TASMAN GEOSCIENCES

917 1st Ave N, Suite 3
Billings, MT 59101
www.tasman-geo.com
406-259-1033
Billings, MT 59101

April 20, 2021 **SENT VIA ELECTRONIC MAIL**

Ms. Kate Fry
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

Subject: Revised FLIR Systems Well Evaluation
Bozeman Solvent Site
Bozeman, Montana

Dear Ms. Fry:

Tasman Geosciences, Inc. (Tasman) has conducted an evaluation of the potential effects of the proposed geothermal heating and cooling system at FLIR Systems, Inc. (FLIR) facility, which is located near the northwestern boundary of the Bozeman Solvent Site (BSS) Controlled Groundwater Area (CGWA), in Bozeman, Montana. This evaluation was conducted on behalf of the City of Bozeman (City) and CVS Pharmacy, Inc. (CVS) in response to the Montana Department of Environmental Quality's (MDEQ) February 21, 2021 letter. In the letter, the DEQ requested that the City and CVS "qualitatively evaluate if the proposed FLIR extraction wells pose an exposure to PCE contaminated groundwater and/or a movement of PCE contaminated groundwater into uncontaminated areas." This letter presents the conclusions reached by Tasman after evaluating a significant amount of information and data related to the proposed geothermal system and related testing and analyses.

Background

FLIR has proposed installation and operation of an open loop geothermal heating and cooling system at its new facility in Bozeman. The system is composed of three extraction wells, located 50 feet apart, in an east-west line. Two of the injection wells are located approximately 200 feet north-northwest of the center of the extraction well system, and two extraction wells are located approximately 250 feet and 325 feet east-northeast of the center of the extraction system. The east, middle and west extraction wells are completed to a total depth of 181, 181, and 206 feet below ground surface (bgs), respectively. The extraction wells were perforated based on drilling observations and varying intervals are perforated between 130 feet bgs and total depth. The four injection wells are all completed to a total depth of 120 feet bgs.

FLIR proposes a maximum total flow rate of 700 gallons per minute (gpm) as part of the open loop geothermal system. All water extracted will be pumped through a heat exchange system and discharged under pressure directly into the injection wells. Submersible pumps within the extraction wells will be interfaced with variable-frequency controllers that will receive a flow-demand signal from the heat-exchange system in the building. The

submersible pumps' flow rates will be variable throughout the year and will provide a combined flow up to a peak of 700 gpm.

As part of the permitting process, FLIR's consultant, CTA Environmental (CTA), conducted several pump tests of the extraction wells to determine the aquifer properties. The data were provided to the DNRC. Both DNRC and CTA evaluated the data and modeled pumping and injection scenarios. The DNRC evaluation was limited to the physical quantity of groundwater. DNRC determined that there was sufficient water available in the aquifer for the system and that operation of the system would not drawdown any water rights holder's well more than one foot. The DNRC evaluation did not include groundwater quality or the potential for migration of contaminants of concern, as the result of the operation of the geothermal system.

On February 21, 2021, the DEQ requested that the City and CVS "qualitatively evaluate if the proposed FLIR extraction wells pose an exposure to PCE contaminated groundwater and/or a movement of PCE contaminated groundwater into uncontaminated areas." A link to download data related to the testing and evaluation of the geothermal system and the potential effects was subsequently provided to the City and CVS.

Information Reviewed

Numerous documents and data were provided to the City and CVS by MDEQ. Documents and/or data that were provided by MDEQ and reviewed by Tasman as part of the evaluation include:

Montana DNRC Interim Permit – 7/25/2019;

MDEQ CECRA Site inspection Report – 12/11/2019;

Analytical Summary Report for FLIR-EX#3 – 12/26/2019;

MDEQ Data Validation Summary – FLIR-E#3 – 1/6/2020;

Revised Work Plan for Geothermal Extraction Well Testing, New FLIR Systems, Inc. Facility, Bozeman, Montana, CTA Environmental, 1/7/2020;

Additional Information for Form 600 Groundwater Application Submittal, CTA Environmental, 4/15/2020;

06a_FLIR_Form633-MiddleExtractionWell_72-HourTest.xls – Undated CTA Environmental spreadsheet containing aquifer test data;

06c_FLIR_Form633-WestExtractionWell_8-HourTest.xls– Undated CTA Environmental spreadsheet containing aquifer test data;

06b_FLIR_Form633-EastExtractionWell_8-HourTest.xls– Undated CTA Environmental spreadsheet containing aquifer test data;

Montana DNRC Depletion Report – 6/30/2020;

Montana DNRC 41H 30127867 Draft Aquifer Test Report – 1/29/2021; and

07a_DNRC_AquiferTestReport-Appendix-A-41H-30127867-FLIR.XLSX– Undated DNRC spreadsheet containing water rights data.

In addition to the data and information provided by MDEQ, Tasman reviewed and incorporated into the evaluation, historic water level data, water quality data and monitoring and sampling reports going back as far as 1990. Groundwater monitoring reports for the Bozeman Solvent Site are available in DEQ's Bozeman Solvent Site CECRA file. The most recent report submitted to DEQ was the 2020 Annual Groundwater Monitoring report dated February 15, 2021.

Discussion/Conclusions

Determining whether the proposed FLIR extraction wells pose an exposure risk to PCE contaminated groundwater is straightforward. No groundwater data collected in the vicinity of the site, including the groundwater sample collected from extraction well #3 has exhibited detectable concentrations of PCE. Additionally, the open loop geothermal system proposed by FLIR extracts groundwater, pumps it through a heat exchanger system and injects it under pressure into the aquifer. There is no atmospheric contact with the groundwater under the typical operating scenario, and no exposure pathway between the water and a receptor is present. Therefore, the FLIR system does not pose an exposure risk to PCE contaminated groundwater.

In order for the proposed FLIR geothermal system to pose a risk of moving PCE contaminated groundwater into uncontaminated areas, the combined cone of depression would have to intersect the PCE plume. The PCE plume downgradient of the BSS source area has generally reduced in extent and concentration over time; likely as a result of source remediation and natural attenuation. Currently, the nearest well with detectible concentrations of PCE is more than 2,000 feet to the east-northeast of the FLIR site. The well is B-13 which was last sampled on June 2020, and exhibited a PCE concentration of 1.2 µg/L (Tasman, 2021). The direction of regional groundwater flow in the alluvial aquifer is generally to the north in the area. Based on historic monitoring and sampling data collected in the area, the PCE plume is located a significant distance to the east of the FLIR site and is migrating in a south to north direction.

Tasman reviewed the analysis and modeling of data conducted by CTA and DNRC and generally agrees with the methods and results. Because of the lack of aquifer data in the area and the heterogeneity of the aquifer, preparing a precise model of the effects of the pumping and injection system isn't possible.

During the pump tests, one extraction well was pumped and the other extraction wells were used as observation wells. Significant drawdown was measured in the pumping wells and in the extraction wells used as observation wells. As much as 89 feet of drawdown was measured in a pumping well and as much as 27 feet of drawdown was measured in an observation well, 50 feet away. In operation, interference, as a result of the intersecting cones of depression between the three pumping wells, will substantially increase the drawdown observed at each pumping well, based on the data collected during the pump tests.

The extracted water was not injected in the injection wells during the pump test, so as not to affect data collection for aquifer characterization purposes. During operation, injecting the extracted water in the four injection wells will create substantial mounding of groundwater

and/or an increase in hydrostatic head, depending on the degree of confinement of the section of the aquifer the water is injected into. Similar to pumping well interference, and increased drawdown due to intersecting cones of depression, mounding or increased hydrostatic head will occur where the mounding from the four injection wells intersects. The effects are additive. The mounding of groundwater will likely occur from the northwest of the extraction wells to the north, northeast and east of the extraction wells. During operation, the mounded groundwater, combined with the substantial drawdown in the extraction wells will create an extremely steep groundwater gradient from the injection wells to the extraction wells. Once the system is in equilibrium, it is likely that a large portion of the water extracted by the pumping wells will be water that was previously injected.

Although the particle tracking model prepared by CTA did not include injection, Tasman believes it is particularly informative related to evaluation of whether the combined cone of depression from the pumping/injection system will intersect with the PCE plume to the east. The particle tracking model was prepared using limited water level data collected from the extraction and injection wells. Based on that limited data set, the potentiometric surface was contoured as dipping to the northwest. The potentiometric surface my have a localized gradient to the northwest in the immediate area of the test. However, larger datasets, including data collected as part of the Bozeman Solvent Site, indicate that the alluvial aquifer gradient is to the north. Reorienting the particle tracking model to align with the north-dipping gradient results in a primarily south-facing capture zone. The mounding provided by the two pairs of injection provide a steep gradient toward the extraction wells from the northwest direction clockwise to the east.

Because the system has a net zero withdrawal rate, and a significant amount of water that will be extracted will be water that was previously injected, the changes to the potentiometric surface will be minimal, outside of the immediate area of the cones of depression and mounded groundwater, when the system is at equilibrium.

Based on Tasman's evaluation of the significant amount of information and data related to the proposed geothermal system and related testing and analyses, combined with historic data collected as part of monitoring and sampling activities at the BSS, it is Tasman's opinion that it is highly unlikely that the operation of the system would pose an exposure to PCE contaminated groundwater and/or a movement of PCE contaminated groundwater into uncontaminated areas.

If you have any questions about this evaluation, or require further information, please call me at 406-371-6772 or contact me via email at jsullivan@tasman-geo.com.

Sincerely,

Tasman Geosciences, Inc.

Jim Sullivan
Project Manager

References:

Tasman, 2020. 2020 Annual Groundwater Monitoring, Bozeman Solvent Site, Bozeman, Montana, Tasman Geosciences, Inc., February 15.