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MOFFETT FIELD
SSIC NO. 5090.3

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PRC

July 21, 1992

Mr. Cyrus Shabahari
State of California EPA
Department of Toxic Substances Control
700 Heinz Avenue, Bldg. F
Berkeley, CA 94704

RE: Aluminum Levels in Naval Air Station (NAS) Moffett Field Ground Water

Dear Mr. Shabahari:

PRC Environmental Management, Inc. (PRC) reviewed metal analytical results for filtered and non-filtered samples in response to your concern about aluminum levels in the A1 hydrologic zone at NAS Moffett Field Site 9. The data review suggests that high aluminum levels in ground water samples result from the dissolution of aluminum from suspended solids (aluminosilicates) as a result of sample preservation using nitric or hydrochloric acid. This letter presents the results of the data review.

Total and dissolved metals ground water results for samples collected from monitoring wells were compared to determine bias when evaluating total metals data. Table 1 contains total and dissolved metal results for monitoring wells W56-2(A1) and W29-2(A1). Results for wells W9-46(A1) and W61-1(A1) appear in Table 2. All ground-water samples were collected in July 1991.

The comparison indicates the less water soluble metals, such as aluminum and iron, show the largest disparity between the two analyses. Total aluminum concentrations range from 7,050 to 34,100 micrograms per liter ($\mu$g/L), while dissolved concentrations range from not detected to 39.4 $\mu$g/L. A similar pattern of lower observed concentrations in dissolved metals analyses compared to total metals analyses was found with iron and to a lesser extent with barium, manganese, potassium, vanadium and zinc. These results suggest suspended materials present in NAS Moffett Field ground-water samples are responsible for the elevated levels of aluminum in total metals analyses.

Elevated levels of aluminum were also evaluated in a memorandum (May 22, 1992) from James M. Montgomery, Inc. (JMM) to International Technology Corporation (IT Corp.). As indicated in this memorandum (attached), samples collected from monitoring wells using bailing techniques often contain higher-than-desired levels of turbidity (suspended solids) resulting in anomalous detections of aluminum. During operation of the source control system, the turbidity of extracted ground water will be relatively low. Thus, low aluminum concentrations will be present in the effluent from the Site 9 source control measure treatment systems.

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If you have questions regarding this matter, please call me or Mr. Mike Young at (303) 295-1101.

Sincerely,

**PRC Environmental Management, Inc.**

Jeff Reichmuth
Project Engineer

Attachments (3)

cc: Mr. Stephen Chao, U.S. Navy
Mr. Joshua Marvil, PRC
Mr. Mike Young, PRC
PRC File

**Table 1**

**Total and Dissolved Metal Concentrations for NAS Moffett Field Ground Water Samples (Concentration in μg/L)**

| Metal | Total (W56-2A1) | Dissolved (W56-2A1) | Total (W29-2A1) | Dissolved (W29-2A1) |
|---|---|---|---|---|
| Aluminum | 21,900 B | 24.6 UB | 34,100 B | 18.5 B |
| Antimony | 32.0 U | 32.0 U | 32.0 U | 32.0 U |
| Arsenic | 3.60 JB | 1.00 U | 47.2 J | 25.3 |
| Barium | 482 | 54.5 B | 907 | 556 |
| Beryllium | 1.00 U | 1.00 U | 1.00 U | 1.00 U |
| Cadmium | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Calcium | 175,000 B | 153,000 B | 187,000 B | 157,000 |
| Chromium | 7.06 | 4.00 U | 86.0 | 4.00 U |
| Cobalt | 16.9 UB | 5.00 U | 25.7 UB | 5.00 U |
| Copper | 37.5 J | 5.00 JB | 74.3 J | 4.00 UJ |
| Iron | 32,800 B | 8.00 U | 52,200 B | 25.3 B |
| Lead | 6.40 | 2.00 U | 31.0 | 4.40 |
| Magnesium | 69,600 | 56,200 | 85,800 | 66,200 |
| Manganese | 1210 | 239 | 1590 | 952 |
| Mercury | 0.20 U | 0.20 U | 0.21 | 0.20 U |
| Nickel | 77.2 | 7.00 U | 124 | 7.00 U |
| Potassium | 4160 B | 1760 B | 5460 | 1400 B |
| Selenium | 20.0 U | 20.0 U | 20.0 U | 20.0 U |
| Silver | 2.00 U | 2.00 U | 2.00 U | 2.00 U |
| Sodium | 39,900 R | 40,500 JB | 47,000 JB | 47,200 J |
| Thallium | 10.0 U | 2.00 U | 10.0 U | 2.00 U |
| Vanadium | 75.6 | 2.00 U | 97.0 | 2.00 U |
| Zinc | 101 JB | 6.00 UB | 130 JB | 6.40 BJ |

U - Undetected at the concentration reported
J - Value is estimated
R - Value is unuseable
B - Analyte is found in associated blank as well as in sample

**Table 2**

**Total and Dissolved Metal Concentrations for NAS Moffett Field Ground Water Samples (Concentration in µg/L)**

| Metal | Total (W9-46A1) | Dissolved (W9-46A1) | Total (W61-1A1) | Dissolved (W61-1A1) |
|---|---|---|---|---|
| Aluminum | 3730 JB | 39.4 BJ | 15,800 B | 60.4 UB |
| Antimony | 32.0 U | 32.0 U | 32.0 U | 32.0 UJ |
| Arsenic | 1.00 U | 1.00 U | 4.40 B | 1.70 JB |
| Barium | 71.0 B | 29.9 BJ | 198 B | 70.8 JB |
| Beryllium | 1.00 U | 1.00 U | 1.00 U | 1.00 U |
| Cadmium | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Calcium | 192,000 | 193,000 J | 168,000 B | 155,000 |
| Chromium | 4.00 U | 4.00 U | 36.2 | 4.00 U |
| Cobalt | 7.60 B | 5.00 U | 10.9 B | 5.00 U |
| Copper | 4.30 UB | 5.10 B | 43.7 UB | 26.1 UB |
| Iron | 3,810 JB | 38.3 BJ | 20,300 | 32.2 JB |
| Lead | 2.00 U | 2.0 U | 5.30 | 2.00 U |
| Magnesium | 64,800 | 64,500 J | 63,300 | 53,700 |
| Manganese | 189 | 127 J | 328 | 11.2 JB |
| Mercury | 0.20 U | 0.20 U | 0.23 | 0.20 U |
| Nickel | 11.0 B | 7.00 U | 50.3 | 7.00 U |
| Potassium | 2730 R | 2030 B | 4060 B | 1,700 B |
| Selenium | 2.00 U | 2.00 U | 10.0 UJ | 43.8 J |
| Silver | 2.60 UB | 2.00 U | 3.20 B | 2.30 J |
| Sodium | 37,600 | 38,500 J | 35,600 B | 34,900 B |
| Thallium | 2.00 U | 2.00 U | 10.0 U | 10.0 U |
| Vanadium | 14.2 B | 3.60 B | 47.5 B | 4.00 B |
| Zinc | 33.7 B | 7.80 B | 86.6 B | 13.9 UB |

U - Undetected at the concentration reported
J - Value is estimated
R - Value is unuseable
B - Analyte is found in associated blank as well as in sample

JAMES M. MONTGOMERY, INC.
365 Lennon Lane, Walnut Creek, California 94598 510•975•3400

**MEMORANDUM**

| | | | |
|---|---|---|---|
| TO: | Lowell Wille/IT | DATE: | 22 May 1992 |
| FROM: | Joe LeClaire | JOB NO: | 2738.0543/3.13 |
| PROJECT: | NAS Moffett Field Remedial Investigation/Feasibility Study | CLIENT: | PRC EMI/Navy CLEAN |
| cc: | Joshua D Marvil/PRC-Denver<br>Lynn M Valdivia/PRC-SF<br>Mike Howar/JMM-WCK | | |

SUBJECT: FIELD FILTERING OF GROUNDWATER SAMPLES FOR METAL ANALYSES

This memorandum briefly describes some of the issues about the filtration of metal samples which were raised in the Monthly Managers' Meeting yesterday at PRC's San Francisco office. In summary, high aluminum values are indicative of the dissolution of suspended particulates from the monitoring well. These values are reduced considerably by filtering the samples prior to acidification. Metals sorbed to suspended particulates (or which are part of the mineral structure) are probably not mobile in the NAS Moffett Field aquifer environment and should pose no risk.

Groundwater samples collected for metal analyses are discharged directly into a sample bottle containing nitric acid. Nitric acid-acidification to a pH value of ≤ 2.0 and cooling the sample to ~4°C are US Environmental Protection Agency (EPA)-approved protocol to increase sample holding times to 6 months. However, in monitoring wells that are bailed for evacuation and sampling, samples may contain higher-than-desired levels of turbidity. These suspended solids are effectively dissolved by the nitric acid preservative, releasing sorbed, coprecipitated and occluded metal ions. Field filtration of groundwater samples eliminates errors introduced by dissolution of suspended particles, but may introduce non-conservative errors, if postulated facilitated-transport mechanisms (Puls and Barcelona, 1989) are important in metal transport in aquifers.

Filtration is used as a physical separation technique for several reasons. Removal of finely divided particulate matter from the solution matrix reduces spectral interference during analysis. Batley (1983) has reported higher biological activity (toxicity) of trace elements associated with smaller size-fractions. Others (Turner and Whitfield, 1980; Florence, 1982; Salomens and Förstner, 1984) have defined operationally 0.45 µm as the border between the dissolved and particulate fractions (Table 1). However, Hiemenz (1977) considers particles up to 1 µm to be colloidal. The partition of the groundwater sample into "solution" and "solid"

phases is particularly critical, and the consequences of this separation are non-trivial.

Using the operationally-defined convention of 0.45 µm, "dissolved metal" also includes metal adsorbed by organic and inorganic colloids, as well as free species and complexes (Table 2). LeClaire (1985) compared Nuclepore circular (47 mm) polycarbonate filters, with an effective pore size of 0.4 µm and Gelman cellulose acetate filters (0.45 µm). The Gelman cellulose acetate filters were found to retain between 20 and 50 percent of copper in solution over the polycarbonate filters. Cellulose acetate filters are approximately 150 µm thick, with irregular, tortuous pore channels, and a high surface area for adsorption. Polycarbonate filters are thinner (10 µm) with holes etched into the membrane, and an inherently smaller surface area, because of a larger pore size to filter thickness ratio (Salomens and Förstner, 1984). However, screen filters such as the polycarbonate membrane have a tendency to clog, resulting in filtration by the filter cake rather than the membrane. Ultracentrifugation prior to filtration precludes this problem.

Truitt and Weber (1979) compared copper loss from solution at low concentrations (≈0.4 µ*M*), using various combinations of filtering apparatus: glass versus polycarbonate filter supports, cellulose acetate versus polycarbonate filters, and pH 5 versus pH 7 solution. They conclude that an acid-cleaned, all polycarbonate filtration system will minimize sorption contamination problems. In this study, a metal loss to the filter of less than 5% is found at pH 5.5 ±0.2, and for the range of concentrations used.

Puls and Barcelona (1989) contend that colloids in the range of 0.1 to 1.0 µm (100 to 1,000 nm) may be mobile in sandy porous media. They cite concentration difference of 20 to 600 times between filtered and non-filtered samples for lead and 6 to 24 times for chromium at a California Superfund site. Penrose *et al.* (1990) found that plutonium and americium are irreversibly bound to colloids in the 0.025 and 0.45 µm size fraction. The mobility of the particles entrained by the filter cannot be ascertained *a priori*. If they are mobile, and filtered concentrations are used, then a potential contamination problem is overlooked. If the particles are not mobile, and non-filtered results are used, then a non-existent problem is created. Because bailers and air lift sampling devices can displace solids that are not mobile in aquifers, one possible solution is to sample the wells using positive displacement pumps (bladder pumps). Another solution is to field filter the metal samples, using a *1.0 µm* rather than a *0.45 µm* filter. This filter will eliminate the larger particles, which are likely to be non-mobile, thus avoiding the facilitated transport controversy. It should however, eliminate a certain fraction of the suspended solids which are contributing to the high metal concentrations, and would provide a conservative estimate of mobile metal concentrations in groundwater.

High values of aluminum in groundwater samples are almost always indicative of dissolution of particulates by the sample preservative. Aluminum is a major elemental component of clays (aluminosilicate compounds). At normal pH/Eh ranges the solubility of aluminum would be low (Sposito, 1984) because of precipitation or coprecipitation. Any free aluminum would likely be sorbed to

mineral surfaces because of its high ionic charge/radius ratio. (Aluminum is trivalent.)

TABLE 1
CLASSIFICATION OF METAL FORMS IN NATURAL WATERS BASED ON SIZE.

| 0.45 μm | | | | | |
|---|---|---|---|---|---|
| "dissolved" | | | "particulate" | | |
| free | complexed | colloidal | adsorbed on particles | structural (organic) | structural (inorganic) |

From Salomens and Förstner (1984)

TABLE 2
POSSIBLE FORMS OF METALS IN NATURAL WATERS.

| Physiochemical Form | Examples | Approximate Diameter (nm) |
|---|---|---|
| Particulate | retained by 0.45 μm filter | >450 |
| Simple Hydrated Metal Ions | $Cd(H_2O)_6^{2+}$ | 0.8 |
| Simple Inorganic Complexes | $Pb(H_2O)_4Cl_2$ | 1 |
| Simple Organic Complexes | Cu-glycinate | 1-2 |
| Stable Inorganic Complexes | PbS, $ZnCO_3$ | 1-2 |
| Stable Organic Complexes | Cu-fulvate | 2-4 |
| Adsorbed on Inorganic Colloids | $Cu^{2+}$-$Fe_2O_3$, $Pb^{2+}$-$MnO_2$ | 10-500 |
| Adsorbed on Organic Colloids | $Cu^{2+}$-humic acid | 10-500 |
| Adsorbed on Mixed Organic/ Inorganic Colloids | $Cu^{2+}$-humic acid/$Fe_2O_3$ | 10-500 |

(Florence, 1982)

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