Summary

i Reasons

Chromium is a naturally occurring element in the environment that primarily exists in one of three oxidative forms; the 0, +3 (chromium (III); trivalent chromium), and +6 (chromium (VI); hexavalent chromium) valency states. Chromium (III) plays an essential role in insulin metabolism in man, however, chromium (VI) is carcinogenic. Carcinogenicity appears to be localised to the point of absorption, as chromium (VI) rapidly penetrates the cell membrane, where it is reduced intracellularly to chromium (III), which in turn binds to macromolecules. The World Health Organization (WHO) has derived a provisional Guideline for Drinking-water Quality (GDWQ) of 50 μg/l for total chromium. WHO states that separate guideline values for chromium (III) and chromium (VI) should be derived, however, there are technical difficulties in analytically measuring chromium at different valencies. Therefore, this study was undertaken to evaluate the current toxicological knowledge on chromium (VI) and undertake a survey in England and Wales to understand the significance of chromium in drinking water.

ii Objectives

1. A review of the toxicokinetics and toxicity of chromium has been undertaken.

2. A review of the fate of chromium in water treatment and supply and previous chromium (VI) monitoring studies was conducted.

3. An analytical method has been developed and tested for the analysis of chromium (VI) and surveys of chromium, chromium (III) and chromium (VI) concentrations in drinking water has been conducted.

iii Benefits

This report provides significant additional understanding on the current state of knowledge of the toxicity and toxicokinetics of chromium. It also highlights several areas where several gaps in knowledge remain and makes suggestions on how these may be addressed. This report also provides the most comprehensive information to date on occurrence of chromium in drinking water supplies in England and Wales.

iv Conclusions

In general, concentrations of chromium (VI) in drinking water in England and Wales are very low, and are consistent with levels reported in other countries (<1 μg/l). One site was the exception to this, where levels of up to 9.94 μg/l were reported. The gaps in the toxicity and
toxicokinetics data mean that at present it is very difficult to establish a definitive level upon which to propose a new drinking water standard, a range of values have been suggested. For the majority of sites considered in this survey, the concentrations of chromium (VI) were well below even the more conservative of these health-based values, and in the majority of cases were <1 µg/l. However, there would be concern at the one site where concentrations approaching 10 µg chromium (VI)/l were detected if the most conservative lifetime health-based value of 5.4 µg/l is applied. However, it should be noted that this statement is based on the assumption of drinking water only accounting for 20% of total exposure to chromium (VI) (i.e. other sources such food would account for significant exposure). This may be an overly-precautionary assumption, as the available data indicate that food would not provide a significant source of chromium (VI). Therefore, if more realistic assumptions are applied (i.e. drinking water accounts for 80% of total exposure to chromium (VI)), the level detected at this site would be below the derived health-based value (21.6 µg/l).

Overall, in the majority of cases, exposure to chromium (VI) via drinking water in England and Wales is very low and there is no evidence to suggest exposure to the typical concentrations reported in the survey (<1 µg/l) will result in adverse human health effects.

v Recommendations

Further information on the toxicokinetics of chromium (VI) is required to allow the more precise derivation of health-based values. In addition, more information of the effect of drinking water treatment processes on oxidation of chromium (III) to chromium (VI), or the reduction of chromium (VI) to chromium (III) is required.