The role of the Assiniboine River in the 1826 and 1852 Red River floods

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Abstract: Hydrologic conditions in the Assiniboine River basin during the extreme Red River floods of 1826 and 1852 are evaluated from historical sources. In both years, commentaries suggest that extreme floods also occurred in the Assiniboine, with the dominant source of water being the Souris River; in 1852 (and possibly 1826), the Qu'Appelle River discharge was also very high. It is concluded that the Assiniboine made large contributions to each of the epic historic floods, in contrast to its minor contribution to 'natural' flow in 1997. If reasonable allowance is made for the Assiniboine's contribution to the estimated total historical flows of the Red, it is likely that the 1997 discharge of the Red alone (upstream of The Forks) was larger than in 1852, but still much smaller than in 1826.

Key words: Assiniboine River, Red River, flood history, return period, 1826, 1852

Introduction

The historic floods of 1826 and 1852 which devastated the Red River Settlement are the benchmarks against which modern floods in Winnipeg are judged. Until 1997, these floods had discharges far beyond any in the period of gauge records (Table 1), and even the third largest historic flood (in 1861) paled in comparison.

The 1997 'natural' (i.e., uncontrolled) discharge in Winnipeg almost equalled the normally-accepted value for the 1852 flood and precipitated planning to increase the level of Winnipeg's protection to encompass a recurrence of 1826-magnitude or even larger floods. An improved understanding of the historic floods will add perspective to the 1997 event. Because the focus of the increased protection is on the Red River south of the city, the question of the relative contributions of the Red and Assiniboine Rivers to the total flows in the historic floods is especially relevant.

The 1997 flood was predominantly a Red River event, principally the result of an early April blizzard which blanketed the basin upstream of Winnipeg. The Assiniboine basin largely escaped the blizzard and the

Table 1: *Discharges of the Red River at Winnipeg during the 'Big Four' floods.*

Year	m^3/sec	ft^3/sec	Comment
1826	6,372	225,000	Calculated (Red River Basin Investigation 1953c)
1852	4,673	165,000	Calculated (Red River Basin Investigation 1953c)
1997	4,588	162,000	Natural flow[1]
1861	3,540	125,000	Calculated (Red River Basin Investigation 1953c)

[1] Natural flow is the flow which would have occurred without the operation of the Red River Floodway, Assiniboine Diversion or Shellmouth Dam

Assiniboine's discharge, although high, had peaked prior to that of the Red. Its natural flow had been reduced by storage in the Shellmouth Dam and as the Red's crest approached Winnipeg, the Assiniboine River was essentially 'shut down' at Portage la Prairie by diverting almost its entire flow northward to Lake Manitoba via the Assiniboine Diversion. Of the peak 'natural' discharge of 4,588 m^3/sec (162,000 cfs) in Winnipeg, 3,908 m^3/sec (138,000 cfs) arrived at the Floodway from the south and with local additions between the Floodway and the Forks, the Red River component was probably about 4,000 m^3/sec (141,000 cfs) or about 88% of the total combined flow.

Effective evaluation of the 1997 flood, then, should take account of this dominance of the Red River component. Ideally, the actual flows of the two rivers in each of the floods should be compared. The discharges during the 1826 and 1852 events, however, are not measured values but were calculated by the Red River Basin Investigation (1953a) using slope-area procedures based on water surface profiles obtained by the CPR in the 1870s. Thus they represent the combined flow of both rivers. The Red River Basin Investigation did not attempt to partition the relative contributions of the Assiniboine and Red and paid little attention to conditions in the Assiniboine basin during the floods.

Warkentin (1999) argued against the possibility of coincident major floods on the Red and Assiniboine Rivers, based on meteorological considerations and the absence of such coincident events in the gauged history of the two rivers.

> It is ... unlikely that causal flood parameters would be extreme over both the Red River and Assiniboine River watersheds for any given spring event. Weather systems simply are not

> large enough to produce very heavy precipitation over the entire area. If extreme inputs are used for the Red River Watershed south of Winnipeg, then it is very unlikely that they will also be extreme for the Assiniboine River Watershed, except perhaps for the downstream area from Brandon to Winnipeg. There is no reliable record of coincident major floods on the Red River and the Assiniboine River... The odds of coincident major floods on the Red and Assiniboine rivers are therefore very low based on observations as well as on the meteorological considerations ... (Warkentin 1999, V, 19-20).

Warkentin made these comments in the context of generating 2000 artificial spring peaks on the Red River from randomized combinations of flood-forming factors. Some assumption about the Assiniboine's contribution was necessary, and for this purpose his observations are reasonable. The correlation between annual peak discharges on the two rivers is indeed modest (r = 0.40 between the Assiniboine at Portage la Prairie and the Red at Emerson) and the two basins exhibit considerable independence. Low probability, however, does not preclude such an occurrence having happened in the past, especially since the historic floods themselves had low probabilities (the 1826 event had an exceedance probability of about 0.2%). Warkentin further argued that some evidence for high Assiniboine flows presented by Rannie (1999) do not necessarily suggest conditions as extreme as were postulated.

In this paper, historical observations of the state of the Assiniboine River in 1826 and 1852 are reviewed and their implications for the relative magnitude of the 1997 flood in the Red River Valley are discussed.

Sources of Floodwater in the Assiniboine Basin

The Assiniboine River at Portage la Prairie drains 153,000 km^2 of western Manitoba, south-central Saskatchewan and northwestern North Dakota (Figure 1). The watershed can be divided into four principal regions, namely: the upper basin above Kamsack, Saskatchewan, the Riding/Duck Mountain uplands, the Qu'Appelle River watershed, and the Souris River watershed. These together account for more than 85% of the total basin area and individually contribute to major Assiniboine floods in varying proportions.

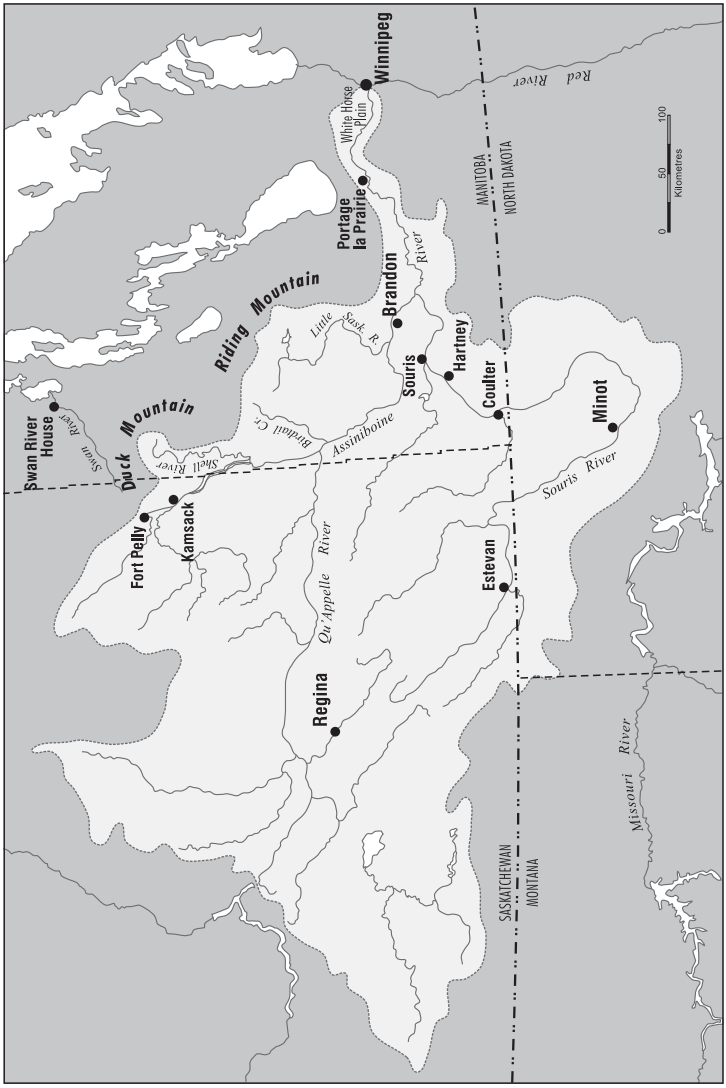

Figure 1: *The Assiniboine basin.*

Peak flows during eleven major events are given in Table 2. The peaks in 1882, 1902 and 1904 are estimated values at Brandon, derived by PFRA (1952) using the Manning Equation and water elevations. The possibility that they overestimate discharge is offset by the fact that they do not include contributions from the Souris which joins the Assiniboine downstream of Brandon. Annual peak discharges of the Assiniboine (at Brandon) and the Souris are strongly correlated ($r = 0.90$). It should be noted that the individual peaks are given only to illustrate the variability in the contributions from each sector from flood to flood. Differences in the timing of the peaks on individual rivers and the routing of the flow downstream would alter their actual contributions to the peaks along the Assiniboine. In some years (e.g., 1913, 1922, 1923, 1927), the majority of the flood water originates in the upper basin; in others, the Souris is the dominant contributor (e.g., 1882, 1904, 1969, 1974, 1976). The Riding/Duck Mountain and Qu'Appelle contributions are normally the smallest components, but in some years (as in 1955) they may account for a large part of the flood discharges at Brandon.

Discharges for a range of frequencies for each sector are given in Table 3. The pivotal role of the Souris in the extreme floods on the lower Assiniboine is clear from Tables 2 and 3. In the largest recorded event, in 1976, the Souris peak was higher than any *recorded* discharge on the Assiniboine itself prior to 1974 and transformed a 25-year event at Brandon

Table 2: *Sources of peak flows for selected floods of the Assiniboine River.*

	Peak Flow (m^3/sec)										
	1882	1902	1904	1922	1923	1927	1955	1956	1969	1974	1976
Upper Assiniboine (Kamsack)	---	---	---	504	411	357	239	203	64	190	273
Qu'Appelle (Tantallon[#]/Hyde[=])	---	---	---	56[#]	---	---	240[#]	157[#]	84[=]	122[=]	206[=]
Souris (Wawanesa)	646[1]	---	340[2]	58	167	65	116	205	323	345	742
Riding/Duck Mountain tributaries*	---	---	---	---	---	---	88	116	139	155	188
Assiniboine at Brandon	1,218[3]	692[3]	904[3]	603	651	484	541	430	360	309	617
Assiniboine (Holland[#]/Portage la Prairie[+]/Headingly[=])	---	---	---	547[=]	626[=]	578[=]	629[+]	637[+]	626[+]	909[#]	1,460[#]

* Riding/Duck Mountain tributaries = Little Saskatchewan + Birdtail + Shell
[1] estimated flow at Minot, ND (Long 1976)
[2] measured flow at Minot, ND (Long 1976)
[3] estimated flow at Brandon (PFRA 1952)

Table 3: *Discharge (m^3/sec) for selected return periods on the Assiniboine River and its major tributaries.*

	Return Period (years)					
	10	25	50	100	150	200
Assiniboine at Kamsack	225	365	500	650	760	850
Qu'Appelle at Tantallon/Welby	87	128	160	195	220	235
Riding/Duck Mountain tributaries						
Shell at Inglis	49	66	80	95	104	111
Little Saskatchewan near Rivers	75	100	119	136	148	155
Birdtail near Birtle	38	52	64	76	84	105
Souris at Wawanesa	225	400	570	800	960	1,150
Assiniboine at Brandon	470	660	830	1,010	1,130	1,220
Assiniboine at Portage la Prairie	620	840	1,010	1,210	1,350	1,420

Source: frequency curves provided by D. Kelln, Manitoba Surface Water Management

into a >200-year flood downstream. In 1882, the Souris discharge at Minot, ND (far upstream of the junction with the Assiniboine with a drainage area only about 45% of the full basin) was estimated to have been 646 m^3/sec and, in combination with the extraordinary discharge at Brandon, it is likely that on the lower Assiniboine this event was even larger than the record gauged flood of 1976. In 1904, the measured peak at Minot (340 m^3/sec) and the estimated peak at Brandon also indicate a very large discharge below the confluence. It should be noted that the large discharges for the Souris in the 1955 to 1976 floods occurred despite increasing regulation of the river from the 1930s onward.

Assiniboine in 1826

The only direct observations of the Assiniboine's status during the 1826 flood come from the Red River Settlement at the river's mouth and from Fort Pelly in the upper basin. At the Red River Settlement, little direct mention was made of the Assiniboine but the use of the plural 'rivers' in several of the abundant descriptions of rising stages implies very late breakup and high water in concert with the Red.

> May 1: ...showers of snow, sleet and rain throughout the day-The ice in the Rivers begins to rise in consequence of the flush of waters pouring into them from the plains and

> mountains, caused by the melting of the snow... (*Red River Journal*, HBCA [Hudson's Bay Company Archives] B.235/a/7 1825/26).

> May 3: The ice in the Rivers has attained the height that the floods reached at the highest pitch last summer, and the water in several places has overflowed the banks and many houses are surrounded thereby (*Red River Journal*, HBCA B.235/a/7 1825/26).

> May 4: The water in the Rivers rose about 5 feet perpendicular during the last twenty-four hours, and the ice is now on a level with the highest banks, but it is still so thick and strong that even the present flush of waters have not sufficient force to break it... (*Red River Journal*, HBCA B.235/a/7 1825/26).

> May 7: About 4 A.M. the ice in the Assiniboine River broke up, and the waters therein rose as high as those of the Red River. The immense discharge of ice poured in from the former, into the latter mentioned rivers, made the scene as destructive as terrific. The whole population were again in motion, flying to such situations as might afford them a temporary security, leaving in many instances their cattle to perish, and most of their other effects to be swept away; happy in escaping with their lives... (*Red River Journal*, HBCA B.235/a/7 1825/26).

> May 8: The rivers have become almost clear of ice, but the waters increase apace (*Red River Journal*, HBCA B.235/a/7 1825/26).

These comments cannot be taken at face value, however, because observations of the Assiniboine from the Red River Settlement are within the backwater zone of the Red River and, given the stages of the Red, the Assiniboine would have been described as high regardless of its own discharge. More definitive data, then, must be sought upstream of the backwater zone.

The only *direct* upstream observations come from Fort Pelly in the upper Assiniboine basin near the modern settlement of Kamsack, Saskatchewan (Figure 1). There, breakup of the river was also very late and initial water levels were described as high.

> April 24: Rivers much Swollen the water running on the Ice which has not moved yet (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

> April 29: ...the Ice in the Red [meaning Assiniboine] River beginning to move the River much Swollen (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

> May 1: the Ice Still strong in Red [meaning Assiniboine] River (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

As the flood on the Red River grew to epic proportions, however, the Fort Pelly Journal made no mention of the state of the Assiniboine. Daily entries after May 1 contain only brief and benign routine weather observations with no further attention to the river until May 17 when water levels were still described as high.

> May 17: Stormy weather the wind blew from all points of the compass-some thunder and rain...[Buffalo are] now within two Days march of us but the water is so high that it is impossible to get to them some rain in the after noon (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

These references to "high" water are difficult to interpret in terms of actual water levels but a comment made four years later suggests that the level of the upper Assiniboine in the vicinity of Fort Pelly was not nearly as extreme as in the Red River and indeed was possibly not even overbank.

> May 14, 1830: Keen frost in the night...The country in our vicinity all overflowed the Red River [meaning Assiniboine] not known to be so Hi in this quarter for many years, it did not overflow its banks Here the Year the Colony was overflowed (*Fort Pelly Journal*, HBCA B.159/a/11 1829-30).

In the Red River watershed, the 1826 flood was caused by the preconditions which typically lead to large floods. As Alexander Ross wrote in his classic description of the flood:

> The previous year had been usually wet; the country was thoroughly saturated. The lakes, swamps, and rivers at the fall of the year were full of water; and a large quantity of snow had fallen in the proceeding winter (Ross 1856, 106).

The Assiniboine basin also experienced spring flooding and heavy late-summer rainfall in 1825, and by late September both the Red and Assiniboine Rivers were rising. Frequent rain (and snow) was reported at Fort Pelly in October and it is concluded that at freeze up, the basin in the Fort Pelly region was in a saturated state. However, the daily weather entries at Fort Pelly from November 1825 to April 1826 do not suggest especially severe or abnormal winter weather conditions in the upper basin. Intense cold certainly occurred but was broken by periods of more moderate temperatures. Snow or rain was reported on only 24 days from November 1 to March 31, a modest total, with about two-thirds of the observations indicating light amounts (Rannie 2001). Several apparently heavy falls in late February, mid-March, and on April 7 would have increased runoff potential (especially given the moisture status of the basin in the autumn). In summary, although the Fort Pelly data provide some support for moderately high spring runoff, there is little in the record from the upper Assiniboine basin which would indicate spring conditions of the magnitude experienced in the Red River Valley. Entries for Fort Pelly after May 17 are also routine weather observations with no mention of the state of the river, suggesting that it was not sufficiently high to warrant comment.

The first mention of excessively high water *in the region* came from reports received from Swan River House (approximately 90 km to the northeast) on May 14.

> May 14: ...the [Swan] River has overflowed its banks and [the men there] are under great apprehension for the safety of the property (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

On May 28, the Fort Pelly party left for Swan River House. They encountered very difficult conditions along the route, and at Swan River House (May 31) they observed first-hand the effects of severe flooding of the Swan River.

> May 28: rained much all day [en route to Swan River] (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

> May 29: fine weather to day...the roads are impassable the carts are often aflote & the water & mud continually up to the knees [en route to Swan River] (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

> May 30: march very slow owing to the high state of the water...Rained very much all Day the weather most stormy [en route to Swan River] (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).
>
> May 31: [Swan] River...[was] a most dismal looking place the water having washed away all the [houses]...rained much all Day (*Fort Pelly Journal*, HBCA B.159/a/9 1825-26).

The Swan River drains the Duck Mountain and it is reasonable to assume that similar conditions occurred in Riding Mountain immediately to the south. Both of these regions make important contributions to the Assiniboine downstream of Fort Pelly via such tributaries as the Shell, Birdtail, and Little Saskatchewan which join the Assiniboine between Fort Pelly and Brandon. It is probable, then, that whereas flow in the Assiniboine in the vicinity of Fort Pelly may have been relatively high, it was excessively so in the Riding/Duck Mountain tributaries and would have significantly increased Assiniboine levels downstream.

Other second-hand reports also suggest conditions on the Assiniboine which were as severe as those on the Red, apparently as a consequence of very high flow from the Souris basin.

> May 17: This morning I was conversing with an old Indian whose tent joined ours when I asked him if he had seen such a flood as this before, he said "No my father, I once saw the site of the Company's Fort an island, but that was nothing to this"...Intelligence has just arrived from Brandon House which states that the country is all a sea between the sources of The Assiniboine and The Missouri; and that the waters of the latter are now passing by us to the Lake Winnipeg (*David Jones Journal*, PAM [Provincial Archives of Manitoba] CMS 18 A92 1825-26).
>
> May 20: Some freemen arrived from the upper part of [the Assiniboine] river, and report that the waters in that quarter are as high as with us. The Missouri River it appears by their accounts, has overflowed its banks, so as to drive part of its waters this way. They also say that a number of the natives of that quarter have been drowned in consequence. The waters continue rising... (*Red River Journal*, HBCA B.235/a/7 1825/26).

> August 21: Since my last we have received further accounts of the recent flood and I very much fear for the safety of the American Settlements on the lower parts of the Missouri and St. Peter's Rivers. Report says that some of their military posts have been overwhelmed and many soldiers drowned. We are also informed that several Indian villages have fallen victims to these destructive waters. It is now clearly ascertained that they flowed from the Rocky Mountains and passing over the banks of the Missouri (their usual channel to the Gulf of Mexico) overflowed the adjacent country; and were conducted here by the Riviere a La Souris which falls into the Assiniboine River about one hundred miles from this place. (extract from a letter by John Pritchard of the Red River Settlement cited by his grandson [S.P. Matheson] in Matheson, S.P., 1947 'Floods at Red River' *Transactions*, Manitoba Historical Society, Series III, No. 3, 5-13).

All three comments attributed the high flow of the Souris to overflow from the Missouri, suggesting that the information may have come from a single source. A Missouri origin for the water can be dismissed on topographic grounds but such an impression may have been created by widespread flooding along the loop of the Souris closest to the Missouri combined with extensive inundation of the land surface and filling of depressions by overland runoff. For example, notes from an aerial reconnaissance during the epic 1976 flood described this region as follows:

> Fields adjacent to Plum Creek near Souris were covered with water... The Souris River upstream of Hartney appeared to be one large lake area... The land east of the Souris River and south of Coulter was a myriad of lakes with only small patches of land showing. The Souris River by the International Boundary appeared to be one long endless lake stretching north and south. Road and railway crossings were barely discernable (Long 1976, 17).

In summary, although the Assiniboine at Fort Pelly was described as "swollen" in late April and "high" on May 17, the lack of mention of the river during most of the severe flood period on the Red is striking and the 1830 comment suggests that the upper reach of the river may not have exceeded bankfull stage. It seems likely, then, that runoff in the upper basin was high but not at all comparable in severity to the conditions in the Red River Valley. Nevertheless the other reports from the Brandon

and downstream reaches indicate very high water and are explicit about the extreme state of the Souris. Thus it is concluded that the main sources of the high waters on the Assiniboine were the Souris and Riding/Duck Mountain sectors. The contribution of the Qu'Appelle is unknown but the strong correlation between the Qu'Appelle and Souris annual peak discharges ($r = 0.88$) suggests that it may also have been significant.

Assiniboine in 1852

The 1852 flood in the Red River basin was caused by very heavy snowfall in March with cool temperatures during much of April, a late breakup (April 26-27), a rapid transition to warm temperatures, and rain during the rising phase. Unfortunately, there are no weather observations from the Assiniboine basin during the winter and there is no way of knowing whether similar conditions occurred there.

In the vicinity of the Red River Settlement, the great majority of comments on river levels referred to the Red River but the Assiniboine was included in a number of observations.

> April 24: ...river rose last night about 2 inches ice unmoved...Ice has moved this evening in both rivers... (Diaries of Dr. William Cowan, PAM MG2 C15 M154).
>
> April 26: Ice unmoved on main river started about ½ past 8, and clear water as far as visible up and down. Assiniboine fast... (Diaries of Dr. William Cowan, PAM MG2 C15 M154).
>
> April 27: both rivers pretty clear of ice. Small river has fallen a little (Diaries of Dr. William Cowan, PAM MG2 C15 M154).
>
> April 28: River has risen more than a foot during the night...Ice commenced to run about 10 o'clock in the Assiniboine & still continues. river rising very fast... (Diaries of Dr. William Cowan, PAM MG2 C15 M154).
>
> May 19: ...The water gained upon us all day... a rise in the Assiniboine of 5 ½ inches during the night... (Anderson, D., 1852. *Notes of the Flood at Red River* 1852 by the Bishop of Rupert's Land. PAM MG7 B2 CMS A83).

Again, because of the backwater effect of the very high stage of the Red none of these comments positively indicate that the Assiniboine itself was high. Confirmation that the river was extremely high, however, comes from three comments by Abraham Cowley as he canoed down the lower Assiniboine at the time the Red was reaching its peak and beginning to fall.

> May 22: Reached Portage la Prairie; Here the people have been flooded out of their houses & we learn that the RR Settlement is also overflowed (*Journal of Abraham Cowley*, PAM MG7 B2 CMS A86).
>
> May 24: Left Portage la Prairie & descended the river till nearly sun set when finding a favourable place we encamped. It has become difficult to land when one wishes the banks being overflowed (*Journal of Abraham Cowley*, PAM MG7 B2 CMS A86).
>
> May 25: reached White Horse Plain much of it is overflowed learned more particulars of R. River flood it is I fear very extensive and destructive (*Journal of Abraham Cowley*, PAM MG7 B2 CMS A86).

When Henry Youle Hind explored the region in 1858, he made several comments on the severity of 1852 conditions in the Assiniboine basin. Particularly interesting are his observations which indicate exceptional flooding of both the Qu'Appelle and Souris Rivers.

> Leaving Prairie Portage ... we took the trail leading to the Bad Woods, a name given to a wooded district about thirty miles long, by the buffalo hunters in 1852, who, in consequence of the floods of that year, could not pass to their crossing place at the Grand Rapids of the Assiniboine by the Plain or Prairie Road... [and were] compelled to cut a road through the forest of small aspens which forms the Bad Woods, to enable them to reach the high prairies (Hind 1860, 283-84).
>
> In 1852... the Indians represent the Qu'Appelle Valley as filled with a mighty river throughout its entire length... (Hind 1860, 329).

> The country [adjacent to the Souris River near the HBC Sand Hills post] becomes very low after passing the last sand-hills, and over a large extent of prairie south of them, drift timber is distributed, showing the extraordinary rise in the waters of the [Souris] river during the floods of 1852 (Hind 1860, 295).

The region of the Souris described in the latter comment was approximately the same as that noted above as being observed from the air in 1976. The fact that the effects were still evident and noteworthy six years after the flood suggests an extremely large event.

Clearly the discharge of the lower Assiniboine in the spring of 1852 was extraordinarily high with very large contributions from the Souris and Qu'Appelle basins. Although no information is available for the upper basin or the Riding/Duck Mountain regions, high flows may also have occurred there.

Discussion

Antecedent conditions are particularly important for flood formation on the Assiniboine where a large portion of the basin which is normally non-contributing because of topography becomes contributing or 'effective' area when saturated. The 1826 flood occurred after the basin had been saturated by spring flooding and heavy late-summer rainfall in 1825. Antecedent conditions in the Assiniboine basin in 1851-52 are not known but unusually abundant rainfall and a large flood occurred in the Red River basin in the summer of 1851. A comment by Provencher suggesting flooding at White Horse Plain in July, 1851, implies that these conditions may also have applied in the Assiniboine basin and it is concluded that the basin was probably in a saturated state prior to freeze up in 1851.

> July 21, 1851: L'eau monte toujours et pourrait détruire la recolte dans les terres peu élevées; déjà c'est la cas a la Prairie du Cheval Blanc (Letter, J.N.Provencher, Evêque du Nord-Ouest, to L'Archevêque du Quebec, 21 Juillet, 1851, in 'Lettres de Monseigneur Joseph-Norbert Provencher, Premier Evêque de Saint-Boniface' *Bulletin de la Société Historique de Saint-Boniface* (1913) III, 279, Imprimerie du Manitoba, Saint-Boniface, Manitoba).

Table 4: *Flow conditions in major sectors of the Assiniboine Basin in 1826 and 1852.*

Sector	1826	1852
Upper basin (above Kamsack)	moderate	unknown
Qu'Appelle	unknown	very high
Riding/Duck Mountain	high	unknown
Souris	very high	very high

Thus, in the autumns preceding both floods, the Assiniboine basin had been primed for maximum effective area and high runoff in the following spring, conditions which were similar to those which led up to the maximum recorded flood in 1976. Based on the historical evidence, flow conditions in the major sectors of the Assiniboine watershed in 1826 and 1852 may be summarised as in Table 4.

As was noted above, the largest known floods on the lower Assiniboine have been associated with very large flows from the Souris basin (Table 2) and the historic sources strongly implicate the Souris in both the 1826 and 1852 floods. In 1826, the Riding/Duck Mountain region probably also made a significant contribution; the state of the Qu'Appelle in that year is unknown but the strong correlation (r = 0.88) between the peak flows of the Qu'Appelle and Souris makes a large contribution likely. In 1852, both the Souris and the Qu'Appelle were extremely high and the conditions of the upper basin and Riding/Duck Mountain sectors are not known.

Despite Warkentin's concern about the improbability of coincident major floods on the Red and Assiniboine Rivers, the historical evidence points to such an occurrence in both 1826 and 1852. Moreover, the evidence suggests that the Assiniboine flows were of the same order of severity as those of the Red. Unfortunately, the historical commentaries provide no physical basis for estimating the actual discharges and a cautious paper might end here without attempting to do so. Nevertheless, it is difficult to resist speculating, particularly about the place of the 1997 flood in the history of the Red River.

The historical descriptions seem compatible with a flood of perhaps 100-year Return Period magnitude which modern flood frequency curves at Portage la Prairie indicate to be about 1,200 m^3/sec (Table 3). This value was exceeded in 1882 and 1976 by a wide margin and possibly also

in 1904. Given the apparently extreme state of the Souris in 1826 and 1852, and of the Qu'Appelle in 1852 at least, this may be a conservative figure and the 1882 and 1976 floods (>1,400 m^3/sec) might provide better models for the historic events. It is assumed then, that the Assiniboine discharge in the vicinity of Portage la Prairie in each of the historic floods was in the range 1,200-1,500 m^3/sec.

Assessment of the Assiniboine's actual contributions to the Red River in 1826 and 1852 is further complicated by two additional factors: the timing of the Assiniboine peak with respect to the Red and the fact that under extreme conditions some Assiniboine water escapes to Lake Manitoba.

Timing:

The dates for the 1826 and 1852 flood peaks were very late compared with modern floods, approximately May 22 and May 18-20 respectively (Red River Basin Investigation 1953b). The historical evidence (particularly in 1852) provides no basis for inferring significantly different dates for the Assiniboine peaks. The Red River Basin Investigation (1953c, 102-103) concluded that "Owing to the fairly flat peaks of both rivers at high stages, a lag of one week would not materially affect the magnitude of the combined discharges at the Redwood Bridge... (and) the later the peak on the Red River, the greater is the discharge from the Assiniboine." It is assumed here that the hydrographs of the two rivers were sufficiently in-phase that timing differences can be ignored.

Lake Manitoba component:

At Portage la Prairie and for about 60 km downstream, the Assiniboine channel is elevated above the adjacent land on an alluvial ridge as it crosses the Portage la Prairie alluvial fan. During high flows, overbank water would travel away from the channel northward toward Lake Manitoba along paleochannels and overland, and southward toward the La Salle River (another paleochannel which flows into the Red at St. Norbert). The southern overflow passing along the La Salle paleochannel route would have contributed to Red River flow moving toward the Forks but the Lake Manitoba component would have 'escaped' the Red River altogether. This phenomenon was reported in 1882 (Upham 1890), in 1922 and 1923 (Morris 1955), and would have occurred in several other years without dyking and/or the operation of the Assiniboine Diversion (most notably in 1974 and 1976). By both routes, a significant proportion of the overbank

flow would have bypassed the lower Assiniboine along which Cochran canoed in 1852. A part of this loss would have been made up by local additions from Sturgeon Creek, which joins the Assiniboine 11 km above the Forks and perhaps other smaller downstream sources. Peak flow in Sturgeon Creek in 1997 was 71 m^3/sec, one week prior to the Red River crest.

If the arguments presented above are even approximately correct, what do they mean for the magnitude of the 1997 flood relative to the historic events? In terms of *total natural* discharge at Winnipeg, the 1997 flood was close to but slightly smaller (98%) than the conventionally accepted value for 1852 and only 72% of 1826 (Table 1). As was noted above, however, the 1997 flood was principally an event of the Red River proper (i.e., upstream of the Forks) whereas in the historic floods the Assiniboine appears to have made a very large contribution. Assuming reasonably synchronous peaks and a (somewhat arbitrary) 20% net loss to Lake Manitoba, the Red River components of the historic floods can be approximated by subtracting the Assiniboine contributions from the total. The results for Assiniboine discharges at Portage la Prairie of 1,000, 1,200, 1,350 and 1,500 m^3/sec are given in Table 5, representing modern return periods ranging from 50 to 250 years (to avoid any pretence of false accuracy, most values have been expressed to the nearest 100 m^3/sec).

The differences between the historic floods and 1997 on the Red River for each assumed Assiniboine contribution are given in Line G. For all assumptions, the 1826 Red River component remains substantially larger than 1997, although the difference between the two is narrowed somewhat, particularly for the longer return periods. However, the data suggest that the 1997 Red River flow was larger than in 1852, making 1997 the second-largest event in the more than 200 years of documented Red River flooding. The difference was slight (and probably meaningless) at the 50-year return

Table 5: *Implied Red River peak discharges (m^3/sec) upstream of The Forks, 1826 and 1852 under various assumed Assiniboine River flows.*

	1826				**1852**			
A. Assumed Assiniboine discharge (m^3/sec)	1,000	1,200	1,350	1,500	1,000	1,200	1,350	1,500
Approximate Return Period at Portage la Prairie (yr)	50	100	150	250	50	100	150	250
B. Assumed net loss to Lake Manitoba	200	200	250	300	200	200	250	300
C. Net Assiniboine contribution to Red River (A-B)	800	1,000	1,100	1,200	800	1,000	1,100	1,200
D. Total combined Red/Assiniboine flood discharge	6,400	6,400	6,400	6,400	4,700	4,700	4,700	4,700
E. Red River upstream of The Forks (D-C)	5,600	5,400	5300	5,200	3,900	3,700	3,600	3,500
F. 1997 Red River natural flow upstream of The Forks	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
G. 1997 vs historic floods on Red River (F-E)	-1,600	-1,400	-1,300	-1,200	+100	+300	+400	+500

period but rises to about 10 to 15% for the larger assumed Assiniboine contributions.

A final caution is in order. The only known value in Table 5 is the 1997 Red River natural flow upstream of the Forks. Any analysis such as this is dependent not only on the perilous interpretation of conditions on the Assiniboine and its contribution to the Red River peak attempted in this paper, but ultimately on the accuracy of the discharge estimates of the historic floods themselves. These were derived by the Red River Basin Investigation (1953a) using modern (1951) channel dimensions and roughness coefficients, and assuming the validity of the water surface profiles reported by Fleming for the CPR in 1879. The historical estimates are averages of slope-area calculations for multiple reaches on the lower Red River. For the 1852 event, the estimates ranged from an anomalously low value of 3,512 m^3/sec to three values between 4,970 and 5,100 m3/sec; if the anomalous low value is disregarded, the true discharge may have been closer to 5,050 m^3/sec. The value adopted for 1826 was the approximate average of two estimates of 5,660 and 7,250 m^3/sec. The conventional Red River Basin Investigation values used in Table 5 have been accepted in all subsequent studies and it is certainly not the purpose of this paper to critically evaluate them. Nevertheless, the range in estimates should be borne in mind when the implications of Table 5 are assessed.

Conclusions

Historical observations from 1826 and 1852 suggest that large floods occurred in the Assiniboine basin coincident with the better-known extreme events in the Red River valley. In both years, the commentaries identify the Souris as a major source of the water and in 1852 at least, the Qu'Appelle is also implicated. The relatively large contribution of the Assiniboine in these years is unusual in the modern record in which simultaneous major floods in both the Red and Assiniboine Rivers have not occurred, and are in sharp contrast to the 1997 flood which was overwhelmingly a Red River event. If allowance is made for the Assiniboine's contribution in 1852, it is likely that the 1997 flood was larger than the 1852 event in the Red River valley.

Acknowledgements

Part of the research on which this paper is based was supported by a grant from the Geological Survey of Canada (TS500-194). The writer is grateful to Scott St. George and Bob Halliday whose constructive comments greatly improved the final manuscript.

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