Overview
ALS Environmental can provide analytical testing for quaternary ammonium herbicides in water with reporting limits of less than 5 ng/l. On the basis of their toxicity, the World Health Organization (WHO) has classified diquat and paraquat as moderately hazardous and considered as priority pollutants, chlormequat and mepiquat are classified as slightly hazardous. Due to this, there is concern about the presence of these compounds in different matrices such as fruits, soils and waters. In response to this issue, ALS Environmental has developed, validated and accredited a method capable of analysing these compounds in water at ultra-trace levels using state of the art instrumentation.

Quaternary Ammonium Herbicides
Background
Quaternary ammonium herbicides and plant growth regulators, commonly known as “quats”, constitute an important group of pesticides. Included in this group are the two herbicides diquat and paraquat, and the two plant-growth regulators chlormequat and mepiquat.

Diquat and paraquat are widely used as fast-acting non-selective contact herbicides for the control of weeds. The commercial herbicide formulations usually contain diquat dibromide and paraquat dichloride.

Diquat and paraquat are suitable for many agricultural uses because of their high solubility in water, their low production of vapours during application and their ability to bind rapidly and tightly to clay materials in soils and when absorbed are biologically inactive. Many incidents of accidental and intentional exposures to these compounds have been reported. The primary route of exposure is ingestion, although in rare occurrences, inhalation and dermal exposure has caused toxic effects. Upon paraquat absorption, the compound primarily accumulates in the lungs, resulting in acute pulmonary distress, but it also has drastic effects on the gastrointestinal tract, the kidneys, the liver, and the heart. Diquat also accumulates in the lungs, liver, and kidneys, but to a lesser extent than paraquat. Both paraquat and diquat target the central nervous system, with most effects seen in the brain stem. Paraquat is believed to be associated with Parkinson’s disease because of its deleterious effects on the dopaminergic neurons.

Chlormequat and mepiquat are used as plant growth regulators to reduce unwanted longitudinal shoot growth without lowering plant productivity. Chlormequat and mepiquat are used on several food crops, especially in cereals and in some fruit and vegetables.

Quaternary Ammonium Herbicides
Regulatory Guidelines
The United States Environmental Protection Agency’s (EPA) has established a health advisory level of 20 µg/L for diquat, and a maximum contamination level of 3 µg/L for paraquat in drinking water. The European Union directive (98/83/EC) on the quality of water intended for human consumption declares maximal acceptable concentrations for individual pesticides and their metabolites to 0.1 µg/L while the sum of all pesticides and metabolites must not exceed the value of 0.5 µg/L.

Analysis Of Quaternary Ammonium Herbicides
Quaternary ammonium herbicides are a particularly difficult group of compounds to analyze. Their high solubility in water, non-volatile and cationic character makes extraction and detection difficult. Ion-pair high performance liquid chromatography (HPLC) using ultraviolet (UV) detection has been the quantitative method of choice for these ionic species in the past. However, UV detection is susceptible to interferences from water matrices and lacks the detection specificity to provide unequivocal analyte identification.
To overcome the problems of quantification and identification ALS have developed a weak cation exchange solid phase extraction HPLC-triple quadrupole tandem mass spectrometry (MS/MS) method for the simultaneous determination of four quaternary ammonium herbicides. Use of this sensitive and selective instrumentation enables ALS to achieve detection limits (LODs) of less than 5ng/L for chlormequat, diquat, mepiquat and paraquat in treated and raw water. The range of application for this method is up to 125 ng/L.

**Quats Performance Summary for ALS Method WPC51.**

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS Number</th>
<th>Recovery from Water at 100ng/L</th>
<th>Limit of Detection (LOD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlormequat</td>
<td>7003-89-6</td>
<td>102.8%</td>
<td>3ng/L</td>
</tr>
<tr>
<td>Diquat</td>
<td>2764-72-9</td>
<td>97.7%</td>
<td>3ng/L</td>
</tr>
<tr>
<td>Mepiquat</td>
<td>15302-91-7</td>
<td>100.2%</td>
<td>3ng/L</td>
</tr>
<tr>
<td>Paraquat</td>
<td>4685-14-7</td>
<td>97.2%</td>
<td>4ng/L</td>
</tr>
</tbody>
</table>

**Accreditation**

ALS quaternary ammonium herbicide analysis of treated and raw water is UKAS accredited under ISO/IEC 17025:2005 to the Drinking Water Testing specification (DWTS) to provide our customers with additional confidence in the analytical data provided.

**General Sampling & Preservative Requirements**

Bottle: 125ml PE/HD bottle preserved with ascorbic acid.
Storage: Stored at 5°C.
Holding Time: Samples are stable for at least 14 days under these storage conditions.