PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT
WATER MANAGEMENT BRANCH

PRELIMINARY REPORT

ON

MILLSTONE RIVER FLOODING

by

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SYNOPSIS

A potential for flooding exists in the Bowen Road - Buttertubs Marsh area adjacent to the Millstone River in the City of Nanaimo.

This preliminary report outlines two options for proposed remedial works to prevent flooding. Option A proposes dyke construction but no channel improvement to lower water levels, and is estimated to cost $984,000. Option B utilizes the same dyke alignment but has lower required dyke elevations due to channel improvements. The estimated cost of Option B is $1,064,000.

Further engineering investigation and detailed design and discussion among affected parties is required before proceeding to construction; however, this report can be used as a focus for further discussion and a basis for further action.

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1.0 Introduction

In October 1982 the consulting engineering firm Associated Engineering Services Limited (AESL) completed a stormwater drainage report for the City of Nanaimo entitled "Stormwater Management Plans, Millstone River Basin". Since the northern area of the City drains into the Millstone River system, a preliminary analysis of the water levels in the Millstone River was included in the study. This study indicated a flooding problem in the Bowen Road - Buttertubs Marsh area which it was estimated would require approximately $2.6 million to rectify. The City of Nanaimo felt that it was beyond their means to implement remedial works and requested consideration for cost-sharing assistance under the Provincial River Protection Assistance Program.

2.0 Description of the Area

The watershed of Millstone Creek is approximately 39 square miles and is located to the west of the City of Nanaimo. See Drawing No. 86-17-1. Flow originates at the 2030 feet elevation in Lucid Lake, west of Mount Benson which at elevation 3340 feet is the highest point in the watershed. This lake is drained by Benson Creek which flows north into Brannen Lake. Several other small creeks (Metral Creek, Heikkila Creek, Jepson Brook and an unnamed creek draining Long Lake) also flow into Brannen Lake. Millstone River drains Brannen Lake flowing generally in a southeasterly direction into the Strait of Georgia in Nanaimo Harbour. Between Brannen

Lake outlet and the Strait of Georgia, Diver Lake, Cathers Lake and Westwood Lakes drain into the Millstone River.

Generally speaking, the eastern portion of the drainage basin is residential/commercial and comprises approximately 10% of the drainage basin; the western portion of the basin is forested and comprises approximately 75% of the basin while approximately 15% is agricultural and is more-or-less centered on the Millstone River Valley.

The upper section of the Millstone River between Brannen Lake and the Bowen Road bridge has a mild slope, approximately 1.6 feet fall per thousand feet of length. The river banks are tree and brush lined and the river meanders through agricultural land. There are several small bridges which constrict the flow somewhat and back the flow up at high water. Approximately 1500 feet upstream of the Bowen Road bridge on the right bank of the river is a large marsh area, Buttertubs Marsh, which is owned by the Nature Trust and is operated by the Provincial Fish and Wildlife Branch as a wildlife habitat area. On the eastern side of Buttertubs Marsh, in the area of Jinglepot Road and Bird Santuary Drive, there is a small subdivision. Some lots abut the marsh and are subject to flooding from high water in the marsh.

Immediately upstream of the Bowen Road bridge on the right bank, there are two multiple housing complexes, two senior citizen housing complexes and one apartment building. On the left bank are a hotel, a sports club, six

multiple housing buildings and eight houses adjacent to the stream. It is in this location that the potential flooding would cause the main problem, however, there is also potential for flooding in the vicinity of Bird Sanctuary Drive. Here several houses are subject to flooding from water which flows into Buttertubs Marsh both from the adjacent river and from upstream across a low spot in the cross dyke which runs along the boundary of the Mountain and Nanaimo Land Districts. On some occasions the water is sufficiently high to run across Jinglepot Road and into the Cat Stream drainage system. See Drawing No. 86-17-2, produced by the City of Nanaimo, which outlines approximately the area of potential flooding. This map is based on water levels calculated in the consultant's report.

Between the Bowen Road bridge and the Strait of Georgia, the river becomes quite steep with probable critical or super critical flow. The land adjacent to the river is parkland; hence there is a no major flooding problem in this section of the river.

3.0 Scope of Report

This report has been prepared to examine in more detail the potential for residential flooding as a result of a 1 in 200 year flood in the area between Buttertubs Marsh and the Bowen Road bridge. Means of preventing the flooding and the estimated costs of remedial works will be presented. Since the base mapping available for the area was in Imperial units, the

report has been prepared using Imperial units (feet, cubic feet per second, etc.) rather than the normal metric units.

4.0 Hydrology

There are two inactive Water Survey of Canada gauges on the Millstone River. Station 08HB027, Millstone River near Wellington is located on Biggs Road just downstream of the outlet of Brannen Lake. The period of record is 1961 to 1964 and 1969 to 1974. The maximum daily flow recorded for this gauge was 790 cubic feet per second (cfs) on December 16, 1973. The other gauge, 08HB032, Millstone River near Nanaimo, is located on the Bowen Road bridge. The period of record for this gauge is 1961 to 1965 and the maximum daily flow for the period of record was 660 cubic feet per second on December 24, 1963. The flow at Station 08HB027 on this same date was 550 cubic feet per second. In addition, the City of Nanaimo has operated a water level recording gauge on the Millstone River at Wall Street since 1983. This gauge has not been calibrated, however, and provides only water levels. In August 1986, at the request of the City of Nanaimo, a Water Survey of Canada gauge was re-established on the Millstone River at the Bowen Road bridge.

The Millstone River system includes a considerable amount of natural storage in Brannen Lake, Long Lake, Diver Lake, Westwood Lake as well as in-stream storage in the river itself such as the Buttertubs Marsh area. This

has the effect of reducing the peak flows in the system by a considerable amount.

It does, however, make the flow pattern and runoff characteristics quite complex and the use of a computer program such as HYMO (Hydrologic Modelling) is quite useful. This program estimates flow in a watershed at a given point and time by considering rainfall, the runoff and storage characteristics of the various sub basins, time of concentration, etc., and was used by AESL in their report. The AESL model was calibrated using a neighbouring watershed since the Millstone River lacked sufficient data. The peak flow estimated in the AESL report was evaluated by a regional peak flow study using available neighbouring watershed data and was assessed to be very reasonable. Based on this evaluation and the complexity of the river regime, no further work was attempted and the AESL results were adapted for use in further computer studies by the Ministry.

The AESL HYMO program gives a 1 in 100 year peak flow estimate at the Buttertubs Marsh area of 122 cubic metres per second (4308 cubic feet per second). It is estimated that the 1 in 200 year flow would be 10% greater than the 1 in 100 year flow. Hence, the design 1 in 200 year flow used in this report was 4740 cubic feet per second.

5.0 Design Criteria

Dyke crest elevations to Ministry standards are calculated by determining the water levels which would occur when the 1 in 200 year flow occurs and then adding on a two feet allowance for freeboard. Where sufficient space

exists, dykes will be constructed of well compacted granular material at a 2 to 1 slope with a twelve foot crest, to permit access for maintenance and in emergencies. Where space is limited, but access is available along the inside toe, the dyke will be similarly constructed but with a crest reduced to five feet. In locations where space is severely limited, a concrete retaining wall will be used as a dyke.

Internal drainage under normal conditions is handled by means of culverts through the dykes with flap gates on the river side. Under conditions of high flow, it must be recognized that there may be some ponding of water inside the dyke either from dyke seepage or from local runoff. Should water levels become too high, some temporary pumping may be required.

6.0 Survey and Investigation

In order to accurately ascertain water levels at various flows in the problem area as well as to investigate various means of alleviating and/or preventing flooding of the residences, it was decided to construct a computer model of the river using the HEC-2 Water Surface Profile computer program. Although the AESL report had calculated water levels on the Millstone River using the HEC-2 program, the whole river was done and consequently the river cross sections were spaced a considerable distance apart. Thus the river was resurveyed in May 1986 with channel cross sections taken at approximately 120 feet intervals over the area of interest. See Drawing No. 86-17-3. The channel cross sections were extended for coding into the computer program using sheets 2A and 3 of mapping of Millstone River produced by Dayton and Knight Ltd. in August 1975.

High water marks for the November 1983 high flows were obtained from the City. Using the stage-discharge table for the old gauge on the Bowen Road bridge, a flow of approximately 2300 cfs was estimated for the 1983 event. Similarly, high water marks were obtained from local residents and a flow of approximately 1700 cfs was estimated for the January 1986 storm. Use of this data permitted calibration of the computer model by adjusting the Mannings channel roughness, "n". It was found that use of a channel "n" of 0.055 and an overbank "n" value of 0.1 in the problem area matched the observed conditions fairly well.

Using the calibrated "n" values and the 1 in 200 year flood of 4740 cfs, the water levels in the Millstone River along the problem area were determined. Drawing No. 86-17-3 and -4 show the houses affected in the Bowen Road and Bird Sanctuary Road areas respectively. It should be noted that the houses shown as affected include both those houses which are at or below flood elevation and also those houses which are above flood elevation but which do not have 2 feet of freeboard above the flood elevation. These houses are not built to the flood construction level hence require dyking to conform to Ministry of Environment dyking standards.

Next, dykes were put in place in the model on both the left and right banks in the problem area between Cross Sections 100 and 200 and the resulting

water levels noted. These levels with 2 feet freeboard added determine the required dyke height and are shown on Drawing 86-17-5 as Profile Option A.

It was then decided to investigate the effects of widening Bowen Road bridge and channel improvement. The channel improvement involves cutting back the overhanging and overgrown brush to reduce the channel roughness and deepening the channel bottom through and downstream of the problem area. It was found that widening the bridge by 12 feet, from 37 to 49 feet, had very little effect on the floodwater levels but did reduce velocity through the bridge.

Brushing the channel out and thereby reducing the channel "n" to an estimated value of 0.04 reduces flood levels by an average of 0.6 feet. Deepening the channel to the grade shown on Drawing No. 86-17-5 (Option B) reduces floodwater levels by an average of 1.62 feet and at the upper end at Cross Section 200, by 2.0 feet. The combined channel improvement work reduces flood levels by an average of 2.2 feet and is illustrated in Drawing 86-17-5 as Profile Option B.

7.0 Proposed Remedial Work

It was thus concluded that two options would be considered. The first, Option A, would be dyke construction with no channel improvement. Option B would involve dyke construction combined with with channel improvement by brush removal and channel deepening. Common to both Options A and B is the construction of dykes along the rear property boundary of the affected

houses on Bird Sanctuary Road (see Drawing 86-17-4). The dyke crest elevation at this location is based on the river level at the cross dyke.

The dyke alignment under both options is identical and is shown on Drawings 86-17-3 and -4. The main difference between the two options is the required dyke height, with dykes under Option B being approximately 2 feet lower.

7.1 Bowen Road Dykes

On the right bank of the river from Bowen Road upstream for approximately 650 feet to Cross Section 104 (see Drawing 86-17-3), very limited space between the housing development and/or access roads and the riverbank necessitate the construction of a reinforced concrete retaining wall to act as a dyke. From the end of the concrete dyke/retaining wall at Cross Section 104 to Cross Section 200 a dyke of granular fill with a 5 foot crest is proposed. From Cross Section 200 to the high ground east of Buttertubs Road, there is sufficient space to construct a standard granular fill dyke with a 12 foot crest.

On the left bank, a standard dyke with a 12 foot crest is proposed commencing at Bowen Road and running upstream to the end of Bartlett Street. At Cross Section 102, very limited space necessitates a reinforced concrete retaining wall/dyke for approximately 150 lineal feet. From the end of the retaining wall, a standard dyke with a 12 foot crest will continue up the

left bank, across Fuller Street then run up the south side of Fuller Street for approximately 500 feet.

The cost of the Bowen Road dykes for Option A is $774,000 and for Option B is $918,000 and is detailed at Annex A and B respectively.

7.2 Bird Sanctuary Road Dykes

As shown on Drawing 86-17-4, the dykes would commence at Lot 7 Plan 29761 at the junction of Bird Sanctuary Road and Jinglepot Road. The dyke would cross Bird Sanctuary Road, where ramps would be required, and run along the rear property boundaries. For Option B it would tie into the high ground on the right-of-way between Lots 19 and 20. For Option A it would continue and tie into the high ground at Lot 22. In addition, for Option A, berms would be required around the houses on Lots 28, 31 and 35.

The cost of this work is $208,000 for Option A and $123,000 for Option B. A breakdown of the cost estimates are included at Annexes A and B respectively.

8.0 Discussion

The total estimated cost of Option A would be $984,000 while Option B would cost $1,064,000, or $80,000 more than Option A. Hence, based on cost, Option A is slightly less expensive. Option A would cause less damage and

disruption to the local river environment since it requires little in-stream work and brush and tree removal only on the dyke right-of-way. In addition, Option A has the advantage of requiring little or no in-stream maintenance as it does not depend on keeping the brush trimmed away from the channel's edge as Option B does.

Option B results in lower water levels in the area of concern. Consequently, dykes will be lower and the amount of right-of-way required for the earth fill dykes will be less than Option A. Also, dykes will be lower and restrictions on the view of landowners and pedestrians will be less.

Because of the extensive in-stream construction work to implement Option B and the requirement for periodic maintenance work to maintain the overhanging brush away from the stream edge, this option is viewed with disfavour by the Federal & Provincial fisheries agencies. Hence, approval for this option may require considerable mitigative works or perhaps even be impossible to obtain.

As an indication of the possible benefits of flood protection scheme, it was estimated by the City of Nanaimo (see Drawing 86-17-2) that the 1 in 100 year flood would affect some 147 units with an estimated population of 332. The assessed value of the buildings affected by this flood was estimated at some $4.5 million. The 1983 and 1986 floods which came very close to flooding the G.R. Pearkes Senior Citizens Housing were estimated at somewhere between a 1 in 25 and 1 in 40 year event; however, this estimate

is very preliminary and is subject to revision when further rainfall and stream flow data is available.

As previously mentioned, widening the Bowen Road Bridge has little benefit in lowering water levels. It does, however, have the effect of lowering velocities and thus reducing scour and erosion and also provides a wider channel for passing debris. Hence, if and when the bridge is replaced, it should be widened to at least 50 feet, preferably 60 feet. Also, since the 1 in 200 year water level in both Option A and B is approximately 1 foot above the bottom chord of the bridge, the bridge should be raised. In order to provide at least 3 feet of clearance for floating debris, the underside of the bridge should be raised by 4 feet to elevation 194.5 G.S.C.

Should it be decided to undertake the work in phases, it is suggested that the first phase be in the Bowen Road area on the right bank. This is the area with the potential for greatest damage in a flood. The next phase could be in the Bowen Road area on the left bank followed by the dyke at Bird Sanctuary Road.

9.0 Conclusions

This report examines the potential for flooding in the Bowen Road - Buttertubs Marsh area and outlines proposed remedial measures along with estimated costs. The cost of dyke construction without improvement to the

channel would cost $984,000 while the cost of dyking combined with channel deepening and bush removal would be $1,064,000. The cost of acquiring the dyke right-of-way, if necessary, is not included in these costs. The channel improvement option is not favoured by fisheries agencies and approval for this option may be difficult to obtain.

This preliminary report is not in sufficient detail to allow construction to proceed immediately. Prior to construction, further survey and investigation is required to produce a detailed design, cost estimates and to acquire right-of-way. The preliminary report will, however, give an indication of the scope of the problem and serve as a basis for further discussion among the affected agencies and as a possible future course of action in implementing flood control works in the area.

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Original maps available for viewing at

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