# SECTION 3
# RIVER ICE MONITORING

## 3.1 COLLECTION SUMMARY

Monitoring of the river ice cover and the subsequent ice breakup on the Grasse River was conducted during winter 2003/2004 and spring 2004 to observe ice conditions in the lower Grasse River (downstream of the Massena Power Canal or sediment probing Transect 1 [T1]) and, to a lesser extent, monitor conditions in the upper river to understand how they may affect the lower river. The upstream and downstream limits of observation were the bridge downstream of Pyrites at Route 21 and the confluence with the St. Lawrence River, respectively (**Figure 3-1**).

The ice monitoring program was conducted in accordance with the 2003/2004 Grasse River Ice Monitoring Work Plan (Alcoa, December 2003) and consisted of several activities. Daily climatological data at Massena International Airport during winter 2003/2004 and spring 2004 were obtained from the National Weather Service. Data on water levels were downloaded, as needed, from the United States Geological Survey (USGS) gaging station at Chase Mills, NY (http://waterdata.usgs.gov/nwis/uv/?site_no=04265432) and from Alcoa's staff gage/stage recorder at Outfall 001; instruments at these two locations automatically record data every 15 and 5 minutes, respectively. In addition, relative water levels at the various bridges in the area were also obtained through measurement of the distance from a reference point on the bridge rail to the water or ice surface below using a weight suspended on a cloth tape (**Figure 3-1**). The frequency of these tapedown measurements changed from every 2 to 4 weeks during December and January to daily near the time of ice breakup in March.

The formation, extent, thickness, and breakup of the ice cover were observed and documented during field observations from December 2003 through April 2004. The extent of ice cover on the Grasse River was monitored periodically at the 17 locations shown in **Figure 3-1**. Dated land-based photographs looking both upstream and downstream were taken at each location. Monitoring was performed approximately biweekly during ice formation (late

November to early December), once a month from December through February, biweekly near mid-March, and daily when the ice cover was deteriorating (March 25th to 31st). Additional activities were conducted during the ice deterioration and breakup period, including field sketches of the ice cover and one aerial photography event.

Ice thickness measurements were attempted from January 15th to 22nd and again on February 22nd at seven locations: near river transect T71 (near the Amvet's property), the Route 131 Bridge, near river transect T5 (near Outfall 001), the Alcoa Bridge, the Route 37 Bridge, near the Rod and Gun Club, and the Madrid Bridge. When safe field conditions existed, holes were drilled through the ice and ice thickness was measured at distances approximately 50 and 100 ft. from the accessible shore (up to three locations across the river). In addition, frazil slush beneath the solid ice cover was noted and measured when possible. The thickness of snow cover and snow pack was also measured.

## 3.2 RESULTS

### 3.2.1 Climatological Conditions

Daily minimum and maximum air temperatures during the winter of 2003/2004 are shown in **Figure 3-2**. Average daily temperatures remained below freezing for all but five days between January 1st and February 29th. This period was followed by five days in early March with average temperatures well above freezing and temperature highs of 50 degrees Fahrenheit (°F). Average temperatures from March 7th to 24th were near freezing. On March 25th, the air temperature warmed considerably and highs up to 60° F were seen on March 26th.

The winter of 2003/2004 was warmer than the severe winter of 2002/2003, as evidenced by the computation of freezing degree-days. Freezing degree-days are computed as departures of the mean daily temperature above and below 32°F, positive if above and negative if below. A cumulative freezing degree-day (CFDD) for a specific time period is the summation of the freezing degree-days; thus, a lower CFDD means a colder time period. For December 2003

through March 2004, the CFDD is 1733; a CFDD of 1656 was estimated for December 2002 through March 2003.

Daily precipitation data[1] for January through March 2004 are shown in **Figure 3-3**, as measured at Massena International Airport. Precipitation events depositing more than 0.3 inches on one day occurred in early and late March. The total amount of precipitation from January through March 2004 was lower than the total during the same time period in 2003 (2.7 vs. 4.0 inches).

### 3.2.2 River Stage Monitoring

**Figure 3-4** shows the water levels at Alcoa Outfall 001 during the winter months of 2004. **Figures 3-5 and 3-6** illustrate the water levels for the month of March at the Outfall 001 and Chase Mills locations, respectively. The dramatic rise of about 2 ft. in river stage in late-March at the Chase Mills location is attributed to the precipitation during this period as noted above and the shallow nature of the river at the USGS gaging station. The ice breakup period in the lower river is illustrated on **Figure 3-5**. During this time period, river stage at Outfall 001 increased by up to one foot.

Relative river stage measured via tapedown measurements at the Main Street and Alcoa Bridges are shown in **Figure 3-7**. Relative river stage was also recorded at other bridge locations in the area; these data are provided along with the Main Street and Alcoa Bridge data in **Table 3-1**.

### 3.2.3 Monitoring of River Ice Formation and Extent

Photographs of the river ice cover for key dates are included on the CD-ROM in **Appendix B**. These photographs are numbered to correspond with the locations shown in

[1] Due to the type of winter precipitation (i.e., snow), on many occasions the amount of precipitation cannot be measured accurately and was reported as "trace". These trace amounts were assumed to be zero.

**Figure 3-1**. The CD-ROM in **Appendix B** also contains aerial photographs taken near the time of ice breakup, on March 30th.

The lower Grasse River below T1 was fully covered with ice by December 5th. The ice cover formed through a combination of ice growth near the shoreline and arrival of frazil ice slush from the steeper, faster flowing upstream river reaches. This is the typical mode of ice formation in areas of the Grasse River that exhibit a low flow velocity. In these areas of the river, the ice remains stationary through the winter with little to no visible distortion.

In areas of the river with rapids or sharp drops in elevation, namely within Massena, Louisville, and Chase Mills, the ice takes longer to form and typically does not completely cover the river. The mode of ice formation is similar to that described above.

### 3.2.4 Ice Thickness Measurement

Ice thickness was measured in January and February at seven locations on the Grasse River as summarized in **Table 3-2**. The packed snow cover atop the river ice was estimated at 2 inches and 5 inches, respectively, for the two field events.

### 3.2.5 Monitoring of River Ice Breakup

Locations where the river ice cover was periodically monitored/photographed are shown in **Figure 3-1**. Photos were taken approximately biweekly during ice formation (late November to early December), once a month from December through February, and biweekly near mid-March. The frequency of ice cover monitoring increased to daily during the expected period of ice breakup (March 25th to March 31st). In the discussion that follows, the associated photographs included on the CD-ROM in **Appendix B** are referenced in parentheses.

### *3.2.5.1 Climatological Observations*

Average temperatures between March 2nd and 6th were well above freezing, with high temperatures nearing 45°F. It was anticipated that these warm temperatures, coupled with 0.54 inches of rain on March 5th, might initiate ice breakup. This, however, was not the case as the ice cover remained intact on most of the river. The warming did, however, cause the ice cover between the Main Street Bridge and T1 to open up. Ice piled up near the Parker Street Bridge on March 6th (3-06-04 09 U). During this period open water appeared in the immediate vicinity of Outfall 001.

Colder air temperatures returned on March 7th and average daily temperatures remained below freezing through March 24th. The daily highs during this period exceeded freezing on all but six days, with an overall maximum of 43°F (observed on March 10th and 11th). The ice cover remained largely unchanged during this period.

On March 25th, the air temperature rose to nearly 50°F and temperatures remained relatively warm into early April. Also, as noted above, significant amounts (almost half an inch per day) of precipitation fell on March 25th and 26th. The warm air temperatures and precipitation caused the ice cover to further deteriorate, thin, breakup, and clear the river by March 31st.

### *3.2.5.2 Ice Cover Observations*

In Louisville, some ice jamming was observed in the rapids downstream of the Louisville Bridge on March 26th. This ice jamming was not observed on March 27th. On March 29th, some ice jamming was again observed downstream of Louisville. This area of the river was observed to be clear of ice on March 30th.

Upstream of the Main Street Bridge, the ice cover remained intact through March 29th. Just upstream of the Main Street Bridge, the areas of open water slowly extended upstream beginning on March 26th. The water level in this upstream area had risen and overtopped the

bank onto the floodplain upstream of Route 37 by March 26th (3-26-04 11 U West). Ice broke up in the region of the river upstream of the Main Street Bridge past the Route 37 Bridge on March 30th. This ice floated downstream in thin sheets (3-30-04 11 D) that broke into small pieces after passing the Main Street Bridge (3-30-04 10 U).

As noted above, the area of the river between the Main Street Bridge and T1 was essentially clear of ice in early March. A small amount of ice piled up downstream of the Parker Street Bridge on March 26th (3-26-04 09 D); by March 27th, this ice had moved to the head of the ice cover at T1. The ice cover at T1 had already thinned due to warm air temperatures.

In the lower river (downstream of T1), small areas of open water were observed on March 26th, namely near T1 with small amounts of ice pieces present at the head of the melting ice cover (3-26-04 08 U). By March 28th, the open area of water near T1 had extended past T2, and areas of open water were observed near T16 and at many of the bends in the river. There continued to be only a small amount of ice piled up at the head of the ice cover (3-28-04 08 U). The areas of open water seen on March 28th continued to expand on March 29th and 30th. On March 29th, a small ice run had pushed from T1 down the north bank to approximately T3 (3-29-04 08 D and U); small, thin ice pieces at the head of the ice cover began to increase as ice pieces were transported to the lower river from upstream. This supply of ice pieces from upstream continued through March 30th and began to build up behind the melting ice cover. This buildup of ice pieces extended from Outfall 001 to upstream past the Alcoa Bridge by the afternoon. As ice pieces continued to flow down from upstream through the evening, the build up extended upstream to the Power Canal and was extensive enough to cause the already thin ice cover to break up (3-30-04 08 D and U). The ice debris that developed was similar in thickness to the material that had been building up throughout the day on March 30th. The force of the ice debris and weakened state of the ice cover (due to warm air temperatures) resulted in the rapid disintegration of the ice cover throughout the evening of March 30th/31st, as the ice debris initially present at T1 pushed downstream. The lower river was observed to be clear of ice on March 31st (3-31-04 08 D).

## 3.3 SUMMARY

Ice cover on the Grasse River began to deteriorate in early March due to warmer air temperatures. Areas of the river with swifter moving water (i.e., between the Main Street Bridge and T1), were observed to be clear of ice in early March. Ice remained downstream of T1 until March 25th, when the ice cover began to deteriorate rapidly due to elevated air temperatures, rain events, and an increase in water flow. Ice cover deterioration continued through March 30th and the river was observed to be clear of ice on March 31st. The mode of ice breakout during the spring of 2004 was essentially a thermal melt-out, and no significant ice jamming was observed.

**GRASSE RIVER STUDY AREA**
**MASSENA, NEW YORK**

**Table 3-1**
**2004 Data Sumary Report**
**Distance from Bridge Railing to Water/Ice Surface**

| | Feet From Reference Elevation [1] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location [2]** | Rt. 131 Bridge | Alcoa Bridge | Parker Street Bridge | Main Street Bridge | Rt. 37 Bridge | Louisville Bridge | Chase Mills Bridge | Chamberlain Corners Bridge | Madrid Bridge | Bucks Bridge | Canton Bridge (right) | Canton Bridge (left) | Pyrites Bridge | Pyrites Dam |
| | 5 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | 16 | 17 | 18 | 18 | 19 | 20 |
| 12/5/03 | 52.9 | 60.6 | 50.7 | 21.5 | 37.0 | 18.9 | 29.6 | 20.5 | --- | --- | --- | --- | --- | --- |
| 12/10/03 | --- | --- | --- | --- | --- | --- | --- | 22.0 | 22.7 | 16.7 | 17.1 | 24.4 | 20.0 | 13.6 |
| 12/12/03 | 56.5 | 59.8 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12/23/03 | --- | --- | 50.0 | 21.6 | 37.1 | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12/24/03 | --- | 59.9 | --- | 21.8 | --- | 18.2 | 27.8 | 21.7 | 21.8 | 16.7 | 16.3 | 24.1 | 19.6 | 13.5 |
| 12/31/04 | --- | --- | --- | --- | 35.9 | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1/6/04 | --- | --- | --- | --- | --- | --- | 27.0 | --- | --- | --- | --- | --- | --- | --- |
| 1/28/04 | 50.8 | 59.6 | 49.1 | 22.2 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2/13/04 | 54.8 | 60.6 | 49.8 | 22.4 | 38.8 | 18.8 | 26.3 | 20.5 | 21.8 | 16.6 | 17.0 | 24.1 | 18.9 | 13.6 |
| 3/2/04 | 54.0 | 61.4 | 49.0 | 21.3 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/3/04 | 54.0 | 60.0 | 42.8 | 20.8 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/4/04 | 54.2 | 60.2 | 48.1 | 20.9 | 35.0 | 17.6 | 25.5 | 18.9 | 20.7 | --- | --- | --- | --- | --- |
| 3/5/04 | 54.0 | 60.0 | 49.0 | 21.8 | 34.7 | 17.6 | 25.6 | 19.9 | 22.0 | --- | --- | --- | --- | --- |
| 3/6/04 | 54.0 | 60.0 | 48.1 | 21.3 | 34.7 | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/7/04 | 51.8 | 60.1 | 47.1 | 20.6 | 36.4 | 17.6 | 25.0 | 18.5 | 20.4 | --- | --- | --- | --- | --- |
| 3/8/04 | 51.6 | 59.5 | 46.0 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3/9/04 | 51.5 | 60.8 | 45.8 | 20.5 | 34.7 | 17.8 | 26.3 | 20.8 | 19.9 | --- | --- | --- | --- | --- |
| 3/11/04 | --- | 60.0 | 48.0 | 21.3 | 36.8 | 19.4 | 27.0 | 22.3 | 21.2 | --- | --- | --- | --- | --- |
| 3/12/04 | --- | 61.3 | 48.5 | 21.6 | 36.7 | 19.6 | 28.2 | 22.1 | 21.5 | --- | --- | --- | --- | --- |
| 3/16/04 | --- | 60.6 | 49.1 | 21.7 | 36.9 | 19.7 | 27.3 | 21.6 | 22.3 | --- | --- | --- | --- | --- |
| 3/25/04 | 52.3 | 60.9 | 50.3 | 21.9 | 37.4 | 19.9 | 26.9 | 22.0 | 22.4 | --- | --- | --- | --- | --- |
| 3/26/04 | 52.2 | 60.6 | 49.2 | 21.0 | 36.6 | 19.7 | 26.8 | 21.2 | 20.6 | --- | --- | --- | --- | --- |
| 3/27/04 | 52.4 | 60.3 | 48.7 | 20.0 | 36.3 | 18.7 | 26.4 | 20.7 | 18.7 | --- | --- | --- | --- | --- |
| 3/28/04 | 52.0 | 60.6 | 48.0 | 19.3 | 33.4 | 17.9 | 25.7 | 20.2 | 17.0 | --- | --- | --- | --- | --- |
| 3/29/04 | 52.5 | 60.3 | 47.8 | 19.0 | 32.7 | 17.1 | 25.8 | 20.0 | 18.6 | --- | --- | --- | --- | --- |
| 3/30/04 | 52.5 | 60.6 | 47.9 | 19.3 | 33.8 | 18.8 | 26.2 | 20.5 | 19.7 | --- | --- | --- | --- | --- |

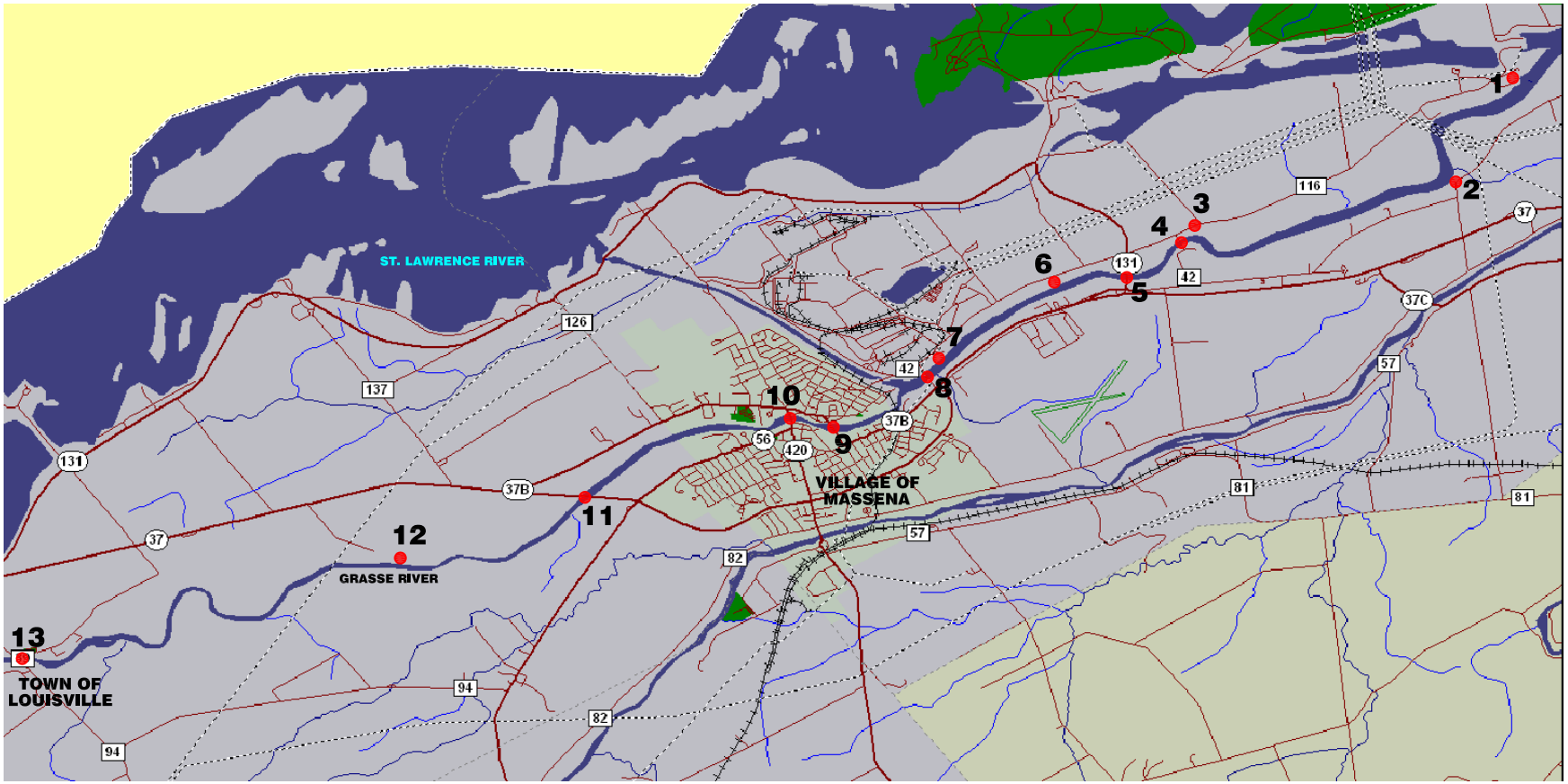
Notes:
1. Measurement taken from a fixed point at the location (i.e., bridge railing) to the water or ice surface using a weight suspended on a cloth tape.
2. Location number corresponds to the monitoring locations shown in Figure 3-1.
3. --- = not measured

**GRASSE RIVER STUDY AREA**
**MASSENA, NEW YORK**

**Table 3-2**
**Ice and Frazil Slush Thickness Measurements in January and February 2004**

| Location | 1/15/04 to 1/22/04 | | 2/25/04 | |
|---|---|---|---|---|
| | Ice (inches) | Frazil Slush (inches) | Ice (inches) | Frazil Slush (inches) |
| AmVets | 17 – 19 | 4 | 24 | 2 |
| Route 131 Bridge | 12 | 0 | --- | --- |
| Outfall 001 | 7.5 | 0 | 17 – 20 | 2 |
| Alcoa Bridge | 17 – 20 | 17 – 24 | 17 – 20 | 17 – 24 |
| Route 37 Bridge | 13 – 15 | 14 | --- | --- |
| Rod and Gun Club | --- | --- | 21 – 23 | 2 |
| Madrid Bridge (Rt. 345) | --- | --- | 17 | 0 |

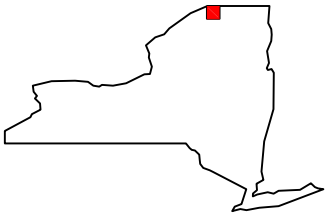
Note:
1. Ice thickness measurements represent the range of thicknesses measured at multiple (up to 3) drilled holes across the river.
2. Frazile slush thickness is an estimate from the quantity of slush in the hole drilled.
3. --- = measurements not made due to unsafe river conditions




**OTHER MONITORING LOCATIONS UPSTREAM OF LOUISVILLE BRIDGE, MONITORING LOCATION 13**

| No. | LOCATION | DISTANCE UPSTREAM * |
|---|---|---|
| 14 | CHASE MILLS BRIDGE, RT. 36 | 5 mi |
| 15 | CHAMBERLAIN CORNERS BRIDGE, RT. 44 | 6.75 mi |
| 16 | MADRID BRIDGE, RT. 345 | 12 mi |
| 17 | BUCKS BRIDGE, RT. 34 | 15.75 mi |
| 18 | CANTON BRIDGE, RT. 68 | 25.75 mi |
| 19 | BRIDGE BELOW PYRITES, RT. 21 | 32.5 mi |
| 20 | HYDRO DAM AT PYRITES | 33.5 mi |

* ALL DISTANCES ARE REFERENCED FROM LOUISVILLE BRIDGE AND ARE APPROXIMATE.



NEW YORK STATE LOCATION MAP

GRASSE RIVER STUDY AREA
MASSENA, NEW YORK

# 2003/2004 RIVER ICE MONITORING LOCATIONS

ALCOA

FIGURE
3-1

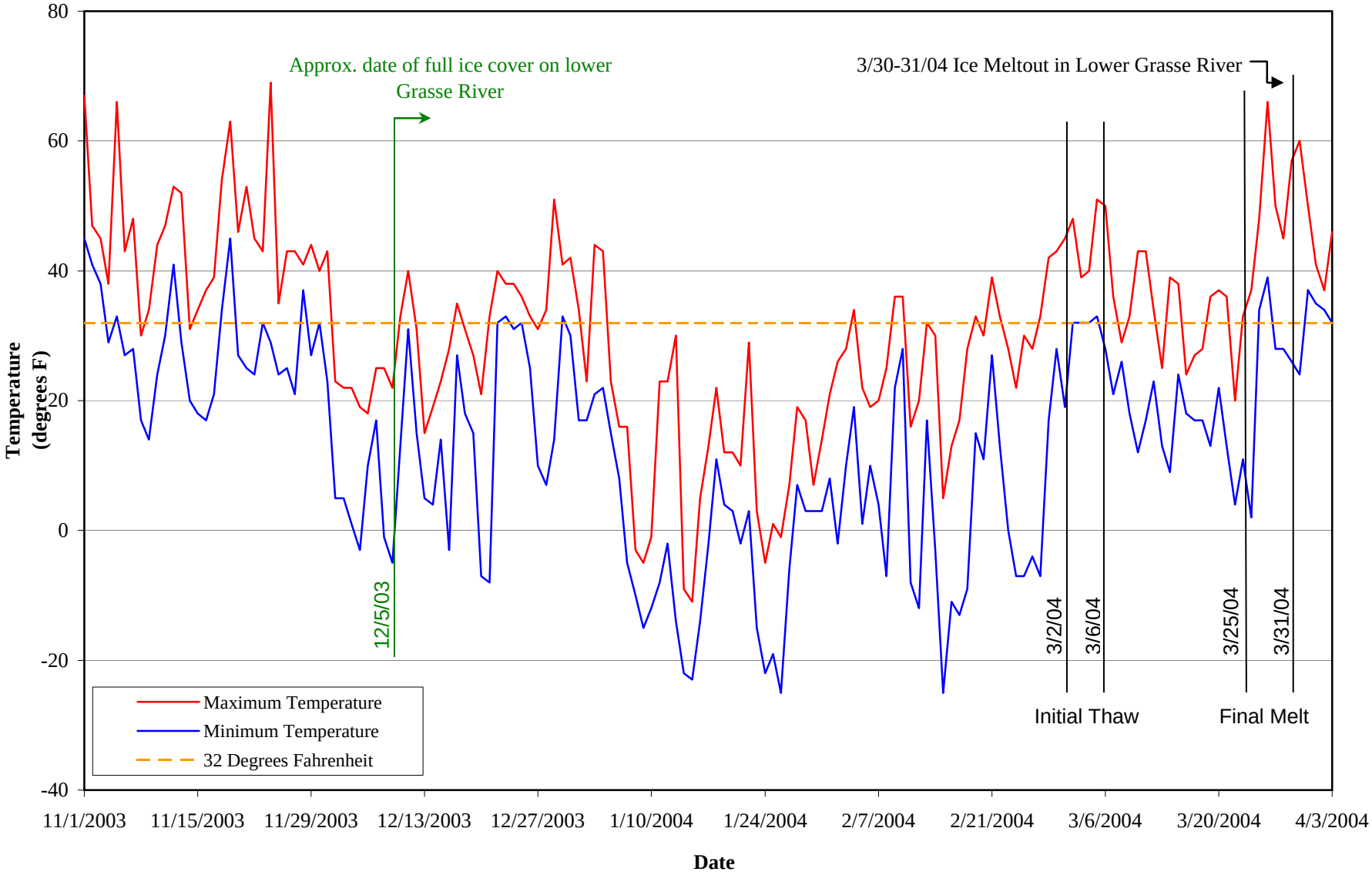



**Figure 3-2. Daily Air Temperatures for November 2003 Through March 2004**

*Air temperatures recorded at Massena International Airport by the National Weather Service.*

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3/28/20059:25 PM

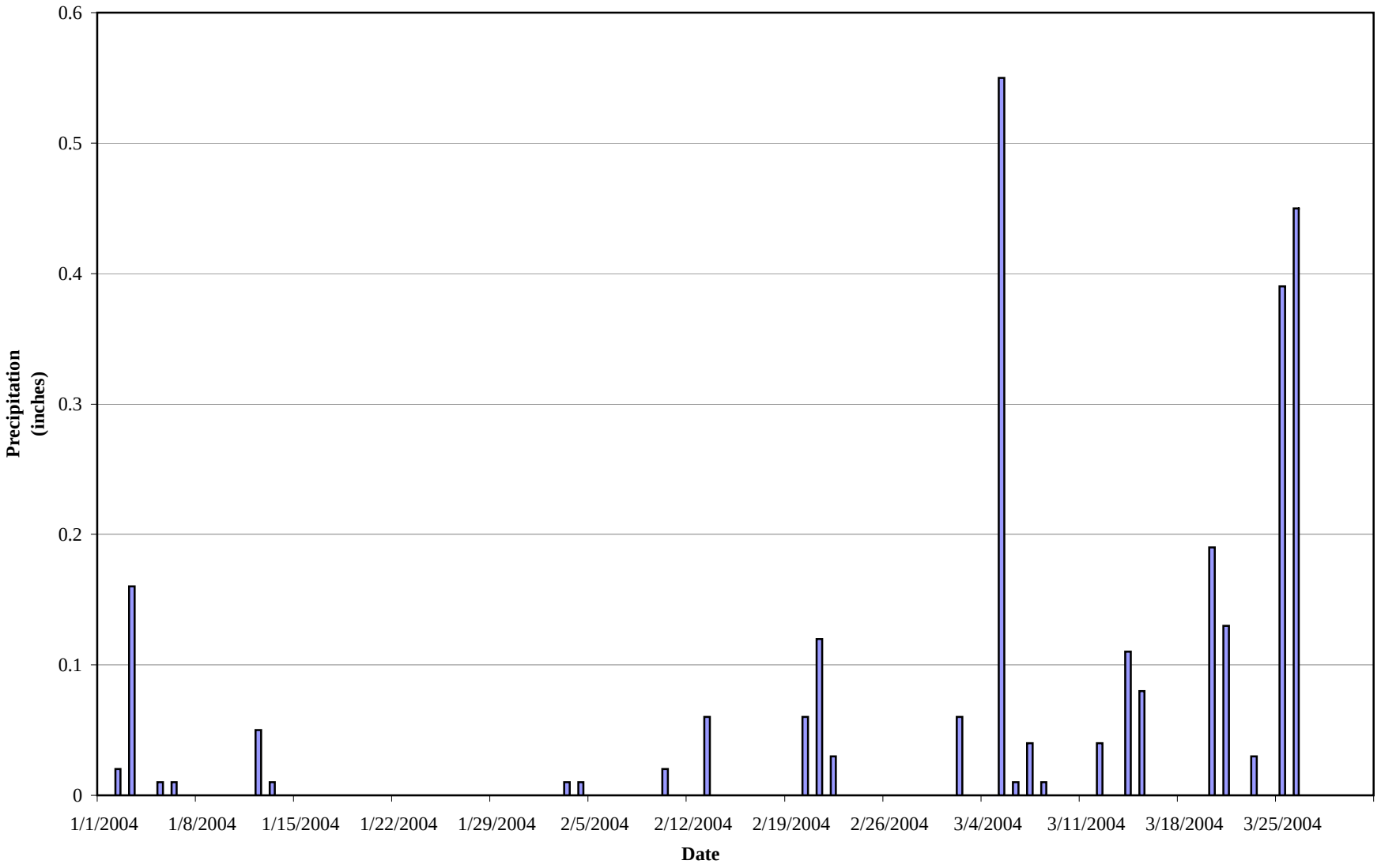


**Figure 3-3. Daily Precipitation from January through March 2004**

*Due to the type of winter precipitation (i.e.,, snow) on many occasions, the amount of precipitation cannot be measured accurately and was reported as "trace". These values are shown here as zero. Precipitation measured at Massena International Airport by the National Weather Service.*

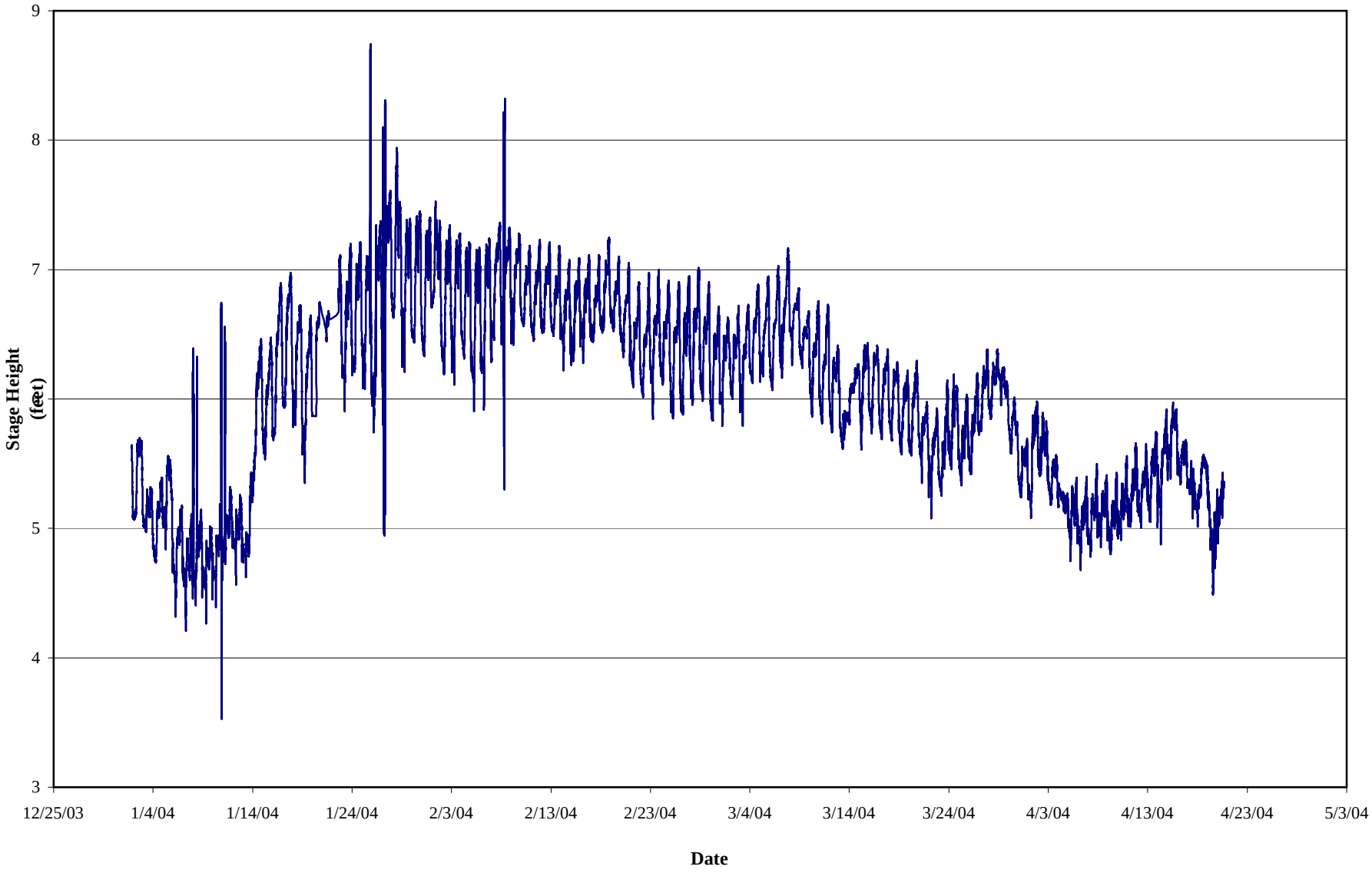


**Figure 3-4. Stage Height at Outfall 001 from January to April 2004**
*Stage height recorded every 5 minutes.*

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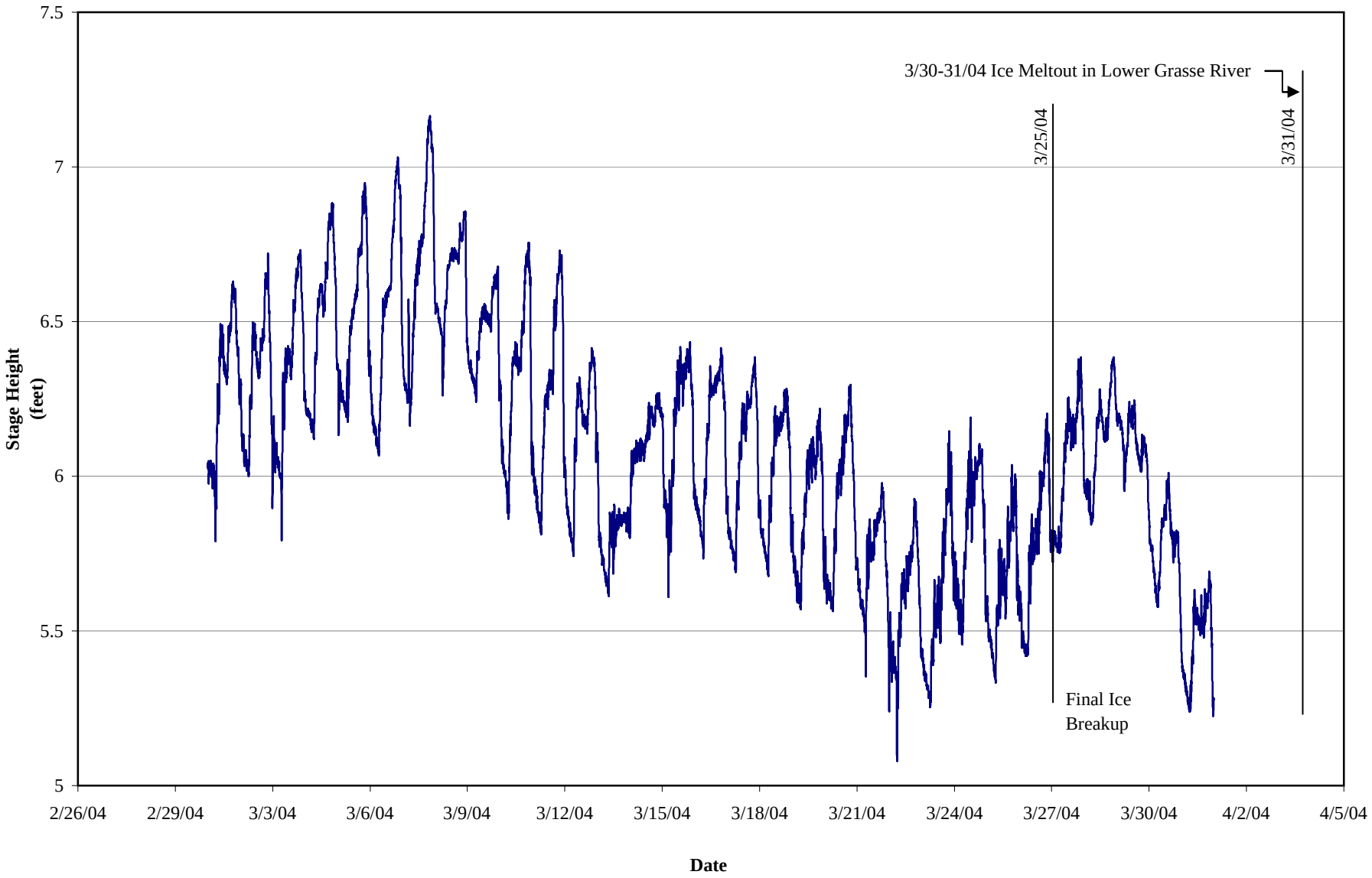


**Figure 3-5. Stage Height at Outfall 001 During March 2004**

*Stage height recorded every 5 minutes.*

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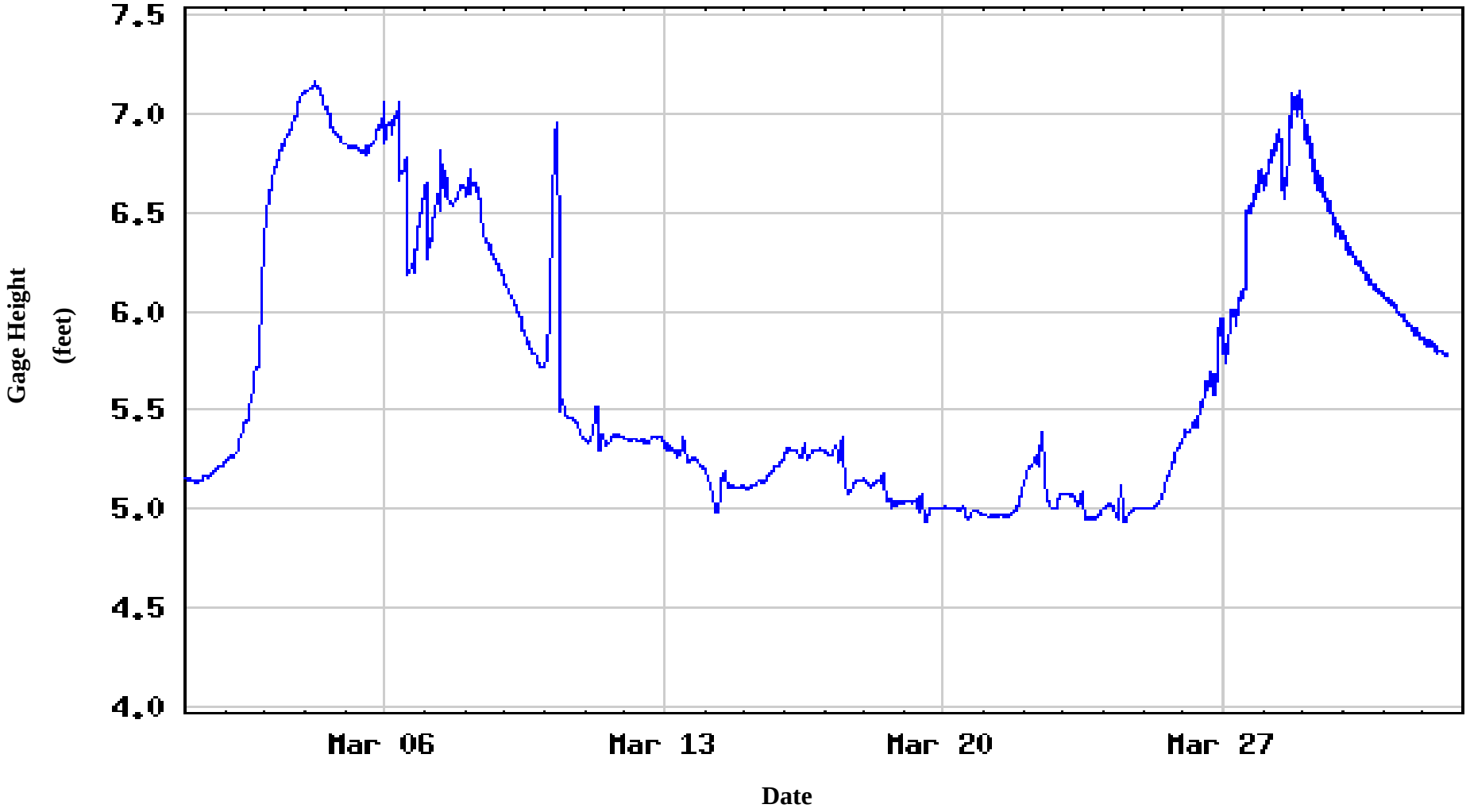


**Figure 3-6. Gage Height at USGS Gaging Station at Chase Mills, NY During March 2004**

*Stage height was recorded every 15 minutes.*

*Provisional data for Chase Mills (station # 04265432) downloaded from USGS website:* http://waterdata.usgs.gov/nwis/uv/?site_no=04265432

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Mon Mar 7 2005

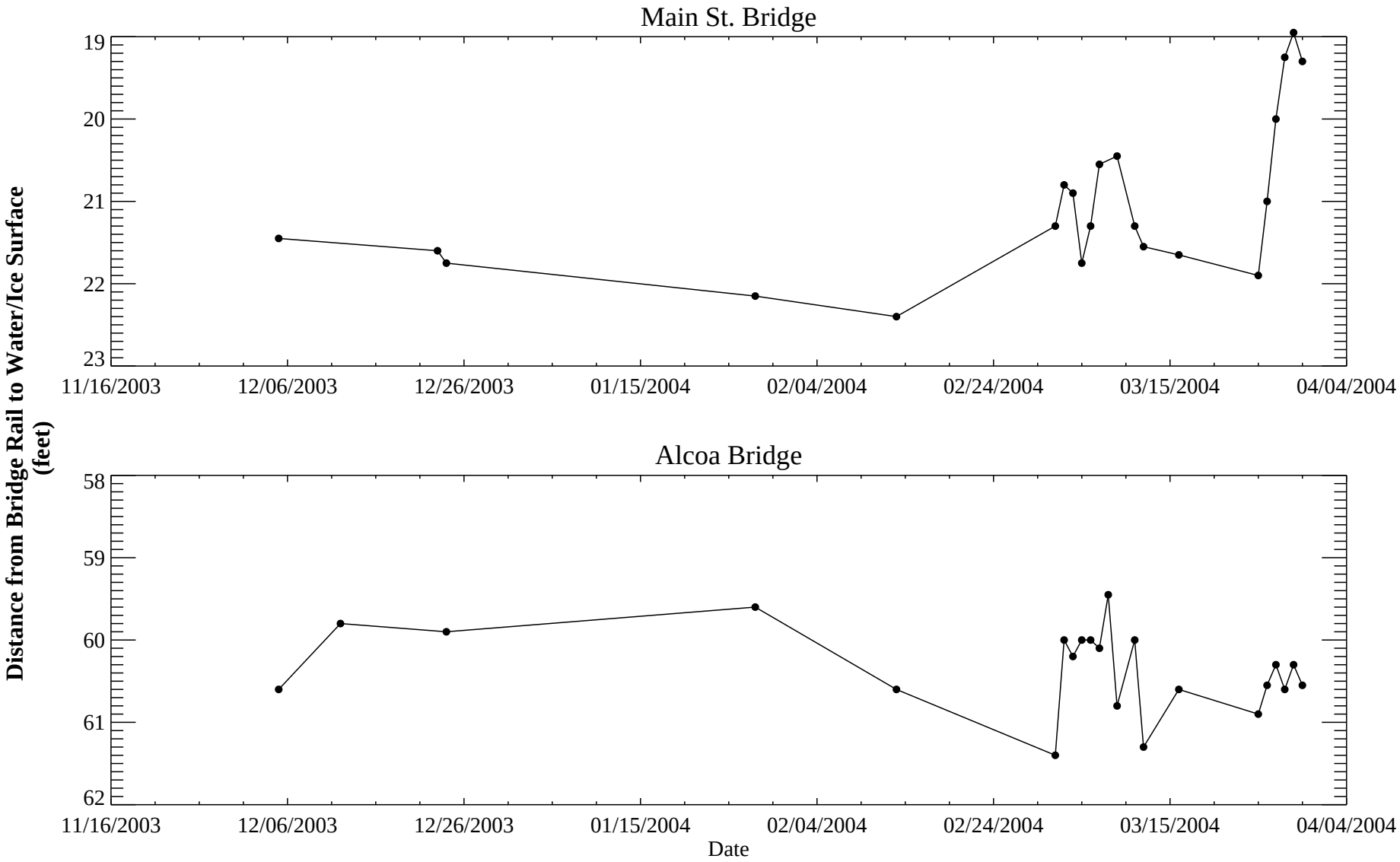


**Figure 3-7. Relative Water/Ice Surface Elevation at Main St. and Alcoa Bridges During December Through March 2004**

*Tapedown measurement made from the bridge rail to the water/ice surface approximately one third of the river width from the northern shore.*

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Tue Mar 29 13:55:44 2005