



Tetra Tech EM Inc.

1099 18th Street, Suite 1960 ♦ Denver, CO 80202 ♦ (303) 295-1101 ♦ FAX (303) 295-2818

February 16, 1999

Messrs. Stephen Chao and Hubert Chan
Engineering Field Activity West
Naval Facilities Engineering Command
900 Commodore Drive, Building 210
San Bruno, California 94066-5006

CLEAN Contract Number N62474-94-D-7609
Contract Task Order 153

**Subject: Plan to Improve Yield of Extraction Wells, West-side Aquifers
Treatment System, Moffett Federal Airfield**

Dear Messrs. Chao and Chan:

Tetra Tech EM Inc. (TtEMI) has developed the plan described in this letter to improve the yield of the two West-side Aquifers Treatment System (WATS) extraction wells that are not attaining their design flow rates. Wells EA1-1 and EA1-6 are intended to be source control wells; as such, their locations were dictated more by proximity to potential sources than by favorable lithology. However, their current estimated pumping rates (less than 1 gallon per minute [gpm]) are considerably less than their design rates (3 gpm). The following plan to improve well yield consists of three steps. Step one is relatively easy to achieve and should be implemented at once. Each subsequent step should be undertaken only if previous actions do not improve well yield to achieve design flow rates.

Step One - Change Pump Cycling Program

The first step is to change the pump cycling program to include an automatic pump turn-on function. Currently, the pumps are programmed to shut off automatically when water in the pumping well declines to a level equal to 15 percent of the screen interval, measured from the bottom of the screen. The pump must be reactivated manually. During the preliminary well yield testing, rates may have been estimated low because of the time that elapsed between pump shut-off and the pump being manually reactivated. A change in the pump controller program, that would cause the pump to automatically reactivate when water levels rebound to a predetermined point is an inexpensive action that will result in a more accurate estimate of well yield. TtEMI recommends a reactivation level equal to 50 percent of the screened interval.

Step Two - Redevelop Wells

TtEMI conducted oversight during well construction and development and observed that well development guidelines, which were based on standards developed by the American Society for Testing and Materials (ASTM 1994), were generally followed. The development techniques applied - surging, pumping and backwashing - are generally adequate to develop most wells. However, these actions do not preclude the possibility that these two wells require unusually strenuous well development procedures due to the fine-grained, highly stratified nature of the surrounding alluvium.

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Both wells EA1-1 and EA1-6 were drilled in areas where the A1-aquifer zone sand units were few, and individual sand units were generally less than 1 foot thick. The low permeability associated with this lithologic setting can be exacerbated by the formation of a well skin during drilling, where clay particles dragged down from above seal off the thin permeable intervals.

A well development technique that may be effective in alleviating this situation is hydraulic jetting. Development by hydraulic jetting employs several horizontal jets of water operated from inside the well screen so that high-velocity streams of water exit through the screen and loosen fine-grained material from the formation. The loosened material moves inside the well screen and can be removed by concurrent bailing or pumping. This development method allows the redevelopment effort to be focused on discrete zones inferred to contain thin sand units, based on lithologic logs from the closest continuously sampled borehole.

It is also recommended that a chemical deflocculant, such as sodium hexametaphosphate, be used to break up the well skin. The deflocculant can be mixed into the injection water. The only precaution for using a phosphate-based deflocculant is that the well must be flushed with chlorine after the treatment to inhibit the growth of bacteria on the well screen.

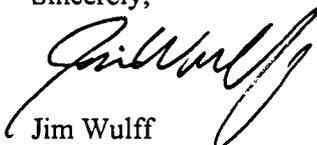
This technique would require the involvement of the construction contractor, International Technology (IT) to remove the well pump and auxiliary equipment, but the well development company could be subcontracted directly by TtEMI. An estimated total subcontractor cost for redevelopment of the two wells by jetting with the deflocculant is \$2,000 to 2,600.

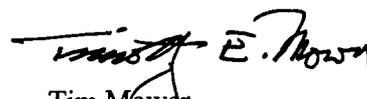
Step Three - Well Enhancement/Replacement

If steps 1 and 2 do not improve well yield to at least 2 gpm, further action may be warranted. Two types of measures may be employed: well yield enhancement by increasing the permeability of the nearby formation, or well replacement. The local permeability could be increased through trenching or hydrofracturing, or either a vertical or horizontal replacement well could be drilled.

If you have any questions, please call me at (303) 295-1101 or Tim Mower at (303) 312-8874.

Sincerely,


Jim Wulff
Project Geologist


Tim Mower
Project Manager

JW/jed

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**Plan to Improve Yield of Extraction Wells
West-side Aquifers Treatment System
Moffett Federal Airfield
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