 1 in 100 year waves on Placentia Road overtopped the beach and also

1. Introduction (Cont'd)

when high tidal levels were encountered in Southeast Arm. No assessment has been made in this study of the effect of the flooding caused by waves overtopping the beach; instead, the study has concentrated on the effects of tidal flooding as a result of high water levels in Southeast Arm. It should be noted, however, that the extent and recession of flood waters resulting from waves overtopping the beach could be affected by backfill in the Bruley area.

2. Background Information

The Bruley area is located at the southwestern end of the Town of Placentia (as shown on Sketch SK-1). This triangular area of land is relatively flat and low lying and is bounded by Blockhouse Road on the north, Dixon Hill on the east, and Southeast Arm on the south. A portion of the Bruley area bordering Blockhouse Road, as well as along Bartlett Drive, which runs southward for a short distance into the Bruley area from Blockhouse Road, is essentially developed. We understand that the area of the recently constructed Senior Citizen's Home located at the south end of Bartlett Drive has been locally backfilled above the 1 in 100 year flood contour.

2.1 Physical Features

The Bruley area generally slopes less than 0.02% in a southerly direction toward Southeast Arm. Most of the area is covered with a very thin soil cover and grassy growth except for wooded areas which are interspersed throughout the undeveloped section of the Bruley area. The area adjacent to Dixon Hill is somewhat marshy. It is

2.1 Physical Features (Cont'd)

understood that the shallow wet depressions just north of the beach have a tendency to dry up during summer, while along the beach, which borders Southeast Arm, the surface material is comprised of rounded cobbles ranging from 20 mm to 150 mm.

The subsurface materials in the Bruley area appear to vary from fine sand to rounded cobbles. Town council staff reported that sand was encountered during excavations at the corner of Blockhouse Drive and Bartlett Drive.

2.2 Existing Drainage Patterns

Natural drainage in the Bruley area is toward Southeast Arm. There are no drainage channels in the area except for existing ditches southeast of Bartlett Drive and localized ditching at the base of Dixon Hill escarpment near the Senior Citizens Home. These ditches drain the east side of the Bruley area toward Southeast Arm. There were no ditches or culverts evident in the area bounded by Beach Road, Roosevelt Street and Blockhouse Road. This area is overlain by large cobbles except for areas which have been backfilled, generally with gravel material.

Runoff from rainfall and snowmelt generally follow three routes, viz. infiltration into the soil flowing laterally in the near surface soil, percolation through the pervious/semi-pervious soil to the groundwater table, or along the slightly sloped surface and eventually draining into Southeast Arm, generally as indicated on Sketch SK-2.

2.3 Land Ownership and Development

It is understood that the Bruley area is virtually all privately owned land and control on development of land in the area could be maintained by the Town Council. The Council could stipulate any fill or grading requirements in the flood zone as a condition of obtaining building permits.

3. Assessment of the effect that landfill in the Bruley area would have on the water level in Southeast Arm

The placement of fill material in the undeveloped area of Bruley to the 1 in 100 year flood contour (1.75 metres above mean sea level) would create a loss of storage on the flood plain under flood conditions. This item was addressed briefly in the Hydrotechnical Study which indicated that the effect on water levels in Southeast Arm was small. Therefore a simple method, considering volume displacement, was used to determine the maximum water rise in Southeast Arm resulting from the loss of storage. This method assumed that the same volume of water would flow into Southeast Arm, on a rising tide, regardless of whether the Bruley area was infilled or not. The calculations below show that placement of fill over the entire Bruley area would increase the water level in Southeast Arm by approximately 60 mm (2.4 in.).

Surface areas:

Bruley area (between Blockhouse Road and Southeast Arm)	=	570,000 m^2
Southeast Arm (at normal water level)	=	4,840,000 m^2

3. Assessment of the effect that landfill in the Bruley area would have on the water level in Southeast Arm (Cont'd)

Existing ground elevations in the Bruley Area:

- at Shoreline = 0.80 m (approx)
  at Blockhouse Road = 1.75 m (approx)

Maximum water level (1 in 100 yrs) = 1.75 m

Volume of water displaced by infill (1 in 100 yrs)

$$= (1.75-0.80) - 2 \times 570,000$$
$$= 271,000 \text{ m}^3$$

Maximum increase in water level in Southeast Arm

$$= 271,000 - 4,840,000 = 0.056 \text{ m}$$
(Say 60 mm)

A practical consideration of the hydraulics, however, would suggest that, on a rising tide when the Arms are filling, the same volume of water may not flow into Southeast Arm if the Bruley area was infilled. The reduction in the storage capacity of Southeast Arm would increase the rate of water level rise in Southeast Arm and thereby increase the rate in reduction of the differential head between Swan Arm and Southeast Arm. This would tend to reduce the volume of inflow into Southeast Arm which, in turn, would tend to reduce the effect of the storage loss and the subsequent rise in water level due to the storage loss.

3. Assessment of the effect that landfill in the Bruley area would have on the water level in Southeast Arm (Cont'd)

Considering the above, it is expected that the maximum increase in Southeast Arm water level, due to infilling of the Bruley area, would be 60 mm which would increase the 1 in 100 year flood level in Southeast Arm from 1.75 m to 1.81 m. Flooding would be eliminated in the Bruley area where infilling above the flood level is completed; however, in other areas where the high water level could circumvent the infill area, the aerial extent of flooding would be only slightly increased as shown by the cross-hatched area on SK-1.

Another practical consideration of the hydraulics would suggest that there could be a backwater effect through MacDonald Gut and the Narrows, resulting in progressively smaller increases in the water levels of Swan Arm and Northeast Arm. It is expected, however, that this backwater effect would be minimal and the resultant increases in the water levels, and therefore, the aerial extent of flooding in these Arms, would be too small to show on any aerial mapping of the areas.

4. Assessment of the effect of landfill on the surface drainage system of the Bruley area and its impact on existing development in the area

The assessment of the effect of landfill on the surface drainage system in the Bruley area has also considered how the landfill may affect the extent and recession of flooding.

4. Assessment of the effect of landfill on the surface drainage system of the Bruley area and its impact on existing development in the area (Cont'd)

The developed areas which are uphill (north) of the Bruley area, as well as the Bruley area itself, slope toward Southeast Arm. As a result, the undeveloped area of Bruley is only part of an overall surface drainage system and any changes to this system could affect drainage from the developed areas.

No permeability tests of the insitu soils were carried out as part of this Study (not included in scope). However, as a result of a site visit some general observations can be made of the ground conditions and surface drainage patterns of the area.

In the area to the south and east of Dalfen's Mall, which is grass and tree covered, localized ponding of water is evident, which indicates that the subsurface material is somewhat impervious and that drainage from this area is primarily by surface runoff. In the small area west of Dalfen's Mall, where coarse cobbles dominate the surface, drainage is primarily by infiltration through the surface material. Both areas slope very gently toward Southeast Arm.

Placement of fill on the grass covered surface of the Bruley area would tend to retard the surface drainage unless special precautions were undertaken during the placement of landfill to provide an alternative means for drainage. By retarding the surface drainage in the landfilled area, runoff in the developed area would be restricted and the time for runoff to dissipate there would

4. Assessment of the effect of landfill on the surface drainage system of the Bruley area and its impact on existing development in the area (Cont'd)

be increased. Consequently, flooding could occur in the newly created low areas uphill of the landfilling. Depending on the intensity and duration of rainfall/snowmelt, such flooding could rise to the height of the landfill (minimum elevation 1.75 m) before the water would flow over the landfilled area.

Use of perforated drainage tile or pervious landfill material would enable the runoff from the developed area to infiltrate into the landfill and follow the gently sloped original ground/landfill interface. Rainfall/-snowmelt on the landfilled area itself would also percolate into, infiltrate, or run off the landfill. Such percolation or infiltration could retard any drainage from the developed area. As landfilling and development progresses in the Bruley area, the construction of buildings, paved streets, driveways and lawns would tend to decrease the surface area contributing to infiltration and percolation. Consequently, drainage of rainfall/-snowmelt from the landfilled area would tend to runoff mainly along the surface.

5. Assessment of the Effects of Landfilling on Subsurface Drainage

If the insitu soils are sufficiently pervious to permit surface water from rainfall/snowmelt or high tidal levels to infiltrate and flow subsurface to Southeast Arm, landfill on the original ground surface should have no effect on the drainage. This assumes, of course, that the

insitu soils are also sufficiently dense that the new landfill, and any construction on the landfill, will not compact the original surface and make it less pervious. If, however, the original ground surface in the developed area is pervious and the ground surface in the landfilled area is impervious, causing subsurface drainage to rise to the original ground surface, as it flows to Southeast Arm (see Sketch SK-2), the landfill will tend to retard the surfaced drainage. Consequently, there would be an increase in the time required for both drainage of runoff or recession of flooding.

It should be noted that where water percolates through the soil to the groundwater table (in the developed area), landfilling should have no effect since it is anticipated that the groundwater table will not change.

Another aspect to consider, which is related to subsurface drainage, is the infiltration of water through the landfill during high tidal levels. During such flooding, water could filtrate through the landfill and reach the uphill end of the landfill. As a result, the developed areas could still be flooded.

The time it would take for flooding to occur in the developed areas after high water levels were achieved in Southeast Arm would depend on the permeability of the landfill; the more pervious the landfill or the smaller the area landfilled, the less time before flooding.

6. Feasibility of Landfilling

Landfilling of the undeveloped Bruley area is a technically feasible way to create developable land provided it is filled above the 1 in 100 year flood level. The landfilling should be progressive from Blockhouse Road to Southeast Arm and extended to high ground at both the east and west ends of the area to prevent high water levels during floods from circumventing the infilled areas and causing flooding uphill of the Bruley area.

The landfilling would interfere with the natural drainage of the already developed area. Provisions must be made to accommodate drainage from the filled area, as well as drainage of the already developed area.

Drainage of the landfilled area could be accomplished by providing a minimal slope (say 0.5%) toward selected ditch locations, generally as shown on Sketch SK-2. Surface drainage emanating from the developed area would require some means of drainage through the landfill, or pumping to prevent flooding. Several alternatives were considered for this.

Alternative 1

To cater for rainfall/snowmelt runoff in the developed area of Bruley, ditches could be created at selected locations through the backfilled area to provide the necessary drainage channels. The invert elevation for the ditches would have to be slightly below the low point of the developed area to provide a positive means of drainage. Since the ditch inverts would be below the 1 in 100 year tidal flood level, tidal gates would be required to discharge rainfall/snowmelt runoff into Southeast Arm while preventing an occurrance of tidal flooding of the developed area.

6. General Feasibility of Landfilling (Cont'd)

Alternative 2

A second alternative to cater for the runoff in the developed area could involve a gravel filter or perforated drainage tile arrangement that would permit runoff to drain freely into the uphill end of the landfilled area and slowly drain through the fill or along the fill/original ground interface until it exits at Southeast Arm. In the case of a tidal flood, flood waters would have to filtrate through the fill (in the undeveloped area) before any flooding of the developed area would be initiated. It is envisaged that the time for the flood waters to reach the lower developed areas via infiltration of the landfill, would be longer than the duration of the tidal flood but further studies on the permeability of fill material, filter material and time of tidal flooding would be required to confirm the feasibility of this alternative.

Alternative 3

A pump arrangement could also be used to drain the developed area of runoff trapped immediately uphill of the landfill. The pumped water could either be discharged into ditches formed through the filled area or discharged northward into Placentia Road.

Alternative 4

Consideration should also be given to the alternative of constructing a dyke along the shoreline of Southeast Arm as identified in the Hydrotechnical Study.

7. Order of Magnitude Quantities and Cost

The total undeveloped area of Bruley is approximately 250,000 m^2. A rough quantity take-off shows that approximately 135,000 m^3 (175,000 cu.yd.) of material would be required to fill the undeveloped area to the 1 in 100 year flood contour and it would require an additional 75,000 m^3 (100,000 cu.yd.) of material for sloping of the landfill (at a minimal slope of 0.5%) for local surface drainage. There is no ready source of fill material in Placentia to meet the above quantities of landfill but it may be possible to obtain such quantities from Point Verde (privately owned gravel pits). A series of pits have been operating from a sidehill deposit of gravel along the road to the lighthouse in that community.

The quantity of landfill amounts to approximately 0.85 m^3 of fill per square metre of undeveloped area. The estimated cost of such landfilling would be in the range of $1 million to $1.5 million. If the cost of the landfilling was borne by a developer, such cost would amount to approximately $3700 per lot (average 720 m^2 per lot) and $5.00 per m^2 of road right of way and similar common spaces.

It is noted that this estimate only identifies landfilling costs and does not reflect any additional costs for measures that might be needed to protect the developed areas from flooding.

8. Conclusions

Landfilling the undeveloped Bruley area will affect the natural drainage of the existing developed areas along

8. Conclusions (Cont'd)

Blockhouse Road and Bartlett Drive. Since drainage from the undeveloped area appears to occur primarily by surface runoff, placement of landfill in the undeveloped area will tend to retard this drainage. Although such landfilling is considered a technically feasible way to create developable land, provisions must be made during the landfilling to accommodate the drainage. Such provisions could include ditching, use of pervious fill material, installation of gravel filters or perforated drainage tile, or by pumping.

The infilling must be carried out in a progressive manner to eventually create a barrier to high water levels across the area from east to west, thereby preventing high water levels from circumventing the infilled areas. Assuming the area is ultimately completely infilled, the minimum elevation of the infilling, at the shoreline of Southeast Arm should be 1.81 m, as shown on SK-2.

To fully assess the economic feasibility of landfilling in the undeveloped Bruley area, further studies will be required to assess the permeability of insitu surface and subsurface materials and proposed landfill. As well, the extent of filtration for various tidal heights and cycles should be studied. The alternative of constructing a dyke along the shoreline of Southeast Arm, as previously identified in the Hydrotechnical Study, should be included in any future studies related to finding an economically feasible way to create developable land in the Bruley area.

SK-1

PLACENTIA
ROAD

A

MAXIMUM EXTENT OF ADDITIONAL FLOODING TO EL. 1.81m IF INFILLING OF BRULEY AREA IS NOT COMPLETE. WHEN INFILLING IS COMPLETE THERE WILL BE NO FLOODING IN THIS AREA

1:100 YEAR FLOOD CONTOUR (1.75m) WITHOUT INFILLING OF BRULEY AREA.

DALFEN'S MALL

DEVELOPED BRULEY AREA
(BELOW 1:100 YEAR FLOOD CONTOUR)

N

UNDEVELOPED BRULEY AREA
(BELOW 1:100 YEAR FLOOD CONTOUR)

A

SOUTHEAST ARM

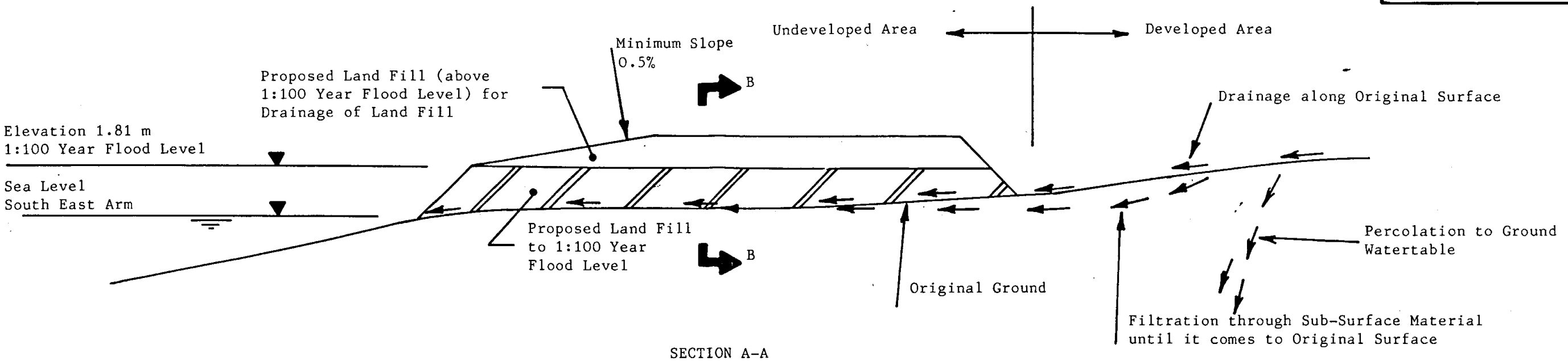
NOTES

1. 1:100 YEAR [illegible] CONTOUR (1.75m) IS BASED ON CONTOURS SHOWN ON DWG. NO. 4 INCLUDED IN THE MAIN REPORT ON HYDROTECHNICAL STUDY OF THE PLACENTIA AREA FLOOD PLAIN (VOLUME 1 OF 2) DATED APRIL, 1985. THE CONTOURS SHOWN ON THIS SKETCH ARE BASED ON LATER MAPPING AND DO NOT NECESSARILY AGREE WITH THE CONTOURS ON DWG. NO. 4.

BRULEY AREA OF PLACENTIA

MAP OF DEVELOPED AND UNDEVELOPED AREAS

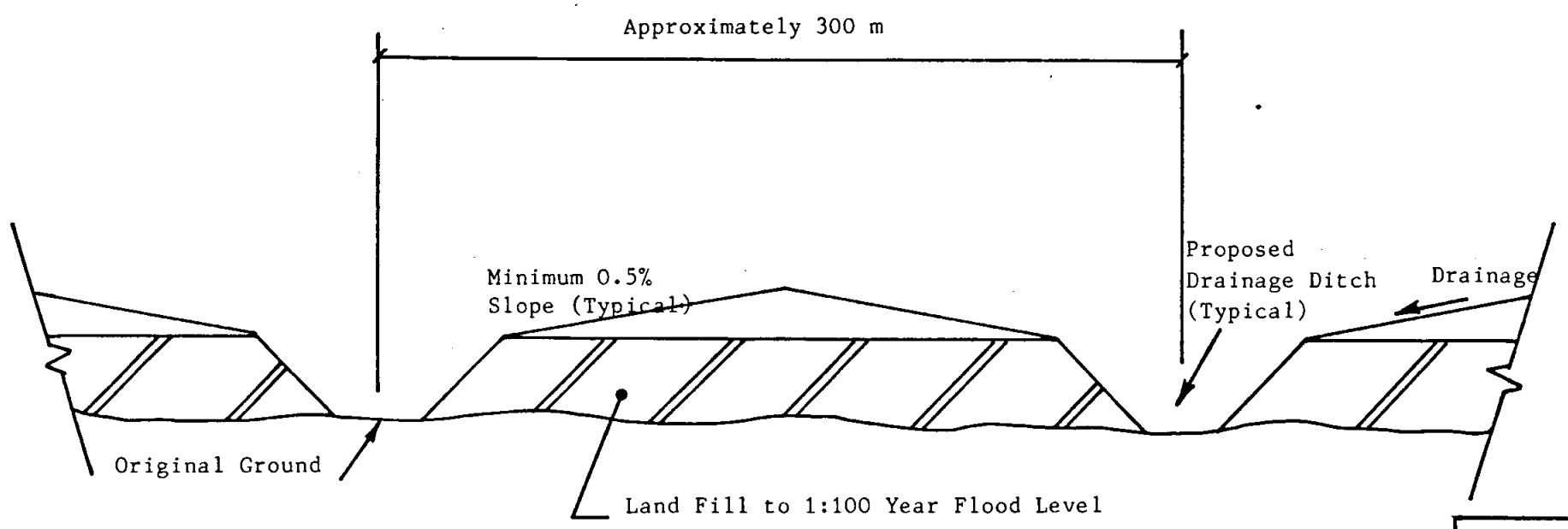
SK-2



SECTION A-A

TYPICAL SECTION THRU PROPOSED LANDFILL OF BRULEY AREA

NOT TO SCALE



SECTION B-B

NOT TO SCALE

BRULEY AREA OF PLACENTIA

TYPICAL SECTIONS
THROUGH PROPOSED
LANDFILL