PACIFIC REGION TECHNICAL NOTES

81-003
January 13, 1981

The Boxing Day Floods of 1980 over Southwestern B.C.

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INTRODUCTION

Boxing Day of 1980 will be remembered by many citizens of southwestern B.C., as the day of the floods. Numerous washouts, mudslides, and floods were reported in such areas as the Fraser Canyon, Hope, Mission, Squamish, Alta Lake - Whistler, and the Alberni - Parksville section of Vancouver Island. For a time, all three railway lines and two highways between the coast and the interior were closed, cutting off all surface transportation routes.

This paper presents a brief look at the meteorological factors that contributed to these memorable year end events.

SYNOPTIC EVENTS

At 500 mb, a ridge of high pressure extended from Nevada into B.C. while a trough was aligned along 155W about 10 days prior to Dec. 26. During the next couple of days a trough across the Northwest Territories began to sag southeastward with an extension across northern B.C. into the Gulf of Alaska. In response to this trough the upper ridge retrogressed and by the 19th it was aligned from western Alaska to off the California coast. The trough along 155W also shifted to a northwest - southeast orientation.

A change in the 500 mb pattern emerged on the 20th as short waves began to penetrate the southern fringes of the ridge along latitude 40N. The erosion of the ridge continued and by the 21st short wave, troughs were now able to move onto the coast from California to southern B.C.

Upstream, a split in the flow became established near 40N 150W. The northern branch tracked northward around the high over western Alaska. The southern stream meanwhile began pumping mild moist Pacific air towards the coast from latitudes just north of Hawaii.

From the 22nd through the 26th the southern stream drifted northward so that by Christmas morning a broad belt of southwesterlies covered the coast from northern California to the southern Charlottes as shown by

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the 500 mb analyses of 0000Z December 26 to 0000Z December 27. (Figure 1).

SATELLITE AND SURFACE FEATURES

During the period of the 16th to 19th the ridge offshore prevented frontal systems from reaching the coast. By the 20th, however, the short waves breaking through the ridge brought the frontal system and rain to the coast. This was the beginning of the moist southwest flow that was to bring the heavy rains to the southern B.C. coast during the Christmas holidays.

One major thrust passed through the coast on the 21st. The next major and most significant short wave arrived Boxing Day morning. The satellite photographs and the accompanying surface analyses 0000Z December 26 to 0000Z December 27 depict the broad and complex nature of the frontal band. (Note figures 2 and 3).

At least two short waves are evident on the satellite picture of 0045Z December 26. The leading wave extends from the southwest of the Charlottes to off the Oregon coast. The second lies behind the cold front along longitude 145W. By 1245Z the leading short wave had moved well inland and the second to 140W. However, another wave had developed in between and extended from 48N 133W to 42N 127W. With the passage of this short wave, the heavy rain subsided over most areas. Rainfall accumulation with the following cold front was relatively small.

THE PRECIPITATION AMOUNTS

Recorded precipitation amounts for a number of southwestern B.C. locations for the period 24-28 December 1980, are listed in Figure 4. It is seen that the peak in the amounts was achieved on the 26th of the month at all locations.

The Boxing Day precipitation amounts were greater than with the average winter frontal system crossing southern B.C. For a major storm, however, the amounts were not excessive or unusual. Precipitation amounts in excess of 30mm per 24 hours at Vancouver airport, for example, were reported on 7 occasions during the past 12 months. The maximum quantity of precipitation ever recorded at the airport, over a 24 hour period, was 92.7 mm on Christmas Day of 1972. This is more than twice the 39 mm of the Boxing Day just past. Similar comments can be made for the other reporting points on the south coast, though the actual amounts would differ somewhat. Areas further inland received a proportionally greater amount of precipitation than at Vancouver airport. The rainfall at Hope, on the 26th, was about 80% of the record 24 hour amount.

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The heaviest rainfall occurred over a 15 hour period centered on the early part of Boxing Day. The largest amount for a 24 hour period was recorded at Hope (82.3 mm), followed by Abbotsford (63.2), and Alta Lake (57.0). On the 27th, Hope received another 57 mm, but the other reporting points had by this time considerably reduced amounts.

FREEZING LEVELS AND THE SNOWPACK

Freezing levels, which were at sea level early in December, gradually rose to 1500-2000 metre level by mid-month. This resulted in a fairly slow decrease in the mountain snowpack, but as Christmas approached, snow amounts of near 100 centimetres were still being reported at the 1000-1500 metre levels of the mountains of south-western B.C.

On Boxing Day the strengthening southwesterly flow aloft led to a rapid increase in the freezing level; (see figure 5: note Quillayute 3320 metres at 27/12Z). As a consequence, the snow melt increased dramatically. By the 27th of the month, areas below 1500 metres, other than with northerly exposures, were essentially bare of snow.

THE FORECASTS

The series of forecasts and warnings for southwestern B.C., that were issued from 4 p.m. of Christmas Day to the 5 a.m. issue of the 27th, are listed in Figure 7. Rain was forecast in all issues but no mention of heavy precipitation was made until the morning of the 26th. A heavy rainfall warning was issued at 7:30 a.m. of Boxing Day calling for total precipitation amounts of 50 to 100 millimetres during the day. This warning was ended with the 5 a.m. forecast of the 27th.

CONCLUSIONS

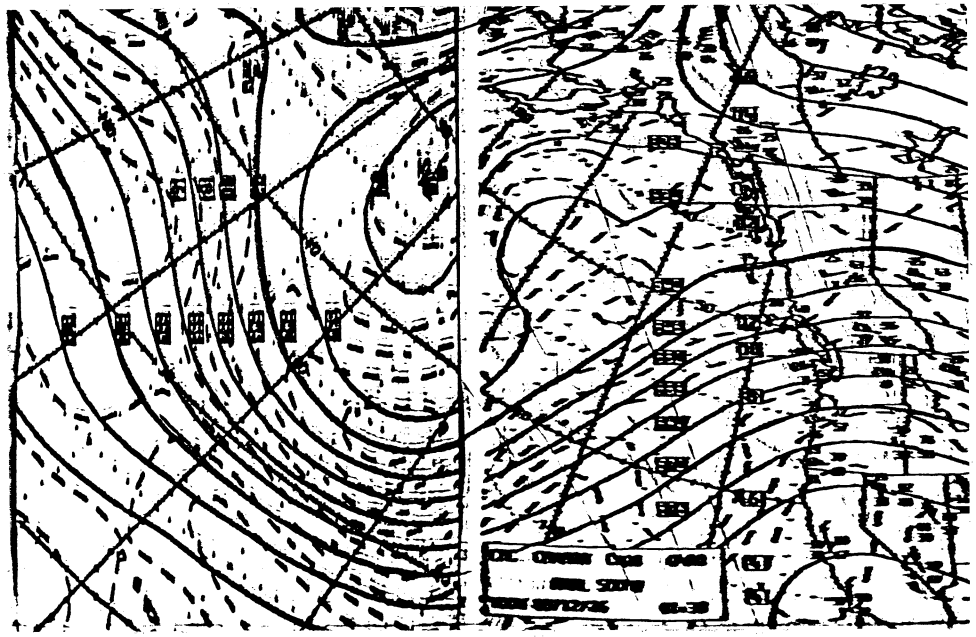
Moisture of subtropical origin in the southwesterly flow aloft interacted with a source of cold air in the Gulf of Alaska. This led to development in the offshore baroclinic zone and the subsequent arrival of the Boxing Day deluge. The rains over southwestern B.C. were fairly heavy, but not excessively so. The main causative factor for the run-off reaching flood stage, would seem to be the addition of the melting mountain snowpack to the precipitation run-off water. In addition, in the case of Squamish, the occurrence of high tides likely contributed to a back-up of water at the mouth of the Squamish River, and as such, hindered the run-off over the lower part of the valley.

Forecasts issued by the Pacific Weather Centre proved adequate in maintaining the precipitation regime through Boxing Day. The heavy

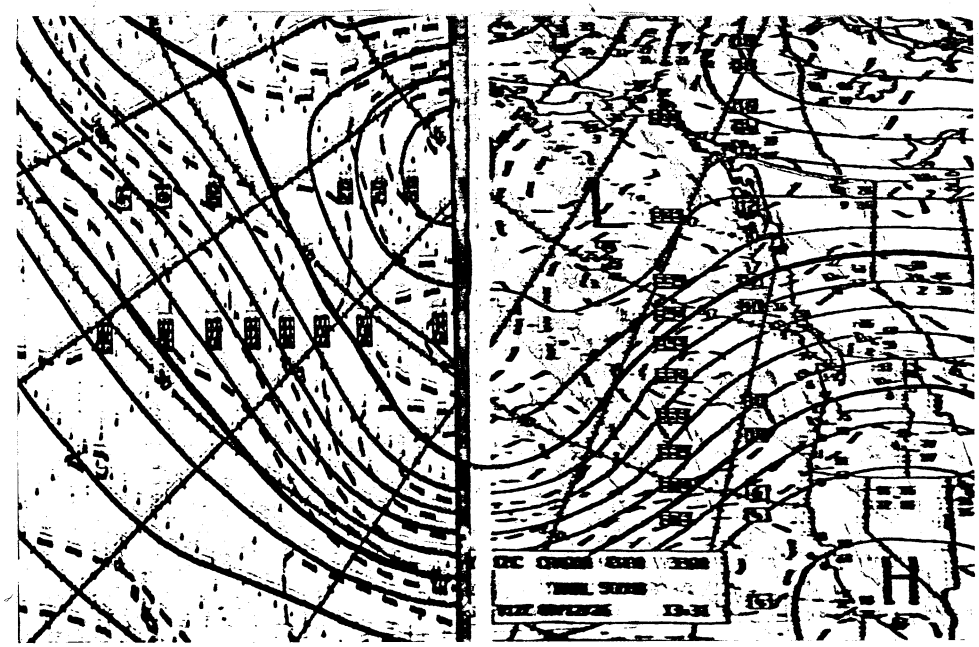
.../4

rain warning proved warranted, but it would have been more useful if it had been issued on the evening of Christmas Day.

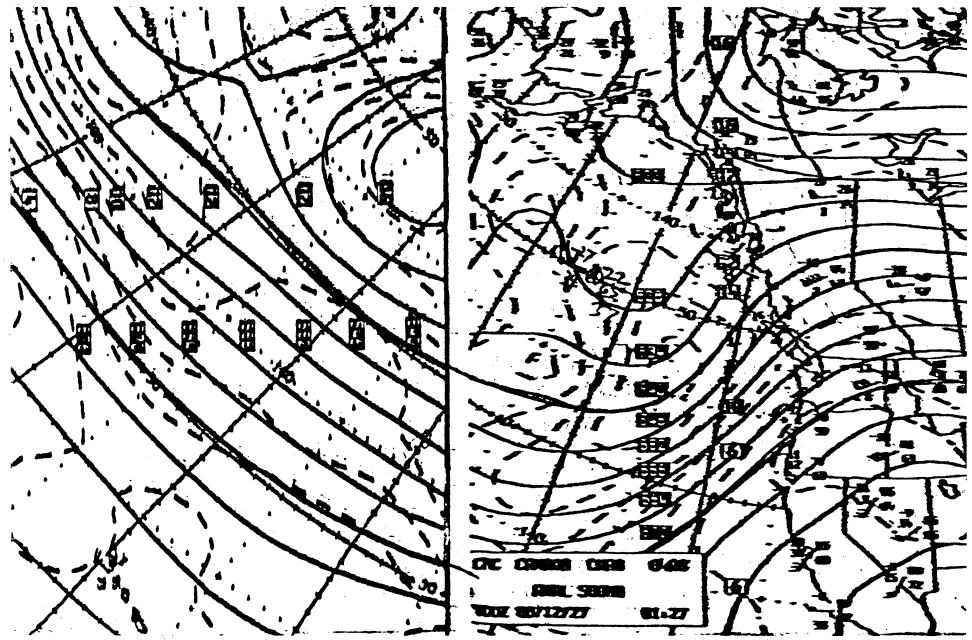
This study seems to indicate that an adequate flood warning system for B.C. requires the year-round monitoring of freezing levels, snow packs and precipitation amounts. These observations should then be combined with forecast precipitation amounts and predicted freezing levels and interpreted by a knowledgeable hydrometeorologist in order to issue the required flood warnings.



(a)



(b)



(c)

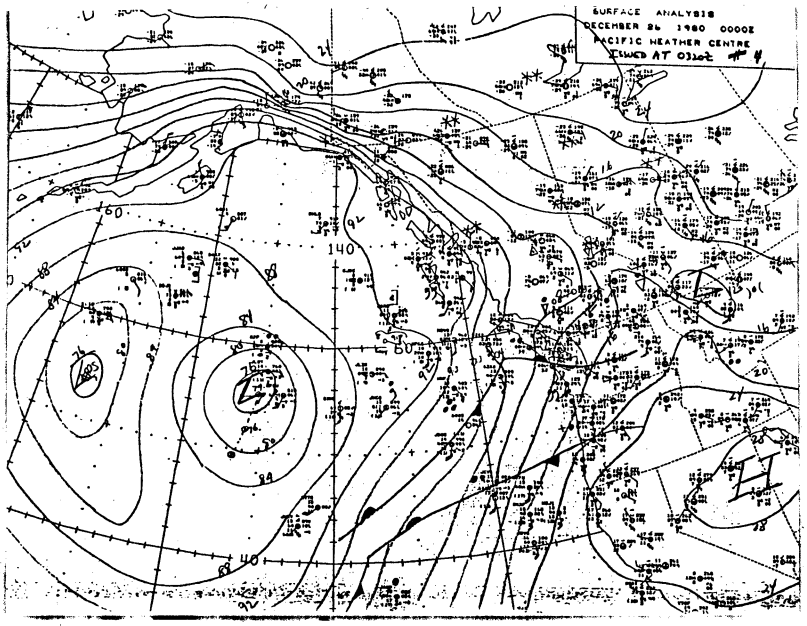
FIGURE 1.

CMC 500 MB ANALYSIS

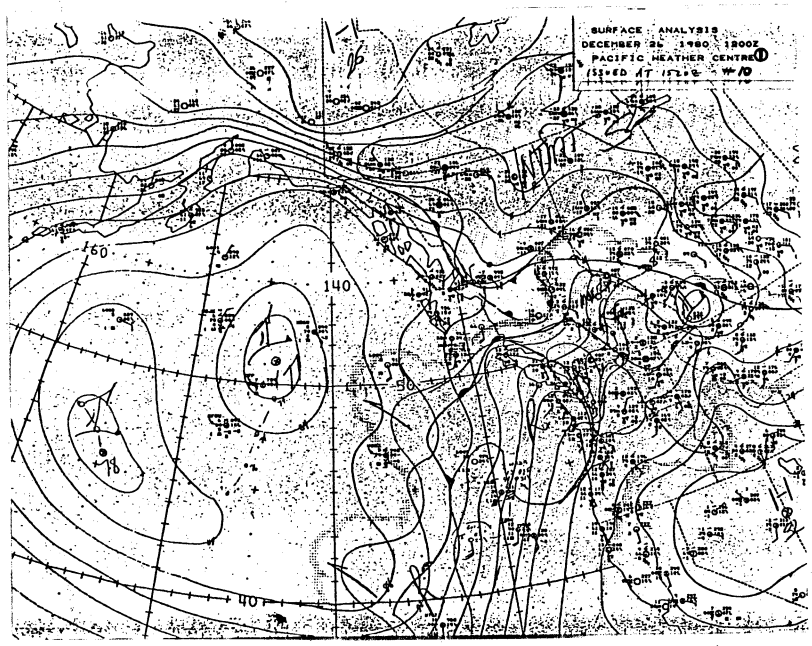
(a) 0000Z DEC. 26, 1980.

(b) 1200Z DEC. 26, 1980.

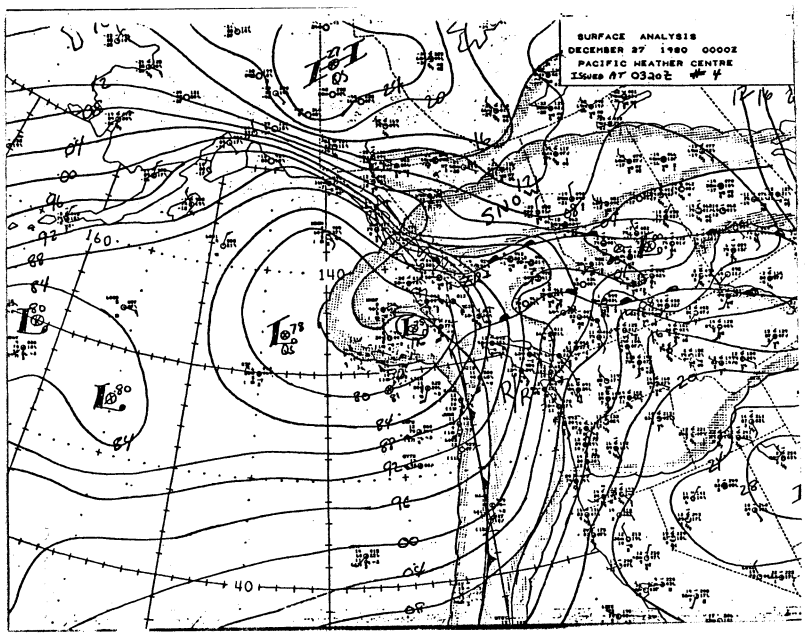
(c) 0000Z DEC. 27, 1980.



0000Z DEC. 26, 1980.



1200Z DEC. 26, 1980.



0000Z DEC. 26, 1980.

FIGURE 2. SURFACE ANALYSIS

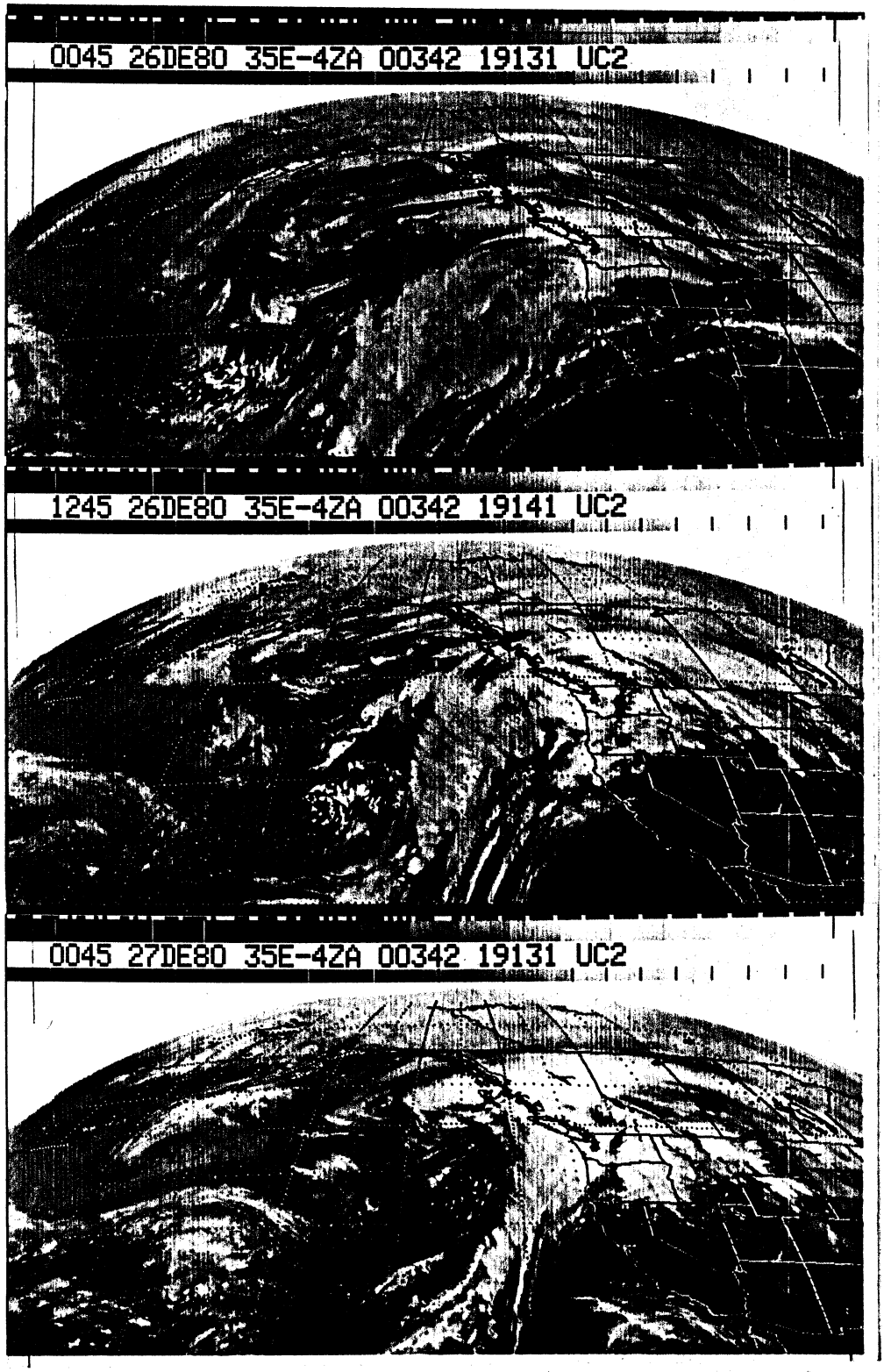


FIGURE 3.
SATELLITE IMAGERY SHOWING CLOUD STRUCTURE
DURING HEAVIEST PRECIPITATION

24-HOUR PRECIPITATION AMOUNTS...(DEC 1980)

	24TH	25TH	26TH	27TH	28TH
VANCOUVER AIRPORT	14.2	19.0	39.0	6.3	0
VANCOUVER HARBOUR	12.4	13.4	45.4	27.4	9.6
VICTORIA AIRPORT	12.4	16.8	45.2	9.6	0
ABBOTSFORD	10.4	24.0	63.2	12.2	3.4
COMOX	34.6	17.6	40.9	1.0	0.2
HOPE	7.4	45.1	82.3	57.2	6.0
NANAIMO	14.1	MISG	38.0	7.6	0.2
PORT ALBERNI	30.4	64.8	MISG	12.0	4.8
ALTA LAKE	8.7	40.4	57.0	2.4	MISG

Figure 4. Recorded precipitation Amounts December 24-28, 1980

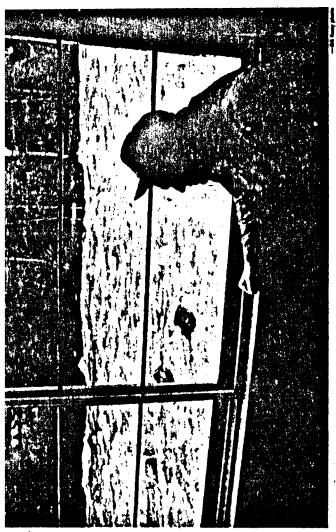
(HTS = METERS) ('0' = SURFACE)

F R E E Z I N G L E V E L S

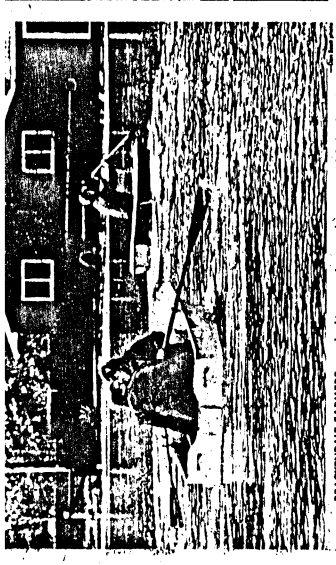
('*' = UPPER

		C7P	ANN398	YZT109	UIL797	SLE694	GEG785
DEC25	12Z	960	980	1680	2260	2770	2770
DEC26	00Z	1550	1370	1700	2380	3050	2800
	12Z	1580	1280	2040	3320	2990	3140
DEC27	00Z	1250	1370	2710	2990	3290	2990
	12Z	700	1070	1330	1550	2160	2530

Figure 5. Actual freezing level reports from radiosondes

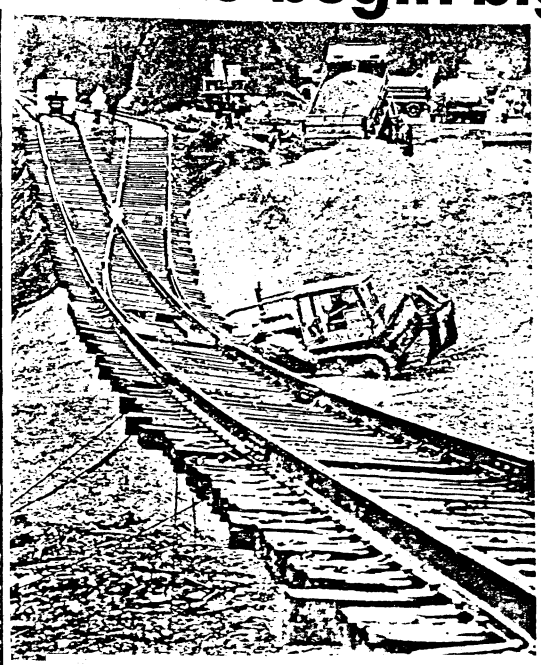


REG MASTIN ... watching the Silver Skagit River near post motel in Hope



BRACKENDALE FARMERS ... checking out damaged property with help of rowboat

300 homes damaged in 'once-in-a-lifetime' floods



SPORTS REVIEW

MONDAY, DECEMBER 29, 1980

The Vancouver Sun

VANCOUVER, BRITISH COLUMBIA

Tomorrow's weather: RAINY PERIODS Details Page A2

25 CENTS

Flood victims begin big cleanup

Main highways open as heavy rain eases

The heavy rains are over and all major provincial highways have reopened, but cleanup operations have just begun for hundreds of B.C. residents whose homes were devastated by floodwaters over the Christmas holiday.

Provincial Environment Minister Stephen Rogers promised millions of dollars in aid after touring the flood-stricken regions near Hope and Squamish on Sunday, but he could not estimate the exact cost of the damage caused by the record rainfall.

"God it's awful," he said. "But I just can't give you a number estimate that would make sense."

Damage to major highways is estimated at $6 million and Rogers said damage to private homes would easily surpass $2.5 million, which means that federal aid will also be forthcoming.

As rivers near Hope, Squamish and Princeton receded Sunday, weary residents who had stayed with friends or had been put up at local schools headed back to their homes to inspect the damage and begin to clean up. Squamish RCMP arranged nightly patrols of private homes after receiving several reports of looting.

Four helicopters worked day and night Friday and Saturday near Squamish as they plucked residents off the roofs of their homes. A woman with a heart condition rewarded two rescuers with a kiss as she left their helicopter.

Stranded holiday travellers slowly made their way home Sunday as the Trans-Canada Highway between Hope and Yale reopened to single-lane traffic after a washout Friday at Gordon Creek, 19 kilometres northeast of Hope. The Hope-Princeton Highway reopened Saturday, and highway officials advise that winter tires are compulsory on both routes.

But three major rail lines in the province remain closed due to washouts caused by the heavy rains. CP Rail officials said the company's mainline at Gordon Creek wouldn't reopen until this afternoon at the earliest.

CNR officials said their mainline at Hope won't be repaired for at least a week, and the B.C. Railway has halted service on a 130-kilometre stretch of track between Squamish and Lillooet because of flood damage to roadbeds and bridges. Service is disrupted for about a month and hundreds of BCR employees may be laid off until the service returns to normal. A company spokesman said there were about 20 washouts on the line between Squamish and Lillooet.

As the Squamish Highway reopened Sunday, disappointed skiers headed home after heavy rain and high winds prevented most of them from attempting any of the runs on Whistler and Blackcomb mountains.

In the Lower Mainland, crews are still working to repair portions of the Lougheed

Squamish and Hope flooding in story and pictures, A3

Highway that were washed out by the rains. Motorists going from Maple Ridge to Mission must detour from 272nd Street to 280th Street.

Municipal officials in Greater Vancouver say they have only received a few minor complaints of flooded basements. A waterworks water works spokesman said Sunday that city residents should not be alarmed to find their tapwater discolored as it's "quite safe" for drinking and bathing. He said turbulence in the reservoirs has caused the discoloration.

Weather forecasters say the province can expect more rainy weather today and Tuesday, with temperatures reaching highs from 10 to 13 degrees, but the record rains that accompanied the flooding are not expected to return.

Vancouver has already experienced its wettest year on record with 1,412 millimetres of rain compared to the previous high of 1,387 millimetres set in 1961.

Figure 6. Some newspaper accounts of the floods

FPCN11CWVR 260000
PART 1 OF 2
FORECASTS FOR BRITISH COLUMBIA ISSUED BY ENVIRONMENT CANADA
AT 4.00 PM PST THURSDAY 25 DECEMBER 1980 FOR TONIGHT AND
FRIDAY WITH AN OUTLOOK FOR SATURDAY
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT
5 AM FRIDAY 26 DECEMBER 1980
GREATER VANCOUVER
LOWER FRASER VALLEY
HOWE SOUND-WHISTLER
SUNSHINE COAST
EAST VANCOUVER ISLAND.
TONIGHT RAIN. BOXING DAY CONTINUOUS RAIN CHANGING TO SHOWERS
NEAR NOON. LOWS TONIGHT 5 TO 7. HIGHS BOXING DAY NEAR 11
OUTLOOK FOR SATURDAY SHOWERS

FPCN11CWVR 261300
PART 1 OF 2
FORECASTS FOR BRITISH COLUMBIA ISSUED BY ENVIRONMENT CANADA
AT 5.00 AM PST FRIDAY 26 DECEMBER 1980 FOR TODAY AND SATURDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT
4 PM TODAY 26 DECEMBER 1980.
GREATER VANCOUVER
LOWER FRASER VALLEY
HOWE SOUND-WHISTLER
SUNSHINE COAST
EAST VANCOUVER ISLAND.
TODAY.. RAIN. TEMPERATURES STEADY NEAR 11 TO 13 TODAY.
LOWS TONIGHT NEAR 9.
SATURDAY.. CLOUDY WITH SHOWERS. HIGHS NEAR 9.

FPCN11CWVR 261530AMD
REVISED FORECASTS FOR BRITISH COLUMBIA ISSUED BY ENVIRONMENT CANADA
AT 0730 AM PST FRIDAY 26 DECEMBER 1980 FOR TODAY AND SATURDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT
4 PM FRIDAY 26 DECEMBER 1980.
GREATER VANCOUVER
LOWER FRASER VALLEY
HOWE SOUND-WHISTLER
SUNSHINE COAST
EAST VANCOUVER ISLAND.
HEAVY RAIN WARNING ISSUED.
TODAY RAIN HEAVY AT TIMES. TWENTY FOUR HOUR RAINFALL TOTALS UP TO
THIS EVENING ARE EXPECTED TO BE IN THE 50 TO 100 MM RANGE.
TEMPERATURE STEADY NEAR 13 TODAY. LOWS TONIGHT NEAR 9.
SATURDAY CLOUDY WITH SHOWERS. HIGHS NEAR 9.
END
REVISED SYNOPSIS FOR BRITISH COLUMBIA.
A SERIES OF PACIFIC WEATHER SYSTEMS STRECHING SOUTHWESTWARD FROM
THE SOUTH COAST WILL CONTINUE MOVING NORTHEASTWARD ACROSS THE
SOUTH COAST TODAY. STEADY RAIN HEAVY AT TIMES WILL CONTINUE OVER
THE COASTAL AREA TODAY BEFORE CHANGING TO A LIGHTER VARIETY OF
SHOWERS TONIGHT. 24 HOUR RAINFALL AMOUNTS ENDING BY LATE THIS
EVENING ARE EXPECTED TO BE IN THE 50 TO 100 MM RANGE BEFORE THE
CHANGE TO SHOWERS OCCURS. SHOWERS WILL CONTINUE ON SATURDAY.
END

WWCN1 CWVR 261530
HEAVY RAIN WARNING FOR GREATER VANCOUVER LOWER FRASER VALLEY
HOWE SOUND-WHISTLER AND SUNSHINE COAST REGIONS OF BRITISH
COLUMBIA
ISSUED BY ENVIRONMENT CANADA AT 0730 AM PST FRIDAY DECEMBER 26 1980
A SERIES OF WEATHER SYSTEMS STRETCHING SOUTHWESTWARD INTO THE
PACIFIC OCEAN ARE CONTINUING TO MOVE NORTHEASTWARD ACROSS THE
SOUTH COAST. THEY ARE PRODUCING EXCESSIVE RAINFALLS HEAVY AT TIMES
AND TWENTY FOUR HOUR RAINFALL TOTALS FROM THURSDAY EVENING UP TO
THIS EVENING ARE EXPECTED TO BE IN THE 50 TO 100 MM RANGE BEFORE
THE RAIN CHANGES TO SHOWERS OF A LIGHTER VARIETY BY MID EVENING
TODAY.
THIS WARNING WILL BE UPDATED BY 2 PM TODAY

WWCN1 CWVR 262200 DEC 26 PM 2 47
UPDATED HEAVY RAIN WARNING FOR .
GREATER VANCOUVER
LOWER FRASER VALLEY
HOWE SOUND-WHISTLER
SUNSHINE COAST AND
EAST VANCOUVER ISLAND REGIONS OF BRITISH COLUMBIA
ISSUED BY ENVIRONMENT CANADA AT 2 PM PST FRIDAY DECEMBER 26 1980.
ANOTHER IN A SERIES OF DISTURBANCES HAS PUSHED HEAVY RAIN INTO
EAST VANCOUVER ISLAND REGION AND WILL SPREAD TO THE REMAINING
REGIONS THIS AFTERNOON. FURTHER RAINFALL AMOUNTS WILL BE IN THE 30
TO 50 MILLIMETRE RANGE. FOR THE 24 TO 30 HOUR PERIOD ENDING MIDNIGHT
TONIGHT TOTAL RAINFALL AMOUNTS WILL BE NEAR 50 MM FOR GREATER
VANCOUVER...130 MM FOR EAST VANCOUVER ISLAND...100 MM FOR THE
REMAINING REGIONS. SHOWERS WILL PERSIST TONIGHT AND SATURDAY
BUT GENERALLY OF LIGHT INTENSITY.
THIS WARNING WILL BE UPDATED BY 8 PM TODAY.

FPCN11CWVR 270000 DEC 26 PM 3 49
PART 1 OF 2
FORECASTS FOR BRITISH COLUMBIA ISSUED BY ENVIRONMENT CANADA
AT 4.00 PM PST FRIDAY 26 DECEMBER 1980 FOR TONIGHT AND SATURDAY
WITH AN OUTLOOK FOR SUNDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT
5 AM SATURDAY 27 DECEMBER 1980.
GREATER VANCOUVER
LOWER FRASER VALLEY
HOWE SOUND-WHISTLER
SUNSHINE COAST
EAST VANCOUVER ISLAND.
HEAVY RAIN WARNING CONTINUED.
TONIGHT..RAIN HEAVY AT TIMES THIS EVENING. CHANCE OF A
THUNDERSHOWER. WINDY ALONG THE COAST. LOWS 4 TO 6. SATURDAY..CLOUDY
WITH SHOWERS. LOWS NEAR 9.
SUNDAY OUTLOOK..RAIN.
SYNOPSIS FOR BRITISH COLUMBIA.
A WARM MOIST FLOW OF PACIFIC AIR CONTINUES TO GIVE B.C. WARM WET
WEATHER. SEVERAL RECORDS HAVE BEEN SET INCLUDING MAXIMUM
ANNUAL PRECIPITATION IN VANCOUVER..1383 MM EXCEDES THE PREVIOUS
VALUE OF 1367 MM SET IN 1961. TODAYS HIGH TEMPERATURES IN THE LOWER
MAINLAND REGION...13 TO 17 DEGREES...HAVE ESTABLISHED NEW DAILY
AS WELL AS MONTHLY RECORDS IN SEVERAL LOCALITIES.
RAINFALL HAS BEEN EXTENSIVE OVER VANCOUVER ISLAND TODAY AND IS
SLOWLY MOVING INTO THE SOUTH COAST REGIONS IN ADVANCE OF A FRONTAL
SYSTEM THAT WILL SWEEP THROUGH EASTERN AREAS SATURDAY MORNING.
THE MILD TEMPERATURES WILL PERSIST IN MOST AREAS THROUGH SUNDAY.
END PART 2 OF 2

Figure 7. Forecasts and Warnings that were issued during the period

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WACN1 CWVR  270300                    DEC 26 PM 7 41
UPDATED HEAVY RAIN WARNING FOR
GREATER VANCOUVER
LOWER FRASER VALLEY
HOWE SOUND-WHISTLER
SUNSHINE COAST AND
EAST VANCOUVER ISLAND REGIONS OF BRITISH COLUMBIA
ISSUED BY ENVIRONMENT CANADA AT 7 PM PST FRIDAY DECEMBER 26 1980.
A COLD FRONT WEST OF VANCOUVER ISLAND WILL CROSS THE LOWER MAINLAND
THIS EVENING. HEAVY RAINS AND SOME THUNDERSHOWER ACTIVITY AHEAD OF
THE FRONT WILL GIVE MOST AREAS AN ADDITION 20 TO 50 MILLIMETRES
OF RAIN BEFORE EASING TO SHOWERS OVERNIGHT.
NO FURTHER STATEMENTS WILL BE ISSUED UNLESS CONDITIONS WARRANT.

FPCN11CWVR  271300
PART 1 OF 2
FORECASTS FOR BRITISH COLUMBIA ISSUED BY ENVIRONMENT CANADA
AT 5.00 AM PST SATURDAY 27 DECEMBER 1980 FOR TODAY AND SUNDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT
4 PM TODAY 27 DECEMBER 1980.
GREATER VANCOUVER
LOWER FRASER VALLEY
HOWE SOUND-WHISTLER
SUNSHINE COAST
EAST VANCOUVER ISLAND.
RAIN WARNING ENDED.
TODAY..MOSTLY CLOUDY WITH SHOWERS. WINDY ALONG THE COAST.
HIGHS 10 TO 14. LOWS TONIGHT 6 TO 8.
SUNDAY..CLOUDY WITH PERIODS OF RAIN. HIGHS NEAR 11.
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Figure 7(cont'd). Forecasts and Warnings

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CXCN1 CWVR  270730
NEW MONTHLY MAXIMUM RECORDS FOR DECEMBER WERE BROKEN OR TIED
ON BOXING DAY AT THE FOLLOWING BC LOCATIONS...
VANCOUVER AIRPORT      15    .. PREVIOUS 14 IN 1937/40/52/58/63/80
ABBOTSFORD             18    .. PREVIOUS 17 IN 1962 AND 1963
PORT HARDY             15    .. PREVIOUS 14 IN 1958 AND 1976
PENTICTON              14    .. PREVIOUS 14 IN 1936 AND 1941
IN ADDITION NEW DAILY MAXIMUM RECORDS FOR DECEMBER 26 WERE SET
OR TIED AT THE FOLLOWING BC LOCATIONS...
VICTORIA AIRPORT       15    .. PREVIOUS 13 IN 1975
COMOX                  13    .. PREVIOUS 12 IN 1975
LYTTON                 10    .. PREVIOUS  9 IN 1953
CRANBROOK              11    .. PREVIOUS  6 IN 1956
WILLIAMS LAKE           9    .. PREVIOUS  6 IN 1975
PRINCE GEORGE           7    .. PREVIOUS  7 IN 1975
END
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Figure 8. Temperature records reflect the mild flow

"On the other hand, in this day and age can one look askance when one is blessed with a surplus . . . ?"