LAC DE GRAS WATER CHEMISTRY AND TRENDS

Plain Language Summary

In 2014, the GNWT asked Deton' Cho Stantec to describe in statistical terms what the water chemistry in Lac de Gras was like before development of the Diavik and Ekati diamond mines. They also wanted to find out if the water chemistry in the lake had changed since the two mines started putting treated wastewater into the lake, and if so, which mine had contributed the most to the changes that were found.

Lac de Gras is located about 300 km northeast of Yellowknife. It's one of the headwater-source lakes of the Coppermine River, which flows north and discharges into the Arctic Ocean. The area has long, cold winters with short, cool summers. Lac de Gras is about 60 km long, with a maximum depth of 56 meters and an average depth of about 12 meters. The lake is a clear, deep, cold-water lake, and reaches an average summer temperature of only about 10ºC. Not a lot of naturally-occurring substances are dissolved in the water, so it is naturally very pure and dilute, very soft, and with a slightly acidic pH just a bit higher than rainwater. This means that there is little food to support the growth of aquatic plants and algae, and so it is classified as an 'oligotrophic' lake. Because there are so few substances dissolved in the water, the lake and the plants and animals that live in the lake are also relatively sensitive to inputs of nutrients, acid, and metals.

Treated wastewater from the mines has now been released into Lac de Gras for about 14 years. During that time, there were always higher amounts of substances dissolved in the wastewater compared with the natural chemistry of the water in Lac de Gras. The treated wastewater being released by the mines has a lot more of almost all the substances that environmental regulators are concerned about today, including (1) the nutrients nitrogen and phosphorus, which could increase the amount of algae and plants in the lake; (2) the major ions calcium, magnesium, sodium, potassium, sulphate and chloride, which could change the plant and animal communities that live in the water, and; (3) many of the metals naturally found in mined ore. However, the water chemistry data clearly shows that the treated wastewater released by the mines has always been rapidly diluted in the lake, over relatively short distances. This means that the areas of the lake with concentrated mine water remained relatively small when compared with the size of the whole lake, and that there were no spatially overlapping plumes from the Ekati and Diavik discharges.

However, an analysis of how the water chemistry has changed over time also showed that the concentration of many substances had increased a good deal throughout the entire lake over the past 14 years. These included calcium and magnesium (which make the lake water "harder"), chloride, sulphate (which can, in high concentrations, affect the taste of tea), and the metal strontium. The result is that the total amount of dissolved substances has increased in the whole of Lac de Gras.

Sulphate provides a good example of the amount of increase over time. Before the mines opened, the average sulphate concentration in the lake was about 1 mg/L, which is very low. In 2013, the average concentration of sulphate ranged from about 3 to 4 mg/L, depending on location in the lake. This is still a relatively low concentration, but represents an increase of about 100% to 250% over the amount that was measured before the mines opened.

It is suspected, but not proven, that many other substances have also increased. This is because before the mine opened, many of these substances were so uncommon in the lake that they could not be

measured, but after the mines opened and began releasing treated wastewater, these substances became measurable over time.

The increased amounts of many substances over time indicates that there has been a ‘cumulative effect’ of mine operations over time on water chemistry in the whole of Lac de Gras.

The increased concentrations of some of these substances accumulating within Lac de Gras have been caused, at least partially, by natural processes. Data from nearby ‘reference’ lakes, or lakes that are not affected by the mine activities, also showed increases in calcium and magnesium (making the water “harder”), sulphate, and the metal strontium. But, in the reference lakes, these substances have not increased as much as they have in Lac de Gras. This means that the increases seen in LDG are largely the result of treated wastewater released by the mines.

The total amount of substances released by Ekati and Diavik in their effluent was compared, and the results show that the Diavik mine site released the greater amount of substances into the lake. This suggests that the Diavik treated wastewater has contributed the most to the ‘cumulative effect’ that has been measured in Lac de Gras.

Given the volume and chemistry of treated wastewater that is being released by the mines at the present time, it is likely that the changes that have been seen in the lake will continue. However, despite these changes in water chemistry, Lac de Gras is still clear, ‘oligotrophic’, very pure and dilute, very soft, and with a pH just a little bit above rainwater.

This work has created the foundation that environmental regulators need to understand water chemistry in Lac de Gras and how and why it has changed, and to regulate future discharges that could reduce water quality in the lake and its value to people, fish and wildlife.