# Flood sediments and archaeological strata

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**Preamble**

The goal of science is the enhancement of knowledge and the identification of the processes that result in an event, as well as the quantification of the complexity of components that make up the event. Once the underlying components and processes of an event can be defined, attempts can be made at developing models for predicting future behaviour of the system. Archaeological recovery of data from past events can be applied to current knowledge of processes, thereby providing multiple data sets for testing various models. Cultural information (both temporal and palaeoenvironmental) can be used to date the flood sequences of the past which then can be correlated with changes in the continental climate, resulting in refinement of the models and potentially accurate prognostication.

Variations of the climate are reflected by rivers. The amount of precipitation results in either high water or low water episodes. The low water episodes on the Red River would have been frustrating for the captains of the river steamboats during the 1870s and 1880s, but even a trickle of water nourishing the gallery forests along the rivers would have provided a survival oasis for animals and people traversing the xeric plains during the Hypsithermal. However, it is the floods which have left their mark on each generation of the inhabitants of the valley. For no events define the character of both the people and the environment of southern Manitoba as do the periodic floods of the Red River and the Assiniboine River.

As the word "flood" is semantically loaded, so too are the waters sediment-laden. It is these sediments, laid down by past floods which can provide a view into the magnitude and frequency of floods prior to the advent of archival data. The junction of the Red and Assiniboine Rivers (The Forks) in Winnipeg, Manitoba (Figure 1) has been the site of numerous archaeological investigations over the past decade. These archaeological projects have produced a body of stratigraphic data which can be utilized to investigate previous floods. The depth of excavations have varied, depending upon the focus of the research. Some projects have limited their investigations to the Fur Trade Period (post A.D. 1737) while others, conducted in conjunction with infrastructure developments, have delved deeper into the past.

Over the past millennia, the two rivers have deposited, in some locations, as much as eleven metres of sediment over the underlying lacustrine clays of Glacial Lake Agassiz. Auger drilling on the north bank of the Assiniboine River (Figure 1 - Location 1) recorded sediment depths of 10.35 to 11.0 metres before encountering vegetative mats and clam shells at the surface of the Agassiz clays (Kroker and Goundry 1990:147). It would be extremely useful if one of the recorded sediment columns had evidence of each and every high water episode. However, given the vagaries of sediment deposition and erosion during flood situations, the textbook illustration of well-defined layers is an anomaly. With back eddies, ice jams, toppled trees, and uneven topography, the overall stratigraphy of The Forks area could best be described as a marble cake, with even thick sediment layers pinching out and disappearing over short distances—sometimes as little as 10 metres. With the lack of widespread continuous strata, cultural evidence may be one of the few mechanisms of actually determining the sequence of flood events.

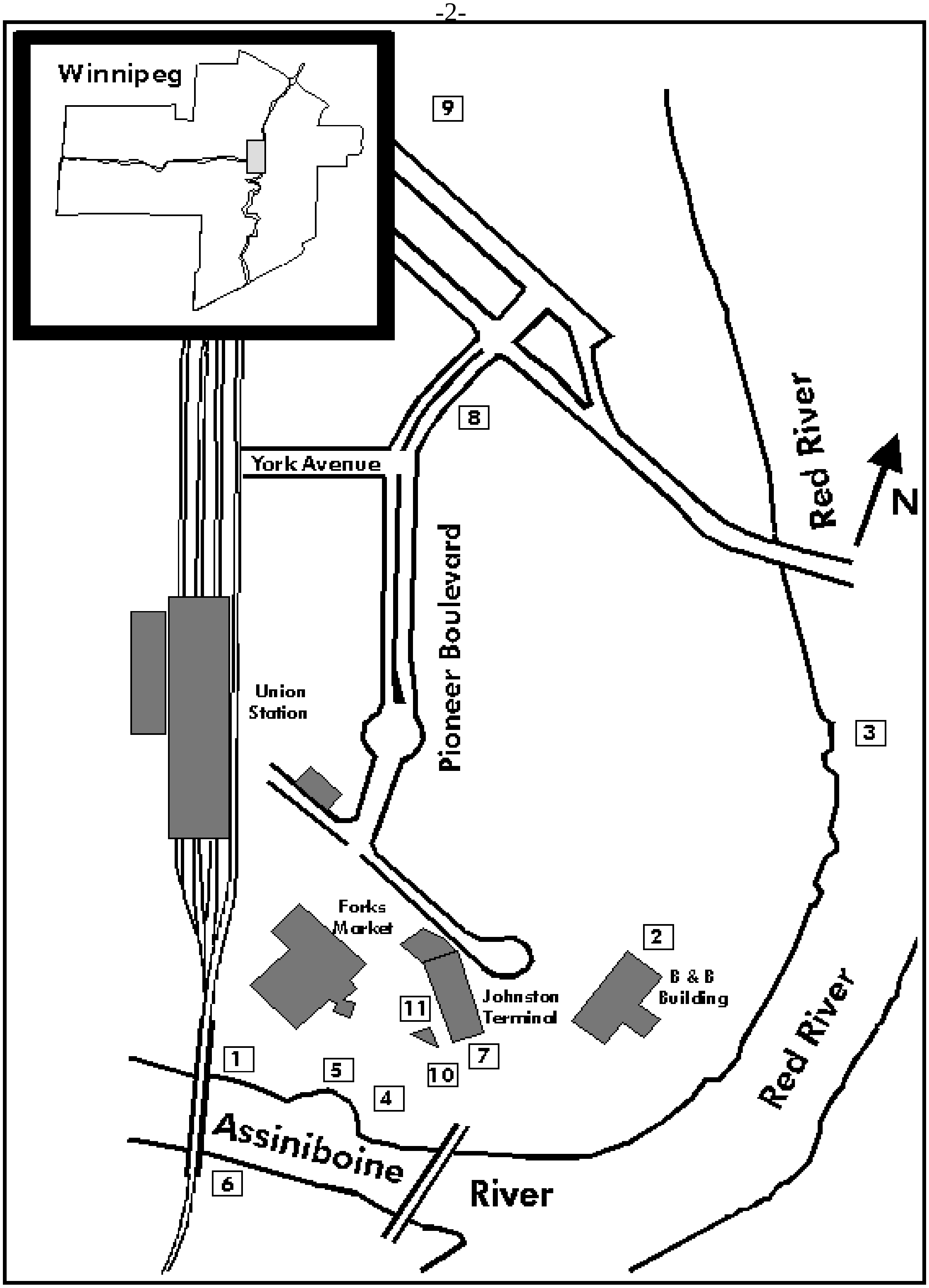



Figure 1: A Map of The Forks Showing Data Collection Locations

**Correlation of sediment layers with nineteenth century floods**

Archaeological excavations of Fort Gibraltar I (Figure 1 - Location 2), a North West Company trading post, provided a stratigraphic profile of recent flood-deposited sediments. As much of The Forks area was modified by land leveling and grading when ownership passed from the Hudson's Bay Company to the Northern Pacific and Manitoba Railroad Company in 1888 (Guinn 1980:140) very few locations have intact evidence of the upper soil strata. The vicinity adjacent to the former Locomotive Engine Repair Building (first called the Bridges and Buildings Building by Canadian National Railway and now the Children's Museum) is one of them. However, even when the flood dates are known, it is often difficult to correlate specific strata with specific flood events. Four major floods have been recorded at Winnipeg during the 19th century—1826, 1852, 1861, and 1882, not all of which can be definitely linked to observed strata recorded during the excavations of Fort Gibraltar I (Kroker *et al.* 1990, 1991, 1992). The stratigraphic profile (Figure 2) has definite bounding limits. The basal layer of partially charred timber and fired chinking would have occurred when the fort was destroyed and burned by the Hudson's Bay Company in 1816. The uppermost layer, underlying a metre-thick stratum of railroad cinders, consists of a mottled layer of sands which relate to the 1888 construction of the adjacent roundhouse and engine repair facility.

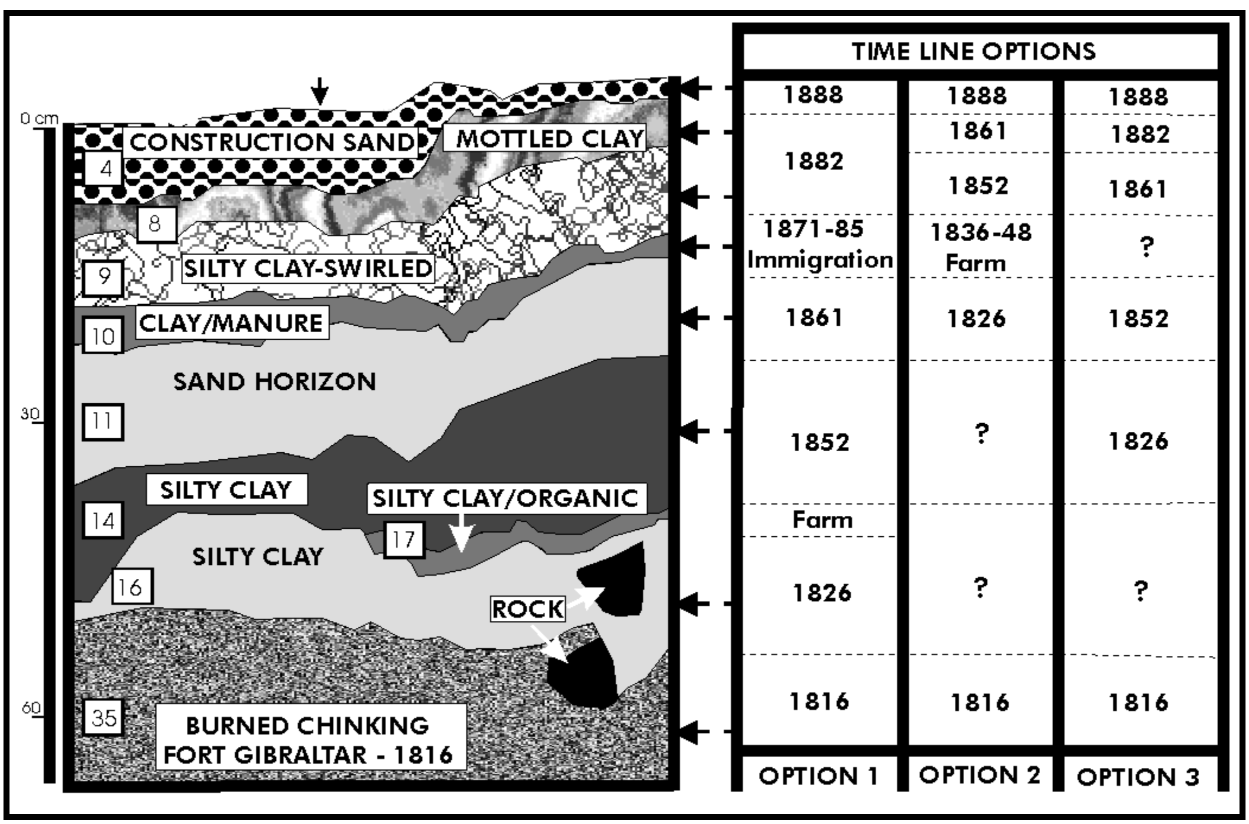



Figure 2: Soil Profile from Fort Gibraltar I

Between these two layers, there are seven distinct strata. Two layers have indications of being an original soil surface. Layer 8 is a dark brown clay with lighter mottling. Layer 10, an organic-stained clay, contains manure. Layer 17 is a buff silty clay with some dark brown organic stains, but is probably not a soil surface. It is seen as a variant of Layer 16 where organic material was incorporated into the sediment during deposition and decayed *in situ*.

Layer 10 is the most strongly defined horizon and, in addition to the manure, contains artifacts probably related to the Hudson's Bay Company Experimental Farm which was in operation from 1836 to 1848 (Guinn 1980:87). An alternative source for the manure deposits could have been the presence of horses which would have been hitched near the Immigration Sheds (1872-1885), slightly to the west of the excavation area (Guinn 1980:108). No stable structures or corrals are recorded adjacent to the Sheds where women and children lived while the adult males of the family were establishing the homestead. Any horses would have been hitched at a rail or probably ground-hitched resulting in minimal concentrations of manure. (Radiocarbon dating of manure samples would not resolve the age question of layer 10 because of the large error associated with dating material that is younger than 1750 AD. Much more exact dating could be obtained by tree-ring dating if wood was ever recovered from layer 10.)

Three different interpretations are possible (Figure 2). Option 1 is based upon the assumption that every flood is represented. This, in turn, assumes that the manure layer derives from activities adjacent to the Immigration Sheds. To conform with this interpretation the upper two sediment layers would have had to derive from the 1882 flood or from two discrete high water episodes between 1871 and 1882. If the 1882 flood deposited two layers, the heavier silty clay (Layer 9) would have been during the initial phase and the lighter clay (Layer 8) during the receding or standing water phase. The mottling in Layer 8 derives from organic components in the soil matrix and indicates the presence of vegetative cover, beginning the development of an A Horizon. It is unlikely that this horizon derives from the 1882 flood as there would be insufficient time to develop an incipient A Horizon (6 years). Furthermore, the 1882 flood was not as large as the earlier three, with the flood crest being measured at 229.7 metres above sea level (asl) at the Assiniboine junction (Labelle *et al.* 1966). The current land level at the Fort Gibraltar Site is 230.9 metres asl and the upper cinder level (railroad era of 1889 to 1989) averages one metre thick. Thus the ground level at the time of the 1882 flood would have been between 229.5 and 230.0 metres, resulting in minimal inundation. However, ice jams which eventually destroyed the newly built Broadway Bridge (Figure 1 - Location 3) (Forks Renewal Corporation 1988:Appendix A) could have resulted in localized deeper waters. Given the above data, it is highly unlikely that Layers 8 and 9 derive from the 1882 flood. Continuing downward, the sand horizon (Layer 11) would represent the 1861 flood, with Layer 14 deriving from the 1852 flood. Layer 14 is a dark brown, mottled silty clay overlying a buff silty clay (Layer 16). This lowest layer, directly overlying the burned chinking of a structure within Fort Gibraltar I, would be correlated with the 1826 flood. Layer 17 appears to be a variant of Layer 16 with some brown organic stains. The degree of staining, along with the lack of organic material at the top of Layer 16, indicates that minimal time occurred between the deposition of Layers 16 and 14. This gives rise to the second problem with this option. The Experimental Farm, with cattle sheds and horse barns, existed in this vicinity for more than a decade. The Moody map of 1848 (Warkentin and Ruggles

1970:193) depicts a complex of at least six buildings. While evidence of the structures has yet to be archaeologically recovered, the manure horizon is extensive (Preiss *et al.* 1986:101) and would suggest a correlation with Layer 10 rather than the minuscule organic content in Layer 17. To summarize, this option is highly improbable inasmuch as the amount of deposition from the 1882 correlated levels does not match the recorded intensity of the flood and the correlation of the manure level with the Immigration Shed period appears weak especially in light of the extensive operations of the Experimental Farm thirty years earlier.

Option 2 is based upon the assumption that the manure layer (Layer 10) derives from the HBC Experimental Farm period of 1836 to 1848. Working upward from this level, and bearing in mind the previous comments about the 1882 flood, Layer 9 would represent the 1852 flood and Layer 8 would represent the 1861 flood. Thus, the sand horizon (Layer 11) would have been deposited by the 1826 flood and the clay component of Layer 10 would have been deposited during the standing water phase of this flood. With this scenario, two distinct layers underlie the sand horizon—Layer 14, a dark brown, mottled silty clay, and Layer 16, a buff silty clay. Layer 17 is a light brown silty clay with organic stains and is seen to be a slightly modified variant of Layer 16. These layers would have had to be deposited by at least one, and more probably two, high water episodes between 1816 and 1826. Surface erosion of disturbed ground after the destruction of Fort Gibraltar could have resulted in the incorporation of charcoal and chinking within these layers if that were the only causative event for these layers. No wide-spread high water events are recorded but ice jams caused by ice from the Assiniboine River being pushed into ice on the Red River could have resulted in localized high water and resultant sediment deposition.

Option 3 was first promulgated by Preiss *et al.* (1986:98-111), based upon stratigraphic evidence from earlier excavations in 1984. This interpretation assumes deposits from all floods with Layer 8 representing the 1882 flood and Layer 9 representing the 1861 flood. A problem with this sequence is that the manure layer is placed circa 1852-1861, although no events which would have resulted in the deposition were occurring at the vicinity. The 1852 flood was nearly as massive as the 1826 flood and is assumed to be responsible for the deposition of the sand layer. This leaves Layer 14 to represent sedimentation during the 1826 flood, with Layer 16 again deriving from an unrecorded high water event after the destruction of Fort Gibraltar.

An additional archaeological discovery during the 1991 excavations was the presence of a series of prints impressed into the silty clay of Layer 14 (Kroker *et al.* 1992:30-34). These marks, 3-4 cm deep, consisted of cattle prints, shod and unshod horse prints, buggy wheel ruts, and a moccasin-clad human footprint. All were oriented toward the north, indicating one-way travel. The marks were preserved by the difference in texture between the silty clay in which they were impressed and the overlying sand layer. The tracks may have been made in wet soil and sun-baked over the summer or frozen in the late fall prior to the flood which deposited the sand layer. Alternatively, they may have been made in the spring when the soil had slightly thawed during daylight hours and subsequently froze overnight, after which the flood waters rose rapidly, depositing the sand layer over the frozen impressions. In order to attempt to provide a temporal placement for these tracks, some historical information must be delineated. After the destruction of Fort Gibraltar I in 1816, the North West

Company built Fort Gibraltar II on the north bank of the Assiniboine River, directly overlooking the junction of the two rivers. Fort Gibraltar II was renamed Fort Garry when the North West Company and the Hudson's Bay Company amalgamated in 1821 and functioned as the administrative and economic centre of the Red River District. This fort is referred to as Fort Garry I by historians due to other successive posts also called Fort Garry. As of 1832, Lower Fort Garry was constructed thirty kilometers further upstream on the Red River, near present day Selkirk with the flood-damaged remnants of Fort Garry being abandoned. In 1836, construction began on Upper Fort Garry, situated on the north bank of the Assiniboine approximately 500 metres west of Fort Garry I.

The presence of the tracks indicates that there had to have been a reason for the traffic and the most probable explanation is the operation of Fort Garry I which would have been both a source, with residents of the fort visiting within the Red River Settlement, and a destination, where local residents would come for supplies. Prior to the flood, extensive economic and social activity occurred at Fort Garry I which was an elaborate complex consisting of palisades, bastions, a retail shop, a warehouse, dwelling houses, an icehouse, a powder magazine, and a roothouse (Coutts 1988:123). This would account for a steady stream of traffic between the fort and the Red River Settlement to the north. Additionally, at the onset of the 1826 flood

> *about 60 families and almost 200 head of cattle sought refuge in the fort, but were forced to flee again for their lives a few days later when the ice on the Assiniboine River broke up* (Coutts 1988:122).

Either the pre-flood traffic or the exodus from the fort during the initial phase of the flood could have accounted for the tracks.

After the 1826 flood, some restoration was undertaken at Fort Garry I but eventually only a single sales shop remained by 1832. The five years of continued operation after the flood, prior to establishment of Lower and Upper Fort Garry, would have seen continued traffic. However, after the abandonment of the damaged fort, minimal movement would have occurred and thus, the tracks would have had to been preserved until the flood of 1852 (Option 3) or the flood of 1861 (Option 1). Both do not seem feasible. While not definitive, the presence of the tracks is persuasive evidence that the sand horizon was deposited by the 1826 flood.

To summarize, there are three possible options for interpreting the stratigraphic sequence and correlating soil layers with the recorded floods of the nineteenth century. Option 1 and Option 3 assume the presence of sediments from each flood, while Option 2 assumes that the weaker flood of 1882 did not leave a sedimentological record of its presence. Option 1 assumes the manure layer results from activities around and adjacent to the Immigration Sheds of 1871-1885 and Option 2 correlates the layer with the Hudson's Bay Company Experimental Farm of 1836-1848, while Option 3 assumes an unnamed event between 1852 and 1861 as the source of the horizon. The sand layer, based upon assumptions encapsulated in each of the options, can be correlated with the flood of 1861 (Option 1), 1826 (Option 2), and 1852 (Option 3). All three floods were of sufficient magnitude to be responsible for the deposition of a sand layer, although the source of the sand would have been the Assiniboine River which flows through surficial till deposits upstream of The Forks. Both Option 2 and Option 3 require the presence of high water episodes resulting in the deposition of silty clay layers between 1816 and 1826, unlike Option 1. While none of the options provide a comfortable fit between the historical data and the stratigraphic profile, Option 2 is seen as the most likely. To provide definitive evidence, archaeological recovery of temporally definitive artifacts from Layer 10 is necessary. Artifacts with a very restricted time range would eliminate the uncertainty about the time period and the events from which this horizon derives, allowing further confirmation of the underlying assumptions about the correlations of sediment layers with specific floods.

**Floods of the last millennium**

As can be seen from the discussion in the previous section, correlation of floods and chronologically defined cultural events can be tenuous. It becomes even more so when the cultural record becomes solely archaeological. Different cultures produced artifacts which can be dated to temporal ranges, usually on the basis of radiocarbon dates from the site being investigated or by comparison with similar styles from other dated sites. Two specific problems occur with the temporal controls applied in these cases. First, the radiocarbon date is a statistical average with a range of one (or two) standard deviations. Second, the application of a temporal range obtained at a different location, especially one which is considerably geographically removed, does not take into consideration aspects such as retention of stylistic characteristics on the periphery of a culture core area, i.e., a style may persist longer in the hinterland than at the central area of the cultural complex.

Several distinct stratigraphic horizons have been recorded at The Forks which, while not occurring at every location, are widespread enough to serve as markers. The first is a twin layer of A Horizons (each 4 to 8 cm thick) separated by a thin layer of light brown silty clay (Kroker 1989:173; Kroker and Goundry 1990:148). This *Double A* horizon was first recorded on the north bank of the Assiniboine River (Figure 1 - Location 4) and later at other loci within The Forks area. As no cultural deposits have been recovered from either horizon, they cannot be correlated with a specific time period or cultural group. Temporally, this component pre-dates the 19$^{th}$ century floods and post-dates a major flood episode which is described below.

During a land modification project in 1989, a thick sand layer was recorded on a vertical excavation face on the north bank of the Assiniboine River (Figure 1 - Location 5). The layer, averaging 30 cm, consisted of tan sand and contained a mixture of adult and foetal bison bone at the base (Kroker and Goundry 1990:143, 1993a:166). The presence of the two ages in immediate juxtaposition indicates that the presence is the result of primary deposition wherein the body of a pregnant bison cow decomposed *in situ,* rather than the specimens resulting from water transport from another location during a flood. This sand stratum is recorded in several locations, always occurring at least 40 cm below the Double A stratum. A radiocarbon date (BGS 1377; date from the Department of Geological Sciences, Brock University) of 740±100 BP was obtained from the bison bones (Kroker and Goundry 1990:143). This date corresponds with the climax of a warming trend indicated by pollen data from various sites (Ritchie 1985; Bernabo 1981) and defined as the close of the Neo-Atlantic Climatic Episode (Bryson and Wendland 1970). The warmer, drier climate during this period would have affected the vegetation and made soil more susceptible to wind and water erosion. An onset of wetter weather may have induced heavier sediment loads, which combined with a flood situation, resulted in the deposition of the tan sand stratum. Based on the radiocarbon age of the bison bone, this deposit may represent a massive flood that occurred at about 750 BP. However, as is usually the case, an alternative explanation is possible. The sediments on the south bank of the Assiniboine River at the point of land between the two rivers (Figure 1 - Location 6) consists of alternative strata of sand, silty sand, and silt (Quaternary 1996:42-44). An ice jam at the mouth of the Assiniboine River could have resulted in back eddies eroding sand from the south bank and re-depositing it on the north bank.

A Late Woodland hearth and associated ceramic sherds was recorded under the sand stratum on the north bank of the Assiniboine (Figure 1 - Location 7). No diagnostic artifacts were present and the faunal remains associated with the hearth were calcined (Kroker 1989:150-151), precluding the possibility of obtaining a radiocarbon date. The ceramic artifacts were tentatively identified as representing the Selkirk ceramic tradition (circa A.D. 1000 - 1750), although the sand stratum would suggest that the occupation occurred at the earlier end of the tradition.

The most complete and complex cultural record derived from an archaeological impact assessment undertaken in conjunction with an infrastructure project along Pioneer Boulevard during 1997 (Figure 1 - Location 8) (Quaternary n.d.). The project included the excavation of a continuous trench 120 metres in length, extending to a depth of 3.0 metres below surface (Figure 3). The trench was excavated by a backhoe fitted with a 24” bucket, which removed thin (10 cm) slices of soil over 5 metre long excavation units. The extracted soil was examined by a team of archaeologists at the surface. The stratigraphic profiles of the trench walls were recorded, but only to depths of two metres. The time and logistical requirements for the installation of extensive shoring for trench wall stabilization to enable personnel entry at depths below two metres precluded intensive visual examination of the lower portions of the profiles. Thus, most profiles from this trench are detailed to depths up to two metres below surface, with only the cultural and thick buried soil horizons being recorded below this depth. In the upper portion of the trench, the undulations of a particular stratum could be followed until it disappeared. Even with a continuous trench, short horizons predominated. Often the cultural deposits would be continuous, but resting upon different substrates, i.e., silty clay versus silt or reddish brown versus tan. It should also be noted that, as the focus of the project was archaeological recovery, particle size analysis of each sedimentary level was beyond the scope of the archaeological impact assessment and mitigation project, so that determination of light and heavy fractions of a deposition episode was not undertaken.

The upper soil strata immediately below the railroad fill layer represents the time period between the railroad era and the uppermost Pre-European occupation (Horizon A). The thick soil horizon (Figure 3) would represent the soil surface as of 1889 when the railroad first moved into the area. Several buried soil horizons occur within the first 40 cm of sediments under the railroad fill and some would represent the soil surfaces formed upon sediments deposited by the various recorded historic floods. No artifacts were present in any of these upper strata so that any correlation with archival data or historically recorded floods would be very tenuous.

Culturally, all of the Pre-Contact strata fall within the Late Woodland Period, with representations of Blackduck, Rainy River, Duck Bay, Plains Woodland, and Oneota ceramics. The projectile points recovered from the horizons are either Plains Side-Notched or Plains Triangular. Temporally, the diagnostic decorations on the ceramics from the lowest level (Horizon K) are stylistically similar to those from the uppermost ceramics (Horizon B). This suggests that a minimal timespan has occurred during which riverine flooding has deposited approximately 1.5 metres of sediment in a minimum of eight discrete events.

An underlying assumption is that the cultural deposition at each horizon occurred as a result of a single occupation or, at most, successive occupations at the same location without an intervening flood episode. Where there were short gaps in the linear continuation of the cultural horizon, it was assumed that the stratum continued, especially if upper and lower strata were continuous. In cases where a cultural stratum was isolated and could be an extension of more than one previously defined horizon, it was given a new designation.

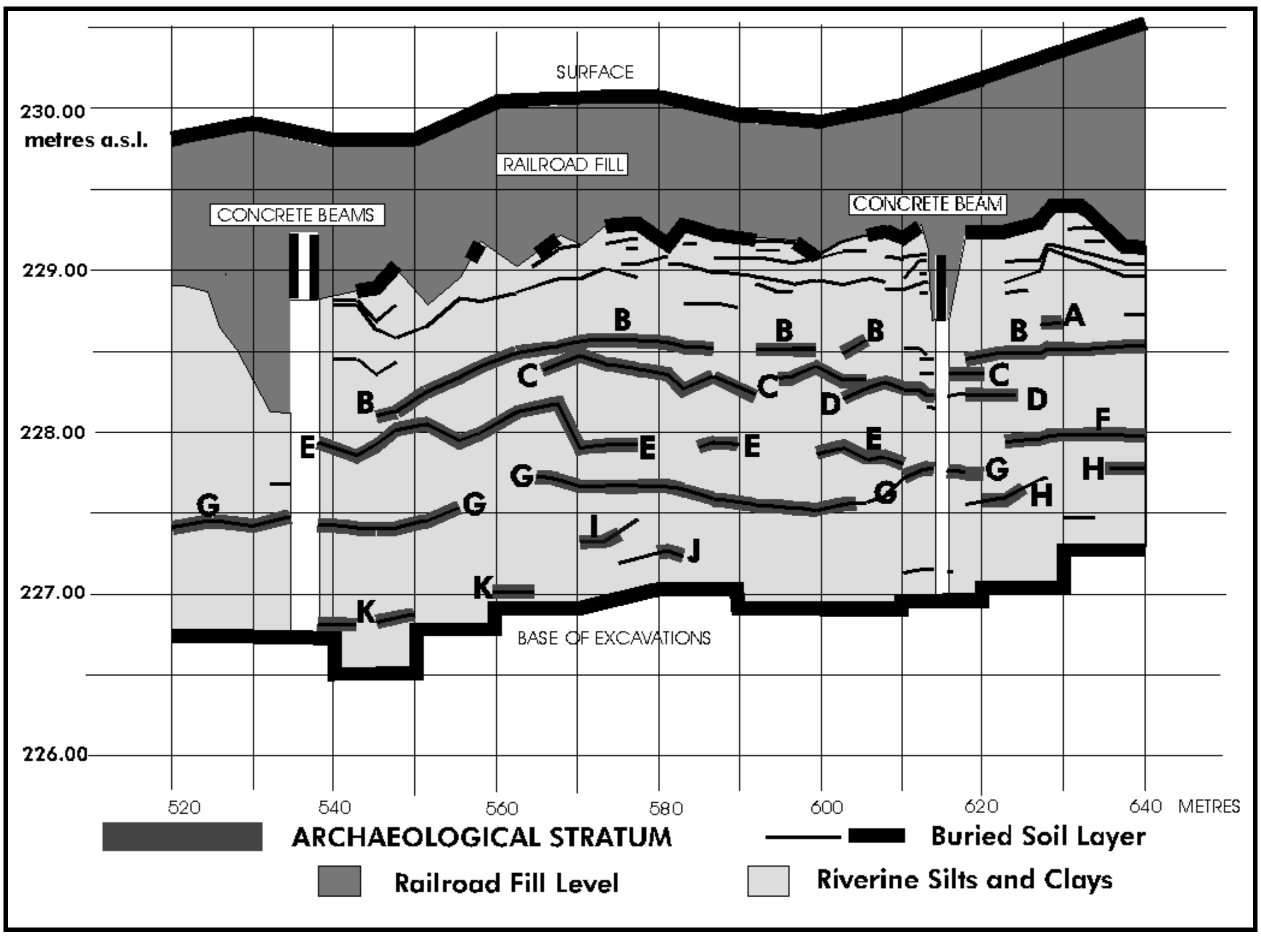



Figure 3: Stratigraphic Profile from Pioneer Boulevard

Eleven samples of mammal bone from different horizons were submitted to the Department of Geological Sciences at Brock University for radiocarbon dating. These dates are presented in Table 1, along with the cultural affiliations represented by the diagnostic artifacts in each horizon. The dates appear to be internally consistent with the exception of BGS 2100 and BGS 2101 (Horizon E) which seem to have had varying degrees of modern contamination. Both samples came from excavation units adjacent to post-railroad disturbance and modern bone may have been inadvertently included in the samples. The dates from Horizon B and C appear slightly inverted. In actuality, the two occupations probably occurred within a brief period (less than twenty years), separated by a single flood event. The dates on the lower three horizons, Horizon G, Horizon H, and Horizon K, are chronologically consistent and the basal date conforms to the temporal range of Blackduck ceramic ware.

At least eight Pre-Contact horizons—A, B, C, D, E, G, I, and K—are distinct (Figure 3). Horizon F may be distinct or a continuation of Horizon G, as the diagnostic ceramics preclude a continuation of Horizon E. Horizon K, Horizon J, and Horizon H are likely be disjunct components of the same occupation layer as the radiocarbon dates for both Horizon K and Horizon H are identical (Table 1). Thus, Horizon I is not equivalent to Horizon H, but is a discrete occupation. Given the generalized upsloping of the strata at the south end of the assessment trench, the buried soil layer at 610 metres (Figure 3) would pre-date Horizon K.

Using Horizon B as the upper limit, a timespan of 245 years occurs after the occupation represented by the basal horizon, Horizon K. Within this timespan, a minimum of seven, and perhaps as many as ten, discrete cultural occupations occurred at this specific location. Each cultural horizon is separated by sterile riverine sediments, usually a light reddish brown silty clay. A detailed stratigraphic profile was recorded at 558.4S (Table 2), where the lowest cultural horizon was encountered. At this location, definite manifestations of Horizon G and Horizon K were absent, although both occurred immediately to both the north and south. Therefore, the appropriate interpolated depths have been added to the profile (Table 2).

It is tempting to view the entire profile as a record of the intensity of flood episodes, as manifested by degree of sedimentation. It can be seen that minimal deposition occurred between Horizon B and Horizon C and between Horizon C and Horizon D. Considerable deposition occurred between Horizon C and Horizon E, between Horizon E and Horizon G, between Horizon G and Horizon I, and between Horizon I and Horizons J and K. This could suggest that the flood episodes between Horizons B, C, and D were not as intense as those that had preceded them. It is tempting to correlate these data with other stratigraphic information, especially the 750 year flood. Horizon G, based upon the radiocarbon dates appears to represent a cultural occupation that occurred after that flood. A visual inspection of a manhole excavation at 557S yielded evidence of a sandy silt layer at a depth of 280 cm, providing some confirming evidence of a more rapidly moving, and therefore laden with heavier clastic material, flood, similar to the profile recorded on the north bank of the Assiniboine River (Figure 1 - Location 5). The favoured date (of the two from this horizon) is BGS 2102 (730±50) which corresponds more closely with the date obtained from the bison bone (740±100) in the sand stratum on the north bank of the Assiniboine River, although the error of uncertainty of all three dates closely overlap making the dates statistically indistinguishable.

| HORIZON | CULTURAL AFFILIATION(S) | LABORATORY NUMBER | $C^{14}$ DATE (BP) | COMMENTS |
|---|---|---|---|---|
| A | No diagnostic artifacts | | | Insufficient bone |
| B | Blackduck?, Rainy River, Bird Lake, Duck Bay, Oneota, Plains Woodland | BGS-2095[1]<br>BGS-2096 | 675±60<br>655±55 | |
| C | Rainy River, Duck Bay, Bird Lake, Plains Woodland | BGS-2097<br>BGS-2098 | 600±55<br>650±50 | |
| D | Rainy River | BGS-2099 | 700±50 | |
| E | Rainy River | BGS-2100<br>BGS-2101 | 550±50<br>130±50 | $C^{14}$ problems Dates **rejected** |
| F | Plains Woodland | | | Insufficient bone |
| G | Rainy River, Plains Woodland, Bird Lake, Blackduck, Plains Side-Notched | BGS-2102<br>BGS-2103 | 730±50<br>650±50 | |
| H | No diagnostic artifacts | BGS-2104 | 920±60 | |
| I | No diagnostic artifacts | | | Insufficient bone |
| J | Blackduck | | | Insufficient bone |
| K | Blackduck | BGS-2105 | 920±50 | |

[1]BGS – Radiocarbon date from the Department of Geological Sciences, Brock Univeristy.

Table 1: Cultural Horizons and Radiocarbon Dates

| DEPTH (cm) | ELEVATION (asl) | DESCRIPTION | COMMENTS |
|---|---|---|---|
| SURFACE | 230.10 | | |
| 0 - 56 | 229.54 | sand, gravel, cobblestones | |
| 56 - 74 | 229.36 | coal dust, sand, wood | |
| 74 - 78 | 229.32 | sand | |
| 78 - 88 | 229.22 | blocky disturbed A Horizon | 1885 Soil Horizon |
| 88 - 94 | 229.16 | clay - B Horizon | |
| 94 - 97 | 229.13 | silty clay | |
| 97 - 105 | 229.05 | diesel stained silty clay | |
| 105 - 119 | 228.91 | clayey silt | |
| 119 - 120 | 228.90 | relict soil horizon | |
| 120 - 125 | 228.85 | silty clay | |
| 125 - 136 | 228.74 | hematite stained clay | |
| 136 - 143 | 228.67 | silty clay | |
| 143 - 156 | 228.54 | clayey silt | |
| 156 - 160 | 228.50 | undulating cultural level | Horizon B |
| 160 - 189 | 228.21 | flood churned clay | faunal inclusions - Horizon C |
| 189 - 201 | 228.09 | silty clay | |
| 201 - 201 | 228.09 | cultural level | Horizon E, fish bone |
| (240) | 227.70 | | Interpolated - Horizon G |
| (295) | 227.15 | | Interpolated - Horizon K |
| 201 - 300 | 227.10 | silty clay | base of excavation |

Table 2: Profile at 558.4S

To place the flood episodes in a chronological sequence, it is necessary to view the cultural occupation as having occurred within a short period of time after the deposition of sediments. The degree of soil formation under the cultural horizon could be an indicator of the amount of time that had passed between the sedimentation episode and the cultural occupation, although in most cases, the thickness of the incipient A Horizon was thoroughly obscured by cultural activity, i.e., charcoal from campfires, decomposition of discarded food remains, and general surface disruption by human activity. The following table (Table 3) represents a preliminary framework of flood events over the past millennium. Obviously, it is sketchy, being based upon a single location. Additional profiles, containing cultural evidence, from other areas will eventually augment this outline.

For clarity, the flood episodes will be designated with the letter of the cultural horizon which lies on top of the sediments deposited by that flood. The $C^{14}$ dates for the horizon provide an upper limiting date (Table 3), while those of the preceding cultural level provide a lower limiting date. Obviously, the standard deviations of the radiocarbon dates should be taken into consideration. For purposes of discussion, the medial date will be used.

| FLOOD EVENT | CULTURAL DELIMITER(S) | DATE | COMMENTS |
|---|---|---|---|
| post - A | None | None | Two culturally sterile relict soils in five discrete strata |
| A | Horizon A | ? | Pre-1750 |
| B | Horizon B | A.D. 1340 | |
| C | Horizon C | A.D. 1320 | Interpolated date |
| D | Horizon D | A.D. 1300 | |
| E | Horizon E | A.D. 1285 | Interpolated date |
| G | Horizon G (+ F ?) | A.D. 1270 | Using BGS 2102 |
| I | Horizon I | ? | |
| K | Horizons H, J, K | A.D. 1080 | |

Table 3: Sequence of Flood Episodes and Probable Dates

Flood A could have occurred at any time after Flood B (A.D. 1340), probably before the arrival of La Verendrye in A. D. 1737 but perhaps as late as the early 19$^{th}$ century as Native campsites occurred in the vicinity of the fur trade posts. Dates become firmer beginning with Flood B. Floods B, C, D, E, and G occurred within a seventy year timespan. The dates for Flood B, Flood D, and Flood G are firm, with those for Flood C and Flood E being interpolated. This sedimentation record illustrates a wet period marked by numerous floods. The frequency (five in 70 years) is very similar to that of the 19$^{th}$ century which experienced four in 55 years, i.e., an average of one flood every fourteen years.

Temporally, this wet period correlates with the onset of the Pacific Climatic Episode (800 BP) which is hypothesized to be the result of stronger westerlies (Wendland and Bryson 1974:20-21), ending the warmer, drier Neo-Atlantic Climatic Episode (Bryson and Wendland 1970:294).The timespan of the Pacific Episode is defined between A.D. 1200 and A.D. 1550 (Bryson and Wendland 1970:280). Pollen studies from Michigan (Bernabo 1981:149) show cooler moister conditions beginning about this time. Similar, but not as well defined, climatic shifts can be seen in the pollen diagrams from Tiger Hills, Manitoba (Ritchie and Lichti-Federovich 1968) and Riding Mountain, Manitoba (Ritchie 1969). Conversely, the precipitation in Iowa (Bryson *et al.* 1970:64-70) and Nebraska (Bryson and Wendland 1970:294) dropped sharply, resulting in population movements. Some of these population movements out of the arid areas may have placed pressure on groups along the Red River, causing a northward migration and increased populations in the northern portion of the Red River valley. The presence of Oneota ceramics in Horizon B adds weight to this postulation as the core area of Oneota ceramic ware is located in southern Minnesota (Anfinson 1997).

Prior to Flood G, two episodes are demarcated by the cultural deposits—Flood I (undated) and Flood K at A.D. 1080. The two hundred years between Flood K and Flood G fall within the Neo-Atlantic Climatic Episode (Bryson and Wendland 1970:280) which is characterized by a warmer, drier climate (Bryson and Wendland 1970:294). During such a climatic regimen, it would be expected that flooding would be less frequent and would be the exception rather than the norm. It must also be noted that the ground level at this time was more than two metres below current (more than one metre below the 1885) ground level so that floods would not have had to have been as intense as those of the 19th century to produce similar degrees of inundation.

It had been hoped that recent mitigative work to the north of the Pioneer Boulevard study area (Figure 1 - Location 9) would provide additional evidence pertaining to this deposition sequence. However, the stratigraphy consisted of numerous thin layers of silty clay separated by thin layers of sand or sandy silt, resulting in totally uncomparable profiles. The reason for this difference became apparent upon examination of maps dating to the 1870s and 1880s which show a stream traversing the area (Warkentin and Ruggles 1970:382-389). Seasonal overflows would result in this deposition pattern which largely obscures the riverine sedimentation pattern.

The pattern of flood episodes displayed by the stratigraphic profile from the Pioneer Boulevard Project show a long period (at least two hundred years) with only two floods followed by a short period (less than a century) punctuated by at least five major floods. After the floods of the 13th century, there again seems to be a long period with minimal flood activity, followed by considerable activity during the 19th century.

**Earlier Flood Episodes**

Numerous other flood deposition sequences are discernable in the stratigraphic profiles of deeper excavations. Changes in colour and texture of the sediments denote different flood episodes. In most cases, there is a distinct lack of cultural horizons or even organic sediments which would provide datable material for placing these episodes in a temporal framework.

An extensive major archaeological horizon, covering at least 2500 $m^2$, is located on the north bank of the Assiniboine (Figure 1 - Location 10). It occurs at a depth of three metres below the surface and has been dated at 2870±80 B.P. [BGS 1316] (Kroker 1989:159), 2850±90 B.P. [BGS 1374] (Kroker and Goundry 1990:142), 2850±75 B.P. [BGS 1482] (Kroker and Goundry 1993a:140), and 2815±75 B.P. [BGS 1483] (Kroker and Goundry 1993a:158). Three distinct types of projectile points (Figure 4) have been recovered from this extensive occupation site. The identification of these points as Hanna, Pelican Lake, and Shield Archaic (Kroker and Goundry 1994:207) concur with the radiocarbon dates as the temporal ranges of each style of projectile point encompasses the dates for the site. The point styles are indicative of two different Prairie groups and a Boreal Forest group meeting and trading at the same locality. Several hearths, including a linear fire for drying fish on a rack, were recorded. Large quantities of faunal remains, consisting of several species of fish, bison, deer, beaver, rabbit, bear, wolf, fox, fisher, and mink, indicate that a considerable number of people were present at the campsite (Kroker and Goundry 1993b, 1994)

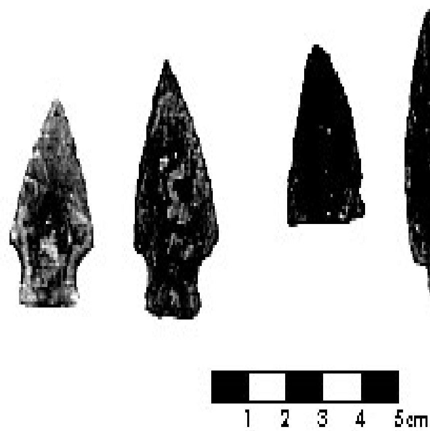
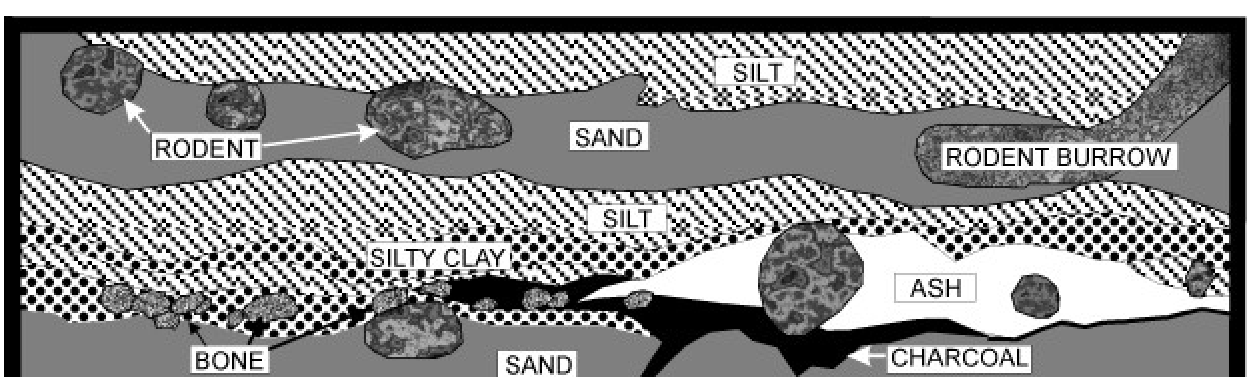



Figure 4: Different Styles of Projectile Points Recovered from the 3000 Year Old Trade Centre

An adjacent portion of the site (Figure 1 - Location 11) was interpreted as a bison processing locality (Quaternary 1993). Hearths and conglomerations of bison bone occurred at the same stratigraphic level as the earlier located campsite location—resting on a thick sand horizon which displayed considerable cross-bedding (Figure 5). The presence of this thick sand stratum, and the one directly above the cultural horizon, represents either a massive flood similar to the 750 Year Flood or the cutting of the channel in which the Assiniboine River now flows.

The presence of such massive quantities of sand, both above and below the cultural horizon, suggests that considerable sediment was being transported by rapidly moving water. The present river channel cuts through glacial till, which is present at the ground surface, approximately 5 kilometres upstream of The Forks. This, and more westerly till deposits, could be the source of these sand layers. It is unlikely that this quantity of sand would be transported by the Red River, due to its gradient and the lack of reasonably nearby sources of sand.

The channel cutting hypothesis differs from the current postulation that the Assiniboine River occupied its current channel approximately 1300 years ago (Rannie *et al.* 1989). Other studies have indicated that the Assiniboine River flowed into Lake Manitoba approximately 4500 years ago and became diverted about 2200 years ago (Teller and Last 1981). Neither postulation precludes the possibility of earlier massive floods resulting in overland water movement which eroded existing stream channels, eventually becoming the existing channel for the Assiniboine River. However, the presence of such an extensive archaeological site, containing evidence of peoples from the west, the



north, and the south, suggests that the junction of the two rivers was already established as a meeting place by the time of the occupation. The Assiniboine River would have been the transportation corridor for the western (Pelican Lake) groups. The cultural evidence, as well as the sand strata, suggests that the Assiniboine River had already established a channel, joining the Red River at The Forks, as much as 2850 years ago.

Figure 5: Bison Processing Area of the 3000 Year Old Trade Centre

Examining climatic shifts, Bryson *et al.* (1970:63) have placed the end of the Sub-Boreal Climatic Episode at 2890 BP. The beginning of the Sub-Atlantic Episode is marked by a substantial increase in precipitation (Bryson and Wendland 1970:293), which could have resulted in a considerable increase in the frequency and intensity of flooding. These floods would be the primary cause of the diversion of the Assiniboine River from Lake Manitoba by developing a new channel which emptied into the Red River. The lower section of the Assiniboine River probably established the present channel as much as 3000 years ago, while the upper section had several former channels as a result of overland flooding and channel erosion through the alluvial deposits in the Portage la Prairie area (Rannie 1990:184).

**Summary**

Over the past millennia, the Red and Assiniboine Rivers have acted in response to climatic conditions. The frequency and intensity of the flooding experienced at the current junction of the two rivers have been a function of the varying states of the central North American climate, which appears to operate in large cycles, shifting from warm and dry to cool and moist. The durations of these climatic episodes are not constant (Bryson *et al.* 1970:56). Given the year-by-year vagaries of the weather, it is only with hindsight that the shift between two climatic patterns can be clearly ascertained. The change from the drier Sub-Boreal Climatic Episode to the moister Sub-Atlantic Climatic Episode around 2900 years ago is marked by evidence of substantial floods at The Forks. The Neo-Atlantic Climatic Episode (ending circa A.D. 1200) was characterized by a warmer, drier climate and only two floods are noted in that portion of the stratigraphic profile, which encompasses more than two hundred years. With the shift to the Pacific Climatic Episode (A.D. 1200 to A.D. 1550), a cooler, moister regimen occurs in the Red River region and five floods are recorded at The Forks within a seventy year period (A.D. 1270 to A.D. 1340). Given the impreciseness of radiocarbon dating and the fact that climatic shifts do not occur simultaneously in all locations, the flood events may have occurred during the transition period between the two climatic regimens.

Currently, the central portion of North America appears to be experiencing a warming trend, especially when compared with the earlier portion of recorded meteorological data. It appears to be a correlation that warmer (and usually drier due to the position of the major frontal systems) climatic episodes result in minimal flood activity. This was definitely the case during the Hypsithermal (from approximately 6000 B.C. to 2000 B.C.) when the average annual temperature was considerably higher than today. Similarly, the stratigraphic profile shows minimal flood activity during the warmer Neo-Atlantic Climatic Episode. If the current warming trend is part of the apparently cyclic climatic pattern of the late Holocene, it is possible that the next century or two may experience few floods. This is not to say that anomalous years cannot occur in which there is a massive flood, but that these events would be few and far between. However, the Red River region may be still experiencing a transition between a cooler, moister period and the warmer, drier period, wherein manifestations of both climatic patterns can occur in rapid succession.

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