

Memorandum

TO: City of Greenleaf

FROM: Civil Dynamics PLLC, City Engineer
Devin Krasowski, PE

Date: 5/5/2026

RE: Manganese – Existing Conditions and Ranked Solutions



I. Summary

Manganese is a naturally occurring metal present in the City's groundwater sources at concentrations that, without mitigation, can be expected to cause taste, staining, and discoloration issues. Solutions to these issues, ranked in order of effectiveness, are as follows:

1) New Source of Supply with No or Lower Concentrations of Manganese

The best way to mitigate manganese issues is to avoid having manganese in the City's well water. A new source of supply water well, designed to access aquifers with lower levels of manganese, has an estimated cost of at least \$1,000,000.

2) Removal of Manganese from Existing Water Sources

The second-best option for manganese mitigation is to treat existing groundwater sources and remove the manganese from the water. Conventional treatment additions to the City's water system have an estimated cost of at least \$2,000,000.

3) Manganese Sequestration and System Flushing

The most economically feasible option for partial mitigation is a manganese sequestration program paired with targeted distribution system flushing. This involves injecting phosphate-based chemicals into the City's well water to keep the manganese in a form that is less likely to cause aesthetic issues and flushing water through fire hydrants throughout the system to clean the water lines. The City currently has sequestration and flushing programs that can be amended and reimplemented.

As the planning/funding phases of options **1** and/or **2** develop, the City can continue optimizing the current sequestration and water system flushing programs to improve water quality, as discussed below.

II. Additional Details

In March of 2026, Public Works and Civil Dynamics conducted comprehensive water quality sampling throughout the City of Greenleaf to better define the water quality issues from manganese present in the system and develop planning level solutions to those issues. Sampling results, analysis, and recommended solutions are explored in the Drinking Water Facility Plan that is currently in review with the Idaho Department of Environmental Quality.

Total manganese concentration in water is the sum of dissolved and particulate manganese. Dissolved manganese is soluble, will pass through most filters, and only tends to cause aesthetic issues once it is exposed to an oxidant (like chlorine or air) and drops out of solution. Manganese present in the City's well water is completely dissolved. The intent of the current sequestration program is to keep the manganese in dissolved form throughout the water system.

Results from the sampling effort indicate that either the dissolved manganese is not being completely sequestered by the sequestering agent and/or conditions in the water system are such that the sequestered manganese is later being released with the potential of being converted to manganese in particulate form. Given these results, there are likely modifications that can be made to the existing sequestration program to improve water quality, including:

- 1) Relocating the dosing location of the sequestering agent.
- 2) Optimizing dosing levels of the sequestering agent.
- 3) Targeted, aggressive flushing.

It should be noted that even under optimized dosing strength and dosing location conditions, sequestration as a solution to elevated levels of manganese in drinking water cannot fully mitigate issues caused by manganese. For example:

- 1) Sequestering agents, and their ability to keep manganese in dissolved form, break down at the high temperatures present in water heaters.
- 2) The complex formed when the sequestering agent interacts with dissolved manganese is too large to pass through some filtration system (e.g. reverse osmosis systems). This can lead to premature filter/membrane failure and unintended water quality issues.
- 3) Even stable sequestering agent-manganese complexes will break down over time. The time between the sequestering agent being added and the water being sent to customers in Greenleaf is often long enough to facilitate this breakdown which can result in increased levels of particulate manganese and related aesthetic issues.

The March 2026 water quality sampling results also indicate buildup of particulate matter (manganese and otherwise) in the distribution system. The City can establish a unidirectional water system flushing program to help reduce this buildup and improve water quality.