Kevin
TONEY ANAYA
GOVERNOR

DENISE D. FORT
DIRECTOR

HEALTH ENVIRONMENT department

STATE OF NEW MEXICO

ENVIRONMENTAL IMPROVEMENT DIVISION
P.O. Box 968, Santa Fe, New Mexico 87504-0968
(505) 984-0020

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GROUND WATER/HAZARDOUS WASTE BUREAU

3 April, 1985

Mr. Russell Erbes
Public Service Company of New Mexico
Alvarado Square
Albuquerque, New Mexico 87158

Re: Phase V Program at Person Generating Station: Ground Water Investigations Progress Report.

Dear Mr. Erbes:

The above-referenced report has been submitted to the Environmental Improvement Division Hazardous Waste Section, by the Public Service Company of New Mexico (PNM), as a milestone toward development of a closure plan and corrective action program at Person Station that will conform with requirements of the Hazardous Waste Management Regulations (HWMR-2). PNM's actions at Person Station are also being reviewed to insure conformance with the requirements of the Water Quality Control Commission Regulations, Part III (Ground Water Discharge) and Part V (Underground Injection Control).

This letter constitutes comments on the above-referenced report and recommendations for further action. It incorporates the comments of Ann Claassen for the Hazardous Waste Section, Kent Bostick and Kevin Lambert for the Ground Water Section, and Paige Grant-Morgan for the Underground Injection Control Program (within the Ground Water Section).

General Comments

We have three major concerns with the work you have done so far: 1) that the pump tests done at Person Station were inadequate to accurately characterize the aquifer; 2) that too much reliance on modeling may not be an efficient method for quick progress toward remedial action at Person Station: and 3) that the possibility of contaminant sources other than the leaking tank has not been adequately explored. These major concerns are addressed below. Detailed technical comments by Kent Bostick are provided as an attachment to this letter.

1) Regarding the pumping tests: For reasons explained in this paragraph, we believe your pumping tests have not provided realistic aquifer parameter values.

We commend your efforts to design monitoring wells and conduct sampling at the Person Station site in such a way as to minimize errors in the detection of contaminants. Unfortunately, a well that is suited to collecting a representative water sample may not be properly designed for use in ascertaining aquifer parameters. We recognize that PNM was wary of conducting lengthy pumping tests on the monitor wells at Person Station because you didn't want to alter the flow pattern of the contaminated ground water, which would add another level of complexity to modeling movement of contaminants from the waste tank area. In addition, we recognize the problem of proper disposal of contaminated ground water that might be developed during a series of long pumping tests. Nonetheless, the very brief, low-rate pumping tests conducted on the monitor wells led to assumptions of hydraulic conductivity and transmissivity that appear to be far too low compared with published values of aquifer parameters for the Rio Grande aquifer, or with published ranges of hydraulic conductivity for the type of materials encountered in the screened intervals of the monitor wells.

2) Regarding the modeling effort: The model results you have presented are brought into question for a number of reasons. Since the modeling of movement of the contaminant plume was based on what we believe to be excessively low transmissivities (see comments on pumping test above), we question the results of the modeling in terms of direction and extent of contaminant transport. The model also utilizes a large number of assumptions, of which the validity may be difficult to verify. The fact that it was necessary to empirically weight particles in the northeast corner indicates that the model may have little predictive value, even if it can be calibrated to present conditions.

It may be possible, by gathering more data and doing more calibration, that the model can be improved to an acceptable degree. However, we are anxious that this not become an exercise in modeling; modeling is not a substitute for real-time data. Once more sufficient data is obtained, a model may be useful for predicting future migration and for determining remedial actions.

3) Regarding other contaminant sources: The question of whether there may have been multiple sources of contaminants detected in ground water has not been resolved; nor has the issue of whether there may be a westerly component of contaminant transport. The nature of the model precludes the possibility of sources upgradient of the tank; by empirically weighting the northeast corner particles, the possibility of contamination from past dumping in the "boneyard" has been ignored. We would like to see this question more thoroughly addressed.

<u>Recommendations and Requests</u>

We recommend/request the following approach to resolving the above questions and proceeding with your closure plan and ground-water corrective action program:

1) Conduct a more extensive, real-time geochemical survey of the Person Station property. If you wish to continue using a model, this survey should extend at

least to the boundaries used in your model. We strongly recommend the soil-gas monitoring technique for this purpose. This would give a strong indication as to whether the assumption of one contaminant source is correct, and would further provide a check on the assumption that all contaminant flux in the saturated zone is easterly. Some additional wells will also be required. It would be acceptable to us if you used a less expensive material than stainless steel for purposes of this survey.

2) Install a well specifically designed for determination of aquifer properties and perform appropriate pumping tests. This well could be placed at a location so that it later may be useful for aquifer reclamation. Alternatively, propose other appropriate hydraulic conductivity tests.

3) If you wish to continue using the model, recalibrate it, using revised aquifer parameters, the information obtained from the geochemical survey, and other changes which address issues covered in the attachment to this letter. Provide to us more thorough documentation of the modeling effort (e.g., the code, sensitivity analyses).

4) Within 30 calendar days of receipt of this letter, submit a revised schedule which reflects the activities to be taken in response to these comments.

We appreciate PNM's ongoing efforts to restore the environment at Person Station and to come into compliance with the regulations, and trust that the above issues will be addressed in an expeditious manner. We are all available for phone calls and meetings with you and your consultants on this matter.

Sincerely,

Peter H. Pache
Program Manager
Hazardous Waste Section

PP/PGM/AC/KB/mp

xc: Guanita Reiter, EPA Region VI
Maxine Goad, EID Ground Water Section
Richard Perkins, EID Ground Water Surveillance Section

Technical Review: Phase V Program at Person Generating Station

Attachment to 1 April 1985 Letter to Russell Erbes

Pumping Tests

The constant rate pumping tests were performed at too low a rate for too short a time period to produce measurable drawdowns in the observation wells and sufficiently test the aquifer characteristics.

1. Most of the water pumped during the pumping tests was water removed from storage in the well casing. In these pumping tests, drawdowns in the pumping well are merely the result of removing water from casing storage, not the potentiometric response within the aquifer. During the test of well PSMW-1, the transmissivity value was taken during the first 10 minutes of pumping at a rate of 0.22 gpm. Over this time period a total of 5 gallons was pumped; approximately the amount in storage in the well casing. Therefore, using Jacob's analysis and drawing a line through early time data indicates casing storage effects rather than true aquifer parameters (see Schaefer, D.C. January, February 1978, Casing Storage can Affect Pumping Test Data, Drillers Journal).

2. The pumping rates and length of the tests had no potentiometric impact on the aquifer. For example, using the Theis equation to calculate a radius of influence during the pumping test on well PSMW-1 and values of

$$T = 29 \text{ gpd/ft}$$
$$S = 1$$
$$Q = 0.22 \text{ gpm}$$
$$t = 0.052 \text{ d}$$
$$s = 0.3 \text{ ft. (measurable drawdown of significance)}$$

$$W(U) = \frac{sT}{114.6Q}$$

Walton, W.L., 1970, <u>Ground Water Resource Evaluation,</u> McGraw-Hill Book Company

Where $W(U) = 0.35$
$U = 7.9 \times 10^{-1}$

$$r = \sqrt{\frac{UTt}{1.87S}} = 2.5 \text{ ft.}$$

By this method, significant drawdown was produced over a distance of only 2.5 ft from the well bore. This does not constitute a pumping test where the aquifer is stressed.

3. The criteria for the Jacob approximation to be used for analysis of water table aquifers has not been satisfied and the method of analysis for T and S is invalid. The tests were not run long enough for U to approach 0.01 (as demonstrated by the value of $U = 7.9 \times 10^{-1}$ in the previous item 2).

. Although the legends on the Jacob plots presented are difficult to read, we surmise that early time recovery data was used for recovery analysis of T during the recovery period. This is unusual as most hydrologists prefer to use late time data in which residual drawdown is not affected by well efficiency or well casing storage. Similar to pumping test interpretation, analysis of late time recovery test data provides information on aquifer parameters over a larger representative volume of the aquifer.

4. The coefficient in the equation for T was expressed in English units (264), while the coefficient in the equation for S was expressed in metric units (2.25). To be consistent, the coefficient in the equation for S must be 0.3, according to Freeze and Cherry (1979). Were the values for T and r converted to metric units to calculate S? In the future, all work should be shown in the Appendix concerning the calculations for T and S.

5. It is highly unlikely that "boundary conditions" were encountered during these pumping tests, as the radius of influence of the tests was only a few feet. This "boundary condition" is an indication of an improperly conducted aquifer test, where the aquifer was not sufficiently stressed to produce nonequilibrium conditions. This leveling off of the drawdown is the equilibrium of the rate of water entering the well with water being pumped out. The pumping rate is insufficient to stress the aquifer. The aquifer appears almost as an infinite source of recharge relative to the pumping rate over a short period. (An analogy would be like trying to produce drawdown in a lake with a straw.)

6. The transmissivities presented in Table 4-1 are 2 to 3 orders of magnitude lower than those presented by Bjorklund, L.J. and Maxwell, B.W., 1961, Availability of Ground Water in the Albuquerque area, Bernalillo and Sandoval Counties, New Mexico State Engineer Technical Report 21, 117 p.

7. Obtaining storage coefficients from the pumping well has no mathematical or physical basis. The only valid method of obtaining a storage coefficient from a short term pumping test is by Theis analysis using observation wells. Distance from the pumping wells to the observation wells should be specified. Storage coefficients greater than 0.1, determined from short term pumping tests indicate the effects of well casing storage, artificially increasing the storage coefficient.

   The aquifer tests violate essential conditions necessary for valid application of the Theis analysis and Jacob approximations. New pumping tests should be conducted or alternative hydraulic conductivity tests performed, taking the points raised here into consideration.

Site Hydrologic Parameters

What assumptions were made to determine hydraulic conductivity? Was the transmissivity divided by the estimated thickness above the bottom of that well to obtain the hydraulic conductivity? The range of hydraulic conductivities used in the model for the uppermost zone of transport is .02 ft/day to 2.0 ft/day, substantially less than those presented by Bjorklund and Maxwell of 200 gpd/ft^2 to 1000 gpd/ft^2. Most of the drilling logs show medium sand and gravel in the saturated zone of transport. Hydraulic conductivities will not vary 3 orders of magnitude in a horizontal direction. This variation is more likely the result of improperly conducted pumping tests.

Rates of mass transport are directly proportional to the hydraulic conductivity under steady state conditions. Using nonconservative hydraulic conductivities in the model will result in artificially low rates of transport of the contaminants and is not representative of the physical situation. The model should be recalibrated with more representative hydraulic conductivities.

Boundary Conditions

1. Constant flux boundaries will need to be reevaluated because the transmissivity is too low. Why was the eastern boundary chosen to be a constant flux boundary condition rather than a constant head boundary condition?

2. The potentiometric surface must be recalibrated with the new, representative hydraulic conductivities. Please provide the calibrated potentiometric map for comparison with the actual water table map.

3. The arroyo recharge nodes for the model are not identified on any figure. Please indicate them.

Retardation Factors and Dispersivity Coefficients

The dispersion coefficient D is expressed in units of ft^2/day

$$D = \alpha V$$

Where α = the dispersivity in units of length (in this case feet)
V = average seepage velocity in units of ft/day

The dispersion coefficient therefore is not accurately defined in the report as D_L with units of ft. We assumed that D_L is the dispersivity, α_L.

The unique case where longitudinal dispersivity equals transverse dispersivity ($D_L = D_t$, or more correctly: $\alpha_L = \alpha_T$) occurs only at very low ground water velocities where no hydromechanical dispersion is prevailant. Defining the dispersion coefficient conventionally:

$$D_L = D_m + \alpha_L V$$
$$D_T = D_m + \alpha_T V$$

Where D_m is due to molecular diffusion and αV is mechanical dispersion.

When $\alpha_L V$ and $\alpha_T V \Rightarrow 0$, then
$$D_L = D_m = D_T$$

However, the ground water velocities at the site are in the range where αV, or mechanical dispersion should dominate. For further discussion of this, please refer to Page 379 of Freeze, R.A. and Cherry, J.A. 1979, Ground Water, Prentice-Hall, Inc. for a discussion of Peclet numbers.

Ratios of α_T to α_L for reasonable ground water velocities in the region should range from 0.1 to 0.33. Using an excessively large α_T such as 40 ft allows contaminants to spread rapidly transversely over the site during calibration while limiting their spread in the longitudual or down-hydraulic gradient direction. Thus the furthest extent of migration is not accurately predicted due to the error in transmissivity and dispersivity calibration.

The fact that contaminants have been detected in a well that is not in a downgradient direction from the waste tank may suggest the existence of other waste sources. It should not be explained by the use of large transverse dispersivities which have no physical basis.

Future Predictions

1. Maximum concentrations may migrate beyond the property boundary after 1987. Please extend the period modeled to 1997.
2. What is the distribution of contaminants in the lower layers of the model?
3. Please provide more detailed contouring of concentrations so that we can evaluate potential exceedance of the standards.

Model Verification

1. Please submit model documentation and test case verification.
2. Please submit compiled versions of the program and all model runs.