McMillan Company Lab

Water Testing Kits - Are They Accurate?

Introduction:

There are many types of water testing kits available for purchase on the Internet. Various tests are available in different kits at different prices. The most outstanding feature of such kits is the very low price. Water testing laboratories using sophisticated equipment to perform similar tests would be hard pressed to compete with such low prices/kit, if the tests in these kits are both sensitive and accurate. *Buyer Beware!*

Experiment:

Two brands of water testing kits were purchased from different vendors and compared to analytical laboratory methods for accuracy and sensitivity.

Procedure:

For anonymity purposes, the two types of water test kits will be referred to as Kit A and Kit B. Kits A and B were used to test water samples for the following contaminants:

1. Sulfate
2. Total Nitrate
3. Total Nitrite (as N)
4. Copper
5. Iron (Fe+2)
6. Hydrogen Sulfide
7. Lead
8. Total Hardness

The same water samples were then tested for above contaminants by EPA approved, accepted or equivalent methods per Hach UV/Vis, titration and Agilent ICP-MS analytical lab instruments. Results were compared between test kits and analytical laboratory methods.

Summary:

1. **Sulfate -** Only Included in test Kit A. This is not a very sensitive test in that it can't determine Sulfate at levels lower than 250 PPM, the EPA maximum contamination limit, or MCL. It's also very hard to distinguish between 250 and 500 PPM per color chart.
   - **Lab UV/Vis: 3.27 PPM Method Detection Limit (MDL) vs. Test Kit: 250 PPM.**

2. **Nitrate -** Only Kit B was sensitive enough to determine Nitrate at levels less than 10 PPM, the EPA MCL. Kit A color reference chart showed it could see Nitrate at levels less than 10 PPM, but it did not.
   - **Lab UV/Vis: <0.2 PPM MDL vs. Test Kit: 2.0 PPM (B) & 10 PPM (A)**

3. **Nitrite -** Both Test kits worked - were sensitive enough to detect nitrite at 0.2 PPM, less than EPA established MCL of 1.0 PPM.
   - **Lab UV/Vis: 0.014 PPM MDL vs. Test Kits: 0.2 PPM**

4. **Copper -** Kit A color chart makes it impossible to distinguish between 0.5 and 1.0 PPM, and Kit B color chart can't distinguish between 0 and 0.5 PPM copper.
   - **Lab ICP-MS: 0.0053 ppb vs. Test Kit: 0.5 PPM (B) & 1.0 PPM (A).**

5. **Iron -** Both Kits are pH sensitive - you must insure the pH of water being tested is neutral for this test to work. This is not mentioned in Kit A and not clear in Kit B. instructions.
   - **Lab ICP-MS: 0.112 ppb vs. 0.05 PPM (Kit A) & 0.1 PPM (Kit B)**

6. **Lead -** Both Kits are pH sensitive - you must insure the pH of water being tested is neutral for this test to work. This is not mentioned in Kit A instructions, vague in Kit B.
   - **Lab ICP-MS: 0.0007 ppb vs. Test Kits: 15 ppb**

Definitions:

Maximum Contaminant Level (MCL)
The highest permissible level (according to the U.S. EPA) of a contaminant in drinking water.

Parts per Million (PPM)
Equal to milligrams per liter (mg/L).

Parts per Billion (PPB)
Equal to micrograms per liter (µg/L)

Test Comparisons and Results:

<u>Sulfate</u>

1. Test Kit A - Included sulfate test strips. Kit B did not have a sulfate test. The test procedure was to dip one test strip into a 50 ml sample for 10 seconds, remove, shake off excess, wait 20 seconds for color development and compare the color of your test strip to the sulfate chart. (See Exhibit 1). The three color choice levels to match were 0, 250 and >500 ppm (parts per million).

A Hach 250 ppm sulfate standard was prepared and used for testing sulfate per Kit A test strip. The test strip worked semi-well, per brochure instructions. The color that developed on the test strip in 30 seconds was not an exact match to color chart. This test is not sensitive enough to detect sulfate at levels below 250 ppm, which is the MCL per EPA safe drinking water guidelines.

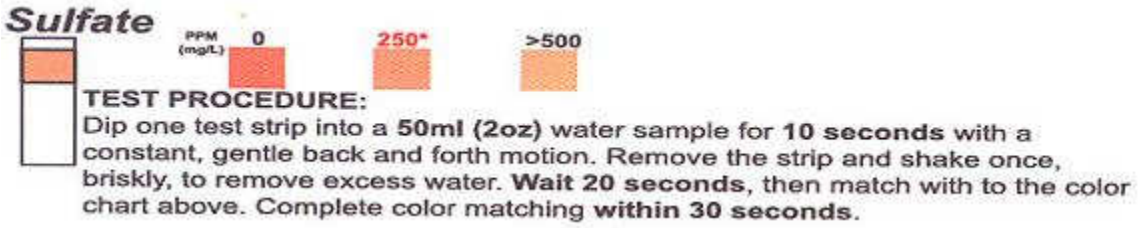

Exhibit 1 - Kit A - Sulfate

2. Hach UV/Vis - The Hach UV/Vis test # 8051, is an approved EPA method and is sensitive enough to detect sulfate at low ppm levels. McMillan's lab has demonstrated sulfate MDLs (method detection limits), as low as **3.27** PPM, per this method.

Total Nitrate (as NO3-N)

1. Test Kit A - Instructions were to dip one test strip into a 50 ml water sample for 2 seconds with a constant, gentle back and forth motion. Remove strip, wait one minute then match to the color chart (See exhibit 2). Complete color matching within two minutes. The four color choice levels to match were 0, 2, 10, 20 and 50 PPM nitrite as NO3-N.

A Hach 2.0 PPM NO3-N Drinking Water Standard was used to test nitrate as NO3-N per Kit A test strip. **The Kit A test strip never indicated the presence of 2 PPM NO3-N** in Hach Drinking Water standard - it did not work! A 10 PPM NO3-N standard was then prepared and used to test nitrate per Kit A. test strips. This time **Kit A test strips did work at 10 PPM NO3-N level** as indicated below on brochure instructions. This test is not sensitive enough to detect NO3-N nitrate levels below 10 PPM, which is the MCL per EPA guidelines.

Exhibit - 2 - Kit A - Nitrate as NO3-N

2. Test Kit B - Instructions listed above in Exhibit 3. Test Kit B had more sensitivity, or more levels to

color match at 0, 0.5, 2.0, 5.0, 10.0, 20.0 and 50 PPM NO3-N. The Hach 2.0 PPM Drinking Water Standard was used to test nitrate per Kit B test strips. **Kit B worked well.** It turned the correct color per color chart for 2.0 PPM NO3-N in the specified amount of time.

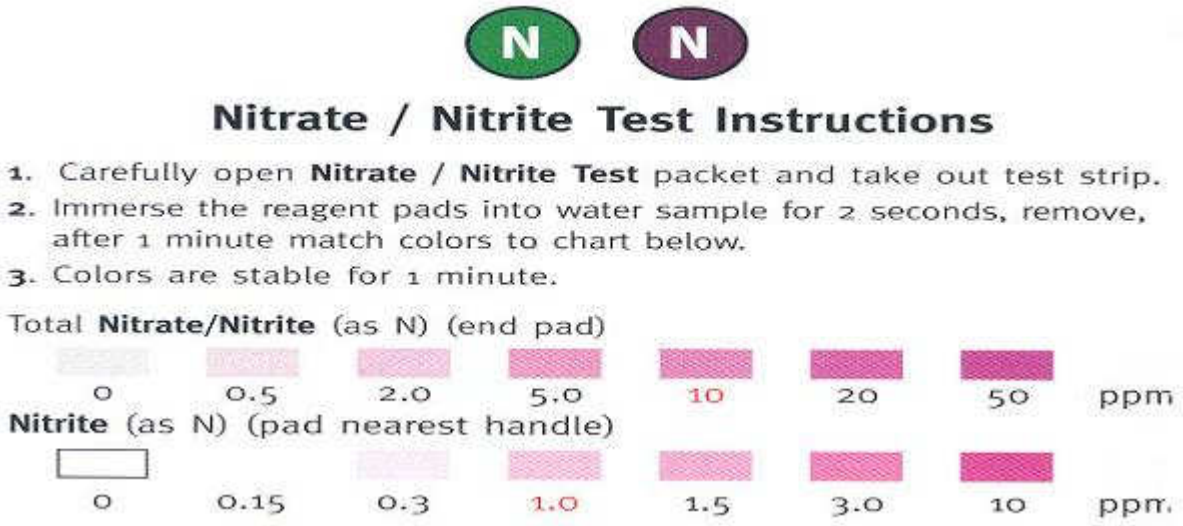

Exhibit - 3 - Kit B - Nitrate as NO3-N

3. Lab Hach UV/Vis - The Hach UV/Vis nitrate test # TNT 835, is sensitive enough to detect down to 0.2 PPM nitrate as NO3-N at 95% confidence interval. Using this method, our lab has calculated MDLs of **0.073** PPM for NO3-N and **0.017** PPM as NO3.

Total Nitrite (as NO2-N)

1. Test Kit A - Test procedure for determining nitrite is the same as described above for nitrate in Exhibit 2. The sensitivity level to detect Nitrite is lower than Nitrate, at 0.2 PPM. The four color levels to match were 0, 0.2, 1.0, 1.5 and 3.0 PPM nitrite as NO3-N. A 0.3 PPM nitrite standard was prepared and used to test the ability of Kit A to determine nitrite as NO2-N. Using this standard, **Kit A test strip worked well at the 0.2 NO2-N PPM level.** The color changed in the right amount of time and was stable up to 2 minutes, per instructions.

2. Test Kit B - Testing procedure was the same as described for nitrate in Exhibit 3. The color levels to match were 0,0.15,0.3,1.0,1.5,3.0 and 10.0 PPM NO2-N. Using the 0.2 PPM nitrite standard, **Kit B also worked well at the 0.15 NO2-N PPM level.** The color changed in right amount of time, was a pretty good color match to brochure and was stable up to 1 minute.

3. Lab Hach UV/Vis - The Hach UV/Vis Nitrite test #TNT 839, was used to determine Nitrite as NO2-N. This is an equivalent EPA method for compliance monitoring and can detect nitrite as NO2-N down to 0.015 PPM. The nitrite MDL per this method is **0.014** PPM as NO2-N.

Copper

1. Test Kit A - The procedure for using Kit A to determine copper is listed below in Exhibit 4. The four

color levels to match are 0, 0.1, 0.5, 1.0 and 2.0 PPM copper. A 100 ppb (Parts per billion) and 1000 ppb Accu-Trace multi-element ICP-MS Quality Control standard, Lot #B7065060; were used to perform Kit A copper test. The 100-ppb QC standard matched the color chart Ok, but the 1000 ppb or 1.0 PPM QC standard showed no difference between the 0.5 and 1.0 PPM color chart levels. There is almost no difference in color between the 0.5 and 1.0 PPM levels, shown below in Exhibit 4. Test Kit A can't distinguish between 0.5 and 1.0 PPM, which is a significant drawback since the MCL for copper in drinking water, is 1.3 PPM.

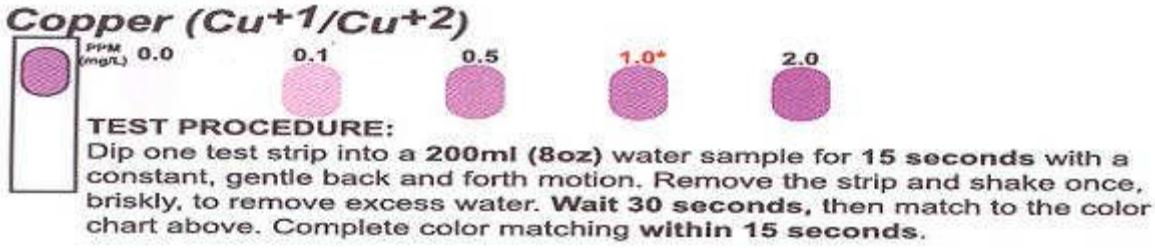

Exhibit - 4 - Kit A - Copper

2. Test Kit B - The procedure for using Kit B to test for copper is listed below in Exhibit 5. The four color levels to match are 0, 0.5, 1.0, 2.0 and 5.0 PPM. Please note color chart levels at 0 and 0.5 PPM - there is very little color difference between the two levels, making it impossible to distinguish between them. Since Kit B wasn't sensitive enough to detect copper at the 0.1 PPM level, the 1.0 PPM Accu-Trace QC Standard was used to test for copper. The resulting color on Kit B test strip matched somewhere between 0.5 and 1.0 PPM, but did not clearly match the color per chart below at 1.0 PPM. Since there was only one test strip/test in Kit B, only one standard could be used to test for accuracy.

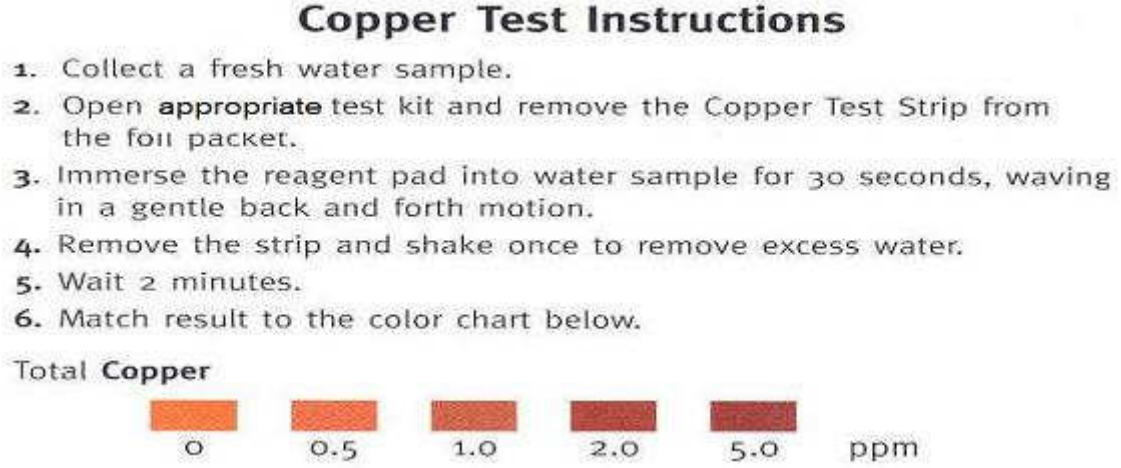

Exhibit 5 - Kit B - Copper

3. Lab Agilent 7500ce ICP-MS - This instrument specializes in ultra-trace metals detection. Analysis per method 200.8, showed Copper detection limits of 0.0053 ppb.

Iron

1. Test Kit A - The procedure for using Kit A to test for iron is listed below in Exhibit 6. The five levels to match results to are at 0, 0.05, 0.1, 0.3 and 1.0 PPM. Kit A listed the lowest sensitivity detection level of 0.05 PPM, but Kit B was only able to detect iron to 0.1 PPM, so the 100 ppb QC Standard was used to test Kit A's ability to detect iron. Following testing instructions below in Exhibit 6, Kit A test strip never changed color to indicate 100 ppb iron. Since there was no color change at 100 ppb or 0.1 PPM,

the 1,000 ppb (or 1.0 PPM), QC standard was used to see if Kit A could detect iron at a higher level. It could not - **Kit A test strips did not show any color change to indicate iron.** Technical Assistance confirmed pH sensitivity - Kit A will only detect iron in solutions above pH 4.5. Since the QC standard is preserved in 2% nitric acid, the pH is < 2.0 and test strip could not detect the iron in it. A 0.095 PPM Fe Std was neutralized to pH 7.5 and used to retest Kit A - Fe. This time Kit A test strip changed color to indicate Fe in the amount of time specified.

Exhibit 6 - Kit A - Iron

2. Test Kit B - Testing instructions for using Kit B are listed below in Exhibit 7. The five color levels to match results to are 0,0.1,0.3,1.0 and 5.0 PPM. Using the 100 ppb or 0.1 PPM QC standard, Kit B also did not show any color change to indicate the presence of iron. When the QC standard solution was neutralized to a pH of 7.5, Kit B iron test strip worked as specified at the 0.1 PPM Level.

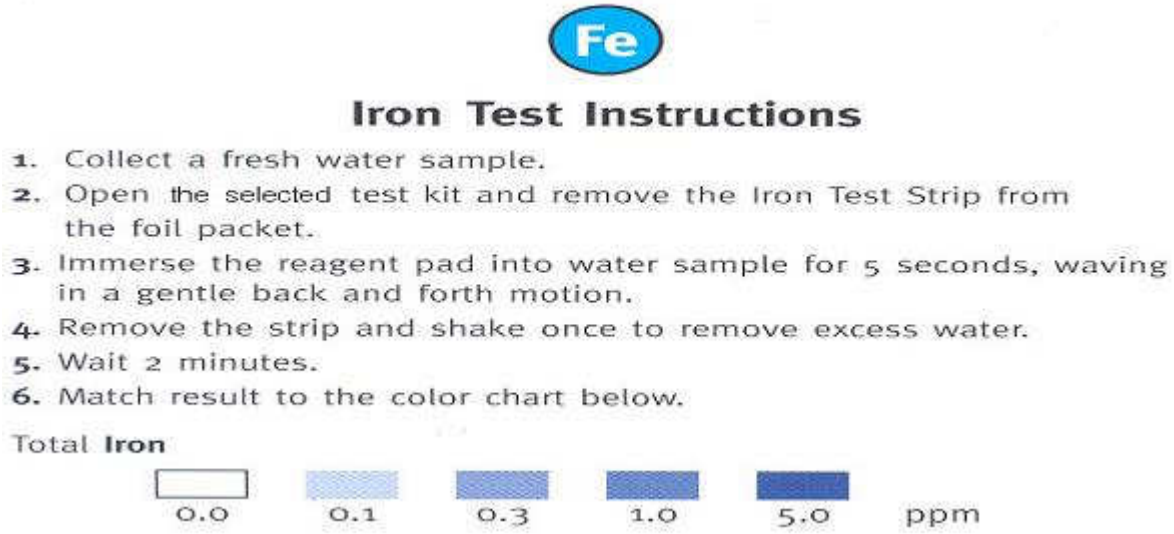

Exhibit 7- Kit B - Iron

3. Lab Aglient 7500ce ICP-MS - Water analysis per method 200.8, showed Iron Detection Limits of 0.1119 ppb.

Hydrogen Sulfide

1. Kit A - Only Kit A contained a test for Hydrogen Sulfide. Testing procedure is listed below in Exhibit 8. A split sample of well water having a distinct "rotten egg" smell was used to test H2S-level by Hach UV/Vis EPA approved method and by Kit A. As you can see from Exhibit 8, the lowest sensitivity for detection is 0.3 mg/L, or 0.3 PPM. Per Kit A instructions, the well water sample tested less than 0.3 PPM. **Note:** Per instructions, it's hard to distinguish the difference between 0.3 and 0.5 PPM, looking down through the two vials of water on color comparison chart.

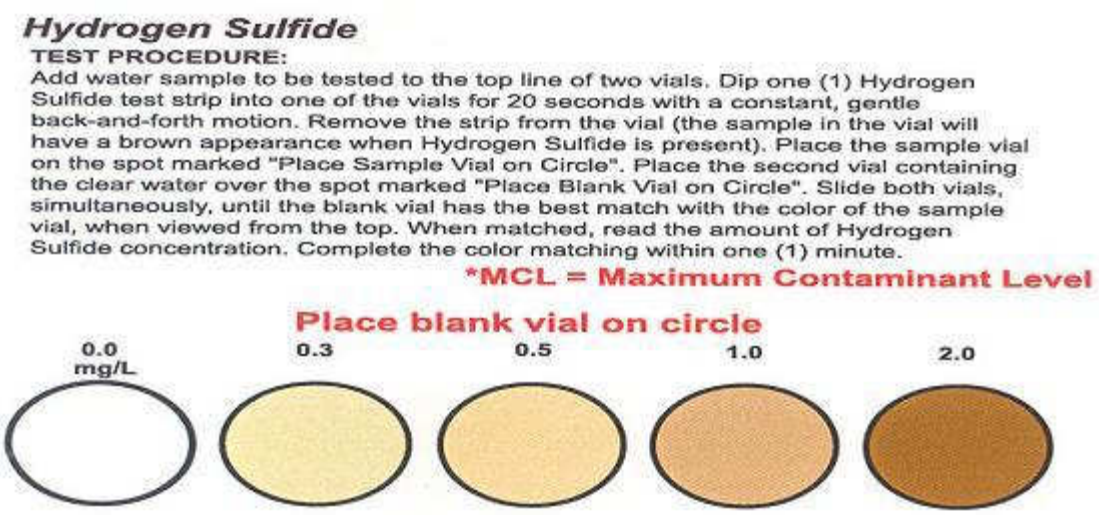

Exhibit 8 - Kit A - Hydrogen Sulfide

2. Hach UV/Vis - The Hach UV/Vis EPA approved method #8131, was used to determine Sulfide as S-, in the split well water sample. The sensitivity of this method is down to 5 ppb. Note: The human nose is very sensitive to H2S-, and can detect smells as low as 5 ppb. Using this method, the amount of hydrogen sulfide determined in split well water sample, was 17 ppb.

Lead

1. Kit A & Kit B - The two kits had identical testing procedures for lead, shown below in Exhibit 9. Following lead testing instructions below, Kit A test strip never changed color to indicate 100 ppb lead. Since there was no color change at 100 ppb or 0.1 PPM, the 1,000 ppb (or 1.0 PPM), QC standard was used to see if Kit A could detect lead at a higher level. It could not - Kit A or B test strips did not work in either 100 or 1,000 ppb lead standard, i.e.; neither test strip showed any color change to indicate lead. Since this was the second metal test that did not show any color change in reference to a fairly large amount of standard, I began thinking about things that could cause interference, and re-read Kit instructions. Kit A only mentioned, "Do not store in direct sunlight or above 90 degrees F." A Technical Assistance phone number listed on the front of Kit A brochure was called. The response was excellent: technical assistance was very prompt and gave good information. It was determined these test strips only work in water samples having a neutral pH. Since I'd been using a QC lead Reference standard preserved in 2% nitric acid, the pH was less than 2. When pH of 100 ppb QC standard was neutralized with KOH, it worked. (Positive results are shown below in Exhibit 9).

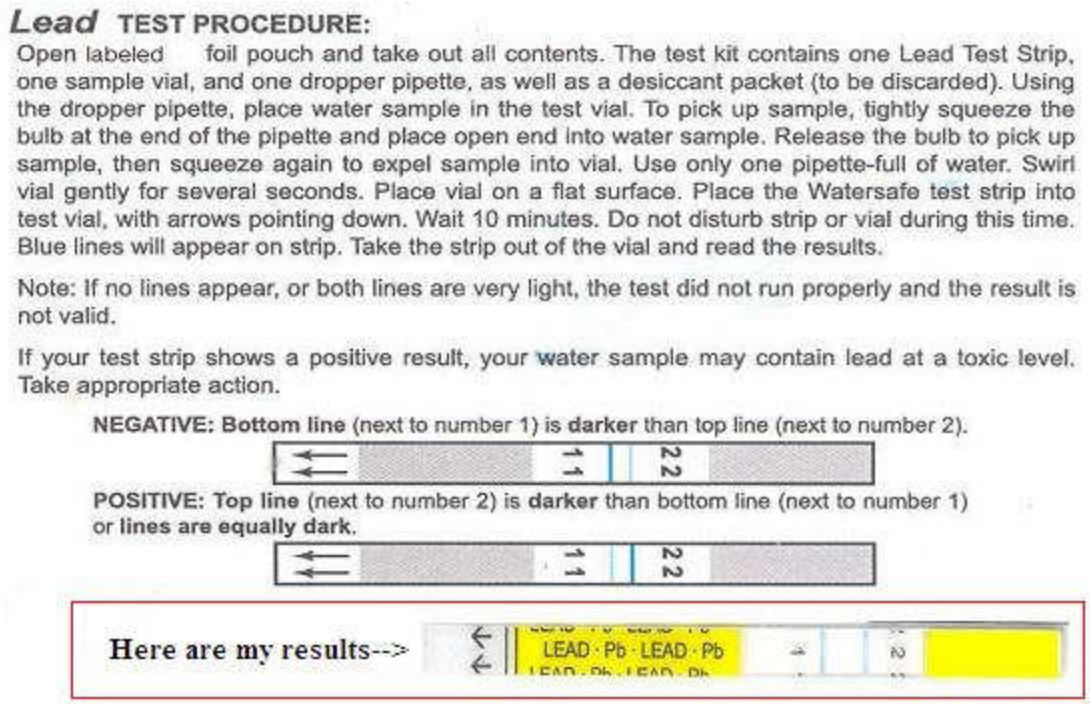

Exhibit 9 - Test Kit A & B - Lead

2. Test Kit B - Test Kit B listed helpful "Before You Begin" cautionary statements, including "Do not use on hot water or water containing bleach or detergents." However, when Technical Support was called, the Technical Assistant gave information that was incorrect. I was told "The iron and lead tests are not affected by the acidity (pH), alkalinity or softness of the water." This statement proved to be incorrect when Kit B iron and lead test strips did not work in solutions with a pH <2, containing both metals at detectable levels of 100 ppb or greater. When the QC standard solutions were neutralized to a pH of 7.5, both iron and lead test strips worked as specified.

3. Lab Aglient 7500ce ICP-MS - Analysis per method 200.8, showed lead detection limits of 0.00074 ppb or 0.74 ppt (parts per trillion).

Total Hardness (mg/L CaCO3)

1. Kit A & B - A & B Hardness test strips gave identical results on well water sample. Both test kits indicated a hardness of >450 PPM per color chart comparison, but it was very hard to distinguish between the >250 and >450 PPM color levels. Both kits are useful as a rough indicator or hardness.

2. Lab Titration - Hach method 5B titration results confirmed this was a very hard water sample. Duplicate titration results showed total hardness to be 340 PPM as CaCO3.

Conclusions: *Buyer Beware!*

Due to the ambiguities of water test kits that base results by comparing test strip colors to levels on color comparison charts, I would not recommend using these test kits to determine

Sulfate, Nitrate, Copper and Hydrogen Sulfide.

- **These kits proved to give sensitive and accurate nitrite results, so I would use them to test for nitrite contamination in drinking water.**

- **These kits proved to be useful to give rough approximations for total hardness and pH.**

- **If kit instructions clearly indicate that iron, lead and copper tests are pH dependent and will only work in water that has a neutral pH; these kits would be useful for rough, field approximations. However, one kit manufacturer gave inaccurate information when the technical support hotline was called. Overall I would have to say *"Buyer Beware."***

If you would like a copy of this report, please click here.

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