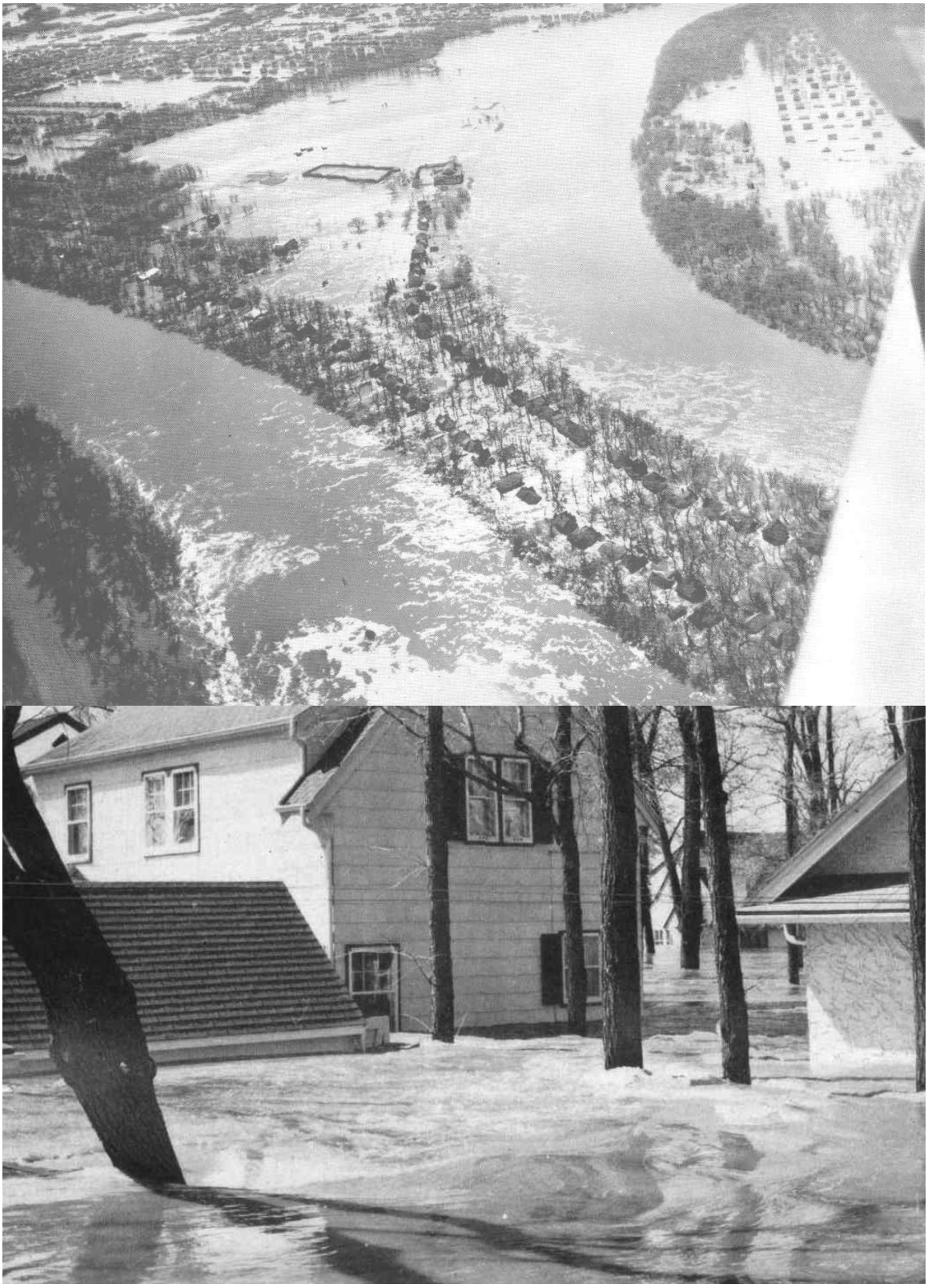
In the Elm Park/Kingston Row area of St. Vital, substantial overland flow (see Figure 2-10) occurred across the narrow section of the meander bend as shown in Figure 2-2. With this overland flow occurring, there would have been a slight backwater at the Elm Park Bridge. Hurst (1957) records that the Elm Park district of St. Vital flooded on May 2 when the river stage was 23.7 ft JAD (6.6 ft below the final peak). Clark (1950) records indicate that discharge at the Elm Park Bridge was metered on May 1 (63,500 cfs), May 4 (70,500 cfs) and June 30 (12,100 cfs). On May 4, the stage at James Avenue was 24.5 JAD, while this stage is only 0.8 ft higher than the May 2 stage in which overland flow begins to occur. There is no indication in Clark's (1950) report whether overland flow was accounted for in the Elm Park metering of May 4.

During the 1950 flood, it is likely that the Seine River carried a portion of the flow from overland flow from the Red; see Figure 2-1 and Figure 2-2. Clark (1950) notes in his report that water began passing from the Red into the Seine on May 8 (river stage 27.70 ft JAD). The Marion Street Bridge over the Seine River was washed out and a temporary wooden ramp was built to allow egress from St. Boniface (Figure 2-11). Although difficult to quantify, it is certain that there was flow from the Red into the Seine River. This is an important factor to note as flow from the Seine River into the Red would have caused a slight backwater effect at the James Avenue gauge, located just upstream of the river's junction. Clark et. al. (1997) noted that this possibility also existed during the 1950 flood. Acres has concluded that this flow pattern must be accounted for in the calibration of the flow model.

During the 1950 flood, water levels were recorded at various locations along the Red and Assiniboine River. In Winnipeg water levels were recorded upstream and downstream of all bridges and at the James Avenue Pumping Station as shown in Figure 2-1. Meterings during the flood were done at the Redwood Bridge by Water Survey of Canada (WSC). Clark et al. (1997) notes that the water level, meterings and river cross-section data collected after the flood (in the winter of 1950/51) were subsequently used as the basis of office backwater studies for the subsequent Red River Basin Investigations (see Appendix B, Section B2.1).

Following the 1950 flood, a number of flood proofing initiatives were conceived. One of these was the formation of the Greater Winnipeg Dyking Board in July of 1950. In a period of 2 months, topographical information was collected, a cost



Source: Manitoba Flood Relief

Figure 2-10
Overland Flow Elm Park Area, St. Vital

Source: Manitoba Flood Relief (1950

Figure 2-11
Photo of Temporary Wooden Bridge over Seine River

estimate developed and approval was obtained from both federal and provincial levels of government to proceed on dyking to provide interim protection for Winnipeg. By the beginning of November the majority of earthworks were completed.

The Dyking Board's proposal consisted of building wide elevated "boulevards" on each side of the river where it passes through the urban centre and keeping these boulevards to a uniform height of 26.5 ft JAD. It was felt that this would provide flood protection "in theory" up to 2 ft higher than the 1948 levels with 1 ft of freeboard. The Dyking Board believed that if a flood equivalent to a 1950 were to occur, the boulevards were designed with sufficient width (i.e. 50 ft) to allow the construction of a temporary dyke on the river side of the boulevards and still provide double traffic passage.

The concept of raising the boulevard or primary dykes was tested during the 1966 flood (Section 2.2). In the middle of March with the expectation of a flood that could potentially surpass the 1950 flood loomed and a floodway not completed, 42 miles of the 68 miles of primary dykes were raised to elevation 31.5 ft JAD over a period of 3 weeks, with the initial lift to 30 ft JAD done in 2 weeks. This work involved the handling of 600,000 cubic yards of material (Weber, 1973 and Section 2.3).

The concept of raising the primaries was recently reviewed at a technical workshop in 1999 by civil engineers/technologists from both the public and private sector (Beaverbrook Communications, 1999). The findings of the workshop were that the 1966 raising was done under very favourable weather conditions and that if conditions were less than ideal, the potential exists that portions of the primaries may not be raised in time. The general consensus was that this should not be relied upon as a reliable flood fighting strategy.

The "boulevards" were constructed along lengths of the riverbank where the natural bank elevation was lower than 26.5 ft JAD. Where the riverbank elevations were above 26.5 JAD connecting roads were abutted to these "boulevards: to provide a continuous line of defence on both sides of the river as shown in Figure 2-12. The majority of the earthworks were completed by November 15, 1950 and finishing work completed the following spring. Discussion of the various aspects of the design, boulevard location and modifications to the original plan can be found in a report by the Greater Winnipeg Dyking Board (1951). A more recent report by Red River Floodway

Operation Review Committee (1999) provides east and west profiles of the primary dyke line relative to legislated Flood Protection Level (FPL) for the City of Winnipeg.

Also included in the Dyking Board's work was the construction of 21 separate sewer pumping stations as shown on Figure 2-12. The purpose of the pumping stations was to isolate the sewer system from the river during high water levels and still provide discharge capacity for the sewers via lift pumps. With respect to the pumping stations the Dyking Board noted in their report that a significant portion of the flood damage in 1950 was caused by sewer backup into houses and businesses.

2.2 1966 Flood

In 1966, the second largest "Winnipeg" flood in recent history occurred. The flood was in part due to the March 4 blizzard that blanketed most of the Red River basin with snowfall amounts of 2 to 3 ft (Long, 1971). Following the blizzard, the Manitoba Flood Forecast Committee met on March 10 and reviewed the recent storm and as a result raised their previous forecast from 23.0 ft to 28.0 ft JAD. The March 10 forecast was based on favourable meteorological conditions over the next three to four weeks. If conditions were not favourable; the Forecast Committee cautioned that flood peaks could be substantially higher.

At the time of the 1966 flood, the Red River Floodway was still under construction with only 75% of the earthworks completed. **Relevant to the current backwater study was the determination of whether any components of the Floodway were operational such that Red or Seine river flows were being diverted around the City.** Based on discussions with a retired engineer that was involved in the construction of the floodway there was no flow down the partially excavated floodway channel from the Red River into the Seine River. PR 306, a southerly extension of St. Anne's Road at the time was still in place and presented a barrier to overland flow from the Red River into the Seine River (Sexton pers. comm, 2004). In 1966, the flow on the Seine River through the City was from a contributing area that included areas south of the floodway up to Ste. Anne as the Floodway's Seine River siphon and overflow had not yet been completed. Further upstream, flows on the Seine River had been reduced with the construction of the Seine River Diversion near Ste. Anne in 1961. With the Seine River Diversion large portions of Seine River flows were diverted into the Red River upstream of the City.

As a result of the March 10 Flood Forecast Committee report, projecting that flood peaks would exceed the City's primary dyke levels, Premier Duff Roblin immediately instructed Manitoba Emergency Measures Organization to develop a Flood Plan to deal with the impending flood. Over the weekend a plan was developed and approved March 15, 1966. The plan outlined an organizational structure for water control and dyking operations, a flood control headquarters in the legislature and a command and control structure. Part of the EMO plan directed the Water Control and Conservation, Department of Agriculture (later the Water Resources Branch) to be responsible for overseeing the raising of primary dykes with a target date of completion of April 15 (Emergency Measures Organization, 1966).

Following release of EMO's Flood Plan, work proceeded in earnest to raise portions of the 64 miles of primary dykes that were only at 26.5 ft James Avenue. In 1966, there were 3 main residential areas outside the primary dykes that were protected by secondary dykes these included: (1) east side of Scotia Street, (2) part of Glenwood Crescent in Elmwood and (3) Kingston Crescent in Elm Park, St. Vital. The plan in these areas was to raise the secondary dykes up to the same elevation as the primaries using sand bag dykes. By the end of March it is reported that all the dyking system had been raised to 30 ft James Avenue. The dike raising occurred in a period of about 2 weeks.

During the April 6 to April 10 period, all dykes were raised to 31.5 ft James Avenue as a result in an upward revision of the predicted Emerson flow to 100,000 cfs by US forecastors on April 4. In the end the predicted peak for Emerson did not materialize and Emerson peaked at about 70,000 cfs on April 11, 4 days later the Red peaked in the City of Winnipeg at 26.2 ft James Avenue (Table 2-1).

The majority of overbank flooding that occurred in Winnipeg was primarily contained in an area between Elm Park Bridge and the Floodway Inlet as illustrated in Figure 2-13. While the 1966 peak was 4 feet lower than the 1950 peaks the construction of the primary and secondary dykes in 1950 and additional dyke works later was effective in reducing the extent of flooding in certain areas, i.e., Scotia Street, Riverview, Kingston Row and Wildwood etc. (see Figure 2-1). **Depending on the degree of constraint the dyking system poses, river stages may be artificially raised.**