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Revision 0

AMEC GEOMATRIX/ARA GROUNDWATER REMEDIATION TRIP REPORT

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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1.0 INTRODUCTION

1.1 SITES VISITED

City of Rialto, Well #3 Demonstration System Integration Project, and Baldwin Park Operable Unit, Baldwin Park, California. The groundwater remediation contractors are AMEC Geomatrix and ARA. The sites were visited on July 22, 2008.

1.2 POINTS OF CONTACT

- Ron Borrego, Principal Engineer, AMEC Geomatrix, (970) 764-4070
- Ed Coppola, Principal Engineer, Applied Research Associates (ARA), (850) 914-3188
- David Towell, P.E., CH2M HILL, (213) 228-8285 (EPA is their client)

1.3 PURPOSE OF SITE VISITS:

Fluor Hanford and the U.S. Department of Energy are currently looking at a variety of alternatives to capture carbon tetrachloride, nitrates, and other COCs from 200-ZP-1 groundwater. A few of the more important objectives of our visits were to:

- Evaluate the treatment systems being used by AMEC Geomatrix to address VOCs, perchlorate, NDMA, 1,4,-Dioxane, and 1,2,3 TCP in a drinking water source
- Evaluate how effective these treatment methods have been
- Determine the types of problems they have encountered with these treatment systems and how they addressed these problems
- Determine the types of secondary wastes being generated by the system
- Determine how clean of an operation these companies run
- Determine if the site is worth being visited by DOE-RL at a later date.

2.0 SITE 1: CITY OF RIALTO, CALIFORNIA, WELL #3

The first site visited was in the City of Rialto, Well #3, where currently there is a 2,000 gpm single-use resin ion exchange system, well #3, and support systems to treat perchlorate. As part of an Environmental Security Technology Certification Program (ESTCP) project with the intention of reducing operation and maintenance costs, ARA and Carollo Engineers are jointly designing and constructing a demonstration system that will be integrated into the existing groundwater treatment system. The demonstration treatment system consists of a weak base anion (WBA) resin ion exchange, pH-dependent system. The regeneration process using WBA resins is followed by a scavenger process using strong-based anion (SBA) resins to provide "zero-discharge" of perchlorate (ClO4-) concentrations in drinking water to less than 1 ppb from untreated groundwater. Concentrations of perchlorate could be as high as 50 to 200 ppb. Nitrate is present, but below the MCL. Trichloroethylene (TCE) may be present up to 30 ppb. Construction and operation of the WBA demonstration system is conducted on a non-interference basis with operation of the existing system.

The ARA WBA resin process utilizes a regenerable ion exchange process which is pH dependent - the process only ionizes at pH less than 7.0. The most expensive part in the system's operation is neutralizing the water to restore the pH. Carbon dioxide is stripped from the water to reduce the consumption of neutralizing chemicals. The demonstration system design flow rate is 1,000 gpm but could be expanded to 2,000 gpm by adding another ion exchange train. The WBA process is capable of removing high concentrations of perchlorate (100 to 1,000 ppb with maximum concentrations of 200-300 ppb anticipated at this site) and nitrate contaminants from the groundwater at a cost savings compared to the current single-use resin system. The contaminants are thought to originate from the San Bernardino County landfill located approximately one mile to the north of the site. Perchlorate contamination from past Department of Defense operations is thought to have been flushed into the groundwater by gravel washing at the landfill.

Originally ARA looked at four resins for scavenging perchlorate from the spent regenerating solution, did a cost effectiveness test, and determined A530 to be most cost effective. A new resin (A532) may prove to be more effective because it has both higher exchange capacity and greater selectivity for perchlorate (and technetium). ARA expects to use the WBA IX resin selective for nitrate and perchlorate (which are less selective than other anions of concern, hence will come off the IX resin first during regeneration), do a thorough regeneration and rinse (occurs in a closed-loop process) reasoning the remaining contaminants won't breakthrough until after nitrate has been removed. The WBA resins are expected to have a seven to eight year life. The key maintenance step is in conducting a proper rinse which is important for limiting bleed of the contaminants. The system will be online approximately 20 days before regeneration. The strong base anion scavenger resin is spent and incinerated after a few months. The system currently in place has two10-foot diameter tanks that run 2,000 gpm (Figure 1). The ARA system will consist of 9-foot diameter tanks to run at approximately 1,000 gpm which will provide for higher loads on the resins and be more cost effective. The use of WBA resins gets the concentrations of the contaminants on the resins up by a factor of 100 over brine regenerable SBA.

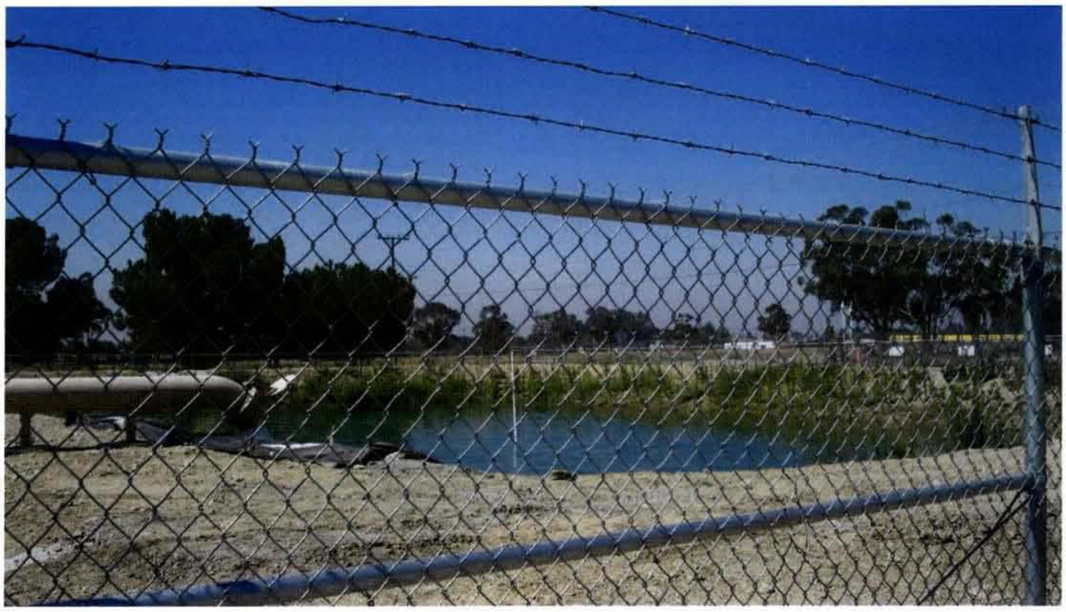
The site's current system is already plagued with biological/bacterial fouling of the resins thought to be caused by the septic systems of local residents not on the city sewer system. San Bernadino County is planning to install an ultraviolet system to kill bacteria in the water prior to entering the ion exchange process. Bacterial fouling will also automatically be reduce once the ARA system is in place since their regeneration process includes an alkaline/acid flush of their resins every two weeks resulting in greatly-reduced bacterial counts. In addition, nitrosamines were a concern initially when EPA conducted an analysis and found nitrosamines. Research found nitrosamines occurred on the virgin resins, but not once resins were regenerated.

Because the San Bernardino County Landfill is suspected of contributing to the contamination of the groundwater, the county is paying for the current plume remediation and the demonstration system is scheduled to go on line for testing in 2009. ARA plans to expand the system as the county adds more wells. The demonstration process is expected to last four months. Once online, the full-scale system will have a 20- to 30-year life expectancy. Expected cost of the system is approximately $3 million, not including well installation.

Figure 1. City of Rialto, CA Groundwater Treatment Demonstration System Integration Project under Construction.

The site also features a well-development infiltration basin (Figure 2). The well being drilled for groundwater treatment is located some distance across the street from the site. Because the water pumped from the newly-developed well is untreated, water from the well is directed through underground piping into an infiltration basin located directly above the center of the plume and allowed to percolate down through the soil and vadose zone. Because untreated water is percolating back down into contaminated groundwater, there were no issues with the regulators.

Figure 2. Untreated Groundwater Infiltration Basin as Part of Well Development.



3.0 SITE 2: BALDWIN PARK OPERABLE UNIT, BALDWIN PARK, CALIFORNIA

The purpose of this site visit was to observe the groundwater extraction, treatment, and water supply project that AMEC Geomatrix and ARA designed and constructed at the Baldwin Park Operable Unit (a Superfund site) in the city of Baldwin Park, CA. The treatment system is removing carbon tetrachloride, chloroform, nitrates, trichloroethylene (TCE), and other COCs from groundwater. The types of information gathered during the site visit included: estimated operations and maintenance costs, reliability of the system, type and volume of waste generated, temperatures of operation, life expectancy of the system, availability of the system, ability of the system to support large scale operations, health and safety issues, etc.

3.1 BACKGROUND

AMEC Geomatrix is currently providing engineering design and consulting services to the Baldwin Park Operable Unit (BPOU) Cooperating Respondents Group for the project planning, coordination, and technical oversight for a groundwater extraction, treatment and water supply project. Four water treatment systems have been designed and constructed with multiple treatment technologies to treat a long list of emerging contaminants from contaminated groundwater. This program provides 26,000 gallons per minute (gpm) of contaminated groundwater treatment in the BPOU including this facility which treats 7,800 gpm of groundwater contaminated with a mixture of VOCs including TCE, tetrachloroethene (PCE), carbon tetrachloride (CT), chloroform, n-nitrosodimethylamine (NDMA), perchlorate, and nitrate.

Historically, this project involved pilot testing and conceptual design, which was followed by construction and operation of four water treatment systems. Pilot testing evaluated the performance of new water treatment technologies for drinking water supply, and subsequent regulatory approval from the California Department of Health Services was obtained since these facilities treat water to drinking water standards. The pilot testing and technology evaluation included evaluation of air stripping, liquid phase granular activated carbon (GAC) ion exchange, fluidized bed and membrane bioreactor biological treatment, and ultraviolet (UV) light treatment to treat perchlorate in raw water and in ion exchange regenerant brine streams. Pilot testing was performed on separate unit processes as well as combined treatment systems to understand unit process interactions. Conceptual engineering design involved development and screening of engineering alternatives to evaluate available water treatment technologies. Engineering alternatives were evaluated for effectiveness, reliability, robustness, ease of operation, complexity, ability to permit, and life cycle cost. Detailed cost estimates were developed for each alternative considering permitting, land requirements and land availability in the analysis. Pipelines were designed and constructed to convey raw water from a network of newly installed groundwater production wells designed to replace existing wells impacted by groundwater contamination and provide capture and containment of the contaminant plume, as well as to convey treated water to specific locations in the existing water distribution system.

- **Year work was completed:** Plant operating since 2004, ongoing monitoring and performance evaluation

- **Point of Contact:** Scott Goulart, Director of Environmental Services, Aerojet Gencorp (916) 355-5454

- **Personnel who worked on project:** Ron Borrego, Geomatrix – engineering design, Grant Ohland, Geomatrix – design support on hydrogeologic and geochemical issues, Ed Coppola, ARA – pilot testing of treatment technologies.

The Baldwin Park Operable Unit (BPOU) Project treatment plant is the Valley County Water District municipal water treatment plant, and is owned by the Valley County Water District. This facility is one of four at BPOU, treating 7,800 gallons per minute of contaminant-impacted groundwater in a plume one mile wide and nine miles long. EPA required 21,000 to 23,000 gpm for containment, but due to residential needs the system was upgraded to treat 26,000 to 30,000 gpm to meet those needs. The impacted groundwater contains a variety of VOCs, perchlorate, nitrate, NDMA, 1,4-dioxane and 1,2,3-trichloropropane (TCP) that must be reduced before the California Department of Health Services allows the water to be delivered to district customers. The groundwater beneath this plant has the highest concentrations of contaminants. Concentrations of TCP must be less than 5 parts per trillion (ppt) to be compliant. Most of the Potentially Liable Persons, contributors to the contamination, are upgradient of this facility. This facility captures contaminants at the leading edge of the plume, and there are three additional facilities that provide 15,000 gpm of capture at a downgradient location on the plume. Treatment unit processes include air stripping with vapor phase GAC treatment of off-gas (VOCs), liquid phase GAC (1,2,3-TCP), Calgon ISEP ion exchange (nitrate and perchlorate), weak base one-pass ion exchange (new perchlorate technology), and ultraviolet oxidation (NDMA and 1,4-dioxane).

3.2 AIR STRIPPER/VAPOR PHASE GAC →LIQUID PHASE GAC →ISEP IX →UV OXIDATION

Some operational problems were encountered initially. Extraction wells were not in place when the treatment facility was designed. Two wells are not located at this site requiring installation of piping to deliver water to this facility. Groundwater monitoring was also done prior to installation using the best technology and data sets available at the time (2000-2001) with the design based on this information. After installation of the wells was complete, the water chemistry was found to be completely different from the initial data set. Additionally, changes in the plume were detected between wet and dry years. It was determined to be vitally important to have flexibility built into a treatment facility to address changes in the influent. The plume changes with changes in precipitation and flood control. It is estimated that 240,000 to 250,000 acre feet per year are pumped from this aquifer.

Ion exchange (IX) has the ability to deal with changes in concentration levels. According to the contractors, this is a good argument for using IX for well-head treatment at Hanford. There is a waste management issue associated with any process. There is a need to understand waste generation issues because AMEC Geomatrix/ARA have a handle on the technology to remove the contaminants, especially radionuclides from wet or dry media, but once out of the media, how are they going to manage the waste? The separation schemes need to be designed and integrated with waste stream in mind.

This facility has to be "tuned" routinely.

At this facility, they initially installed air strippers at approximately 2,000 gpm using an innovative fluidized bed off-gas resin. The system proved to be high maintenance, difficult to keep up with, fell into disrepair, out of favor, and ultimately replaced. However, the VOC off-gas concentration was lower than anticipated proving the technology was a great idea. The decision to use the then existing system and change it to an air stripper/vapor-phase granulated activated carbon (GAC) was based on cost effectiveness. In the new system (Figure 3), vapor-phase GAC is used to capture VOCs, and heaters are used to reduce the relative humidity of the off-gas stream to significantly reduce carbon usage and operating costs.

Figure 3. Baldwin Park Operable Unit Air Stripper/Vapor-Phase GAC Towers.

Vapor-phase granulated activated carbon also uses natural gas to heat the stream which is not cheap, but highly effective in increasing efficiency. Drawbacks include changes in humidity which can significantly increase the cost of heating in some seasons. Additionally, there have been problems with scaling because the water has a high calcium carbonate scaling potential (CCSP). The water district has not operated the strippers to control scale, and are considering the use of polyphosphate as an anti-scalant, using food-grade HCL (expensive), and turning down the air to water ratio to strip less carbon dioxide during treatment,. Turn down the air to water ratio, use less acid (Figure 4), use less air, and reduce costs and scaling. Weekly air sampling is conducted.

Figure 4. Tank Containing Food-Grade Hydrochloric Acid at the BPOU.

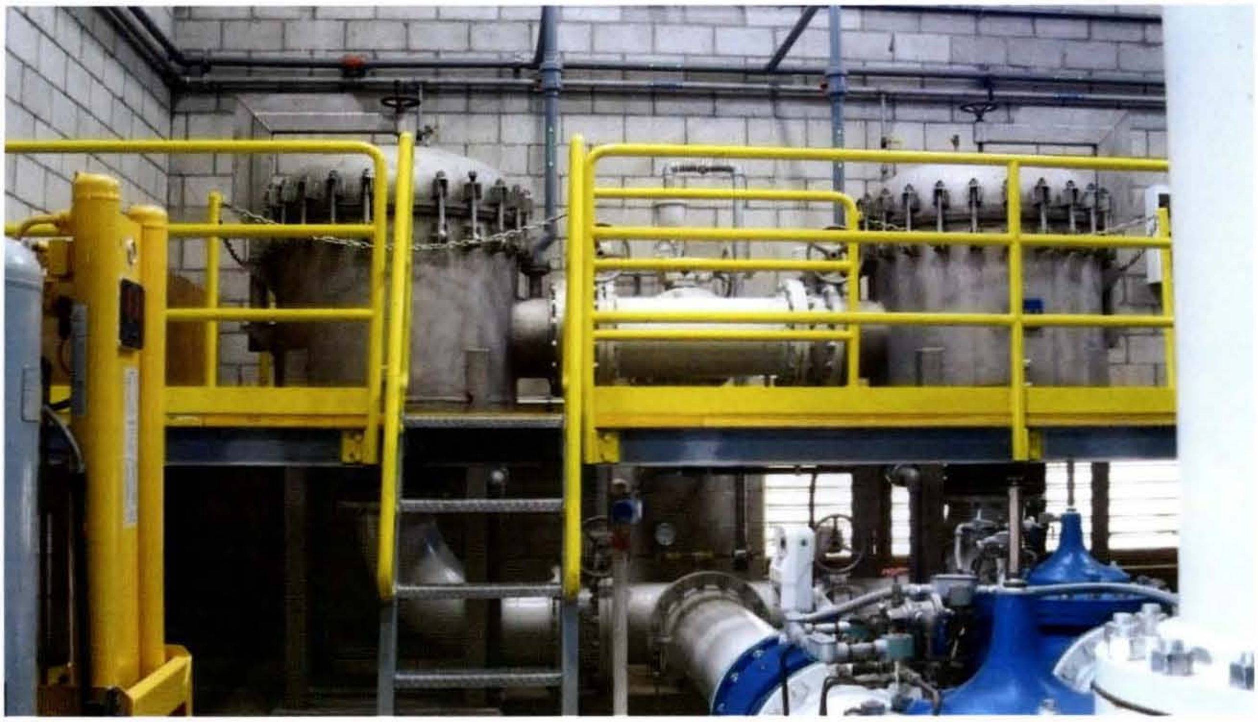
When 1,2,3 TCP was detected in the influent stream, they had to install a liquid-phase GAC process since the vapor-phase GAC process was not successfully removing 1,2,3 TCP to less than 5 ppt. There are 10 tanks in series in this treatment phase (Figure 5). This system cost approximately $2.5 million to remove 1,2,3 TCP.

Figure 5. Liquid-Phase GAC Tanks for Removal of 1,2,3 Trichloropropane at the BPOU.

Following air stripping/vapor-phase GAC and the liquid-phase GAC, the water is run through Calgon ISEP IX resins to remove perchlorate and nitrate (Figure 6). At the time this facility was designed, few options for perchlorate treatment were available commercially. In the ISEP system $4K to $6K of salt per day to regenerate resins is used with a resultant waste brine stream generated that has to be piped and disposed to the public sewer treatment system seven miles away. They plan to update the system to reduce the brine stream. The system has 32 ion exchange canisters. Four of these canisters are on line at one time and the rest are in various phases of regeneration. Since the site has a nitrate problem (~50 ppm), the current plan is to treat perchlorate with the one-pass resins in the new system and retain the ISEP system to remove nitrates. The water is put through a particulate water filter prior to entering the ion exchange system (Figure 7). An ion exchange water softener system is used to provide soft water in the ISEP ion exchange resin rinsing process.

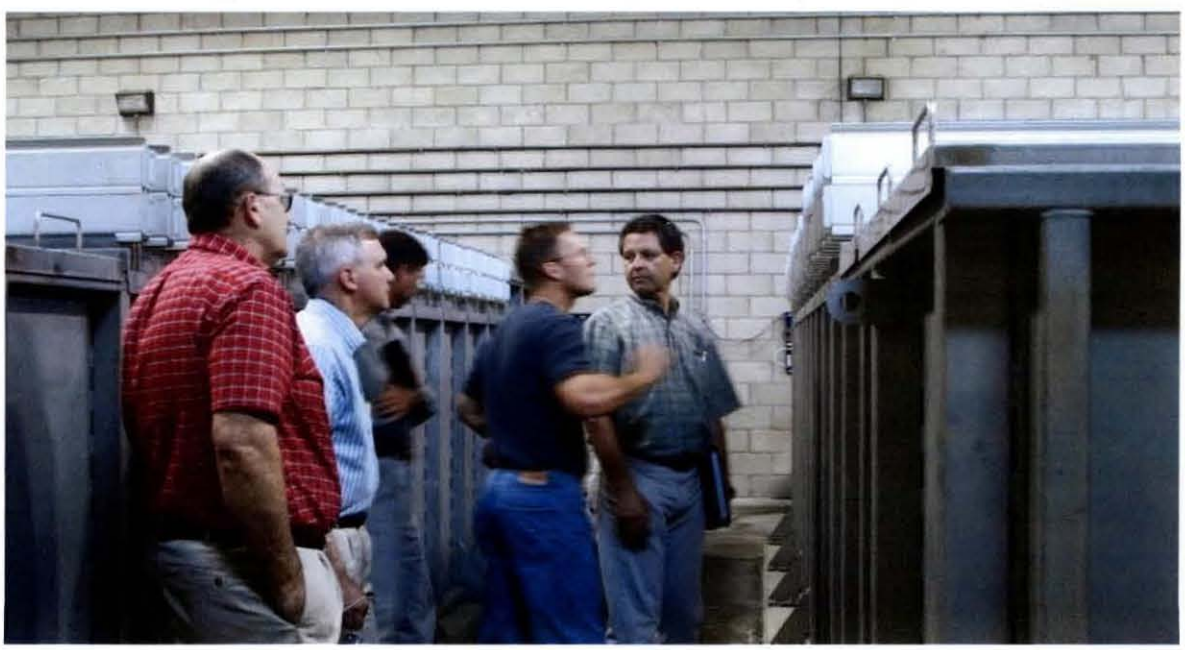
Figure 6. Calgon Ion Exchange Resin Tanks at the BPOU.

Figure 7. Particulate Filters for Pre-Treatment of Groundwater Prior to Entering Ion Exchange Resin Tanks at the BPOU.



The groundwater is then treated using a UV Oxidation treatment process with hydrogen peroxide for organic compound destruction, particularly NDMA and 1, 4-dioxane (Figure 8). The system uses low pressure lamps and a very tight light curve to destroy contaminants resulting in significant energy savings. For each contaminant, the light wavelength for destruction is very specific. By finding the specific wavelength, energy requirements for the treatment of NDMA and 1,4-dioxane have been reduced by a factor of 10.

Figure 8. Ultraviolet Oxidation Treatment System at the BPOU.



Problems associated with the UV Oxidation process initially involved a chloride residual. Chlorine is used to control bacterial growth. They were having problems keeping the residual chloride from interacting with the peroxide. By moving the chlorine dosing port as well as moving the sampling port, they were able to prevent interactions. Initially, too, some consideration was given to the possibility that the UV Oxidation process could actually generate TCP. Subsequent tests determined that generation of TCP is not likely to occur.

Ethyl dibromide (EDB), a toxic carcinogen, is expected to be the next contaminant in the groundwater requiring treatment to parts per trillion. AMEC Geomatrix is conducting a systems check to determine if slight reconfigurations will result in removal of this contaminant.

3.3 APPROXIMATE FACILITY COSTS

Original Facility	$14.0	million
Vapor-Phase Addition	1.0	million
1,2,3 TCP Addition	2.5	million
New IX Process	5+	million
Total	**$22.5+**	**million**

3.4 OPERATIONS

There are two operators and one off-site supervisor for this facility; the facility has an elaborate alarm system that alerts operators when problems arise. The operators are able to view the entire facility at their computer systems at work and at home.

The buildings are equipped with skylights and windows along the top of the two-story walls to provide ambient lighting for the facility at considerable energy savings. No interior lighting was needed during the morning and early afternoon tour. Cinderblock/concrete construction of the building housing the groundwater remediation treatments insures longevity for the facility. The grounds surrounding the facility were low-maintenance white-rock beds and concrete. The facility was immaculately maintained inside and outside. The equipment was clean, quiet and appeared to be operating efficiently.