Prairie Creek Project

EFFLUENT TREATMENT OPTIONS PLAN
WATER LICENCE MV2001L2-0003

April, 2019
Preamble

This *Effluent Treatment Options Plan* applies to the Decline project and mine water from the existing underground workings during activities of Canadian Zinc Corporation during exploration at the Prairie Creek Property associated with Water Licence MV2001L2-0003.

The following formal distribution has been made of this plan:

Mackenzie Valley Land and Water Board

Canadian Zinc Corporation - Prairie Creek Site Office

NorZinc - Vancouver Office

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1.0 INTRODUCTION

Prairie Creek Mine is located in the southern Mackenzie Mountains in the south-west corner of the Northwest Territories at 61° 33’ north latitude and 124° 48’ west longitude (Figure 1). The existing mine infrastructure is situated adjacent to Prairie Creek.

As part of the ongoing mineral exploration process of establishing, confirming and enhancing the mineral resource at the Prairie Creek property, Canadian Zinc (CZN) constructed a new decline tunnel and underground development in 2006-2007 to permit access for underground exploration, including drilling of the stratabound deposit underlying the Zone 3 quartz vein mineralization. Further delineation of the vein-type mineralization was undertaken at the same time. The new decline was accessed via the existing portal at the Mine site at a 870 m elevation. The 870 m level extends approximately 800 m into the mountain to where the collar of the Decline occurs.

During permitting, CZN undertook to also manage mine water emanating from the existing workings during the exploration Decline project. CZN has continued to manage this water after completion of the Decline project. The ‘870’ water and the Decline water both emerge from the portal, the former flows through the old underground workings and along the adit floor to the portal area while the majority of the water flows from the Decline are directed into a pipe for delivery to the portal. The 870 water requires treatment due to elevated dissolved zinc, the Decline water does not.

Treated mine water flows to the Polishing Pond. Thereafter, the water discharges to the existing Catchment Pond, and from there to Harrison Creek (see Figure 2) and then to Prairie Creek.

This Effluent Treatment Options Plan explains how CZN plans to continue to treat mine water under Water Licence MV2001L2-0003.
2.0 MINE WATER PROPERTIES

2.1 WATER FLOWS

The 870 m portal allows the gravity drainage of mine water from the lowest elevations and oldest parts of the underground workings (including water from the Decline), and includes drifts with exposures of vein mineralization. The water is slightly alkaline, and contains dissolved metals, especially zinc. Since 2007, the volume of this discharge during summer months has averaged approximately 15 L/sec, but a peak of 28 L/sec has been recorded.

The Decline is now flooded and makes very little water in summer, in the order of 0.5-1 L/sec.

Calibrated weirs are installed on Polishing Pond outflow and the two drainage ditches flowing into the Catchment Pond. Flows from the Polishing Pond are recorded daily during periods of discharge.

During the winter season, if there is no work activity underground, an ice plug forms at the 870 portal and there is no drainage discharge from the portal area.

2.2 WATER CHEMISTRY

Zinc

Total zinc concentrations in 870 water are usually in the range 8-10 mg/L. However, concentrations as high as 31.7 have been recorded. Concentration peaks are coincident with prolonged and intense rainfall events, which usually occur in early summer. Concentrations are much lower in winter and shoulder periods. Most of the total zinc is in the dissolved form.

Concentrations of total zinc in Decline water vary in the range 0.1-0.2 mg/L. Dissolved zinc concentrations are between an order and a half less.

Ammonia

Elevated ammonia concentrations in mine water were avoided by the use of stick-type explosives. Ammonia concentrations in current mine water discharge are very low.

Hydrocarbons

Oil absorbent pads and/or booms were employed at each sump and the Polishing Pond during underground activities. Hydrocarbon concentrations are now similarly low.
3.0 MINE WATER TREATMENT

3.1 WATER TREATMENT PROCESS

CZN treats mine water at the culvert which receives mine water from the 870 portal, with secondary treatment integrated within the culvert stream in a connected delivery line to the Polishing Pond. The principal metal of concern in mine water is zinc.

Sodium sulphide is the primary treatment chemical which converts dissolved zinc to a solid sulphide form. The sulphide is added from a dosing tank adjacent to the 870 portal where the sulphide is mixed. The sulphide solution is delivered by pipe to the culvert at a steady rate (see Figure 3). Sulphide dose is mainly determined by the mine water flow rate, which is monitored at the outflow of the Polishing Pond.

The culvert delivers dosed mine water into a round reaction tank. Figure 4 shows a square tank, however there is another tank which is round inside it. As the water leaves the first tank, the flow is dosed with iron in the form of ferric sulphate which acts as a coagulant. The coagulant promotes the agglomeration of fine particles created from sulphide treatment. The iron also ensures any excess sulphide is consumed, and promotes settling. The dosed flow then enters a second reaction tank. The flow from the second tank is dosed with flocculants on exit, and is then delivered to the first cell in the Polishing Pond (see Figure 4).
3.2 WATER TREATMENT DOSING

The water treatment process and chemical doses were previously determined by CEMI/SGS following water treatment testing. In 2017, further testing was completed by Applied Water Treatment Inc. (AWT), who recommended doses of 12 mg/L of sulphide (48 mg/L sodium sulphide), 4 mg/L of iron (20 mg/L ferric sulphate) and 1.5 mg/L of flocculant. These chemicals and doses provided improved treatment effectiveness in 2018, but further improvement was desired.

Univar completed further testing in November 2018. Univar confirmed the primary treatment and coagulant steps, but recommended different flocculants. The recommended doses are 12 mg/L sulphide (as 48 mg/L sodium sulfide), 3.9 mg/L iron (as 19.5 mg/L ferric sulfate), followed by Vanfloc FC MT Plus and Vanfloc FS 15 as flocculants in doses of 2 mg/L. Univar’s testing report is provided in Appendix A.

3.3 POLISHING

The primary purpose of the Polishing Pond is to provide polishing for inflowing treated mine water. The Pond provides retention time for the settlement of fine particles, followed by discharge to the Catchment Pond prior to final discharge to Harrison Creek.

The Polishing Pond has a capacity of approximately 1500 m$^3$ with a 0.5 m freeboard above the spillway elevation. Internal baffles prevent short-circuiting and maximize retention time and settling. At an average inflow of 15 L/sec, the retention time in the Polishing Pond is approximately 28 hours. At the maximum recorded inflow of nearly 30 L/sec, the retention time would be approximately 14 hours.
The arrangement of the baffles was reviewed by a hydrologist from Tetra Tech in March 2019. A revised arrangement of baffle openings was proposed to reduce turbulence and promote settling. Tetra Tech’s report is provided in Appendix B.

Sludge from treatment accumulates in the Polishing Pond, and may need to be periodically removed to ensure on-going treatment is not compromised. This has not been necessary to date. Any sludge removed will be a relatively small quantity, and will be taken underground to a disposal location that is isolated from drainage. The sludge will remain geochemically stable in the alkaline underground environment. However, even if leaching occurs, the leachate will report to mine drainage and will be subject to treatment.

3.4 MONITORING

Monitoring of zinc concentrations in mine water after treatment is performed using a portable ultra-violet spectrophotometer which determines zinc content by colourimetry (see Appendix C for meter description). The meter has a quoted test range of 0.2-3.0 mg/L. Water samples from the 1st cell of the Polishing Pond are tested for zinc concentration using the meter, with confirmation against prepared standards (see Appendix D for test method). Results are available within a few hours, and allow adjustments to sulphide dose and/or water management activities if necessary. Representative water samples (SNP) are also collected and sent off-site for the analysis of metals (by ICP) to confirm the accuracy of site data.

Water discharged from the Polishing Pond (SNP Station No. 3-4), is monitored in accordance with the Water License and must comply with the effluent quality requirements specified in Part D, Section 4 prior to discharge to the existing Catchment Pond. The discharge from the Catchment Pond (SNP Station No. 3-5) into Harrison Creek (SNP Station No. 3-6) and subsequently Prairie Creek downstream of the confluence with Harrison Creek (SNP Station No. 3-11), are also monitored as per the Water Licence.
APPENDIX A

UNIVAR TESTING REPORT
Univar – Water Treatment
Canadian Zinc – Zinc Analysis
November 2018
Bench-scale Laboratory Report – Zinc Removal

Customer
Canadian Zinc

Testing goals
1. Evaluate current process and chemical addition – confirm reagent doses.
2. Test polymer performance.
3. Evaluate alternative chemicals that could potentially increase performance.

Background
Canadian Zinc is facing challenges to remove Zinc from the mine drainage currently being treated prior to discharge into the environment.
The current treatment applies sulfide precipitation which converts soluble metals compounds into relatively insoluble sulfide compounds. However, metal-sulfide precipitates most often must be physically removed from solution through coagulation, flocculation, and clarification or filtration, leaving metal-sulfide sludge.
The dissolved Zinc currently is under the limit; however the main challenge is the Total Zinc, which leads to an improvement in the coagulation-flocculation process (precipitate removal).

Testing Procedure
1. Water collected onsite was vigorously mixed before testing.
2. Samples from the jug were collected and directly place on the jar tester.
3. Mixing speed was set to 60 rpm.
4. Sodium sulfide solution was added at t=1 min.
5. At t=20 min, Ferric sulfate solution was added.
6. At t=22 min, filter aid was added.
7. At t=23 min, ½ of the polymer dose was added.
8. At t=24 min, the remaining of the polymer was added.
9. At t=25 min, mixed was stopped.
10. After 45 minutes of settling time, samples were collected and saved for metal analysis.

Jar Test #1
In this set of jars, the goal was to find the correct doses for sodium sulfide and ferric sulfate. We kept the polymer dose fixed as 2 ppm. In this set of jars, we only tested for dissolved zinc at Univar’s lab.
As you can see below, the required doses of sodium sulfide was 10-12 ppm and 14.6 – 19.5 ppm of ferric sulfate.
### Sample Data

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Sod Sulfide (mg/L)</th>
<th>Ferric Sulfate (mg/L)</th>
<th>FC MT Plus (mg/L)</th>
<th>Dissolved Zinc (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CZ 01</td>
<td>6</td>
<td>4.88</td>
<td>2.00</td>
<td>1.2590</td>
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<tr>
<td>CZ 02</td>
<td>8</td>
<td>9.76</td>
<td>2.00</td>
<td>0.7019</td>
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<tr>
<td>CZ 03</td>
<td>10</td>
<td>14.63</td>
<td>2.00</td>
<td>0.2170</td>
</tr>
<tr>
<td>CZ 04</td>
<td>12</td>
<td>19.51</td>
<td>2.00</td>
<td>0.0412</td>
</tr>
<tr>
<td>CZ 05</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>1.2970</td>
</tr>
</tbody>
</table>

Since we couldn’t measure the Total Zinc, we decided to continue the tests with 12 ppm of sodium sulfide and 19.5 ppm of ferric sulfate.

### Jar Test #2

In this set of jars, the goal was to test two polymers combined with a filter aid to see if there were any improvements.

As you can see below, adding Vanfloc FS 4 (Filter Aid) had a great improvement in the dissolved zinc results. For Vanfloc FC MT Plus, adding the filter aid improved the dissolved zinc by 90% and for Vanfloc FS 15 by 70%.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Polymer Name</th>
<th>Sod Sulfide (mg/L)</th>
<th>Ferric Sulfate (mg/L)</th>
<th>Vanfloc FS 4 (mg/L)</th>
<th>Polymer (mg/L)</th>
<th>Dissolved Zinc (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CZ 07</td>
<td>FC MT Plus</td>
<td>12</td>
<td>19.51</td>
<td>0.00</td>
<td>2.00</td>
<td>0.0183</td>
</tr>
<tr>
<td>CZ 08</td>
<td>FC MT Plus</td>
<td>12</td>
<td>19.51</td>
<td>5.00</td>
<td>2.00</td>
<td>0.0019</td>
</tr>
<tr>
<td>CZ 09</td>
<td>FS 15</td>
<td>12</td>
<td>19.51</td>
<td>0.00</td>
<td>2.00</td>
<td>0.0060</td>
</tr>
<tr>
<td>CZ 10</td>
<td>FS 15</td>
<td>12</td>
<td>19.51</td>
<td>5.00</td>
<td>2.00</td>
<td>0.0018</td>
</tr>
<tr>
<td>CZ 06</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>2.014</td>
</tr>
</tbody>
</table>
Jar Test #3
For the last set of jars, we repeated the same products and doses from the past test in order to collect samples for Dissolved Zinc and Total Zinc analysis.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Polymer name</th>
<th>Sod Sulfide (mg/L)</th>
<th>Ferric Sulfate (mg/L)</th>
<th>Vanfloc FS 4 (mg/L)</th>
<th>Polymer (mg/L)</th>
<th>Dissolved Zinc (mg/L)</th>
<th>Total Zinc (mg/L)</th>
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</thead>
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<td>CZ 12</td>
<td>FC MT Plus</td>
<td>12</td>
<td>19.51</td>
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<td>0.161</td>
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<td>CZ 13</td>
<td>FC MT Plus</td>
<td>12</td>
<td>19.51</td>
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<td>2.00</td>
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<td>CZ 14</td>
<td>FS 15</td>
<td>12</td>
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<td>2.00</td>
<td>0.0000</td>
<td>0.176</td>
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<tr>
<td>CZ 15</td>
<td>FS 15</td>
<td>12</td>
<td>19.51</td>
<td>5.00</td>
<td>2.00</td>
<td>0.0000</td>
<td>0.076</td>
</tr>
</tbody>
</table>

CZ 11

Table above confirms the results observed on Jar Test#2. The addition of Vanfloc FS 4 improves the coagulation-flocculation process reducing the final concentration of dissolved and total Zinc.

Summary:

Based on the results obtained in the bench test study, we recommend a dose of 12 mg/L of Sodium Sulfide, followed by 19.5 mg/L of Ferric Sulfate in order to precipitate the soluble metal species (focused on Zinc residuals).

Vanfloc FC MT Plus and Vanfloc FS 15 can be used as flocculants in order to improve zinc removal through coagulation-flocculation (settling). Recommended doses are 2 mg/L.

Addition of Vanfloc FS 4 improves drastically the zinc removal (around 40% increase on Total Zinc Removal). Recommended doses are 5 mg/L.
APPENDIX B

TETRA TECH POLISHING POND REPORT
1.0 POND CONFIGURATION ASSESSMENT

Canadian Zinc (CZN) has asked Tetra Tech to review physical performance aspects of the polishing pond used as the last stage of water quality treatment of mine water effluent from the Prairie Creek mine. The initial stage water quality treatment involves use of sodium sulphide to convert dissolved zinc to total zinc, and then a flocculant is added to bind the fine particles created by the initial process. The polishing pond is the receptor facility for settlement of the treated and flocked particulate and is the last stage of treatment before water is discharged to Prairie Creek.

As shown in the CZN-provided image which follows, the polishing pond has a somewhat trapezoidal footprint with two interior baffle barriers to prevent short-circuiting and extend the internal flow path. Each baffle has a single opening at the locations marked, extending about one third of the pond width. The first (north) baffle’s opening is at the pond bottom and the second (south) baffle’s opening is at the pond surface. Pond side slopes are understood to be about 2:1 (H:V) and the maximum depth is about 2.5 m.

Water enters the pond from a discharge pipe near the “inflow” label, there is also a dock or jetty near this location, not to be confused with the pipe. Starting from approximately the end of the dock there is a dark green plume-like feature which may be an accumulation deposit of coarse settleable particles from the inflow pipe. In discussion with CZN, the colouration for the rest of the pond believed to be an indicator of its depth and is not a useful indicator of flow circulation patterns.

The pond configuration is good overall; the positions of inflow pipe, outlet weir and interior baffles should result in good utilization of the available footprint. We suggest two conceptual alterations which may slightly improve pond performance.

1. The outlet from the pond inlet pipe could be changed from a single point release to a manifold configuration with multiple outlets along the outer edge of pond. This would minimize recirculation (dead) areas near the inlet.

2. The first (north) baffle opening at the bottom of the pond could be changed to a top opening at the pond water surface. This will eliminate the present condition of relatively high velocities at the pond bottom that will locally impair or prevent sedimentation.
2.0 LIMITATIONS

This report and its contents are intended for the sole use of NorZinc Ltd. / (Canadian Zinc Corporation) and their agents. Tetra Tech Canada Inc. (operating as Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than NorZinc Ltd. / (Canadian Zinc Corporation), or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user.
3.0 CLOSURE

We trust this report meets your present requirements. If you have any questions, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

ISSUED FOR REVIEW

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PERMIT TO PRACTICE
TETRA TECH CANADA INC.
Signature ____________________________
Date ____________________________

PERMIT NUMBER: P 018
NT/NU Association of Professional
Engineers and Geoscientists
APPENDIX C

HACH PORTABLE UV SPECTROPHOTOMETER DESCRIPTION
THE VERSATILE AND EASY-TO-USE

POCKET COLORIMETER™ II

RUGGED
WATERPROOF
BACKLIT

The Hach Pocket Colorimeter II is calibrated
for one to two parameters, with low or
high range. Each instrument comes
in a ready-to-use kit that includes
a manual, pre-measured unit use
reagents, sample vials, and a
sturdy custom carrying case.
WE HAVE IMPROVED THE POCKET COLORIMETER BY ADDING NEW FEATURES, MAKING IT EVEN MORE VERSATILE AND EASIER TO USE.
SIMPLE AS EVER
We have added new features to the Pocket Colorimeter II, but it still has the same great advantages as the original. Hach Colorimeters put the accuracy and reliability of a lab instrument in the palm of your hand.

WATERPROOF, LIGHT WEIGHT AND ECONOMICAL
The Pocket Colorimeters can really be carried in your pocket. Weighing only 23 kg (8.1 oz.), the Pocket Colorimeter II is a low-cost instrument that anyone can use. It even floats!

ACCURATE, REPRODUCIBLE MEASUREMENTS
Wherever you are, the Pocket Colorimeter™ II offers accuracy and reproducibility comparable to expensive lab instruments, but is designed for a long working life in harsh conditions. A long-lasting LED is used as the light source.

PRE-PROGRAMMED
The instruments are factory programmed for one of more than 35 parameters; many are based on EPA-approved methods. No manual calibration is ever required. Simply zero the instrument with a blank, insert the reacted sample, and read the result. It's so easy.

BETTER OPTICS
The improved quality of the optical system allows for expanded ranges for ammonia, chlorine, chromium, copper, iron, and molybdenum, reducing the need for dilutions.

<table>
<thead>
<tr>
<th>ANALYTE</th>
<th>OLD RANGE</th>
<th>NEW RANGE</th>
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<tr>
<td>AMMONIA</td>
<td>0-0.50 mg/L</td>
<td>0.01-3.00 mg/L</td>
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<tr>
<td>AMMONIA, FREE</td>
<td>—</td>
<td>0.02-5.00 mg/L</td>
</tr>
<tr>
<td>CHLORINE</td>
<td>0-3.00 mg/L</td>
<td>0.1-10.0 mg/L</td>
</tr>
<tr>
<td>CHROMIUM</td>
<td>0-0.50 mg/L</td>
<td>0.01-3.00 mg/L</td>
</tr>
<tr>
<td>COPPER</td>
<td>0-4.00 mg/L</td>
<td>0.04-5.00 mg/L</td>
</tr>
<tr>
<td>IRON, TPTZ</td>
<td>0-1.25 mg/L</td>
<td>0.01-1.20 mg/L</td>
</tr>
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<td>IRON, FEPO4</td>
<td>0-3.00 mg/L</td>
<td>0.02-5.00 mg/L</td>
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<tr>
<td>MOYOBEDENUM</td>
<td>0.250/5-10.0 mg/L</td>
<td>0.02-3.00/0.1-12.0 mg/L</td>
</tr>
</tbody>
</table>

The ability to accept user calibrations is a first! It allows you to create your own calibration curve or perform a standard adjust.

The improved optics also expand the absorbance range of the instrument to 0-2.5 Abs.

We also manufacture wavelength-specific instruments so you can enter your own methods and calibrations using two to ten standards. Hach makes Spec III™ Standards to verify performance of nine different parameters. Check out our website for more information on these wavelength colorimeters.

PARAMETERS FOR DRINKING WATER AND WASTEWATER

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<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Sensor</th>
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<td>Al</td>
<td>Iron</td>
</tr>
<tr>
<td>Ammonia</td>
<td>NH3</td>
<td>TPTZ</td>
</tr>
<tr>
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<td>Lead</td>
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<td>Cl</td>
<td>Manganese, Low Range</td>
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<td>Manganese, Monochrome</td>
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<td>Chlorine Dioxide</td>
<td>ClO2</td>
<td>Nitrate</td>
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<tr>
<td>Copper</td>
<td>Cu</td>
<td>Phosphate</td>
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<td>Dissolved Oxygen</td>
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<td>Suitable</td>
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<tr>
<td>Fluoride</td>
<td>F</td>
<td>Zinc</td>
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<td>Iron, Ferroxcene</td>
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PARAMETERS FOR ENVIRONMENTAL TESTING

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<td>Ammonia</td>
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<td>Dissolved Oxygen</td>
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PARAMETERS FOR INDUSTRIAL CONTROL

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<td>Chromium, Hazard</td>
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<td>Dissolved Oxygen</td>
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</tbody>
</table>

The compact size of the Pocket Colorimeter II makes it very portable and convenient.

The ability to float is just one of the great new features of the Pocket Colorimeter II.
Pocket Colorimeter™ II

SPECIFICATIONS

POWER SUPPLY
4 AAA batteries, approximate life of 2000 tests
Use of backlight reduces this number

LAMP
Light Emitting Diode (LED)

DETECTOR
Silicon detector

WAVELENGTH
Fixed wavelength ±2 nm, varies with model
45 nm

FILTER BANDWIDTH

ABSORBANCE RANGE
0 to 2.5 Abs
6.1 x 15.5 x 3.5 cm (2.45 x 6.2 x 1.4 in.)
0.23 kg (0.5 lbs.)
0 to 50°C, 9 to 80% relative humidity
15 cm and 22 mm

DIMS

NET WEIGHT

OPERATING CONDITIONS

SAMPLE CELL PATHLENGTH

COMPLIANCE
European CE mark
Lab-1

DISPLAY

WARRANTY
2 years

ENCLOSURE
IP67, waterproof at 1 m for 30 minutes

ORDERING

Alcohol (PN 8704-00)
0.1, 0.5 g ppm thresholds
Method: Immunoassay (10 tests)

Ammonia (PN 8704-00)
0.2 ± 0.0 mg/L
Method: Alum (10 tests)

Ammonia, Free and Nitrite (PN 8704-26)
0.1 ± 0.0 mg/L
Method: Indophenol (50 tests)

Ammonia, Fluorescence (PN 8704-26)
0.05 ± 0.0 mg/L
Method: Indophenol (50 tests)

Bromide (PN 8704-00)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Bromine (PN 8704-00)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Chlorophyll a and b (PN 8704-26)
0.02 ± 0.0 mg/L
Method: Indophenol (50 tests)

Chlorine Free + Total (PN 8704-00)
0.02 ± 0.0 mg/L
Method: Indophenol (10 tests)

Chlorine (PN 8704-12)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Chlorine, Sulfur Test Dispenser (PN 8704-23)
Free Chlorine
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Chlorine, Sulfur Test Dispenser (PN 8704-23)
Total Chlorine
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Chlorophyll (PN 8704-26)
0.02 ± 0.0 mg/L
Method: Indophenol (10 tests)

Chromate (PN 8704-02)
0.02 ± 0.0 mg/L
Method: Indophenol (10 tests)

Chromium, Hexavalent** (PN 8704-17)
0.05 ± 0.0 mg/L
Method: Spectrophotometry (10 tests)

Copper** (PN 8704-15)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Iron** (PN 8704-25)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Lactate (PN 8704-21)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Lead** (PN 8704-21)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Magnesium, Total (PN 8704-18)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Nitrite (PN 8704-02)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Phosphate** (PN 8704-00)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Phosphate (PN 8704-00)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Silica (PN 8704-18)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Sulfate** (PN 8704-29)
0.05 ± 0.0 mg/L
Method: Indophenol (10 tests)

Turbidity (PN 8704-14)
0.02 ± 0.0 mg/L
Method: Indophenol (50 tests)

Total Dissolved Solid (PN 8704-00)
0.01 ± 0.0 mg/L
Method: Indophenol (10 tests)

Total Phosphorus (PN 8704-06)
0.02 ± 0.0 mg/L
Method: Indophenol (10 tests)

Total Nitrogen (PN 8704-02)
0.02 ± 0.0 mg/L
Method: Indophenol (10 tests)

Total Solids (PN 8704-14)
0.02 ± 0.0 mg/L
Method: Indophenol (10 tests)

For current price information, technical support and ordering assistance, contact the Hach office or distributor serving your area.

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Fax: 970-569-2372
E-mail: orders@hach.com
www.hach.com

HACH COMPANY World Headquarters
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Loveland, Colorado 80539-0369
U.S.A.
Telephone: 970-669-3050
Fax: 970-461-3393
E-mail: info@hach.com
www.hach.com

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Fax:+49 (0) 61 52 608-143
E-mail:kundenservice@dlange.de
www.dlange.com

U.K. No. 2441
D05
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Page 24
APPENDIX D

COLOURIMETRIC ZINC TEST METHOD
Zinc

**Method 8009**

**Powder Pillows**

**Scope and Application:** For water and wastewater; digestion is required for determining total zinc (see Digestion on page 1042; USEPA Approved for wastewater analyses**

*Adapted from Standard Methods for the Examination of Water and Wastewater.

---

**Tips and Techniques**

- Caution! ZincoVer® 5 Reagent contains cyanide and is very poisonous if taken internally or if fumes are inhaled. Do not add to an acidic sample (pH < 4).
- Use only glass-stoppered cylinders in this procedure.
- Wash glassware with 1:1 HCl (Cat. No. 884-40) and rinse with deionized water before use.
- Wipe the outside of sample cells before each insertion into the instrument cell holder. Use a damp towel followed by a dry one to remove fingerprints or other marks.
- Use plastic droppers in this procedure. Droppers with rubber bulbs may contaminate the reagent.
- ZincoVer 5 reagent contains potassium cyanide. Cyanide solutions are regulated as hazardous wastes by the Federal RCRA. Cyanide should be collected for disposal as a reactive (DDQ) waste. Be sure that cyanide solutions are stored in a caustic solution with pH >11 to prevent release of hydrogen cyanide gas. See Section 5 for further information on proper disposal of these materials.

---

**Powder Pillows**

1. **Hach Programs**
   - Select program 780 Zinc.
   - Touch **Start**.

2. **2. Fill a 25-mL graduated mixing cylinder with 20 mL of sample.**

3. **3. Add the contents of one ZincoVer 5 Reagent Powder Pillows to the cylinder: Stopper.**

4. **4. Invert several times to dissolve the powder completely. Inconsistent readings may result for low zinc concentrations if all the particles are not dissolved.**

**Note:** The sample should be orange. If the sample is brown or blue, either the zinc concentration is too high, or an interfering metal is present. Dilute the sample and repeat the test.

---

Zinc

Zinc PP Other_ZNC_En-gb_Only.fm
5. Pour 10 mL of the solution into a sample cell (this is the blank).

6. Use a plastic dropper to add 0.5 mL of cyclohexanone to the remaining solution in the graduated cylinder.

7. Touch the timer icon Touch OK.
An 30 second reaction period will begin. During the reaction period, stopper the cylinder and shake vigorously (the prepared sample).

8. Touch the timer icon Touch OK.
A three-minute reaction period will begin. During this reaction period, complete step 9.

Note: The sample will be reddish-orange, brown, or blue, depending on the zinc concentration.

9. Pour the solution from the cylinder into a round sample cell (this is the prepared sample).

10. When the timer beeps, wipe the blank and place it into the cell holder.

11. Touch Zero, The display will show:
mg/L Zn

12. Wipe the prepared sample and place it into the cell holder.
Results will appear in mg/L Zn.
Interferences

<table>
<thead>
<tr>
<th>Interfering Substance</th>
<th>Interference Levels and Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>Greater than 6 mg/L</td>
</tr>
<tr>
<td>Calcium</td>
<td>Greater than 0.5 mg/L</td>
</tr>
<tr>
<td>Copper</td>
<td>Greater than 5 mg/L</td>
</tr>
<tr>
<td>Iron (ferric)</td>
<td>Greater than 7 mg/L</td>
</tr>
<tr>
<td>Manganese</td>
<td>Greater than 5 mg/L</td>
</tr>
<tr>
<td>Nickel</td>
<td>Greater than 5 mg/L</td>
</tr>
<tr>
<td>Organic Material</td>
<td>Large amounts may interfere. Pretreat the sample with a mild digestion.</td>
</tr>
<tr>
<td>Highly buffered or extreme sample pH</td>
<td>May exceed the buffering capacity of the reagents and require sample pretreatment. Adjust pH to 4-5.</td>
</tr>
</tbody>
</table>

Samples containing amino tri(methylene phosphonic acid) (AMP) will exhibit a negative interference. Perform a total phosphorus digestion (Method 8150) to eliminate this interference. IMPORTANT: Adjust the pH of the sample after the total phosphorus digestion to 4-5 with Sodium Hydroxide before analysis with the zinc test.

Sample Collection, Preservation, and Storage

Collect samples in acid cleaned plastic or glass bottles. If prompt analysis is impossible, preserve the sample by adjusting to pH 2 or less with nitric acid (about 2 mL per liter). Preserved samples may be stored up to six months at room temperature.

Before analysis, adjust the pH to 4-5 with 5.0 N Sodium Hydroxide. Do not exceed pH 5 as zinc may precipitate. Correct the test result for volume additions; see Section 3.1.3 Correcting for Volume Additions on page 43.

Accuracy Check

**Standard Additions Method (Sample Spike)**

1. After reading test results, leave the sample cell (unspiked sample) in the instrument.
2. Touch **Options.** Touch **Standard Additions.** A summary of the standard additions procedure will appear.
3. Touch **OK** to accept the default values for standard concentration, sample volume, and spike volumes. Touch **Edit** to change these values. After values are accepted, the unspiked sample reading will appear in the top row. See **Standard Additions** in the instrument manual for more information.
4. Snap the neck off a Zinc Voltette® Ampule Standard, 25 mg/L Zn.
5. Prepare three sample spikes. Fill three mixing cylinders (Cat. No. 20886-40) with 20 mL of sample and use the TenSette® Pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively to each sample and mix thoroughly.
6. Analyze each sample spike as described in the procedure above, starting with the 0.1 mL sample spike. Accept each standard additions reading by touching **Read.** Each addition should reflect approximately 100% recovery.
Zinc

7. After completing the sequence, touch Graph to view the best-fit line through the standard additions data points, accounting for matrix interferences. Touch View: Fit, then select Ideal Line and touch OK to view the relationship between the sample spikes and the "Ideal Line" of 100% recovery.

See Section 3.2.2 Standard Additions on page 46 for more information.

Standard Solution Method

Prepare a 1.00-mg/L zinc standard solution as follows:

1. Using Class A glassware, pipet 10.00 mL of Zinc Standard Solution, 100 mg/L, into a 1000-mL volumetric flask. Dilute to the mark with deionized water. Prepare this solution daily. Perform the Zincon procedure as described above.

2. To adjust the calibration curve using the reading obtained with the 1.00-mg/L Zinc standard solution, touch Options on the current program menu. Touch Standard Adjust.

See Section 3.2.4 Adjusting the Standard Curve on page 48 for more information.

Digestion

Digestion is required if total zinc is being determined. The following is not the USEPA digestion (see Section 4.1 USEPA-Approved Digestions for more information).

a. If nitric acid has not been added to the sample previously, add 5 mL of Concentrated Nitric Acid (Cat. No. 152-49) to one liter of sample (use a glass serological pipet and pipet filter). If the sample was acidified at collection, add 3 mL of nitric acid to one liter of sample.

b. Transfer 100 mL of acidified sample to a 250-mL Erlenmeyer flask.

c. Add 5 mL of 1:1 Hydrochloric Acid (Cat. No. 884-49).

d. Heat sample on a Hot Plate (Cat. No. 12067-01, 02) for 15 minutes at 95 °C (203 °F). Make sure the sample does not boil.

e. Filter cooled sample through a membrane filter and adjust the volume to 100 mL with Deionized Water (Cat. No. 272-56).

f. Adjust the pH to 4-5 with 5.0 N Sodium Hydroxide (Cat. No. 2450-26) before analysis (see Sample Collection, Preservation and Storage for instructions).

Method Performance

Precision

Standard 1.00 mg/L Zn

<table>
<thead>
<tr>
<th>Program</th>
<th>95% Confidence Limits of Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>780</td>
<td>0.95–1.05 mg/L Zn</td>
</tr>
</tbody>
</table>

See Section 3.4.3 Precision on page 53 for more information, or if the standard concentration did not fall within the specified range.

Sensitivity

<table>
<thead>
<tr>
<th>Portion of Curve</th>
<th>ΔAbs</th>
<th>ΔConcentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Range</td>
<td>0.010</td>
<td>0.01 mg/L Zn</td>
</tr>
</tbody>
</table>

See Section 3.4.5 Sensitivity on page 54 for more information.
Summary of Method

Zinc and other metals in the sample are complexed with cyanide. Adding cyclohexanone causes a selective release of zinc. The zinc then reacts with 2-carboxy-2'-hydroxy-5'-sulfonfomazyl benzene (zincon) indicator to form a blue-colored species. The blue color is masked by the brown color from the excess indicator. The intensity of the blue color is proportional to the amount of zinc present. Test results are measured at 620 nm.

<table>
<thead>
<tr>
<th>Required Reagents</th>
<th>Description</th>
<th>Quantity Required</th>
<th>Unit</th>
<th>Cat. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zinc Reagent Set, 20 mL sample size</td>
<td>24293-00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(100 tests = 100 samples + 100 blanks)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Includes:</td>
<td>Cyclohexanone</td>
<td>1 mL</td>
<td>100 mL MDB</td>
<td>14033-32</td>
</tr>
<tr>
<td></td>
<td>ZincoVer® 5 Reagent Powder</td>
<td>1 pillow</td>
<td>100/pkg</td>
<td>21066-69</td>
</tr>
<tr>
<td>Required Apparatus</td>
<td>Cylinder, graduated, mixing, 25-mL</td>
<td>20886-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sample Cells, 10-20-25 mL, w/cap</td>
<td>24019-06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required Standards</td>
<td>Water, deionized</td>
<td>272-56</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc: Standard Solution, 100-mg/L</td>
<td>2378-42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc: Standard Solution, 2 mL PourRite® Ampule, 25 mg/L as Zn</td>
<td>14246-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zinc: Standard Solution, 10 mL Volutette® Ampule, 25 mg/L as Zn</td>
<td>14246-10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>