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Janet Napolitano
Governor

ARIZONA DEPARTMENT
OF
ENVIRONMENTAL QUALITY

1110 West Washington Street • Phoenix, Arizona 85007
(602) 771-2300 • www.adeq.state.az.us

Stephen A. Owens
Director

CERTIFIED MAIL
Return Receipt Requested

September 22, 2006

Attention: John Brack, General Manager
Phelps Dodge Sierrita, Inc.
6200 W. Duval Mine Road
P.O. Box 527
Green Valley, AZ 85622-0527

Re: Mitigation Order on Consent, Docket No: P-50-06 – Work Plan Response

Dear Mr. Brack:

The Arizona Department of Environmental Quality (ADEQ) has completed its review of the Work Plan submitted by Phelps Dodge pursuant to the Referenced Consent Order, and provides the comments attached. At this time, the proposed Work Plan is not approved. Please see the enclosed technical memorandum and schedule to complete actions required in the Mitigation Order.

In the interest of expeditiously finalizing the Work Plan, ADEQ proposes a meeting be held to discuss ADEQ's technical comments. This meeting should be held prior to the Work Plan being revised, and should be held as soon as possible. I will coordinate with Stuart Brown of Bridgewater Group, Inc. to schedule the meeting.

Please call me at 602-771-4614 if you have any questions.

Sincerely,

Robert Casey, Manager
Water Quality Enforcement Unit

Cc: Stuart M. Brown, President,
Bridgewater Group, Inc.,
4500 SW Kruse Way, Suite 110
Lake Oswego, or 97035

Northern Regional Office
1515 East Cedar Avenue • Suite F • Flagstaff, AZ 86004
(928) 779-0313

Southern Regional Office
400 West Congress Street • Suite 433 • Tucson, AZ 85701
(520) 628-6733

Cindy Campbell, Manager, WQCS, ADEQ
Joan Card, Director, WQD, ADEQ
Henry Darwin, Enforcement Coordinator, ADEQ
Moses Olade, Hydro III, WQCS, ADEQ
Frank Smaila, EES, DWS, ADEQ

EU: 06–741

GENERAL COMMENTS

The following are general comments on the selected tasks outlined in the Work Plan.

A. Well Inventory: The purpose of the well inventory is to identify all private, semi-public and public drinking water sources that will potentially be, or are actually impacted by the sulfate plume. PDSI's proposed well inventory depends solely on the Arizona Department of Water Resources (ADWR) Well Registry database for information. ADEQ recommends that PDSI widen the scope of its proposed well inventory work plan to take into consideration the following:

(1) Previous experience has shown that this source may not be sufficient. The ADWR database should be augmented with other sources, such as records at other agencies including the ADEQ (groundwater database), Pima County, cities and water providers. In addition, other avenues of acquiring direct information about private wells should be utilized, such as distributing leaflets, using postage-paid reply cards, and through outreach to community or neighborhood associations, and utilities. All identified wells should be spot checked (field visits) and GPS locations obtained.

(2) This well inventory should not only identify the location of wells but also establish their water levels and water quality, particularly their sulfate concentration. If such data is not readily available, water samples should be obtained for that purpose. Such evaluation should be conducted early in the site investigation so that interim mitigation measures can be implemented without delay.

(3) The one-mile limit as currently described in the Work Plan for well inventory may not be adequate to cover wells in the northeastern portion of the site. Many wells that are threatened by this plume, such as wells ESP-5 and CW-5 are located outside a mile radius of the plume boundary. Considering a maximum spreading rate of 600 ft/yr in the NE, these wells may lie within striking distance of the plume in 10 years. Flexibility in well inventory coverage should be the norm rather than the exception. All drinking water sources in the Green Valley as far east as the Santa Cruz river should be inventoried.

(4) All well information should be entered into an inventory database.

B. Plume Characterization: One of the main objectives of this Work Plan is to conduct a lateral and vertical characterization of the sulfate plume. To achieve this objective, additional monitor wells must be installed, not only to define the leading edge of the plume but also to understand its internal dynamics, such as identification of the hot spots within the plume. The six new monitor wells proposed in the Work Plan are inadequate to accomplish this objective.

ADEQ proposes that at least an additional four wells be installed for a total of ten. Below is ADEQ's rationale for the location of these additional wells.

(1) A well should be located in the west-northwest edge of the plume (near Duval Mine Road) between CW-7 and the I-series of wells at Twin Buttes. Twin Buttes is another potential source of elevated sulfate levels (650 – 800 mg/L). This should aid in determining whether there are two separate or commingled plumes.

(2) The southern edge of the plume is not well defined because of lack of monitoring wells. Wells MH-7 and MH-3A show high sulfate values of >1500 mg/L, and no wells cross-gradient or down-gradient exist.

(3) Sulfate concentration in well ESP-1 has increased from 220 to 360 mg/L within a short time frame (less than a year) . A new monitor well should be located slightly to the northeast between ESP-1 and ESP-5. to monitor the north-northeast boundary.

(4) An up-gradient (nested) well at an appropriate location is needed to establish the background (ambient) water quality concentrations in the basin-fill sediments and underlying bedrock.

C. Groundwater Monitoring: The groundwater monitoring program will involve collecting data from PDSI's monitoring wells as well as other production wells located within and outside the plume area.

(1) For QA/QC purposes, all groundwater data used in the proposed study should be collected and verified in accordance with ADEQ approved procedures in the Quality Assurance Project Plan ("QAPP").

(2) Groundwater data (including water levels) should be collected on a quarterly basis for at least the first eight quarters, and should be analyzed for selected (essential) elements/compounds including sulfate in alternate quarters. The complete suite of analytes proposed in the Work Plan could be analyzed on a semiannual basis. A quarterly schedule of groundwater monitoring is the standard practice in the environmental assessment of contaminated sites.

D. Identification of Potential Interim Actions: The identification of potential mitigation measures should not require a long-term study. Such alternatives are well known, and response action plans can be developed and implemented within a short time frame. Such plans should be available for implementation by the end of the well inventory.

E. Mitigation Plan: The Mitigation Order states in Section IIID that "*PDSI shall submit a Mitigation Plan for ADEQ review and approval, which identifies and evaluates alternatives* (e.g.

containment, collection and discharge with or without treatment, institutional controls, alternative water supplies including, but not limited to, a new supply well, use of an existing supply well, modifying the screened interval of an existing supply well, connection to an existing public water supply system, and bottled water, mixing or blending, technically practicable treatment, and no action) *to practically and cost effectively provide a drinking water supply that meets applicable drinking water quality standards and with sulfate concentrations less than 250 mg/L to the owner/operator of an existing drinking water supply"*

Mitigation action can be "reactive" or "proactive". Reactive actions are those that mitigate receptors after they have been impacted, whereas proactive actions try to prevent or minimize impact to receptors. Although the Work Plan states that the *"FS will also consider mitigation measures that would control or mitigate sulfate through the application of groundwater/source controls that may include groundwater pumping,"* there is no evidence in this Work Plan that data will be collected or presented to evaluate these alternatives involving source controls (excluding interceptor wells). Phelps Dodge should address data needs for all mitigation alternatives in the Work Plan.

F. Schedule: Considering the pressing need for response action at impacted drinking water sources, the schedule of 24 months for completion of these studies is rather extensive. A wealth of information already exists to help in the preparation of the initial deliverables. The well inventory and collection of groundwater data from about 60 wells should not take more than three months. The PDSTI interceptor and POC wells are already being monitored on a quarterly basis. The issue of obtaining access and permits for drilling of monitor wells can be expedited through assistance from the community, municipality and other agencies. ADEQ believes the mitigation plan could be developed within 12-15 months. If interim measures are implemented within a short time, this may alleviate the need to expedite the investigation process.

G. Addendum: The WP Addendum states on Page 1, last sentence that the FS will exclude any measures related to containment of the plume: "The FS also will evaluate and consider mitigation measures that would: 1) control sulfate migration from the PDSTI through mitigation actions such as groundwater pumping, but not removal or physical containment"

(1). This is contrary to ADEQ's Mitigation Order which states in Section IIID that "*PDSI shall submit a Mitigation Plan for ADEQ review and approval, which identifies and evaluates alternatives* e.g. containment, collection and discharge with or without treatment, institutional controls, alternative water supplies…." Removal and containment of the plume should not be excluded as possible mitigation measures and should be evaluated in the FS.

(2). The possibility of removal (remediation) of sulfate from the groundwater has been mentioned by Phelps Dodge in oral presentations as a possible response action, but is excluded in this addendum. It should be evaluated in the FS.

(3). Evaluation of other source control or source reduction measures (other than the

interceptor well system that has failed in the past) should be included in the FS. Please include an analysis of mitigation actions in the tailing ponds and impoundment areas.

SPECIFIC COMMENTS

A. Section 2.1 – Summary of Existing Information

(1). Page 9, Paragraph 1: states that "*In April 2006, the concentration of sulfate in wells ranged from 100 to 1750 mg/L.*" This statement is at variance with available information. There are concentrations of sulfate ranging from 1800 to >2000 mg/L in wells sampled as recently as February 2006.

(2) Page 10, Paragraph 3: A description of the interceptor well system should include the system performance and past failures to capture the seepage of contaminated groundwater.

(3) Page 12, Paragraph 12: " the basin fill sediments are thickest at the center of the basin and thin towards the basin margins." PDSI should provide the average thickness from the toe of the PDSTI (margins) to the centre of the basin (W-E). Are there any depth variations from north to south?

B. Section 2.3 –Geological Setting:

(1) Provide a schematic geologic cross-section of the Tucson basin to illustrate the lithostratigraphic relationships described in this section.

(2) Is there adequate information to plot a map showing the depth to bedrock surface for the basin-fill sediments downgradient of the plume?

(3) The Work Plan should provide information on regional faulting and any impact on sulfate migration from gypsiferous bedrock in the Tucson Basin.

(4) The site geology as presented in Appendix A is well compiled, and uses information from drill logs and other sources to describe the lithologic sequence. However, there is a need for a more detailed stratigraphic analysis of the basin-fill sediments to carefully correlate lithologic units across drill logs and establish if a relationship exists between lithololgy and preferential flow of sulfate-laden seepage waters.

C. Section 2.4 – Hydrogeology

(1) This section provides useful information on the hydrogeologic characteristics and hydraulic properties of the formations underlying the site.

(2) Page 23, Paragraph 2: Figure 6 shows that the hydraulic gradients are steeper immediately downgradient of PDSTI, than towards the eastern part and center of the basin. How are these variations related to the changes in the composition of the sediments that are finer and thicker towards the Santa Cruz river?

(3) Page 24, paragraph 1: Description of potentiometric surface should include depth to groundwater across the basin.

D. Section 2.5 - Water Quality

(1) Background Water Quality: The Work Plan should evaluate the background sulfate concentration in groundwater within the basin using data from locations upgradient and outside the areas affected by the plume. Locations should be selected to represent groundwater which flows through the alluvium, basin fill sediments and the fractured bedrock complex. For example, data from wells S-1, GV-1, GV-2 and the M-series of wells may represent background in basin-fill. On the other hand, data from GV-01, GV-02, CW-5 and ESP-5 may represent elevated background in the Santa Cruz alluvials. Knowing the background levels for contaminants is essential to evaluating their geochemical dispersion and sources.

(2) Spatial Distribution of Sulfate: Only three sulfate isoconcentration lines (250, 500, 1000 mg/L) are used in Figure 8 to portray the distribution of sulfate downgradient of PDSTI. Although 250 mg/L is the selected action level for sulfate, it should not be used as the smallest isoconcentration for sulfate distribution. It is apparent that other isocons can be drawn to define the horizontal distribution of sulfate, such as: 50, 100, 1500, 2000 mg/L. These isocons should be shown on the map.

(3) Lateral Distribution:
The eastern boundary of the plume is definitely dynamic as the plume continues to spread laterally. Sulfate concentration at ESP-1 already exceeds 250 mg/L, and values are increasing at ESP-3 as well. Considering the location of ESP-4, shouldn't the concentration of sulfate be determined, since the last sampling was conducted in 2005?

The western boundary of the plume is also not well defined because there are no monitoring wells west of MH-30 with a sulfate level of 1970 mg/L. ADEQ believes the isocons should be drawn to reflect these elevated values. If not, what is the plan to acquire more data to define this boundary?

(4) Longitudinal Distribution.

Along the south-southeast boundary, the sulfate concentrations of samples collected from IW-2 has dropped below 250 mg/L. What is the pattern of sulfate dispersion west of IW-2 in wells IW-1, MH-8, 9 and 10?

When defining the northern extent of the sulfate plume, it is important to know if there is a commingling with the elevated sulfate beneath the Twin Buttes. It is very doubtful that the single well proposed in this Work Plan will be adequate to delineate this very important northern boundary of the plume. An additional well should be located east of the I-series of wells near Duval Mine Road.

(5) Vertical Distribution

The major objective of the depth specific sampling is to identify the source and vertical location of the plume within the aquifer. Three groups of nested wells have been installed, and ADEQ believes they are adequate to achieve this objective. However, it seems that despite all the previous studies, the only findings "suggest that the leading edge of the 250 mg/L concentrations on the east side of plume may be in deep, rather than near-surface groundwater zones." Can a relationship be established between the position of the plume and specific lithostratigraphic units or features that may cause preferential flow?

(6) Temporal Distribution.

It is obvious that the plume is spreading both NNE and eastwards as evidenced by the number of ESP wells that have been impacted by the plume. It will be helpful to calculate the plume spreading rate eastwards. Establishing this rate will assist in any mitigation planning and receptor impact assessment because most of the drinking water supplies lie east of the plume.

E. Section 2.6 – Conceptual Site Model

(1) Page 39, Paragraph 2: states that "*The tailing impoundment represents a finite source of sulfate that will eventually cease following the end of mining and mineral processing, when tailing is no longer deposited and the rate of residual seepage will further diminish as the surface of the impoundment is capped and revegetated to minimize infiltration from precipitation.*"

This is an ominous statement indicating that the source of the sulfate plume will continue to exist as long as mining continues at Sierrita Mine. Without an aggressive containment strategy and a robust well interception system, seepage from the PDSTI will continue indefinitely to degrade a drinking water source aquifer. Other options for source control should ultimately be evaluated including closure of seepage ponds, replacement with lined structures, and capping of portions of the PDSTI .

(2) Page 39, Paragraph 2: states that *"Groundwater in the bedrock upgradient of the tailing impoundment is a second source of sulfate to the basin fill beneath the impoundment. Groundwater sulfate concentrations in bedrock upgradient of the tailing impoundment are generally in the range of 100 to 3,000 mg/L."*

PDSI should explain how the bedrock is a source of sulfate to the basin fill sediments. Is it by upward hydraulic migration, preferred flow through fractures/faults or by detrital sourcing? The information on the range of sulfate from 100-3,000 mg/L needs to be supported by data because the statement gives an impression that the bedrock is as important a contributory source to the sulfate problem as PDSTI.

(3) Page 40, Paragraph 1: What statistical or geochemical methods will be used to determine the source of the sulfate? How about sulfur isotope studies?

(4) Page 40, paragraph 2: PDSI should include in the fate and transport model the reason(s) why sulfate is migrating within the deep layers of the aquifer, and the reason(s) why the sulfate concentrations are so low in the upper units of the basin-fill sediments.

F. Appendix E - Quality Assurance Project Plan (QAPP):

This QAPP document looks preliminary. For a project of this magnitude, PDSI should prepare a more detailed QAPP. This document will also be reviewed by ADEQ's QA/QC Manager. The QAPP should incorporate a detailed Field Sampling and Analysis Plan (including monitor well designs), as well as a Health and Safety Plan. In preparation of the QAPP, ADEQ recommends that PDSI follows the format provided in "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations." (EPA QA/R-5). This and related documents can be found at the ADEQ web site: *www.azdeq.gov/function/business/data.html.*

(1) Section 5.3 – Analytical Methods

ADEQ believes that the range of parameters proposed for testing are too limited. PDSI should include in the Work Plan sampling and analyzing for the dissolved and total concentrations of the following; Arsenic; Barium; Cadmium; Chromium; Lead; Silver; Selenium; and Nickel. Table E.2 should be revised to include these parameters.

(2) Section 6.2 – Data Review, Verification, and Validation

PDSI states "Data validation is not expected for this project. Data evaluation would require a thorough review of all the field data and/or the analytical laboratory results to provide data documentation consistent with EPA Level IV requirements." ADEQ believes that a project of this magnitude does require data validation protocols to established. PDSI should state the criteria used to review and validate – i.e., accept, reject, or qualify data in an objective and consistent manner. ADEQ recommends that PDSI consults EPA's Contract Laboratory

Program National Functional Guidelines for Organic and Inorganic Data Review as a reference for completion of this task.

PROPOSED SCHEDULE FOR AQUIFER CHARACTERIZATION AND MITIGATION PLAN

ACTIVITY or TASK	TIME FRAME		DELIVERABLE DUE DATE	COMMENTS
Summary of Existing Information	1 month	Oct	Oct. 31, 2006	Presented in WP. Final draft to address comments
Quality Assurance Project Plan (including FSP and HSP)	2 months	Oct. – Nov.	Nov. 30, 2006	A MAJOR REQUIREMENT OF Mitigation Order. Preliminary QAPP in WP. Needs revision and compliance with ADEQ QAPP
Well Inventory	3 months	Oct. – Dec.	Dec. 31, 2006	Well inventory will include site visits, GPS, water level and water quality
Interim Mitigation Plan	3 months	Oct. – Dec	Dec. 31, 2006	Technical memorandum can be developed easily because all options are well known.
Groundwater Monitoring (including depth-specific sampling (existing wells) GW Monitoring -1st Round GW Monitoring - 2nd Round GW Monitoring - 3rd Round GW Monitoring - 4th Round	12 months 3 months 3 months 3 months 3 months	.Oct. - Sept Oct. – Dec Jan. – Mar Apr. – Jun Jul. - Sept	September 2007 Dec. 31, 2006 March 31, 2007 June 30, 2007 September , 2007	Currently, PDSI conducts quarterly monitoring of interceptor and compliance wells. Synchronize and include production and other wells
Installation of New Wells First sampling of new wells by end of 2nd round of monitoring	6 months	Oct. – Mar	March 31, 2007	Access , permitting and installation, development and sampling of new monitoring wells
Evaluation of Interceptor System	5 months	Oct. – Feb.	Feb. 28, 2007	Evaluation can proceed simultaneously with other tasks
Final Aquifer Characterization Report (including data from existing and new wells, and fate and transport analysis).	3 months	April - Jun	June 31, 2007	Final report should incorporate previous interim or activity reports
Feasibility Studies (including development and screening of alternatives).	8 months	Jan. – Aug.	August 31, 2007	Development and screening of mitigation alternatives is a continuum
Mitigation Plan	2 months	Aug. - Sept	Sept. 30, 2007	Final mitigation developed after FS and consultation with ADEQ
Treatability Studies and Response Action	3 months	Oct. – Dec.	Dec. 31, 2007	May include testing of removal technologies (if active removal well be involved, or just groundwater modeling and development of institutional controls for passive removal).