Could the Red River Channel have been narrower in the early 19th Century?

W.F. Rannie  
University of Winnipeg, Winnipeg, Manitoba, Canada  
b.rannie@uwinnipeg.ca

Abstract

Several historical documents state unambiguously that the Red River widened its channel after the major floods of the 19th Century (1826, 1852, 1861). Arguments to support and contradict these assertions are presented. Despite its meandering nature, the Red River is not a normal alluvial river; surveyed profiles indicate that the modern channel has been stable for more than a century. The main potential mechanism for the historical widening would have been bank failure which is a common phenomenon along the river, particularly following the floods of 1950, 1997, and summer, 2005. Failure has multiple causes but most studies implicate changes in groundwater pore pressure in relation to river water level as a critical destabilizing factor and long-term drawdown of the Upper Carbonate Aquifer as a stabilizing element. It is argued that the general groundwater environment of the early to mid-19th Century would have been favorable for a higher incidence of bank failure but the evidence for its occurrence is slender. The possibility of widening remains unresolved but should be borne in mind in future studies of the hydraulics of the historic floods.

Keywords: Red River, riverbank stability, channel widening

Introduction

During archival research into the flood history of the Red River, the writer encountered two accounts which claimed that the Red River channel had widened following each of the great 19th Century floods (1826, 1852, 1861). These quotations were included in the flood history report (Rannie 1998) with the comment that if they were valid, they would raise questions about the hydraulics of the great floods. The comments were noted by KGS Group (2001) during studies of Winnipeg flood protection; KGS Group found two more accounts (Carson et al. 2002) and others have subsequently come to light.

The accounts are provocative and deserve more attention than they have received. This paper will not resolve the matter but has three objectives. The first is straightforward and modest: to gather the quotations into a single source to assist future researchers. Secondly, the paper will attempt to evaluate the reliability of the accounts and their sources. Finally, the geomorphic circumstances under which such 19th Century widening might have occurred will be explored.

The Anecdotal Accounts

The first claim of channel widening comes from David Anderson, Bishop of Rupert's Land, who experienced the 1852 flood. In his Notes, written during and shortly after the flood, he commented:

The height [of the floodwaters in 1852] on the whole is certainly not so great as in the former [1826] flood, perhaps by 18 inches, but as the river channel is deeper and broader, and the creeks much enlarged, there may be an equal volume of water... [emphasis added]. (Anderson 1852)

Following the recession of the 1861 flood, the Nor’Wester Newspaper in the Red River Settlement expressed optimism that channel widening would reduce the threat of future floods.

We do not think that the country below Fort Garry will ever be flooded again for experience shows clearly that each successive flood has indicated far less depth on the plains than its
Eleven years later, in 1872, the naturalist John Macoun accompanied Sandford Fleming on an expedition to the prairies. In his 1882 book Manitoba and The Great Northwest, he wrote:

The Red River channel at Winnipeg is very different now to what it was when the first settlers came in. The soil is alluvial and the continual action of the water on the banks is having the effect of increasing the width of the water-way. It is said that the lately deceased Mr. McDermot first crossed the stream on a small oak tree that had fallen into the channel. To-day several trees would be necessary to span the river for the width is about three hundred yards on an average.

(Macoun 1882, p. 489)

Sandford Fleming became the Engineer-In-Chief of the Canadian Pacific Railway. In Macoun’s autobiography (published in 1922, two years after his death), while discussing Fleming’s opinions on the best location for the railway crossing of the Red River, he specified that the river width had increased by four times.

(Fleming 1879, p. 270)

Fleming attributed the extent and duration of the floods upstream to the “limited dimensions of the river channel through the Parish of St. Andrews [which had the effect of] raising and backing of the flood water, until the whole country to the south becomes submerged.” (Fleming 1879, p. 270)

He went on to emphasize that the widening ended in the Parish of St. Andrews where:

… the character of the banks change, they are no longer soft and yielding, on the contrary, they are firm and strong; in more than one locality a ledge of rock presents itself. Generally through the Parish of St. Andrews, and for some distance below Stone Fort, the trench through which the river flows remains contracted, and its appearance indicates that no perceptible change takes place from year to year. Indeed, it is highly probable that this portion of the river is practically the same, in sectional form, as it was many years ago, and its banks are so firm for many miles, that no material change can be predicted.

(Fleming 1879, p. 270)

A person arriving in Winnipeg will observe that the banks of the river are of a soft and yielding character, easily acted on by the elements. They are of clay, but the clay is somewhat of the character of quicksand. They are subject to slides and alteration of form. In consequence of the constant changes that take place, a marked increase in width, between the river banks, has taken place within the past 50 years. Similar changes have occurred at many places along the course of the river, as far north as St. Andrews. [emphasis added] (Fleming 1879, p. 270).

Despite Macoun’s assertion, Fleming had in fact been aware of these claims that the channel had widened because his Report of 1879 contained the following statement:

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In his earlier book, Macoun had also claimed that the Assiniboine River near the Forks had doubled its width.

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Fleming had read Anderson’s account of the 1852 flood since he appended extracts, including the statement about channel widening, to his Report. Thus his opinion may simply have been derived from Anderson, although it is a more considered and elaborate statement which added important details about the process and affected reaches. It would certainly have been reinforced by (and possibly based on) the report he received from his District Engineer, James Rowan, dated a month earlier than Fleming’s own report. Rowan’s report also asserted widening of the river and provided a more extended account of the cause:

[The clay of the river bank] when dry is extremely compact and solid, it has however a great affinity for water, and when brought into conjunction with it, absorbs a large quantity and becomes like bird lime... Owing to the nature of the clay ... it has, when brought into contact with the water, been forced out into the river at low-water level, by the weight of the superincumbent earth, and is carried down to the lake ... The oozing out of this material from under the banks causes them to crack and settle down almost perpendicularly; these cracks sometimes occur as far back as 100 to 300 feet from the outer edge of the bank. By this settling down, the material which otherwise would not be disturbed to any great extent by the current or ice, becomes disintegrated, and is easily carried away by the freshts and ice... Owing to this cause the river valley is much wider at many places than it was fifty years ago, but there are numerous points between here and the lake where, from some unexplained cause, this action does not seem to have occurred to any extent [emphasis added]. (Rowan 1879, p. 277).

The final quotation comes from a paper on Red River flooding which S.P. Matheson read to the Manitoba Historical Society in 1932.
I remember also the late Col. [Henry Norlande] Ruttan, for so long our city engineer, when questioned as to his view of the possibility of flood again taking place, remarking that, while the prospects were greatly lessened by the extension of drainage, and while the rivers, especially the Red River, had greatly widened and also were capable of carrying away rapidly a greater volume of water, he did not consider that the danger had entirely passed away. He gave as his reasons that, while doubtless the Red River was much broader all along its course than it once was, yet he had observed that its mouth where it entered into Lake Winnipeg, had remained the same width and he added that a funnel was only capable of carrying through itself what its small end could convey. [emphasis added] (Matheson 1932).

Assessment of the Accounts and Sources

Setting aside questions of physical evidence and process for the moment, what are we to make of these accounts? They are presented as straightforward statements of fact, unclouded by doubt or ambiguity. They allege that widening was considerable and that it had been progressive from 1826 onward. They are not merely passing observations but several of them offer thoughts on the consequences and causes of the widening. Anderson, the Nor’Wester, and Ruttan, for example, explicitly recognized the consequences of widening for water levels and flood discharges. The most detailed accounts were by Fleming and Rowan, not surprising since both were engineer/scientists who had inspected the river and were charged with finding the best location for the railway crossing. Fleming made a distinction between the reaches above and below the Parish of St. Andrews, and both he and Rowan provided thoughts on the mechanism by which the widening had occurred (and which pressed engineering opinion of a century later). The similarity between the Fleming and Rowan accounts is striking; it seems likely that they had discussed the matter and the two accounts should probably be taken as a single one.

Macoun’s information was clearly obtained from local inhabitants and his phraseology “It is said …” and “Common report …” indicates that the idea of widening, whatever the source, was widely-accepted within the Settlement. His is the only account that provides information on the extent of the widening, apparently ultimately derived from Andrew McDermot. McDermot had witnessed the 1826 and other floods but his claims (as repeated by Macoun) that he “first crossed the stream on a small oak tree that had fallen into the channel!” or that the Red River had enlarged by four times, or that the Assiniboine had doubled its width, cannot be credible.

There is, of course, the possibility that the statements are simply incorrect, possibly deriving from a common, erroneous, source. Only two of the accounts were written by potential primary sources who might have observed the phenomenon—Anderson and the Nor’Wester. A third, Andrew McDermot, is cited by Macoun and he might be a potential candidate as such an ultimate source. It may be that McDermot’s flawed opinion was simply accepted as fact by later observers such as Anderson and the Nor’Wester and then became part of the folklore of the Red River Settlement. Born in 1789, McDermot arrived in the Settlement in 1812 as a clerk in the Hudson’s Bay Company, left the Company in 1825 to become the Settlement’s most successful businessman, and served on the Council of Assiniboia and its Board of Public Works. He lived in the Settlement until his death in 1881 and witnessed all of the great and lesser floods. As one of the Settlement’s most prominent residents, McDermot’s opinions would presumably have commanded respect and might well have been repeated uncritically. He was known for his sense of humour and love of teasing (Lent, n.d.); perhaps he couldn’t resist embellishing the truth to improve the story.

If this scenario is correct, the quotations could be dismissed and further discussion would be fruitless. Ironically, the fact that these are the only such quotations known from the large archival record of the region might argue against their accuracy, as widening on the scale that is implied might be expected to have attracted more attention.

Might it be possible, however, that the quotations are not mere folklore but contain some measure of truth? Anderson, after all, experienced the 1852 flood and wrote an extensive account, the Nor’Wester reported on the 1861 event, and both described widening as if it were a phenomenon they themselves had observed. Their statements also imply knowledge about widening following previous floods, perhaps obtained from McDermot but possibly other “old-timers” as well. Anderson and the Nor’Wester were otherwise reliable observers with nothing to gain by manufacturing or repeating a spurious theory which they had no reason to accept and both made the perceptive connection between channel conveyance and the depth of overbank flooding. Furthermore, given Fleming’s and Rowan’s scientific credentials and the detail they provide about the causes and consequences of the widening and the affected reaches, it seems unlikely that they would be easily fooled by a “tall tale” with no basis in fact. Even McDermot’s improbable claim may have had some factual basis with only the magnitude exaggerated through time and repeated tellings.

The next sections of the paper will set aside the question of the accounts’ veracity to consider the geomorphic context of the river channel and explore possible widening mechanisms.

The River Channel

The reach of the river considered here extends from the confluence of the Red and Assiniboine Rivers (the ‘Forks’) downstream to about Selkirk (Figure 1). No tributaries of consequence enter the river in this section and prior to the construction of the Floodway, discharge below the Forks can be considered to have been constant for all practical purposes.

The Red River is not a conventional alluvial river since it does not flow through materials it has previously transported, it cannot freely alter its dimensions or planform, and it does not have a significant floodplain in the normal geomorphic sense of the term. Its banks are principally composed of cohesive but weak Lake Agassiz clays/silts with a surface veneer of non-lacustrine materials. Alluvium is also found along the channel...
These sediments overlie till, which may be generalized into an upper clay-rich, soft, comparatively weak unit and a lower dense, indurated unit with a strength approaching that of weak concrete (Fernando 2007). Glaciofluvial sands and gravel units may occur above, below, or within the till or Agassiz sediments (Tutkaluk 2000). In the Winnipeg area, the channel bed is composed of variable thicknesses of contemporary alluvium over Agassiz clays or till. Beneath the till is Paleozoic carbonate bedrock which rises very close to the channel bed at Lister’s Rapids (about 14 km south of Lockport) and remains relatively near the surface downstream (RRBI 1953).

The Paleozoic rock “sill” at Lister’s Rapids exerts a control over the river’s base level and gradient. Upstream (south) of the “sill”, the gradient of the channel bed is irregular in detail but gentle overall. From about Lister’s Rapids downstream, the profile steepens. Since 1910, low summer water levels over the sill have been controlled by the St. Andrews Lock and Dam at Lockport to facilitate navigation. This structure maintains summer river stage at artificial levels as much as 2 m above natural stage from the end of the spring freshet to late autumn when the water level is allowed to fall rapidly toward low winter stage (Tutkaluk 2000).

Lateral channel activity is small. Even in the sections with well-defined meanders, there is little physical evidence of either progressive or episodic lateral shifts in channel position. However, it is altered channel dimension rather than shifted position that is important to this paper, an inherently difficult proposition to demonstrate since channel enlargement would obscure or obliterate evidence of the former dimensions. Surveyed profiles of the channel from the late 19th and early 20th Centuries have been used to support long-term stability. The Red River Basin Investigation (RRBI) compared cross-sections surveyed in 1886, 1912 and 1951 and concluded that while bank failures have changed the shape of the channel, “the change in the hydraulic properties would not be sufficient to greatly affect the overall channel capacity” (RRBI 1953, p. 10). More recently, KGS Group arrived at a similar conclusion from channel surveys between 1951 and 2001 (KGS Group 2001). Some difficulties with this conclusion will be raised later in the paper.

These observations notwithstanding, the riverbanks have been subject to change by erosion and bank failure. James et. al. (2008) distinguished between the form and locations of banks controlled by each process. Erosion-controlled banks are typically found on the inside of meanders, in alluvial materials, are steep, and are controlled by the undercutting of the lower bank by current, wave action, and ice scour (James et al. 2008). Tutkaluk (2000) cited bank recession of 9 m in 30 years near St. John’s Ravenscourt and 5-8 m in 15 to 20 years at Kildonan Park. From bank profiles surveyed in 1912, 1951, and 2001 at one site on Kingston Crescent, Fernando (2007) found that the toe of the bank had receded by 39 m. The channel bed is also susceptible to erosion. Scour pools several meters deep give the bottom profile its irregular “saw-tooth” effect (Baracos and Lew 2003). Failure-controlled banks have more gentle slope angles, occur in lacustrine materials, and are most common on the outside (concave) of meanders or in straight sections (James et al. 2008). These banks are commonly the surface manifestations of large, deep-seated, retrogressive single or multiple failures, most of which show evidence of previous movement.

Bank Failure

Bank instability and failure are almost ubiquitous along the Red and lower Assiniboine Rivers. The RRBI report following the 1950 flood contains numerous photographs of large and small failures and many others were initiated or reactivated during the falling stages of the 1997 flood and the abnormally high summer flows in 2005. Of 141 riverbanks in Winnipeg surveyed by Mishtak (1962), 135 were actively failing, showed evidence of previous failure, or had required stabilization measures; only 6 were judged to be stable. He found failures to be most common on the outside banks of meanders where multiple sliding blocks are normal but the inside banks and comparatively straight sections may also exhibit instability (Baracos and Kingerski 1998). Some failure surfaces are circular, others display considerable horizontal (translational) displacement. Some failures (particularly those initiated by undercutting) are confined to the alluvial or lacustrine materials but the largest and most deep-seated fail along the lacustrine/till boundary. The latter include reactivated older failure surfaces which may extend as far as 80 m from the...
river banks (Baracos and Kingerski 1998; Figure 2). Tension cracks that far from the bank were noted by Rowan in 1879.

The factors which contribute to bank instability begin with the inherently low shear strength of the bank materials and the structural weaknesses created by the lacustrine/till boundary or old failure surfaces. The latter provide pathways for the movement of groundwater and the remodeled shear strength along them is especially low. Some failures are directly precipitated by erosion, either by simple undercutting of the bank or by the progressive removal of support from the toe of previous failures. Fernando (2007) suggested that the removal of toe support for the deep-seated translational slides might account for sudden failure after a long period of stability.

The effects of bank erosion and failure are complicated by deposition of new material. Deposition at the top of the slide would add additional weight, increase instability and promote further failure whereas deposition at the toe of the slide would provide support, improve stability, and resist failure (Fernando 2007). Brooks (2005) studied aggradation along concave banks of the Red River channel near Letellier, 80 km upstream of Winnipeg. The concave banks there (as elsewhere along the river) were predominantly landslide zones comprised of multiple slide blocks moving intermittently downward toward the channel. At the base of the lowest block (nearest the channel), accumulated aggradation was up to 4 m thick, thinning rapidly on higher blocks further from the channel (Figure 3). This aggradation represents temporary storage of sediment (on a time scale of several centuries) until it is reworked by erosion of the toe of the sliding block. In addition to increasing the weight on the block, it offsets some of the erosion and contributes to the apparent constancy of channel dimension and overall low rate of lateral migration.

![Figure 2: Stratigraphy and failure profiles, St. Boniface (a) and St. Vital (b) (redrawn from Baracos 1978).](image1)

![Figure 3: Multiple failure blocks and accumulated alluvium, near Letellier (redrawn from Brooks 2005).](image2)
While there are numerous causes of specific failures, the Red River Basin Investigation (RRBI 1953) noted that they “occur more frequently after rapid drawdown such as following high water stages of the spring runoff and ... have also occurred after unusually heavy rains” (RRBI 1953, p. 4) and most subsequent studies have implicated groundwater pore pressure conditions in the river banks as a major factor in bank stability.

Groundwater moves toward the Red River along two routes — a set of shallow pathways along the lacustrine/till boundary or through sublacustrine glaciofluvial sands and gravels, and a more important pathway through the Upper Carbonate Aquifer (UCA) of the Paleozoic Red River Formation (Figure 4). These are recharged through the sands and gravels exposed in the Bird’s Hill and Sandilands regions. Groundwater also moves toward the river from the west and northwest from recharge areas in the Stony Mountain, Stonewall and southern Interlake regions (Johnson 1934; Charron 1965).

Under natural conditions (i.e. before urban development in the Winnipeg region), the piezometric surface of the UCA would have descended gradually toward the Red River from the recharge areas to the east and west. Confinement of the aquifer by the Agassiz clays and the till created upward-directed artesian or subartesian pressure conditions over a broad area. Human activity, however, has greatly altered this simple pattern. Beginning in the 1880s, increasing amounts of groundwater were pumped from the UCA, lowering the piezometric surface (Render 1970; Figure 5a). Construction of the Winnipeg Aqueduct reduced the need for pumping for a time but it gradually increased to another peak. Greatest lowering occurred in St. Boniface where industrial use created a broad drawdown cone (Figure 5b). As the piezometric surface lowered, the area of artesian pressure receded toward the southwest, effectively eliminating artesian conditions over a broad area of the Winnipeg region (Johnson 1934; Charron 1965). In the 1960s, the construction of the Red River Floodway east of the Red further reduced the piezometric surface near the river.

The lowering of the piezometric surface from the 1880s onward would have improved general riverbank stability by creating downward (stabilizing) hydraulic gradients in the vicinity of the riverbank. Nevertheless, numerous studies by Baracos and co-authors elaborated a more complex process, involving the interplay among river water level, the height of the piezometric surface, and seasonal changes in pumping and recharge rates. Baracos’ argument can be summarized as follows. Piezometric elevations are highest when recharge is at a maximum during or after spring melt or after unusually heavy rain in the summer. These would ordinarily produce upward-directed hydraulic gradients and reduced stability except that the relatively high water level in the river provides sufficient support for the bank that failures after the spring peak has passed are less common than they might otherwise be (Baracos and Lew 2003). Stability is also improved in the summer when (a) the St. Andrews Dam maintains artificial river water levels about 2 m above natural summer level and (b) a peak in groundwater pumping (largely for air conditioning) causes lower piezometric elevations and downward pressure gradients conducive to stability. As water levels fall in late summer or after the St. Andrews Dam is opened in the fall, the drop in river stage reduces support for the bank at the same time as the piezometric surface is typically rising due to greater rainfall and a reduction in the demand for groundwater pumping (Baracos 1978); in 1983, for example, groundwater pumping rates varied from 20 million l/day during the summer to only c. 5 million l/day in winter (Baracos et al. 1983). From winter until the following spring, bank slippage may continue but at a much reduced rate. Under modern conditions, then, fall is the most critical time for bank instability and failure.

**Figure 4:** Generalized sequential stratigraphy and groundwater flow (based on Ferguson and St. George 2003).
Differences Between Modern and Historical Conditions

For significant channel widening to have occurred in the 19th Century, bank erosion and failure must have been more prevalent before the period of surveyed cross-sections (i.e. before the 1880s). A circumstantial but strong argument can be made that all of the dynamic factors favouring bank instability would have been more effective in the early to mid-19th Century than during much of the 20th Century. The reasons for this are both natural and human in origin.

Natural factors involve differences in the hydrometeorology of the region in the first half of the 19th Century. The great historic floods of 1826, 1852, and 1861 are well-known. The 1826 flood was the largest in more than 200 years of documented flood history, with a conventionally-accepted estimated discharge (225,000 cfs) almost 40% larger than the 1997 “Flood of the Century”. The 1852 flood (165,000 cfs) was as large as 1997, and the 1861 flood (125,000 cfs), although the smallest of the three, was still very large, comparable to the 2009 event.

Overlooked in most discussions of the 19th Century floods is the fact that the 1826 and 1852 events were preceded by other, less well-known but large, floods. In 1825, a spring flood (probably of about 1950 magnitude) occurred in April/May and after a brief decline in June, the water level rose again and remained very high throughout the summer. The great 1826 flood was then followed by lesser but still significant floods in 1827 and 1828. The 1852 flood was preceded by large spring floods (probably of 1950 magnitude) in 1850 and 1851 and a summer flood in 1849 (Rannie 1998). Equally important was the fact that the great floods occurred within two decade-long abnormally wet intervals (1824-1834 and 1849-1861) during which virtually every summer was remarkably rainy and summer water levels were high (Rannie 2006). In a number of the years (most dramatically in 1849), it is likely that rainfall amounts were comparable to those of 2005 when record summer streamflows with extensive overbank flooding led to another round of heightened concern about bank stability. Alexander Ross’s comment on the preconditions of the 1826 flood, that “the previous year had been unusually wet; the country was thoroughly saturated. The lakes, swamps, and rivers at the fall of the year were full of water…” (Ross 1856, p. 106), could have applied equally to most of the years during these wet intervals.

It can be assumed, then, that in most of the years surrounding the great floods, the succession of large spring melt and excessive summer rainfall thoroughly saturated the ground throughout the Red River region. Most importantly, recharge of the UCA through the Sandilands and Bird’s Hill must have produced a piezometric surface which was considerably higher than in the 20th Century, with more widespread and stronger upward (destabilizing) hydraulic gradients in the vicinity of the Red River. Johnson (1934) cited reports that in 1894, flowing wells had been known in the northwestern part of the original City of Winnipeg; along the Red River (a few km to the east), the water level in wells was 10-20 feet below the ground surface. By the time of this observation in 1894, however, exploitation of the aquifer had begun and the natural piezometric surface near the river may have been higher; it must certainly have been considerably higher during the wet intervals surrounding the great floods earlier in the century.

The increased potential for groundwater-induced riverbank failure would have been compounded by the erosive potential of the floods and prolonged, summer high flows to undercut the banks and remove toe support for the deep-seated large failure surfaces. In fact, without the removal of material, bank failure would constrict, rather than widen, the channel. Fernando’s (2007) modeling indicated that erosion and reduction of the bank safety factor were greatest under medium and high flows of long duration, conditions which were the norm during the wet intervals of the 19th C. For most of the 20th Century (until the
1970s), annual peak flows were low to moderate. Few floods occurred and apart from the 1950 event, all were comparatively small. Even those which were comparable in size or duration to the great 19th C floods (1997, 2009) were in fact very much smaller in terms of their erosive potential since large portions of the discharge were diverted by the Floodway (see below).

If the natural environment of the early to mid-19th Century favoured instability, aspects of urban development from the 1880s onward have favoured relative stability. As was noted above, pumping of the UCA lowered the general piezometric surface, with a pronounced drawdown cone centered on St. Boniface (Figure 5b). The boundary of the area with artesian conditions retreated from Winnipeg and by 1962 was about 25 km southeast of the city (Johnson 1934; Charron 1965). Regulation of summer river levels by the St. Andrews Dam after 1910 provided more support for the toe of the riverbanks than would have been the case with natural summer levels. From the 1960s onward, the Red River Floodway to the east of the river intercepted some of the groundwater which would otherwise have moved toward the river. More importantly, by the time annual peak discharges increased from the 1970s onward, the Floodway was able to dramatically reduce the magnitudes and durations (and thus the erosive potential) of peak flows. During the major floods of 1974, 1979, 1996, and 2005, the Floodway and other flood control structures were used to maintain Winnipeg river stages at or near minimum flood stage (5.6 m above the James Avenue datum), 3.5 m lower than would have occurred under natural (i.e. uncontrolled) conditions. In 1997 and 2009, when uncontrolled discharges were approximately the same as in 1852 and 1861 respectively, stages within the city, although above minimum flood level, were still 3-3.5 m lower than natural, and discharges permitted in the channel within the city were only 50-60% of the uncontrolled values. Moreover the historic floods had much longer durations than the managed 20th Century floods.

Changes in riparian vegetation may also have played a role. A striking feature of photographs of the Red River taken by H.L. Hime during the 1858 Hind Expedition (reproduced in Huyda 1975) is the virtual absence of trees (or any other substantial vegetation) along the river, particularly the west banks. The reason for this is clear—the need for wood for heating and construction materials in a growing settlement strung (mostly) along the western bank between the Forks and Lower Fort Garry. In fact, other photos of many sites in the Red River Settlement show that the deforested area extended for quite a distance from the western bank. Tutkaluk (2000) suggested that the root mass of mature trees may contribute 30% of total soil strength and “a riverbank with mature trees (especially at the crest) would be much more stable than a riverbank without such vegetation.” (Tutkaluk, 2000, p. 103). In addition, riparian trees reduce erosion and promote aggradation during high water. Removal of the natural (i.e. pre-Red River Settlement) riparian forest would have begun as the Settlement became established and would have been well under way in the vicinity of the Forks by the 1826 flood. As the settlement grew downstream over the following decades, more of the bank would have become unprotected and each flood would have done its own damage to the vegetation, further reducing the protection. The reestablishment of the riparian forest in the 20th Century would have increased overall bank stability.

The changes in stability produced by these human activities and the implications for failure prior to human intervention were recognized by Baracos.

Before the turn of the century, the river level in the City of Winnipeg was not controlled by locks, nor had the heavy demand for well-water developed. Johnson (1934) cites old records of flowing wells in northwest Winnipeg. This would indicate that hydraulic gradients in the banks would not have their present downward and stabilizing direction. Without the locks, spring high river levels would have been soon followed by the uncontrolled river levels, thus developing conditions less favorable for stability than presently exist. Slides would have developed, which under present conditions are possibly stable or only intermittently active. Whatever the explanation is for the old slide surfaces, they do exist as has been shown for the St. Vital and St. Boniface banks, and at other sites where excavation has revealed their presence. (Baracos 1978, p. 15)

…it can be reasonably presumed that in earlier times [before urban development], hydrostatic or even upward gradients … may have contributed to the large number of deep-seated slides which are present in the riverbanks… Since the residual strength of the Agassiz clays is very low…, these former landslides are easily reactivated by erosion or construction activity. They are often difficult to stabilize. (Baracos and Graham 1981, p. 395).

These arguments could only have been reinforced had the writers taken the enhanced 19th Century groundwater environment into account.

However persuasive the case is for more vigorous 19th Century bank failure, historical documents make surprisingly little mention of bank failure from 1826 to the 1860s. Nevertheless, it apparently could cause concern. As the 1852 flood receded, Bishop Anderson noted on June 3 that

the land is fast reappearing. The chief fear now is the slip of the bank; many houses are supported and propped up, lest the earth should launch forward and carry them away.” (Anderson 1852).

and following the recession of the 1861 flood, Samuel Taylor wrote in his diary for June 30, 1861, that

... a great deal of the bank of the River has fallen about this time the like is never been known I believe.” (Taylor 1861).

Another indication of historic bank failure is provided on a detailed map of the immediate vicinity of the confluence of the Red and Assiniboine Rivers surveyed by British military engineers, dated July 31, 1848 (Warkentin and Ruggles 1970).
The map was annotated “ground subsiding” at four locations along the bank of the Red in the 0.5 km reach immediately downstream of the Forks and at another location on the Assiniboine adjacent to Upper Fort Garry; the map’s shading along the channel suggests that it was a general phenomenon. Finally, several of Hime’s 1858 photographs of the Red River (referred to above) suggest bank slippage; although most are rather indistinct, one clearly shows well-developed headscars and large slumps along the Assiniboine River immediately in front of Upper Fort Garry (Figure 6).

Discussion and Conclusions

This paper began with the premise that the anecdotal accounts of widening in the Red River deserve attention. The possibility that the accounts are incorrect was discussed above. To the writer, the most compelling reasons for rejecting the accounts are the small number of claims for the phenomena and even smaller number of potential primary sources. Given Macoun’s suggestion that the observation of widening was widely shared within the Settlement, the fact that there are so few accounts in the voluminous archival record is worrisome.

On the other hand, a clear plausible mechanism for widening exists: bank failure accompanied by erosion and removal of the failed material. Most authorities attribute much of the modern bank instability to groundwater pore pressures and there is evidence that the hydrometeorology of the region in the time periods surrounding the floods would have favoured stronger groundwater pressures and greater instability in comparison with those which have prevailed during the 20th Century and the floods themselves would have had greater erosive potential than any in the modern period. Again, however, the archival record of actual failure or erosion is more slender than might be expected given the importance of the riverbanks to the inhabitants of the settlement.

The closest thing to physical evidence are the surveyed channel profiles from which both the Red River Basin Investigation (1953) and KGS Group (2001) concluded that the channel had not changed its hydraulic properties. However, the use of these profiles to infer channel dimensions during the great floods is problematic. The earliest profile, in 1886, was from the vicinity of St. Andrews Church in a reach which Fleming specifically said had not widened. The only other early profiles come from several sites in Winnipeg reported by the Manitoba Hydrographic Survey of 1912 (when pumping of the UCA was nearing its pre-aqueduct maximum), and from the Red River Basin Investigation following the 1950 flood (RRBI 1953). All of these profiles were surveyed long after the purported widening had occurred and reflect conditions during the period of apparent greater stability due to piezometric lowering. Thus they do not necessarily provide certain evidence of channel dimensions earlier in the 19th Century.

All but two of the accounts suggest that widening was general all along the river but Fleming and Rowan excluded the reach from St. Andrews downstream and both said that the river had widened at “many places”, implying a less continuous phenomenon. The possibility that the other 19th Century observers may have over-generalized from localized widening was raised.
by Carson et al. (2002) and non-systematic variations in modern river width provide some support for this view. Figure 7 shows low water channel widths in January, 1951, and the widths during the 1950 flood (103,600 cfs; 2935 m3/sec) from the Redwood Bridge in Winnipeg to the St. Andrews Dam (RRBI 1953).

Width increases in irregular fashion for about 8 km downstream of the Redwood Bridge with fluctuations of 20-40% superimposed on the trend. These fluctuations are most dramatic in the middle section (Mile 36-32) where low-water widths reach their maximum and become extremely variable. Where the banks are subject to extensive failure with multiple blocks moving in translational fashion, the channel margin consists of one or more steps descending toward the water line. Under these conditions, widening would be greatest at the top of the channel margin. This is also suggested by the RRBI data where the sections with the greatest variability also exhibited the greatest difference between the low water and flood widths. Brooks’ data indicate that very little of the widening of the upper channel margin is compensated for by aggradation. Several factors undoubtedly contribute to these anomalous width variations (eg. the topography around small creeks, the proximity of bedrock to the channel bed, etc.) but some may reflect the localities where former widening was greatest.

The possibility that the channel widened during the period of the great floods is not merely a geomorphic curiosity but has potential consequences for the understanding of their hydraulics. For example, the discharges of the floods were estimated by the RRBI (1953) using a Manning-type methodology which assumed 20th Century channel dimensions and water surface slopes based on surveyed water elevations on the floodplain reported by Fleming. If the channel were in fact narrower during the 19th Century floods, then the calculations might have produced overestimates of the discharges. However, the RRBI estimates were based on channel dimensions in the lower reach (from St. Andrews downstream) which Fleming explicitly excluded from widening so it is unlikely that such an overestimate occurred.

During their hydraulic studies following the 1997 flood, KGS Group identified anomalies in Fleming’s 1826 water elevations such that the water levels from present-day Lockport to 4 miles below Selkirk are considerably higher than would be expected for peak flows that would be associated with the high water levels reported in Winnipeg. Or, conversely, the water levels in Winnipeg are considerably lower than can be explained by flows that would be required to generate the maximum stages that occurred at, and downstream of, present-day Lockport. (KGS Group 2001, p. 9).

This anomaly, which became known as the “Fleming Conundrum” (Carson et al., 2002), presented problems in the reassessment of the hydraulics of the 1826 flood in the Lockport-Selkirk reach. The possibility of channel morphologic change, based on several of the quotations, was included among six possible explanations considered by KGS Group. Their modelling of discharge and water surface profiles in the Lockport area indicated that “a channel only 10% narrower than currently exists could reduce the disparity of the water levels between the reach near Selkirk and in Winnipeg” (KGS Group 2001, p. 13). However, KGS Group rejected widening in general terms because of the similarity of profiles over the last century and specifically in the case of the Conundrum, because they found no explanation for why widening would have occurred only (or at least to a greater degree) in the reach near Selkirk and not within Winnipeg. In their judgment, bank failure might have been more likely in Winnipeg but widening there would have exacerbated the Conundrum. Again because Fleming specifically excluded the lower reach from widening, it would seem that the cause of the Conundrum lies elsewhere.

Whether the Red River was indeed narrower in the 19th Century is not resolved here. Even with additional field and archival research or modeling of bank stability under hypothetical 19th Century groundwater scenarios, a satisfactory answer may not be possible. The small number of potential primary accounts raises alarms and however strong an argument may be made for enhanced bank failure and erosion as mechanisms, the slender historical evidence for it is equally troubling. There is an obvious danger of circular argument when observations of questionable reliability spawn a plausible but speculative explanation which is then used to bolster support for the original observations. On balance, while the accounts of widening cannot be dismissed, they should be approached with caution and a healthy skepticism (as this paper has attempted to do). Nevertheless, KGS Group’s finding that a 10% (15-20 m) narrower channel in the Selkirk area could account for the Conundrum indicates the sensitivity of the hydraulics of the 19th Century floods to relatively small changes in channel dimensions; the issue might be worth revisiting when discrepancies arise in future interpretations of the historic behaviour of the Red River.

Figure 7: Width of water surface at 1950 flood peak, 103,600 cfs (upper line) and at low flow, January, 1951 (lower line) from Redwood Bridge in Winnipeg to St. Andrews Dam (data from Red River Basin Investigation 1953).
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