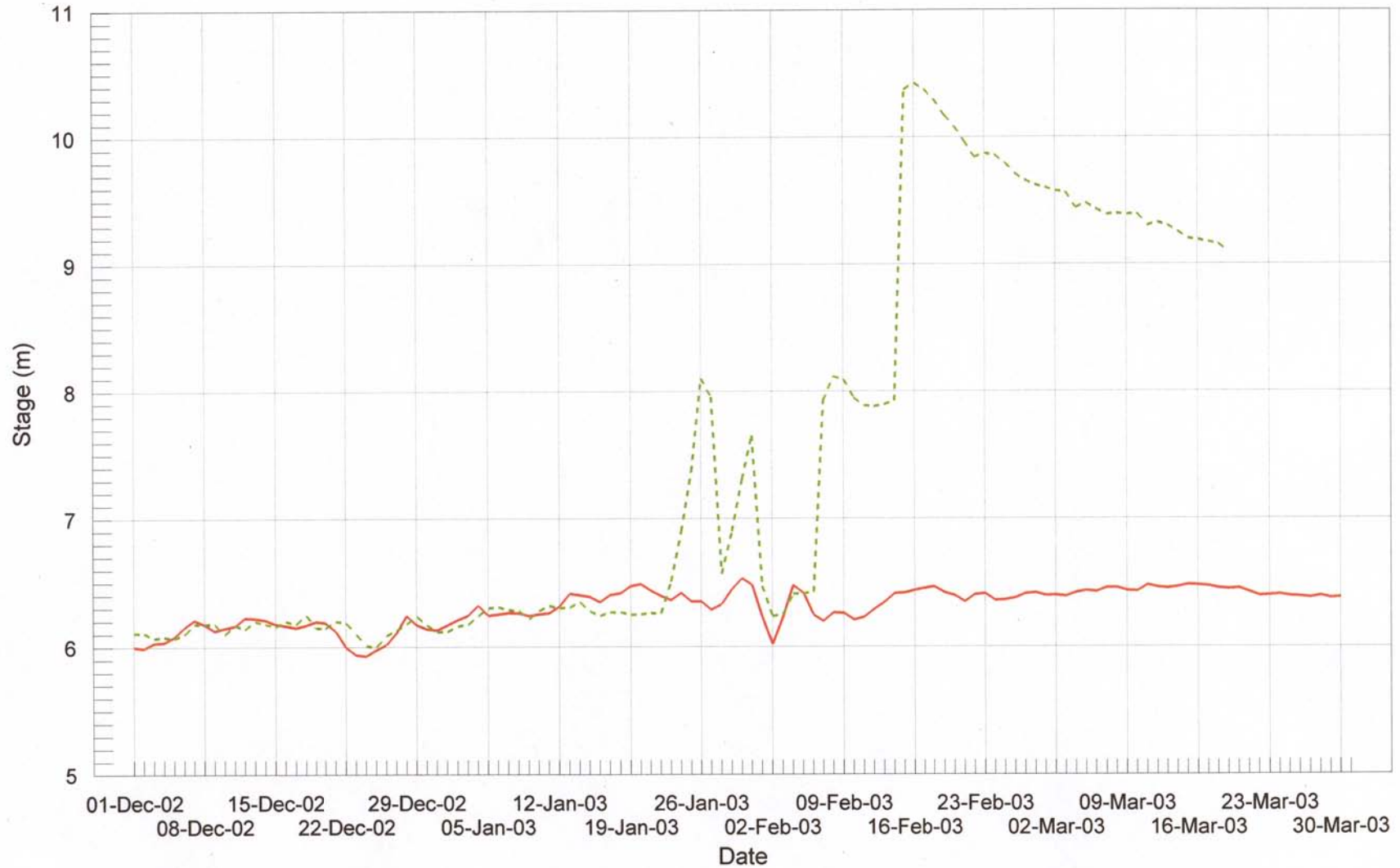


# Daily Average Stage Comparison



— Exploits River below Noel Pauls Brook    - - - Town of Badger near Arena

Figure 7 - Daily Average Stage Comparison

# Exploits River below Noel Pauls Brook

Air and Water Temperatures

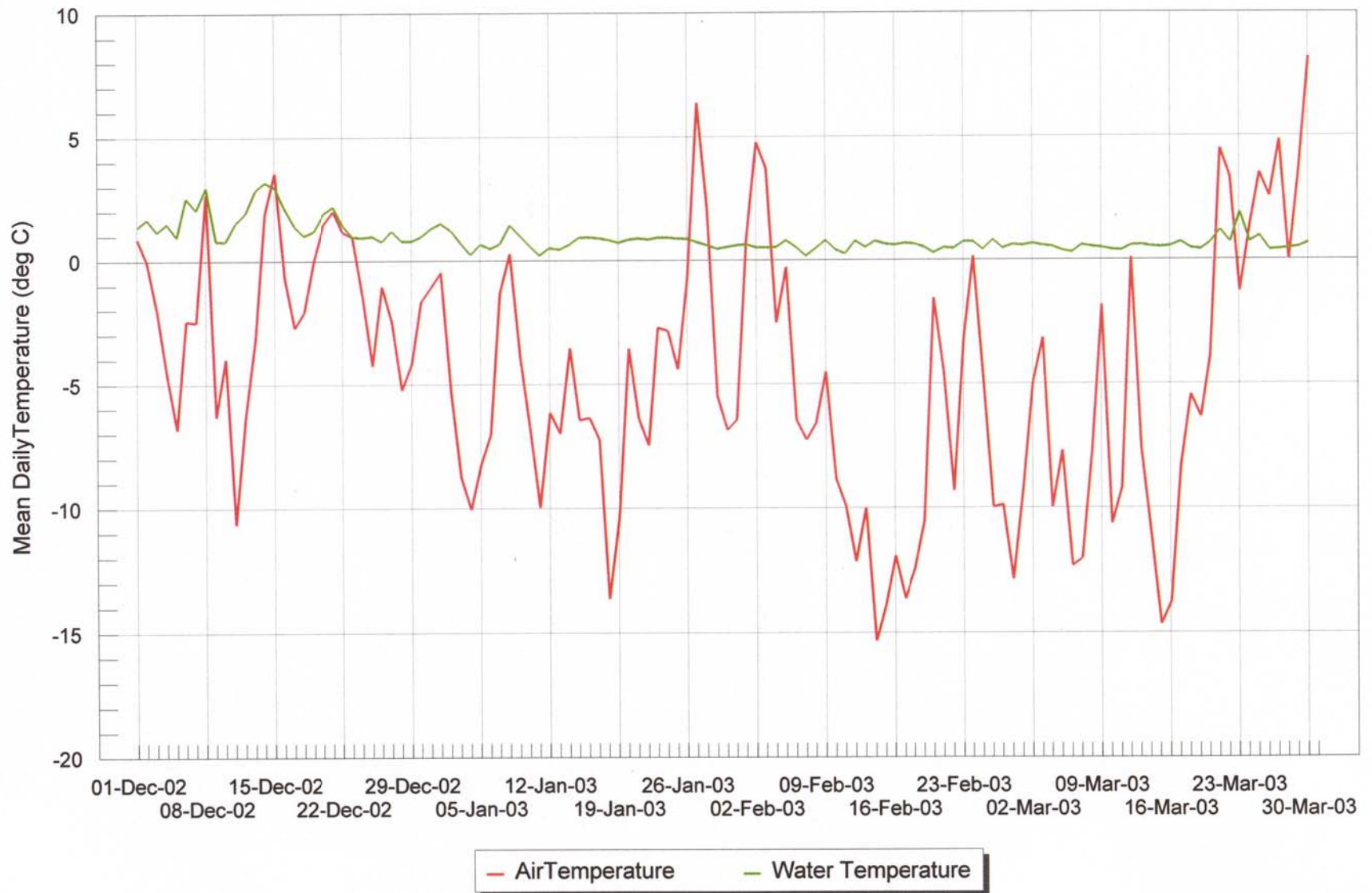


Figure 8 - Air and Water Temperatures

#### d Water Temperature

Hourly water temperature data is recorded at the Exploits River below Noel Paul's Brook station. Water temperatures are plotted alongside air temperatures for the Noel Pauls Brook station in Figure 8 and on their own in Figure A-2 in Appendix A. The only other source of water temperature information in the region is at the Gander River at Big Chute hydrometric station. It could be used as a proxy for water temperature at the outlet of Red Indian Lake.

### 3. Ice Formation and Flood Forecasting

#### a Ice Progression

For ice progression tracking and flood forecasting the river has been divided into 32 segments, these segments are shown in Figures 9 & 10. The ice progression in the Exploits River for this winter season is described below:

- December 4-7: The ice modelling described below indicated that an ice cover was established at Grand Falls (Segment 32) on December 5, however, field observation indicated that the ice cover was established on December 4. Using satellite imagery, the ice cover was confirmed to be at Segment 31 on December 7.
- December 13-18: The ice cover opened on December 13 and started to fill back in on December 18.
- January 3-7: On January 3 the ice front was below Aspen Brook (Segment 26). By January 7, 2003 the ice front was located above Aspen Landing (Segment 26).
- January 8-9: On January 8 the ice front was below Aspen Landing, and on January 9 the ice front was back up to Aspen Landing.
- January 13-20: On Jan 13 the ice cover moved from Aspen Landing up to Badger Chute (Segment 24). On January 16 the ice front moved downstream to Segment 25. On January 20 the ice front was back up to Badger Chute.
- January 24-28: The ice front first arrived at Badger (Segment 21) on January 24. The stage shot up nearly 2 metres from the pre-ice elevation of 96.2 metres to 98 metres on January 26.
- January 29: The ice front regressed downstream below Badger. The stage retruned to about 96.5 metres (Segment # not known)
- January 30-February 7: The ice front moved past Badger on January 30, below Badger on January 31, above on February 1, below on February 2 and above again on February 7. (Segment #'s not

# Exploits River - River Segment Numbers

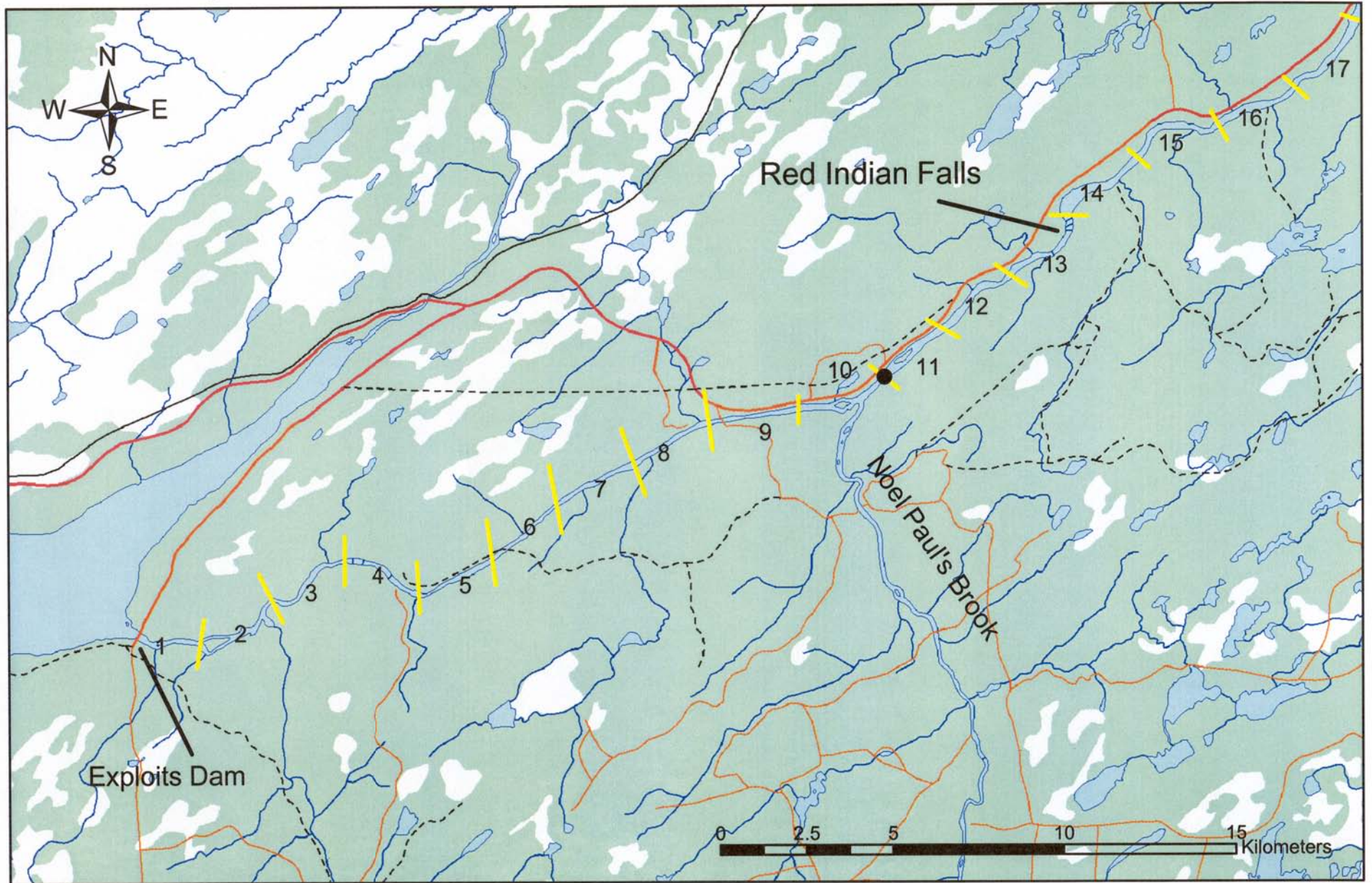


Figure 9 - Exploits River Segments



# Exploits River - River Segment Numbers

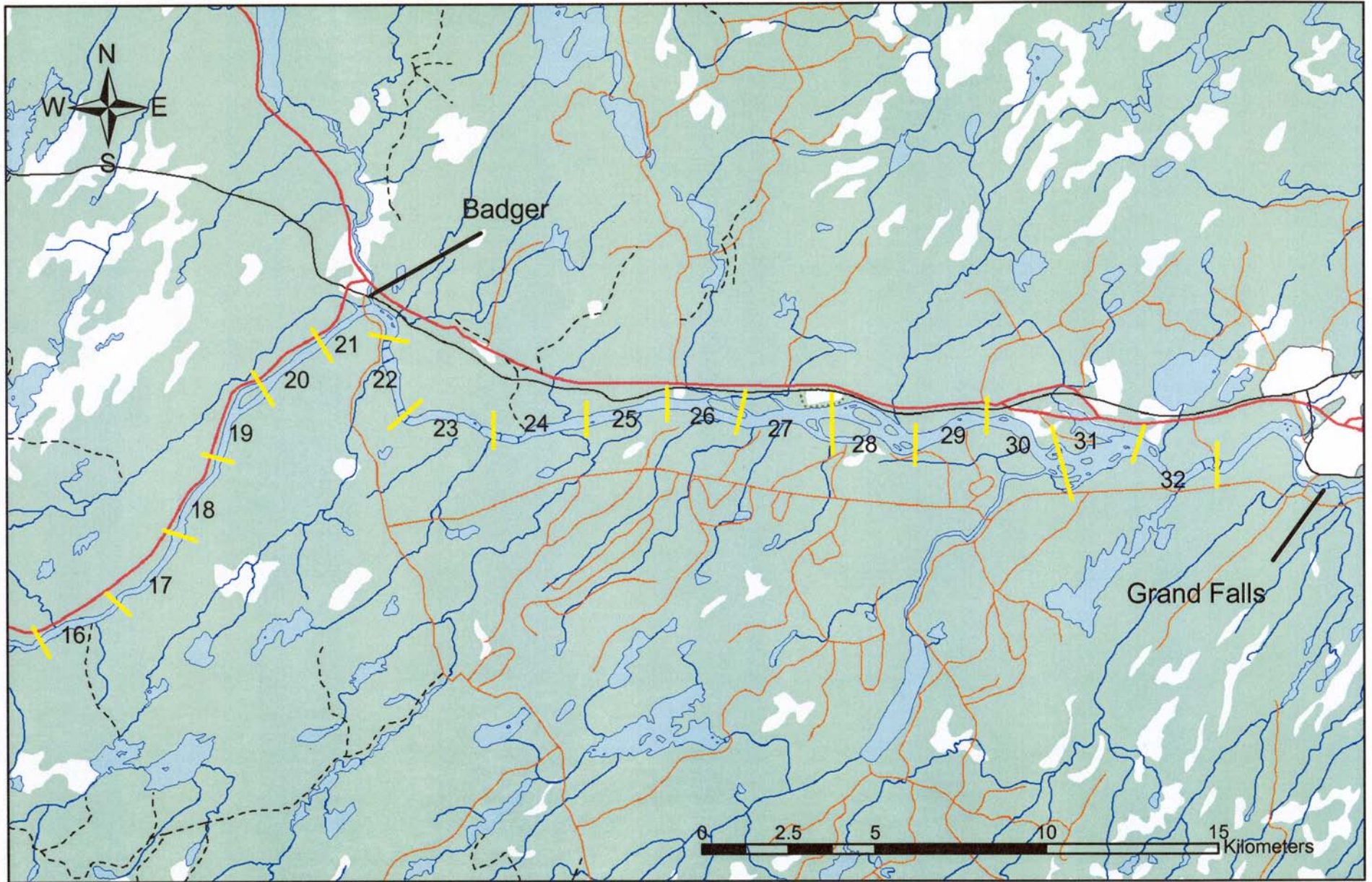


Figure 10 - Exploits River Segments



known) The water level increase to 97.6 metres on January 31 and dropped to 96.1 on February 2.

February 8-14: The ice cover progressed rapidly upstream until it reached Segment 15 on February 14. The water level rose sharply on February 8 to 98 metres, slowly receded to 97.8 on February 14.

February 15: On February 15, the ice cover above Badger moved downstream resulting in the 1:100 year level being exceeded at Badger, from Segment 15/16 to Segment 19. By February 17 the ice front was located between Segment 17 and 18. On February 15 the water level shot up to 100.3 metres and gradually increased to 100.5 metres.

February 15-25: The ice front reached Red Indian Falls on February and did not progress past the Falls (Segment 13). Water levels in the Falls area increased as frazil ice moved under the ice cover threatened to flood some cabins in the area. At Badger the water levels continued to drop slowly and were down by 0.87 m on February 25.

#### b Ice Production

The principal driving force behind frazil ice generation is sub-zero temperature. Ice generation can be greatly enhanced by high winds. The freezing degree days for this ice season and the wind chill factor, derived from mean daily and forecasted wind speeds at Badger, which were used by the model are shown in Appendix C.

The total volume of ice generated from Red Indian Lake to Grand Falls is shown in Figure 11 and the total amount of ice generated from Segments 1 to 21 (Red Indian Lake to Badger) is shown in Figure 12. The ice generated in Segments 1 to 21 affects the freeze up elevation at Badger when the ice front is located immediately below Badger.

Figure 13 shows the location of the ice cover extent based on the ice model and the actual location where it is known. The model does not account for the regression of the ice cover.

#### c Flood Forecasting

The WRMD operates a flood forecasting system for the Town of Badger. Initially this system was set up after the flood in 1977. The methodology has evolved over the years and is reviewed and updated annually. In 1995 a major review by an outside consultant was carried out. [2]

The current system uses a mathematical model developed in the studies [1,2] to calculate the volume of ice generated in the open sections of the Exploits River. For this purpose, and as described above, and shown in Figures 9 and 10, the river was divided into 32 sections between Grand Falls and the Exploits Dam at the outlet of Red Indian Lake. Once the ice is generated, the

# Exploits River from Red Indian Lake to Grand Falls

Total Ice Generated

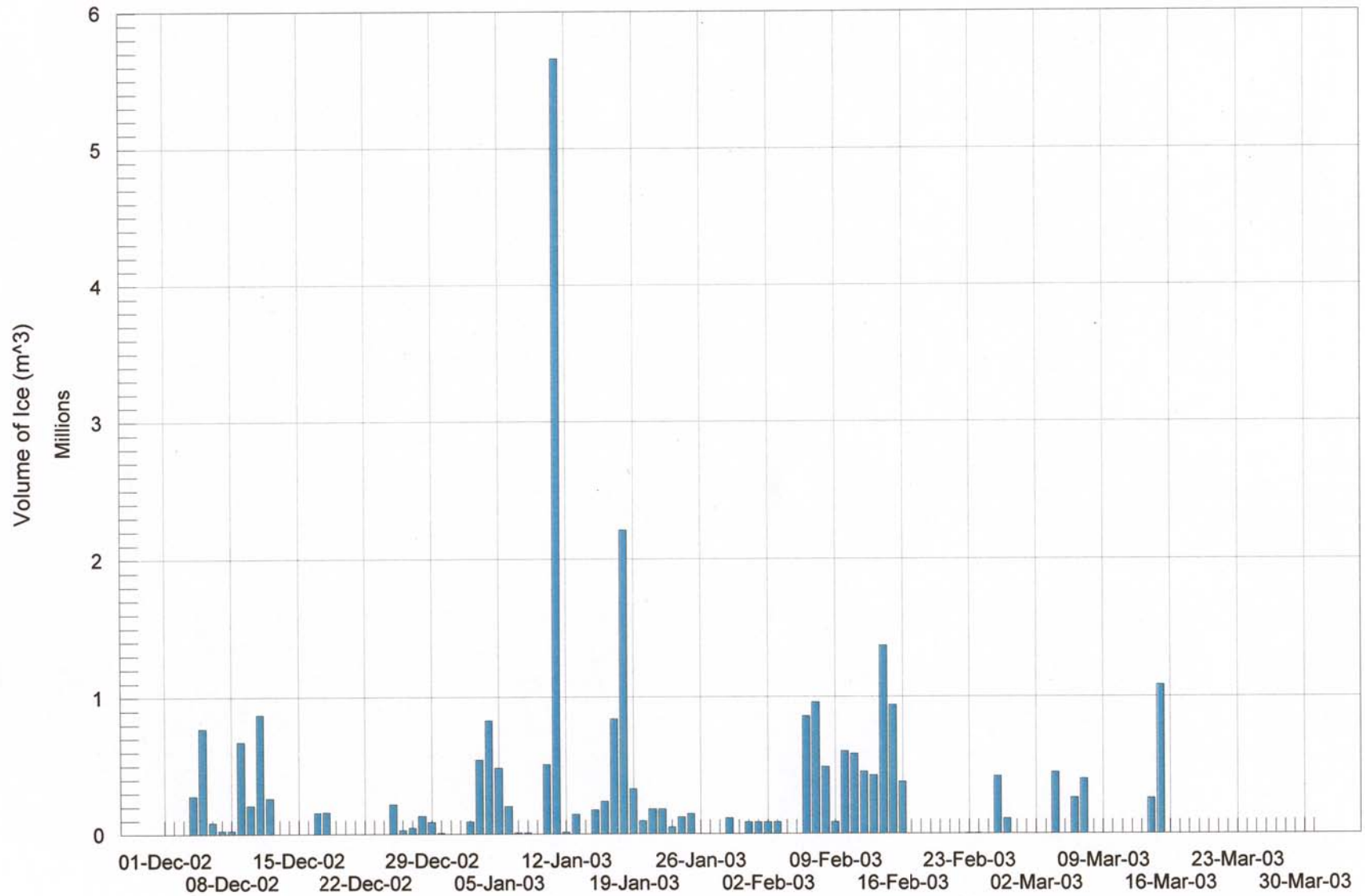


Figure 11 - Total Ice Generated - Exploits River

# Exploits River from Red Indian Lake to Badger

Ice Generated Segments 1-21

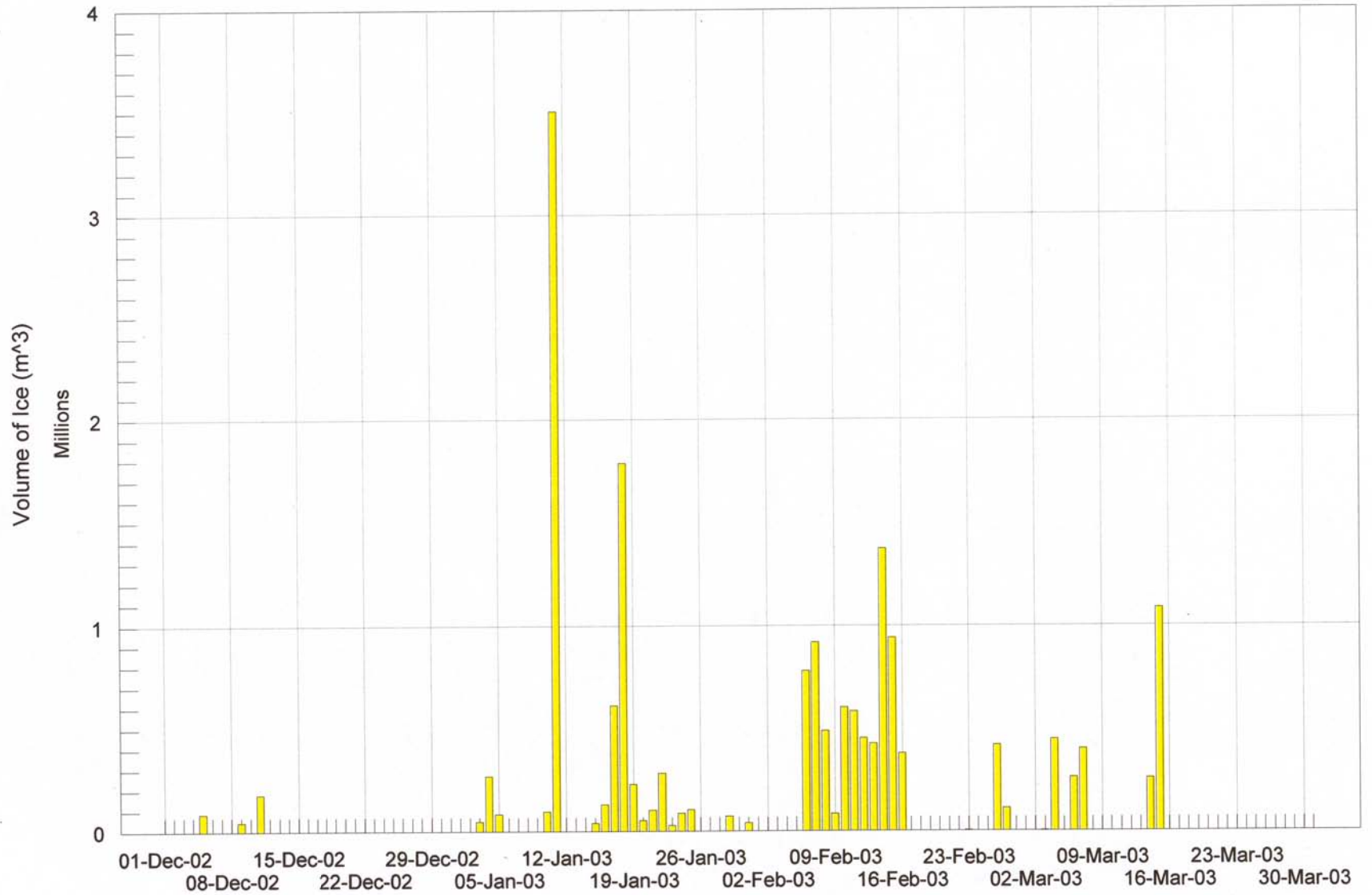
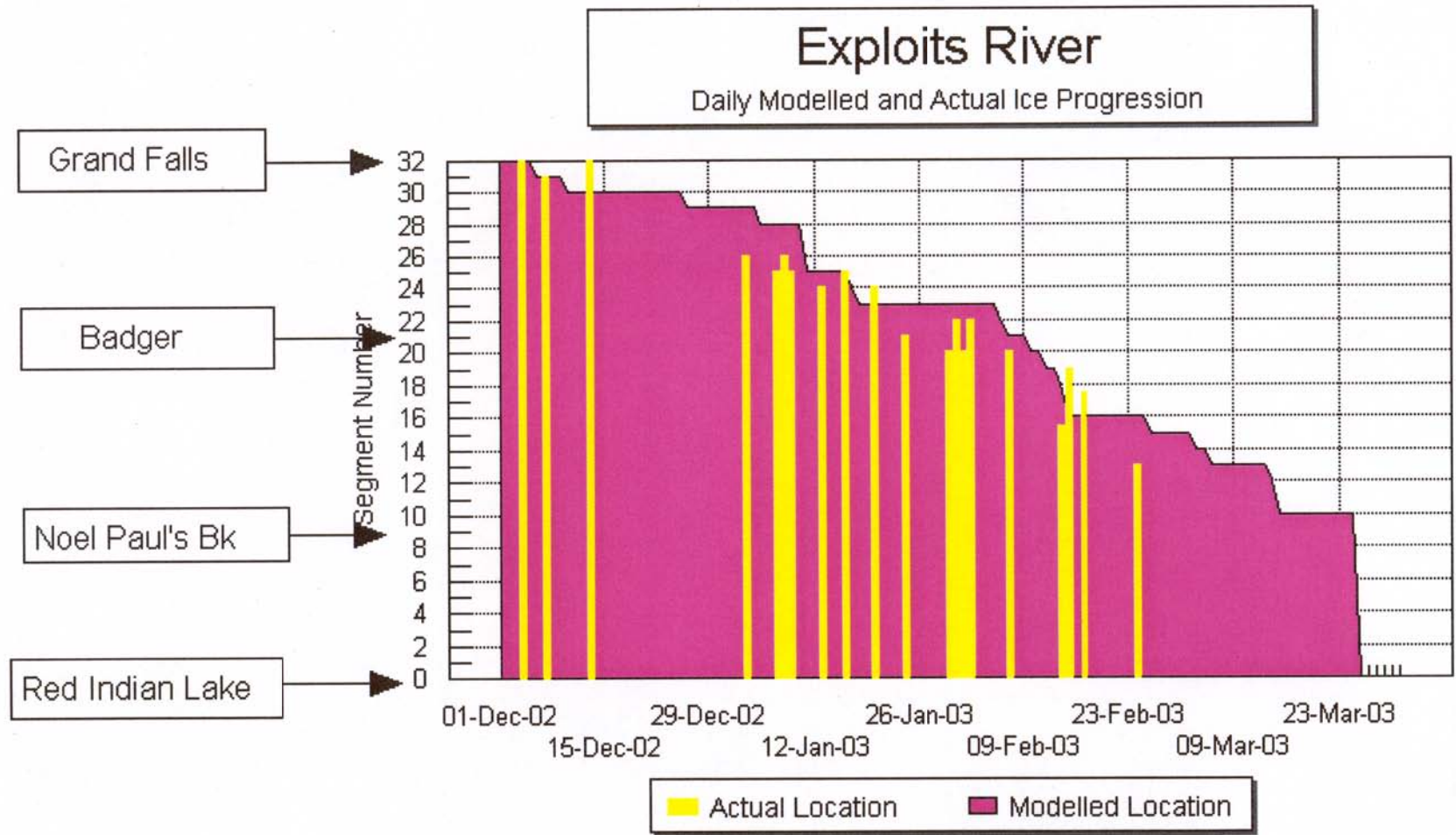


Figure 12 - Ice Generated - Segments 1-21



Figure 13 - Ice Progression



model tracks the progression of ice cover as it fills the segments from Grand Falls towards Red Indian Lake.

Two model runs were made on February 14, 2003. The morning model run forecasted 2.6 MCM (million cubic meters) of ice being generated and coming down the Exploits River between Red Indian Lake and the Town of Badger. The alert level for WRMD is 2 MCM. The afternoon forecast run estimated 3.1 MCM to be generated.

The Town of Badger and Abitibi were advised by telephone and EMD by fax that there was a considerable amount of ice coming down the Exploits tonight but that there would be no change expected in the water level. The Town and Abitibi were agreed that since the ice front was confirmed to be at least to Three Mile Island (about 5 km upstream) that there was little cause for concern.

Historically, the danger to Badger would have passed once the ice front travels upstream past Three Mile Island. As of February 14, the rafted ice at Badger had not moved in over a week. This gave the impression that the ice cover was stable.

#### d Noel Pauls Brook

The ice cover on Noel Pauls Brook broke up and flowed into the Exploits River during the mild spell early in February. The event was observed by local residents and showed up as a sharp increase in the water level at the Exploits River below Noel Pauls Brook station on February 4, 2003. Ice shear walls along the sides of the stream and an ice free channel were observed along Noel Pauls Brook for a distance of 8 km from the Exploits confluence. This indicated that all the ice in that section of the river moved out into the Exploits River. Where this ice wound up and what effect it had on the flooding of Badger is unknown at this time.

#### 4. Flood Description

Based on the data from the water level gauge at Badger, the flood started on February 15 between 8:00 am and 9:00 am. Residents of the area report the time between 8:00 and 8:30. The water level rose 2.3 metres in the first hour, rose an additional 0.3 in the next two hours and peaked at an elevation of approximately 100.5 metres (Geodetic). The flood led to the evacuation of the Town and the declaration of a State of Emergency. The state of emergency was not lifted as of the writing of this report.(March 31, 2003) The levels prior to the event, during the event and after are shown in Figure 14.

The ice cover prior to the flood had reached Segment 15 near the transmission line approximately 14 km above Badger. After the ice stopped moving, the ice cover was just upstream of Three Mile Island suggesting that the ice cover had collapsed all the way from the transmission line. The ice jammed across the river restricting flows causing water to flood into the town. The thickest part of the ice jam appeared to be downstream of Badger in the area known as Badger Rough Waters.