APPENDIX A

ST. PETER SANDSTONE AQUIFER
EXTRACTION RATE DESIGN CALCULATIONS

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ALTERNATIVE A3
GROUNDWATER EXTRACTION
NORTH OAKS, MINNESOTA

Upper St. Peter Sandstone Aquifer

A new extraction well (EW-4) would be installed in the upper portion of the St. Peter Sandstone Aquifer to create a maximum 1,000-ft wide capture zone within Area 3, as measured along the western shore of Gilfillan Lake. The actual rate required to achieve a 1,000-ft wide capture zone would be determined based on an EW-4 aquifer pumping test. A range of estimated pumping rates can be determined based on existing hydraulic data. Hydraulic data from single well response tests conducted at Upper St. Peter Sandstone Aquifer monitoring wells (e.g., MW-18A)[1] and from EW-1 pumping test data collected from the on-Site St. Peter Aquifer monitoring well (MW-8B)[2] provide a lower and upper aquifer permeability range, respectively.

To calculate the potential EW-4 pumping rate, the following hydraulic parameters are used:

- Depth to groundwater = 30 ft bgs;
- Depth to middle shale layer = 150 ft;
- Saturated aquifer thickness (b) = 120 ft;
- Regional hydraulic gradient (i) = 0.003 ft/ft;
- Hydraulic conductivity (K) = 0.004 ft/min (single well response tests);
- Low Transmissivity (T) = K*b = 0.48 ft^2/min, or 691 ft^2/d;
- High Transmissivity (T) = 1,964 ft^2/d (EW1 pumping test); and
- Upper St. Peter Sandstone Aquifer maximum capture width (d) is 1,000 ft.

The Upper St. Peter Sandstone Aquifer pumping rate (Q) necessary to achieve 1,000 ft of capture is determined by using the following capture zone analysis formula:

$Q = d*T*i$

By applying the above parameters, the EW-4 pumping rate could range from 2,073 ft^3/d (11 gpm) to 5,892 ft^3/d (31 gpm).

The EW-4 pumping rate will also be considered for the infiltration basin design.

Basal St. Peter Sandstone Aquifer

The projected pumping groundwater for the basal St. Peter Sandstone was determined from the

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1 Conestoga-Rovers & Associates, Groundwater and Residential Well Evaluation February 2006 to January 2007, 2007.

2 Conestoga-Rovers & Associates, Alternatives Analysis Report, 1988.

EW-3 pumping test and a groundwater flow model (CRA, 2007)[1]. The groundwater model determined that EW-3 pumping rate of 10 gpm would create a maximum 2,400-ft wide capture zone, as measured along the western shore of Gilfillan Lake, within the basal portion of the St. Peter Sandstone aquifer. The capture zone analysis was based on a composite transmissivity value of 267 ft^2/d. The composite transmissivity represents the basal portion of the St. Peter Sandstone aquifer and the upper portion of the Prairie du Chien aquifer, which recharges the basal St. Peter Sandstone aquifer under pumping conditions.

Potential Impacts to Nearby Residential Wells

The operation of the Ski Lane ravine extraction system will not adversely affect pumping of nearby basal St. Peter Sandstone aquifer residential wells. Taking into consideration the EW-3 pumping test results and the recharge effects of the Prairie du Chien aquifer, additional drawdown due to pumping should be 3 feet or less at radial distances greater than 300 ft from EW-3.