Appendix B

Groundwater Quality & Elevation/Surface Water Quality/Trends

Memorandum

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RE: Flambeau Mining Company - 2006 Annual Report Groundwater and Surface Water Trends

Background

Groundwater and surface water sample results collected for the 2006 monitoring program were added to the analytical monitoring historical database. These results were statistically tested and graphically displayed to determine whether any significant increasing or decreasing trends are occurring in the groundwater or surface water chemistry. Groundwater quality results, trend graphs and statistical test results are included as Attachment 1 for the quarterly monitoring parameters and Attachment 2 for the annual monitoring parameters. Surface water quality results, trend graphs and statistical test results are included as Attachment 3. Hydrographs are included as Attachment 4.

Intervention boundary wells included in the trend analyses are MW-1000P-R, MW-1002, MW-1002G, MW-1004P, MW-1004S, MW-1005, MW-1005P, MW-1005S, and MW-1010P. The in-pit wells included in the trend analyses are MW-1013, MW-1013A, MW-1013B, MW-1013C, MW-1014, MW-1014A, MW-1014B and MW-1014C. Wells MW-1015A and MW-1015B (also included in the analyses) were constructed in January 2001 approximately 1000 ft. northwest of the backfilled pit and adjacent to the compliance boundary.

Statistical Methods

October of 1997 was selected as the start date for the trend tests. October of 1997 is the beginning of the post-mining period. The trend analyses begin in February, 1999 for the in-pit wells MW-1013B, MW-1013C, MW-1014A, MW-1014B and MW-1014C, and April, 2001 for wells MW-1015A and MW-1015B, which is when monitoring began. Trend analyses are also included for the first time for wells MW-1013, MW-1013A and MW-1014. Monitoring of these wells began in October, 2005, with sufficient groundwater recovery to collect samples.

The trend analyses for the annual monitoring parameters of arsenic, barium, cadmium, calcium, chloride, chromium, lead, magnesium, mercury, selenium and silver begin with July 1999 in all wells since this was the recent start date of monitoring for these parameters. With the exception

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of arsenic, no trend test is yet performed for these parameters in MW-1013, MW-1013A and MW-1014 due to small sample sizes.

The non-parametric Mann-Kendall test for trend was used to statistically determine existing trends in the post-mining data. This test indicates whether any general increasing or decreasing trends have occurred during this time frame. The results of the trend tests are best used in conjunction with the trend graphs of Attachments 1, 2 and 3 to properly evaluate trend conditions. It should be noted that a statistically increasing or decreasing trend does not necessarily indicate a substantial increase or decrease in actual parameter concentrations. There are situations where variation in the data is extremely small, allowing very slight consecutive concentration changes to be detected as a statistically significant trend. Although these minor trends may occur, they should not be construed as an indication of a broader impact on water quality.

In addition, since the statistical trend tests indicate whether a general trend is occurring over the entire time frame of the post-mining period, there may be cases when a short term trend conflicts with the statistical result for the general longer term trend. Therefore as stated, it is most appropriate to interpret the statistical results in conjunction visually with the trend graphs and in the context of the broader site hydrology.

The procedure for the Mann-Kendall test is given in Gilbert (1987)[1]. The Type I error for each test was set to 0.01. All non-detected values were replaced with a common value below the lowest detected value.

In the trend test results of Attachments 1, 2 and 3, a ”+” indicates a statistically increasing trend and a ”-“ indicates a statistically decreasing trend. If neither a ”+” or ”-“ is given, no statistically significant trend is present.

Trend Results

Quarterly Parameters (Attachment 1)

The majority of observable trends, increasing and/or decreasing, were exhibited in the groundwater results for the quarterly parameters of alkalinity, copper, hardness, iron, manganese, sulfate, TDS, zinc, pH, conductivity and redox. A number of the observed trends are similar to those noted in the previous annual report.

Many of the trends indicated as statistically significant are the result of only small consecutive concentration changes over the post-mining period, with overall concentration change being very low. Other trends reflecting greater concentration changes are noted in the intervention boundary wells MW-1000P-R, MW-1005, MW-1010P and MW1015B, and the in-pit wells MW-1013B, MW-1013C, MW-1014A, MW-1014B and MW-1014C. Utilizing both the statistical trend results and the historical trend graphs of Attachment 1, a summary of these is given as follows:

[1]Gilbert, R.O., 1987. “ Statistical Methods for Environmental Pollution Monitoring”, Van Nostrand Reinhold, New York.

- MW-1000P-R: Alkalinity, hardness, iron, manganese, sulfate, TDS and conductivity exhibited an increase in concentrations at the beginning of the post-mining period, but recently have stabilized or decreased.

- MW-1005: Hardness, iron, manganese, TDS and conductivity decreased from approximately 1994 through 2003, at which point moderate increases (still below historical levels) occurred. Concentrations have since stabilized or once again decreased.

- MW-1010P: Decreasing trends of copper and TDS were noted for the post-mining period. In addition, the iron and manganese increases which were noted during 2000, decreased or remained consistent.

- MW-1013B: Copper has illustrated generally increasing concentrations since 2001. Decreasing trends were noted for iron and TDS.

- MW-1013C: Overall increasing trends continue for iron and manganese.

- MW-1014A: Decreasing trends continue for iron and manganese.

- MW-1014B: Decreasing trends continue for manganese and zinc.

- MW-1014C: Decreasing trends continue for hardness, iron, manganese, sulfate, TDS, zinc and conductivity.

- MW-1015B: After increasing in 2002 to 2003, concentrations of iron and manganese have been consistent or decreasing. This is similar to recent trends at the upgradient well MW-1005P.

The following provides a more detailed narrative of the statistical trend results for each well. All statistically significant trends are noted, regardless of the magnitude concentration change.

Intervention Boundary Wells

- MW-1000P-R: Several parameters exhibited an immediate increase in concentrations at the beginning of the post-mining period. These are alkalinity, hardness, iron, manganese, sulfate, TDS and conductivity. While increasing trends from 1997 through 2006 are indicated by the statistical results, these increases occurred primarily following the rebound of water levels after the production period ended and have since stabilized or decreased. As can be seen in the historical trend graphs, concentration trends of hardness, manganese, sulfate, TDS and conductivity reversed in 2000 and have since been decreasing. Iron decreased in 2004. The trend of alkalinity is recently no longer increasing and has stabilized.

- MW-1002: Trends indicated by the statistical results in this well reflect small consecutive changes in actual low concentrations. These are decreasing trends in iron, sulfate and conductivity.

- MW-1002G: A statistically increasing trend is indicated for alkalinity, while decreasing trends are indicated for sulfate, TDS and conductivity. However, actual concentration changes in these parameters are small, with the trends being due to small consecutive concentration changes.

- MW-1004P: Statistically decreasing trends were noted for copper and sulfate, however these were due to small consecutive concentration changes. The increasing trend noted for manganese in 2005 is no longer indicated, with concentrations returning to very low levels.

- MW-1004S: Increasing trends continue to be noted for hardness and sulfate. Concentrations since 1997 have slowly increased a total of approximately 10 to 20 mg/L. Similarly slow increasing trends can be visually detected in the trend graphs for alkalinity and conductivity. However, levels of alkalinity, hardness and conductivity remain below levels observed historically prior to the onset of mining in 1993. A statistically decreasing trend was noted for iron, but due only to small consecutive concentration changes.

- MW-1005: Overall statistically decreasing trends of alkalinity, iron and manganese continue to be observed for the post-mining period. As can be observed in the trend graphs, hardness, iron, manganese, TDS and conductivity decreased from approximately 1994 through 2003, at which point moderate increases (still below historical levels) occurred. Concentrations have since stabilized or once again decreased.

- MW-1005P: Decreasing trends of sulfate, TDS and conductivity and redox continue. Sulfate has not been detected in this well since 1999.

- MW-1005S: A decreasing trend for conductivity and an increasing trend for manganese continue to be noted, however in each case actual concentration changes are small.

- MW-1010P: Decreasing trends of copper and TDS and increasing trends of hardness, manganese and sulfate were noted for the post-mining period. Similar to MW-1000P-R, copper concentrations were elevated from 1994 through 1999, but have since decreased to low levels. The decreasing trend of TDS, however, is due to decreases beginning in 2004. The increasing trends of alkalinity, hardness and sulfate correspond to only small concentration changes well within the historical concentration range. Manganese increased significantly during October of 2000 (however still below 1991 levels) but has since remained consistent or slightly decreased. As can be seen in the trend graphs, iron also increased during this time and has since decreased to low levels.

- MW-1015A: A statistically increasing trend was noted for alkalinity, however this reflects only small consecutive changes in actual low concentrations.

- MW-1015B: A statistically increasing trend was noted for iron. However, after increasing in 2002 to 2003, concentrations have been consistent or decreasing. The recent trend in iron is similar to recent trends at the upgradient well MW-1005P. A statistically increasing trend was also noted for redox.

In-Pit Wells

- MW-1013: No statistically significant trends were noted for the quarterly monitoring parameters in the available data.

- MW-1013A: No statistically significant trends were noted for the quarterly monitoring parameters in the available data.

- MW-1013B: Overall statistically increasing trends (since 1999) were noted for copper and zinc. Copper has illustrated generally increasing concentrations since 2001. The increasing trend of zinc refers to only a slowly increasing trend with small actual concentration increases just above the detection limit. Decreasing trends were noted for iron and TDS. Iron has not been detected in this well since January of 2004.

- MW-1013C: Overall statistically increasing trends continue for alkalinity, iron, manganese and conductivity. The increasing trends of alkalinity, manganese and conductivity are only moderate while the trend of iron is more significant. An overall decreasing trend is denoted for zinc.

- MW-1014: No statistically significant trends were noted for the quarterly monitoring parameters in the available data.

- MW-1014A: Statistically decreasing trends were noted for iron, manganese and TDS. Iron has not been detected since July of 2004. Statistically increasing trends were noted for alkalinity and redox, however the increasing trend for alkalinity was only small.

- MW-1014B: Overall decreasing trends were noted for hardness, manganese, TDS, zinc and conductivity.

- MW-1014C: Overall decreasing trends continue for hardness, iron, manganese, sulfate, TDS, zinc and conductivity. The most significant relative decreases in concentration occur for iron, dropping from 15 mg/L in 1999 to 6 mg/L in 2006, and for zinc, dropping from 2200 ug/L in 1999 to 470 ug/L in 2006.

Annual Parameters (Attachment 2)

Similar to past trend results, the annual groundwater parameters of arsenic, barium, cadmium, calcium, chloride, chromium, lead, magnesium, mercury, selenium and silver illustrated few statistically significant trends. Since 1999, there continue to be several decreasing trends of

cadmium, calcium and magnesium in various wells. These include calcium and magnesium in MW-1000PR and MW-1014C, and cadmium and magnesium in MW-1014B. Chromium in MW-1013B and barium in MW-1015A also illustrated statistically decreasing trends, however these were due to slight consecutive decreases over already low concentrations observed between 1999 and 2001. Statistically increasing trends of barium and calcium were indicated for MW-1004S, however, as can be seen in the trend plots of Attachment 2 these also were due to slight consecutive changes over already low concentrations.

Surface Water (Attachment 3)
No statistically significant trends were observed in either the upstream or downstream surface water monitoring results. Parameters currently included in the surface water monitoring are copper, hardness, iron, manganese, sulfate, zinc, pH and conductivity.

Hydrographs (Attachment 4)
As observed in the hydrographs, all wells illustrating significant drawdown during the production period of 1993 to 1997 now appear to be substantially stabilized. The wells include MW-1000P-R, MW-1001, MW-1001G, MW-1001P, MW-1003, MW-1003P, MW-1004, MW-1004P, MW-1004S, MW-1010P, OW-7, OW-39, OW-42, PZ-1006G, PZ-1006S, PZ-1007S, PZ-1008, PZ-1008G, PZ-1012, PZ-R1, PZ-S1, PZ-S3, ST-9-23 and ST-9-26.

Groundwater elevations increased steadily from 1999 through 2002 for the in-pit wells of MW-1013A, MW-1013B, MW-1013C, MW-1014, MW-1014A, MW-1014B and MW-1014C, but stabilized in 2003. Elevations for MW-1013 rose through 2004, but appear to have stabilized during 2005.

Conclusions

Many of the concentration trends observed during 2005 continued through 2006. Of the trend results listed above, the following are the main conclusions:

Intervention Boundary Wells

- Several parameters in MW-1000P-R (alkalinity, hardness, iron, manganese, sulfate, TDS and conductivity) exhibited concentration increases following the rebounding of water levels after the production period ended. However, as can be seen in the historical trend graphs, concentration trends of hardness, manganese, sulfate, TDS and conductivity reversed in 2000 and have since been decreasing. Iron decreased significantly in 2004. The trend of alkalinity is recently no longer increasing and has stabilized.

- Iron and manganese in MW-1010P also rose following the production period, but currently have stabilized to levels observed during the pre-mining period. TDS is currently following a decreasing trend.

- Copper in both MW-1000P-R and MW-1010P, after being elevated during the production period, have continued decreasing trends, and are now at low levels.

- A rise in iron and manganese concentrations occurred during 2004 in MW-1004P, and again during January of 2006, but decreased again to very low levels.

- Alkalinity, hardness, sulfate and conductivity continue very slow but consistent concentration increases in MW-1004S. Concentrations of these parameters, however, are still quite low.

- Hardness, iron, manganese, TDS and conductivity in the upgradient well MW-1005 observed decreasing trends through the post-mining period until 2002 and 2003 at which point increases occurred. The increasing trends reversed again during 2004 and stabilized through 2006.

- MW1015B had an increase of iron and manganese during the second half of 2002. Both trends have since reversed.

In-Pit Wells

With the in-pit wells, increasing trends continue for copper in MW-1013B, iron and manganese in MW-1013C and redox in MW-1014A. Decreasing trends continue for iron and manganese in MW-1014A, zinc in MW-1014B, and hardness, iron, sulfate, TDS, zinc and conductivity in MW-1014C.

Annual Groundwater Parameter

Few trends were noted for the annual groundwater parameters of arsenic, barium, cadmium, calcium, chloride, chromium, lead, magnesium, mercury, selenium and silver.

Surface Water Parameters

No trends were observed in either the upstream or downstream surface water monitoring results of copper, hardness, iron, manganese, sulfate, zinc, pH and conductivity.