Private Water Supplies

Chromium – Guidance for Local Authorities

Description and Background

Chromium is a shiny, hard grey metal that is highly resistant to corrosion. It has a complex chemistry, and can exist in oxidation states ranging from +1 to +6, with +3 and +6 being the most common. Chromium occurs naturally in some sedimentary deposits and volcanic areas. Large quantities of chromium ore can be found in Southern Africa, Kazakhstan, Russia and India.

There are many industrial uses for chromium and its salts, including pigments, fungicides, ceramics, glass and photography as well as chromium metal production and metal plating[1].

Contamination of waters used for drinking in industrial areas is not uncommon, and there have been a number of high profile cases around the world, with concentrations many times safe limits.

Affected Areas

Naturally Occurring

In the UK, BGS and SEPA have undertaken stream sediment studies[2] to determine the extent of trace contaminants. From these, high quantities of chromium were found in sediments in Lewis, Skye, Mull, Ardnamuchan, the Ayrshire coast and the Southern Uplands of the Scottish Borders and Dumfries and Galloway, however no samples exceeded the EU standard. It can be inferred that private water supplies in these areas may contain elevated chromium concentrations.

Contamination Sources

Elevated groundwater concentrations have been found on the periphery of Glasgow which may reflect contamination, as JJ Whites in Rutherglen was the world's largest chrome producer during the 19th century. The plant closed in 1967 but processing residues were extensively used as landfill material around Glasgow.

Health Significance

Chromium (III) is a nutritionally essential element in humans and is often added to vitamins as a dietary supplement. Chromium (III) has relatively low toxicity and would be a concern in drinking water only at very high levels of contamination; Chromium (IV) is more toxic and poses potential health risks. People who use water containing total chromium in excess of the standard over many years could experience allergic dermatitis. Food is the main source of exposure to chromium. Toxicological data is rather inconclusive, although there is evidence of carcinogenicity for exposure via inhalation. Chromium (VI) is likely to be the most toxic.

Chromium salts do not impart a taste or odour to water[1] .

Standards are generally set for total chromium, as it can convert between oxidation states both outside and inside the human body. There is a provisional WHO Guideline Value of 0.05mg/l in drinking water for total chromium.
The USEPA sets an MCL for chromium of 0.1mg/l.

The EU Drinking Water Directive sets a standard for chromium of 0.05mg/l.

Risk Assessment and Monitoring

The Private Water Supply regulations require regular monitoring for chromium where it is present at more than 75% of the PCV.

Studies by the British Geological Survey (BGS) into metal concentrations in stream sediments may be helpful in determining the risk from chromium in a particular area[3]. Chromium has been shown to be more mobile in acidic conditions.

What if it fails?
If a water sample fails for chromium it would be prudent to gather additional samples to verify the failure and determine the variability of the concentration of chromium in water. If there are multiple sources, it would be worth sampling each one to determine whether one source has greater levels of contamination than the others.

Check the following:

- Is it likely that chromium is naturally occurring, based on other sample data from supplies in the area and BGS data?
- Is there any history of landfill or industrial processes that could have used chromium?
- If multiple sources, are concentrations of chromium consistent across these?
- If the source is a groundwater, how much is known about the construction of the borehole or spring? Is it known at what depth water is being drawn off?

Any failure of the chromium PCV will also exceed the WHO health-based guideline value. Health advice should be sought.

Options for resolving at source
Plumes of Chromium (VI) can spread for considerable distances through contaminated aquifers. Remediation of contamination is possible, and there are a number of remediation schemes underway around the world. Remediation is costly and many sites suffer from historic contamination, giving complicated liability issues.

Treatment

Chromium (III) is easier to remove than Chromium (VI) as it is less soluble in water. Therefore traditional large-scale water treatment process are likely to be more effective at removing chromium (III) [4]. Ion exchange would appear to be the most reliable option for chromium (VI) removal, although there is little evidence of this being done directly on drinking water supplies. Further treatment technologies are the subject of some study [4].

At a small scale, ion exchange may be the most feasible technology and there are some proprietary processes that claim to do this. As with all treatment technologies it is important that the selected process is approved for use with drinking water and accredited for the desired application.

References / Further reading

1 US EPA 2013. Basic Information about Chromium in Drinking Water. USEPA
http://water.epa.gov/drink/contaminants/basicinformation/chromium.cfm#one

[2] Macdonald, A M, Fordyce, Fm, Shand, P And Ó Dochartaigh, B É. 2005.
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[3]Shand, P, Edmunds, W M, Lawrence, A R, Smedley, P L, and Burke, S. 2007.
The natural (baseline) quality of groundwater in England and Wales.
British Geological Survey & Environment Agency, RR/07/06 & NC/99/74/24
USEPA 2003

[4] AWWA 2013. *Chromium in Drinking Water: A Technical Information Primer.* American Water Works Association.

FAQ Fact Sheet for Owners and Users

To be developed if necessary