

PROVINCE OF BRITISH COLUMBIA  
MINISTRY OF ENVIRONMENT  
WATER MANAGEMENT BRANCH

REPORT ON THE  
FLOODPLAIN MAPPING STUDY  
BULKLEY RIVER AT HOUSTON  
(including Buck Creek)

An Overview of the Study Undertaken  
to Produce Floodplain Mapping for the  
Bulkley River (including Buck Creek)  
District of Houston

by  
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REPORT ON THE FLOODPLAIN MAPPING STUDY  
BULKLEY RIVER AT HOUSTON  
(INCLUDING BUCK CREEK)

Preface

The purpose of this report is to present a description of the methodologies used and results of the study undertaken to produce the attached floodplain mapping sheets, Drawings 85-14 Sheets 1 to 3. The study area covers six kilometres of the Bulkley River Valley and two kilometres of Buck Creek in the District of Houston. Detailed information used in the study is available from sources listed in Appendix 1.

1. Location

The study area is located approximately 310 kilometres west of Prince George, as shown on Appendix 2, in the intermontane system, one of the six main physiographic regions in the Province.

Mean annual precipitation in the study area averages between 40 to 50 cm. which is low in comparison with nearby coastal drainages where values exceed 350 cm.

General information related to the people, the environment and resource use in the study area can be obtained from the Atlas of British Columbia (Appendix 1.1).

2. Background

Reference to Files P71-1 of the Rivers Section, Water Management Branch (Appendix 1.2) indicates that the Water

Management Branch has been involved in dyking and river protection works in the Bulkley River and Buck Creek in the District of Houston since the late 1960's. Dyking construction has continued over the years to include a total of approximately 3.2 kilometres of dykes along both banks of Buck Creek and 2.6 kilometres of dykes along the left bank of the Bulkley River as shown on Sheet 3, Drawing 85-14-2.

The Special Projects Section (formerly the Planning and Surveys Section) of the Water Management Branch became involved in preliminary flood profile studies of this area in 1979. These profile studies were based on river survey data obtained in July of 1978 (Project No. 76 FDC 18-1) as listed in Appendix 1.3. The 1979 studies were classified as preliminary as detailed contour mapping of the area was not available.

Results of the 1979 flood profile study were used in connection with an assessment of dyking works, located in the industrial area of the District of Houston, which were constructed in the winter of 1979/80. The study results were also used in the preparation of flood control requirements contained in the "District of Houston Zoning Amendment Bylaw No. 253, 1980" as adopted by Council on January 6, 1981 (Appendix 3).

### 3. Designated Flood

In accordance with the policy of the Ministry of Environment, the flood levels and floodplain limits shown on the floodplain mapping sheets are based on a designated flood (1:200 year frequency) plus an allowance for freeboard,

assuming open water flow conditions. In addition to the above, a 1:20 year frequency flood level (plus freeboard) is shown on the mapping sheets for administrative purposes related to requirements for septic tanks.

#### 4. Survey Data

River Survey data used in the study was obtained in the field in July of 1978. Highwater level data on the Bulkley River was based on the May 11, 1976 flood and obtained during the 1978 river survey. High water levels on the Bulkley River were marked by District of Houston staff in cooperation with the Ministry of Environment. Highwater level data for Buck Creek, based on the May 3, 1979, flood, was obtained by Ministry staff. Appendix 1.3 outlines the data obtained during the river survey (Project 76 FDC 18-1)

Orthophoto topographic mapping for the study area was completed in June of 1984 as indicated in Appendix 1.4. The mapping has a one metre contour interval in the floodplain area and is based on air photography completed in June of 1982.

#### 5. Flood Magnitudes

The Surface Water Section, Water Management Branch carried out a study (Appendix 1.5) in April of 1985 to estimate the required peak flows for the Bulkley River and Buck Creek at their confluence. The method used incorporated peak flow frequency analysis and regionalized data from a previous hydrology study done by the Section (input to the Skeena-Nass Strategic Plan).

The maximum daily peak flows for Buck Creek and the Bulkley River below Buck Creek are based on the frequency analysis. However, maximum instantaneous peak flows are based not only on the daily values but also on maximum instantaneous-to-daily ratios derived from the regional plot of maximum ratios done for the Skeena-Nass study. The short record for Buck Creek at the Mouth is below the long term average peak flows with only two years slightly above average and no extreme high peaks. Since no high maximum instantaneous-to-daily ratios were observed, regional ratios based on neighbouring representative measured watersheds were used.

Results of the flood magnitude study for the study area are indicated on Table 1, attached.

The discharge for Bulkley River below Buck Creek for May 11, 1976, was estimated to be  $167 \text{ m}^3/\text{s}$  (daily) and  $217 \text{ m}^3/\text{s}$  (instantaneous) with an approximate recurrence interval of six years. These were based on observed data at Pinkut Creek (08EC004, 24 years of record) and Buck Creek (08EE013, 12 years of record) and regional peak flow curves from the Skeena-Nass Strategic Plan Study.

The discharge for Buck Creek (station 8EE013) for May 3, 1979, was  $68.8 \text{ m}^3/\text{s}$ . (instantaneous) as published by Water Survey of Canada.

## 6. Hydraulic Analysis

### 6.1 General

The information sources listed in Appendix 1 were utilized in the HEC-2 water surface profile computer

program developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers. The computer runs obtained in the analysis for both the Bulkley River and Buck Creek are as follows:

- A plot run provided a computer plot of river cross-sections and enabled an assessment to be made of the river survey data input and the extensions of sections obtained from the existing topographic mapping. Output from this run was also used to review other data such as flow regime, loss coefficients, bridge information, reach lengths, overbank information and relative Manning's "n" values.
- A calibration run was obtained to determine "n" values required to match the observed highwater levels obtained from the May 11, 1976, flood utilizing the results from the flood magnitude study undertaken by the Surface Water Section for the Bulkley River. For Buck Creek, a calibration run was obtained using level and discharge data for the May 3, 1979 flood.
- Multiple discharge runs were computed to determine the sensitivity of calculated flood levels to different flows.
- Multiple "n" value runs were computed to determine the sensitivity of calculated flood levels to changes in "n" values.

## 6.2 Bulkley River

A review of the results of the hydraulic analysis is summarized as follows:

- the calculated flood levels averaged to within 0.1 metres of the May 11, 1976, observed flood levels. Five observed high level points were available, 3 of which were located downstream of the Buck Creek confluence.
- channel "n" values were calibrated to average 0.034 in the study area.
- the designated flood level (1:200 year frequency, freeboard included) average 0.85 metres above the calculated May 11, 1976 flood levels. The May 11, 1976 instantaneous flow was estimated to be  $217 \text{ m}^3/\text{s}$  below Buck Creek confluence, which is approximately equal to the 1:20 year estimated daily flow.
- a flow of  $335 \text{ m}^3/\text{s}$  results in an average level increase of 0.33 metres above the estimated 200 year daily flow ( $258 \text{ m}^3/\text{s}$  below Buck Creek confluence), which is within the freeboard allowance.
- an average channel "n" increase to 0.054 results in an average level increase of 0.58 metres for a 1:200 year daily flow, which is within the freeboard allowance.



### 6.3 Buck Creek

A review of the results of the hydraulic analysis is summarized as follows:

- the calculated flood levels averaged to within 0.1 metres for the seven observed levels obtained from the May 3, 1979 flood.
- calibration channel "n" values average 0.04 upstream of the highway bridge.
- the designated flood level (1:200 year frequency, freeboard included) averages 0.95 metres above the calculated May 3, 1979, flood levels. The May 3, 1979, instantaneous flow was recorded at  $68.8 \text{ m}^3/\text{s}$  which is less than the estimated 1:20 year return period daily flow of  $74.5 \text{ m}^3/\text{s}$ .
- a flow of  $125 \text{ m}^3/\text{s}$  results in an average calculated level increase of 0.37 metres above the estimated 1:200 year daily flow ( $91.5 \text{ m}^3/\text{s}$ ), which is within the freeboard allowance.
- an average channel "n" value increase over calibrated values to 0.06 resulted in an average calculated level increase of 0.4 metres for a 1:200 year return period daily flow, which is within the freeboard allowance.

### 7. Floodplain Mapping

The flood levels determined in the study were used to draw the designated floodplain limits onto the existing

topographic mapping of the study area. The attached drawings (Appendix 4) were produced and indicate the following information:

- the orthophoto, 1 metre contour, mapping indicates the location of river cross-sections, the designated floodplain limits and the flood levels determined in the study.
- the study area covers six kilometres of the Bulkley River Valley and two kilometres of Buck Creek.
- the floodplain limits are approximate only for two and one half kilometres of the Bulkley River valley, located downstream of the study area, and for five kilometres of the Morice River valley as river cross section and observed highwater level data was not available to calculate flood levels in these areas. The floodplain limits in this area are based on an analysis of the existing air photo and topographic information.
- the Bulkley River is a meandering watercourse which is confined in the study area, as shown on the drawings, by the CNR, Highway 16 and the existing dykes in the District of Houston near the Buck Creek confluence.
- The Bulkley River in the study area has an average slope of one point six metres per kilometre (0.16%).
- Buck Creek is confined by dykes in the study area as indicated in the drawings. The Buck Creek-Henry

Creek Fan has been cross hatched and it is noted that flood levels are indeterminate as the area is susceptible to flooding in the event of dyke failure or overtopping during high flow periods and from internal drainage problems related to highwater levels on the Bulkley River.

- Buck Creek has an average slope of six metres per kilometer (0.6%) or the study area.

#### 8. CONCLUSIONS AND RECOMMENDATIONS

1. This report serves to present an overview of the studies undertaken to produce the floodplain mapping sheets for the Bulkley River and Buck Creek in the District of Houston.
2. The study confirmed that the crest elevations on the existing dykes along these watercourses are adequate to control the designated flood under open water flow conditions.
3. An ongoing concern is the section of Buck Creek in the vicinity of the highway and railway bridges. These structures constitute an impediment to flood flows due to bedload deposition, ice and debris, which in past years have created flooding problems in the area.
4. Preliminary flood profile studies of the Bulkley River in 1979 (see 2. Background), which were undertaken without the benefit of detailed contour mapping, were compared with the results of this floodplain mapping

study. The comparison indicated that the 1979 levels are conservative, being approximately 0.8 metres higher than the levels indicated on the floodplain mapping sheets.

5. Updating of "The District of Houston Zoning Amendment Bylaw No. 253, 1980" should take cognizance of the floodplain mapping produced as a result of the study.
6. River cross-section information is required in the area indicated on the mapping where the floodplain boundary is shown to be approximate only.
7. Highwater data for a flood exceeding a 1:20 year frequency should be obtained for the floodplain area shown on the mapping sheets.



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RWN:res

TABLE 1

## Peak Flow Estimates, Bulkley River and Buck Creek

STREAM LOCATION	DRAINAGE AREA (km <sup>2</sup> )	RATIO OF MAXIMUM INSTAN- TANEOUS- TO-DAILY DISCHARGE	PEAK FLOW							
			DAILY				INSTANTANEOUS			
			MEAN ANNUAL		25-YEAR	20-YEAR		200-YEAR		20-YR
			(L/s/km <sup>2</sup> )	(m <sup>3</sup> /s)	(L/s/km <sup>2</sup> )	(L/s/km <sup>2</sup> )	(m <sup>3</sup> /s)	(L/s/km <sup>2</sup> )	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)
Bulkley River below Buck Cr. (08EE003)	2380	1.30	50.8	121	-	-	200	-	258	260
Buck Cr. at its mouth (08EE013)	580	1.37	79.1	45.9	-	-	74.5	-	91.5	102
Bulkley River above Buck Cr.	1800	1.32	47	85	85	82	147*	107	193	194
										255

\* A ratio of 0.96 was used to convert 25-year to 20-year estimates based on available frequency results of four neighbouring hydrometric stations (08EC002, 08EC004, 08EE004, 08EE020).

# APPENDIX 1

## Detailed Information Sources used in the Floodplain Mapping Study - Bulkley River at Houston

No.	Source	Contents
1.	Atlas of British Columbia, U.B.C. Press W.R. 912.711 F 231 C.4	General information on the people, environment and resource use.
2.	Ministry of Environment, Water Management Branch, Rivers Section, File P. 71, Volumes 1 to 6. September, 1968 to date, District of Houston.	Information related to river improvement works and dyking, reports on flooding etc. in the District of Houston.
3.	Ministry of Environment, Water Investigation Branch, Surveys Section, Survey Project 76 FDC 18-1, "Cross-section data Bulkley River and Buck Creek", District of Houston, March, 1979.	11 cross-sections of Buck Creek including preliminary water level profile; 22 cross sections of the Bulkley River including water level and thalweg profile; 5 cross-sections of Avalon Creek; 5 profiles of proposed dyke routes; a listing and description of temporary bench marks, cross-section and profile plots, spot height listing and sketches; Drawing A 5125-100 sheets 1 and 2 showing cross-section locations, profile, highwater mark and spot height locations; 2 folders of colour prints showing ground and river conditions upstream and downstream of each river cross-section; bridge and culvert descriptions.
4.	Ministry of Environment, Map Production Division, Surveys and Resource Mapping Branch, Project No. 82-071-T0	1 metre orthophoto topographic mapping completed in June, 1984, based on air photos taken in June 1982.
5.	Ministry of Environment, Surface Water Section, Water Management Branch, Bulkley River and Buck Creek Peak Flow Estimate, Memorandum April 17, 1985, File S2102.	Estimates of daily and instantaneous peak flows for the study area.



## STUDY AREA LOCATION

100 0 100 200 300  
KILOMETERS



**Province of British Columbia**  
**Ministry of Environment**  
**WATER MANAGEMENT BRANCH**

TO ACCOMPANY REPORT ON  
**FLOODPLAIN MAPPING STUDY**  
**BULKLEY RIVER AT HOUSTON**  
(including Buck Creek)

SCALE: VERT. \_\_\_\_\_

DATE

**R. W. NICHOLS**

ENGINEER

HOR. \_\_\_\_\_

**AS SHOWN**

**NOVEMBER 1985**

FILE No. **46-0000-S-1** APPENDIX No. **2**

## DISTRICT OF HOUSTON

P.O. BOX 370  
HOUSTON, BRITISH COLUMBIA, V0J 1Z0  
TELEPHONE 845-2238

Mayor: A. MEB SSEN  
Clerk/Administrator: JOHN K. SPANIER

OUR FILE: B.L. 253  
YOUR FILE:

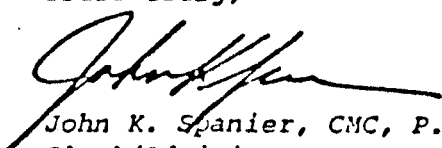
January 8, 1981

Ministry of Environment  
Parliament Buildings  
Victoria, B. C.  
V8V 1X4      Attn.: G. E. Simmons

Dear Sirs:

We enclose herewith two (2) copies of our By-law No. 253, "District of Houston Zoning Amendment By-law No. 253, 1980", (Flood Plain) as adopted by Council on the 6th day of January, 1981.

Yours truly,

  
John K. Spanier, CMC, P. Mgr.  
Clerk/Administrator

JKS/ms

Encl.

MINISTRY of ENVIRONMENT		
PLANNING AND SURVEYS SECTION		
JAN 14 1981		
REF.	J.H.D.-D	9/1
	G.E.S.	gates



BY-LAW NO. 253

1. District of Houston Zoning By-law No. 86 is hereby amended by inserting definitions in Part 1A in alphabetical order "natural boundary" to follow "motor vehicle" definition and "watercourse" to follow "yard, rear".

Natural boundary means the visible high-water mark of any lake, river, stream or other body of water where the presence and action of the waters are so common and usual and so long continued in all ordinary years as to mark upon the soil of the bed of the lake, river, stream or other body of water a character distinct from that of the banks thereof, in respect to vegetation, as well as in respect to the nature of the soil itself.

Watercourse means any natural or man-made depression with well defined banks and a bed 0.6 m. or more below the surrounding land serving to give direction to a current of water at least six months of the year or having a drainage area of two square kilometers or more.

3. Part II(A) of District of Houston Zoning By-law is hereby amended by adding the following as Section 31:

31. a) Notwithstanding any other provisions of this by-law, no building or part thereof shall be constructed, reconstructed, moved or extended nor shall any mobile home or unit, modular home or structure be located:

i) within 8 m. of the natural boundary of any swamp or pond,

ii) within 60 m. of the natural boundary of the Bulkley River or any side channel of the said river or Buck Creek where no adequate dykes exist, or within 8 m. of the inboard toe of any dykes constructed to a 1 in 200 year standard as approved by the Ministry of Environment along the Bulkley River or along Buck Creek as shown on the attached Schedule "A",

iii) For the area outlined in yellow on Schedule "A", Map 3 Zoning Map, the underside of the floor system of any area used for habitation, business, or storage of goods damageable by flood waters, shall not be lower than 0.6 meters above the centre-line of the higher adjacent road for any residential use, or lower than 0.3 meters above the centre-line of the higher adjacent road for any industrial or commercial use as designated in the Houston Community Plan, By-law No. 271, as filed with the Inspector of Municipalities. In case of a mobile home or unit, the ground level on which it is located shall be not lower than 0.6 meters above the centre-line of the higher adjacent road.

iv) For the area outlined in red on Schedule "A", the elevations shown on Schedule "A" shall be the lowest elevation for the underside of the floor system, or ground level upon which a mobile home or unit is located.

- b) The elevations stated in Section 31, Clause (a) (iii) and (iv) above shall not apply in that portion of the development permit area shown number 4 on Map 3 Zoning Map (Schedule A) as a 1 in 200 year dyke has been built to a standard approved by the Ministry of the Environment and the following elevation requirement shall apply:

- 1) Hereafter, no new building or structure intended for any industrial or commercial use, as designated in the Official Community Plan, shall be constructed at an elevation such that the underside of a conventional wooden joist floor system or the top of a concrete slab-on-grade floor thereof is not lower than 590.0 meters Geodetic Survey of Canada datum, or is less than 0.3 meters above the centre-line of the higher adjacent road, or 0.6 meters above the average natural ground surface elevation at the building, whichever elevation is the lesser, but in any event not lower than elevation of 590.0 meters.
- 1i) The required elevation may be achieved by structural elevation of the said habitable, business, or storage area or by adequately compacted landfill on which any building is to be constructed or mobile home located, or by a combination of both structural elevation and landfill. No area below the required elevation shall be used for the installation of furnaces or other fixed equipment susceptible to damage by flood water. Where landfill is used to raise the natural ground elevation, the toe of the landfill slope shall be no closer to the natural boundary than the setback requirement given in Section 31(a)(1)(ii) above. The face of the landfill slope shall be adequately protected against erosion from flood flows.
- c) The provisions of Section 31(a)(iii) and (iv) and 31(b) shall not apply behind 200 year standard dykes to:
  - 1) a renovation of an existing building or structure used as a residence that does involve an addition thereto,
  - 1i) an addition to a building or structure used as a residence that would increase the size of the building or structure by less than 25 percent of the floor area existing at the date of adoption of this by-law,
  - 1ii) that portion of a building or structure designed or intended for residential use that is comprised of essentially non-habitable uses such as carport or garage, utility areas or workshop,
  - 1v) an addition to an existing building or structure used as a residence to be created by raising the existing residence and creating an area for non-habitable uses underneath,
  - v) farm buildings (except dwelling units and buildings used for major crop storage) and greenhouses.
- d) For existing buildings modified or being added thereto, the following conditions shall apply:
  - 1) Where the square footage of the addition is from 0 to 50% of the existing structure at the time of the building permit application, the floor elevation of the new structure shall be not lower than the existing floor elevation of the existing structure.
  - 1i) Where the square footage of the addition is 51% or over the existing square footage at the time of the building permit application, the floor elevation of the new structure shall be 0.3 meters minimum for commercial and 0.6 meters minimum for residential, to the underside of the main floor, wood joist system or top of the slab-on-grade floor above the existing geodetic elevation of the crown of the higher adjacent road, except in area #4 where the elevations stated in Clause b(1) shall apply.

- 111) Where the square footage of the addition is 51% or over the existing square footage at the time of the building permit application, and the 0.3 or 0.6 meter minimum, whichever is applicable, or 590 meters geodetic elevation (to the underside of the main floor system) cannot be attained because of hardship, that the Board of Variance rule on the matter, with the Ministry of the Environment obligated to present objections and reasons for objections.
- e) The required elevations stated throughout may be achieved by structural elevation of the said habitable, business, or storage area or by adequately compacted landfill on which any building is to be constructed or mobile home located, or by a combination of both structural elevation and landfill.
- f) Where landfill is used to achieve the required elevations stated in Sections 31(a)(iii) and (iv) and 31(b)(i), no portion of the landfill slope shall be closer than the distances in Sections 31(a)(i) and (ii) from the natural boundary or inboard toe of a dyke as applicable, and the face of the landfill slope shall be adequately protected against erosion from floodwaters.

RECONSIDERED AND FINALLY ADOPTED BY THE MUNICIPAL COUNCIL ON THE

6th DAY OF January, 1981

