STATE OF NEW MEXICO

DEPARTMENT OF ENERGY & MINERALS

OIL CONSERVATION COMMISSION

RECEIVED
MAY 3 1984
OIL CONSERVATION DIVISION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION ON ITS OWN MOTION TO PROHIBIT THE DISPOSAL OF WATER IN UNLINED PITS, SAN JUAN BASIN, NEW MEXICO.

CASE: 8224

MOTION FOR CONTINUANCE AND FOR DISCOVERY

Comes now the New Mexico Oil & Gas Association (NMOGA), by and through its attorneys, Kellahin & Kellahin, and hereby requests the Oil Conservation Commission to continue the above captioned case, now scheduled for an Examiner hearing on June 7, 1984, for a period of not less than thirty days, and to then set this as a full commission case and during the interim to provide for a discovery schedule for this case. As reasons therefore, the Movant states:

1. That NMOGA has filed, contemporaneously with this Motion, a subpoena to be issued by the Oil Conservation Commission which provide for discovery of information essential to NMOGA's position in this case. NMOGA has a right to such discovery. Matter of Protest of Miller, 88 N.M. 492, 542 P. 2d 1182 (Ct. App. 1975).

2. It is expected that if the subpoena is issued, in whole or in part, the discovery process afforded will take two to three weeks, and analysis of the information gained thereby will take another two or three weeks. In order to afford NMOGA and its individual members a fair and reasonable time to prepare for this case, it is essential that a continuance be granted and that this case be set as a Commission case.

In conclusion, NMOGA requests a continuance of this case, to allow for adequate preparation by NMOGA and its members for this hearing.

Kellahin & Kellahin

By______________________
W. Thomas Kellahin
P. O. Box 2265
Santa Fe, New Mexico 87501

(505) 982-4285

BEFORE THE OIL CONSERVATION COMMISSION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION ON ITS OWN MOTION TO PROHIBIT THE DISPOSAL OF WATER IN UNLINED PITS, SAN JUAN BASIN, NEW MEXICO.	))))))	CASE NO. 8224

SUBPOENA DUCES TECUM

TO: Oscar Simpson

Pursuant to the power vested in this Commission, you are commanded to appear at the times and places specified on the Notice of Deposition attached hereto, and to produce for discovery the documents requested therein.

NEW MEXICO OIL CONSERVATION
COMMISSION

____
COMMISSIONER

ISSUED THIS _____ day of May, 1984, at Santa Fe, New Mexico.

BEFORE THE OIL CONSERVATION COMMISSION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION ON ITS OWN MOTION TO PROHIBIT THE DISPOSAL OF WATER IN UNLINED PITS, SAN JUAN BASIN, NEW MEXICO	))))))	CASE NO. 8224

NOTICE OF DEPOSITION

TO: Oscar Simpson

PLEASE TAKE NOTICE that the New Mexico Oil & Gas Association will conduct your first deposition in this matter commencing at 1:30 P.M. June 7, 1984, and continuing from time to time until completed. The deposition will be taken before an officer authorized to administer oaths. Depositions will be conducted at the Offices of the New Mexico Oil Conservation Commission on the second floor of the State Land Office in Santa Fe, New Mexico.

A. The following person is to be deposed:

1. Oscar Simpson

B. Documents to produce:

1. Any and all data, including studies, reports, letters, correspondence, notes, memoranda, or other documents, which you have examined or used in preparing your testimony in this case.

2. Any and all data including records, reports, and other documents regarding this application.

3. Any exhibits you intend to introduce at a hearing on the exemption application.

INSTRUCTIONS

This Subpoena Duces Tecum and Notice of Deposition seeks all information available to you or in your possession, custody or control from any source, wherever situated, including but not limited to information from any files, records, documents, employees, former employees, counsel and former counsel. It is directed to each person to whom such information is a matter of personal knowledge.

References to the singular shall include the plural and references to the plural shall include the singular. References to the masculine gender include the feminine and neuter genders.

The use of a verb in any tense shall be construed as the use of the verb in the past or present tenses, whenever necessary to bring within the scope of the Interrogatory all responses which might otherwise be construed to be outside its scope.

When used herein, the term "document" or "documentation" means all written, recorded or graphic material of every type and description, in whatever form, however produced or reproduced, including but not limited to all originals and all non-identical duplicates, copies or reproductions thereof, pleadings, responses to discovery, correspondence, letters, memoranda, agreements, contracts, letters of intent, maps, charts, credit reports, telex, cables, wires, telecopies, notes, notations, work papers, desk calendars, appointment journals, diaries, reports, recordings of telephone or other conversations or of interviews, conferences or meetings, ledgers, notebooks, bank records, drafts, checks, negotiable or non-negotiable instruments, leases, credit files, books of account, data compilations, affidavits, notices, microfilm, dictation, recordings, tape recordings, cassette recordings, photographs, films, video tapes or cassettes, software or floopy disks or diskettes, computer storage materials including magnetic tapes, computer materials, purchase agreements or contracts, invoices, purchase orders, statements, monthly or annual reports of condition, and any notes, annotations, jottings, scribblings, file or routing marks or other indications added to any such document, and any drafts, preliminary versions, revisions, corrections and amendments thereof.

When used herein, "person" means any individual, firm, partnership, corporation, club, company, association, joint venture, syndicate, business entity or other organization.

When used herein, "you" or "your" refers to the person or entity to whom this Subpoena Duces Tecum and Notice of Deposition is addressed to include all of his or its attorneys, officers, agents, employees, directors, representatives, officials, departments, divisions, subdivisions, subsidiaries or predecessors.

When used herein, "and" as well as "or" shall be construed either disjunctively or conjunctively, as necessary to bring within the scope of the Subpoena Tecum and Notice of Deposition all information which might otherwise be construed to be outside its scope. "Each" shall be construed to include the work "every" and "every" shall be construed to include the work "all" and "all" shall be construed to include the work "any".

All documents and information shall be produced at deposition.

KELLAHIN & KELLAHIN

By______________________________

W. Thomas Kellahin
P. O. Box 2265
Santa Fe, New Mexico 87501

(505) 982-4285

STATEMENT FOR THE RECORD OF THE APRIL 3, 1985 HEARING BEFORE THE OIL CONSERVATION COMMISSION

The Environmental Improvement Division (EID) supports efforts by the Oil Conservation Commission to develop regulations designed to ensure protection of ground water from liquids discharged to pits associated with oil and gas production wells in northwest New Mexico. EID representatives participated in the Short Term Study Group meetings held during the last 6 months, and EID generally supports the Recommendations document developed by that group at its meeting on January 9, 1985.

We submit the following calculations and discussion relevant to seepage of liquids from unlined pits and possible contaminant migration into the underlying aquifer. These calculations support our contention that no discharge should be permitted to unlined pits within vulnerable aquifer areas, unless site-specific field investigations demonstrate safe discharge levels.

Infiltration Rate

The rate at which a liquid infiltrates into a porous material can be described using the Green and Ampt equation (Bower, 1978, p 253):

$$v_i = \left[\frac{H_w + L_f - h_{cr}}{L_f}\right] K$$

Where
- v_i = infiltration rate
- K = hydraulic conductivity of the wetted zone
- H_w = depth of water above soil
- L_f = depth of wetting front
- h_{cr} = critical pressure head of soil for wetting
  - = $>$-20 cm for coarse sands;
  - = -20 to -60 cm for medium to fine sands; and
  - = -50 to $<$-200 cm for loams and clays.
  - (Bouwer, 1978, p. 243.)

This equation can be used to estimate infiltrtion rates for any particular set of physical circumstances. The equation also illustrates the important concept that infiltration will occur in the absence of ponded water on the soil surface (ie when Hw = 0).

Example calculation using reasonable parameter values for the study area:

Assume K = 1 ft/day
$H_w = 0$
L_f = 10 ft
h_{cr} = -20 inches = -1.67 feet (from Bouwer)

$$v_i = 1\ \text{ft/day}\ \frac{0 + 10\ \text{ft} - (-1.67\ \text{ft})}{10\ \text{ft}} = 1.67\ \text{ft/day}$$

The rate at which a liquid infiltrates into a porous material is highest when the material is dry because the soil moisture tension is highest (i.e. the pressure head is more negative) under these conditions (see Figure 1). The infiltration rate decreases as the material becomes wetter because the soil moisture tension becomes lower (i.e. pressure head becomes less negative) and, if clay is present, because swelling occurs. The infiltration rate approaches a steady-state value, called the final infiltration rate, as the porous material becomes saturated. The final infiltration rate is numerically equal to the vertical hydraulic conductivity of the material. The final rate will remain essentially constant as long as the material remains saturated.

Infiltration rates are higher for coarse, open-textured materials (e.g. sandy soils) and are lower for materials having finer pores (e.g. clay soils). Hillel (1971, p. 140) states that final infiltration rates are typically greater than 20mm/hr (0.79 in/hr) for sands and between 10 and 20 mm/hr (0.39 to 0.79 in/hr) for sandy and silty soils. Initial infiltration rates would be considerably higher than these values.

Assuming a value of 20mm/hr, 0.49 gallons (0.066 ft^3) would infiltrate each hour for each square foot of wetted area. Thus, 12.3 gallons (0.29 barrel) would infiltrate per hour if the wetted area covers 25 square feet and 49.1 gallons (1.17 barrels) would infiltrate per hour if the wetted area covers 100 square feet. These values suggest that virtually all liquid discharged to an unlined pit (assuming an application rate of 0.5 barrel per day) potentially could infiltrate within two or three hours.

Length of time required to saturate porous materials beneath a pit.

The volume of liquid required to saturate an initially dry porous material is equal to the effective porosity of the material. Sand and gravel materials typically have porosities in the range 10% to 30%, unconsolidated fine to medium sands have porosities in the range 35% to 50%, and sandstones typically have porosities in the range 5% to 30% (Bouwer, 1978, p.22).

Assuming the water table is 10 feet below land surface, a material having a 5% porosity could hold 3.74 gallons (0.089 barrel) of liquid per square foot of wetted surface; a material having 30% porosity could hold 22.4 gallons (0.53 barrel) of liquid per square foot of wetted surface; and a material having 50% porosity could hold 37.4 gallons (0.89 barrel) of liquid per square foot of wetted surface. Using the intermediate porosity value (30%), the soil below a 25 square foot wetted area would be completely saturated after 13.3 barrels of liquid had infiltrated.

Negligi ble protection would be afforded to ground water if a discharge of 0.5 barrel per day were permitted since the available storage capacity of the vadose zone beneath the pit could be saturated within 27 days, assuming 25 square foot wetted area and 30% porosity.

Travel Time

Another important consideration is the rate or velocity of downward movement of the liquid. Under saturated conditions, this velocity will be equal to the vertical hydraulic conductivity of the porous material divided by its porositiy.

Typical hydraulic conductivity ranges for various materials are 2.83 to 2835 ft/day for clean sands (i.e., good aquifers); 0.0028 to 2.83 ft/day for clayey sands and fine sands (i.e., poor aquifers); and about 5.84 ft/day for sandstone having a 29% porosity (Davis and DeWiest, 1966, p. 162). These values are for horizontal hydraulic conductivity. A rule of thumb for sedimentary geologic materials is that vertical conductivity is about 10% of the horizontal conductivity.

Assuming a 30% porosity, vertical velocities would range from 0.001 foot per day in an unconsolidated clayey sand to 945 feet per day in a clean sand; and vertical velocities in a sandstone might be about 1.9 feet per day. Assuming an intermediate velocity of 1 foot per day, liquid introduced to an unlined pit would travel to the water table in just 10 days if the initial water table is 10 feet below land surface and the material below the pit is saturated.

If the porous material below the pit does not become saturated or does not remain saturated, the velocity of liquid movement would be reduced. This is because hydraulic conductivity under unsaturated conditions is a function of mositure content. Figure 2 illustrates how hydraulic conductivity decreases as a typical soil becomes drier. Figure 3 illustrates how unsaturated hydraulic conductivity, expressed as the ratio of unsaturated to saturated conductivity, decreases as a function of decreasing pressure head (i.e. as the porous material becomes drier). Information presented in these figures is important because it demonstrates that significant water movement occurs even under unsaturated flow conditions.

Velocity of regional ground-water flow

The average linear velocity of the liquid after it enters the regional ground-water system will be equal to the darcy velocity divided by the porosity of the formation. The darcy velocity is equal to the product of the hydraulic conductivity times the hydraulic gradient times negative 1.

Typical linear velocities for ground water in alluvium and sandstone in New Mexico are 4.3 and 2.0 feet/day, respectively (Wells and Lambert, 1981, p. 50). Velocities for specific sites can be calculated using the relationships presented in the previous paragraph if the local gradient and conductivity are known. However, the typical values presented above illustrate that rates of ground-water movement in river alluvium and sandstone could reasonably be expected to transport contaminants long distances from the point where they enter the aquifer.

Conclusions

Calculations presented in the preceding sections do not consider effects of evaporation, surface films or crusts, layering within the geologic materials, dispersion, adsorption, or biological degredation of contaminants. They do illustrate, however, that the potential exists for significant migration of contaminants from unlined pits to the ground water, if adequate control measures are not taken.

I reached the following conclusions based on calculations and assumptions described within previous paragraphs:

1. infiltration will occur even if ponded liquid is not present in the pit;

2. virtually all liquid discharged to unlined pits could infiltrate within

two or three hours;

3. the available storage capacity of the vadose zone beneath an unlined pit could be saturated within one month if 0.5 barrel per day was discharged to a pit located 10 feet above the water table;

4. the travel time required for liquid to move from the pit to the water table under saturated conditions could be on the order of 10 days; and

5. in the absence of significant retardation, contaminants which enter the regional ground water system might travel 2 to 4 feet per day.

Given this demonstrated potential for ground water pollution by contaminants discharged into unlined pits, EID recommends a conservative approach to establishing discharge limits. We feel that until and unless site-specific field investigations demonstrate safe discharge levels, there should be no discharge to unlined pits within vulernable aquifer areas. EID therefore fully supports the position of the Oil Conservation Division that there should be no blanket small-volume exemption for discharges within vulnerable aquifer areas.

FIGURE 1

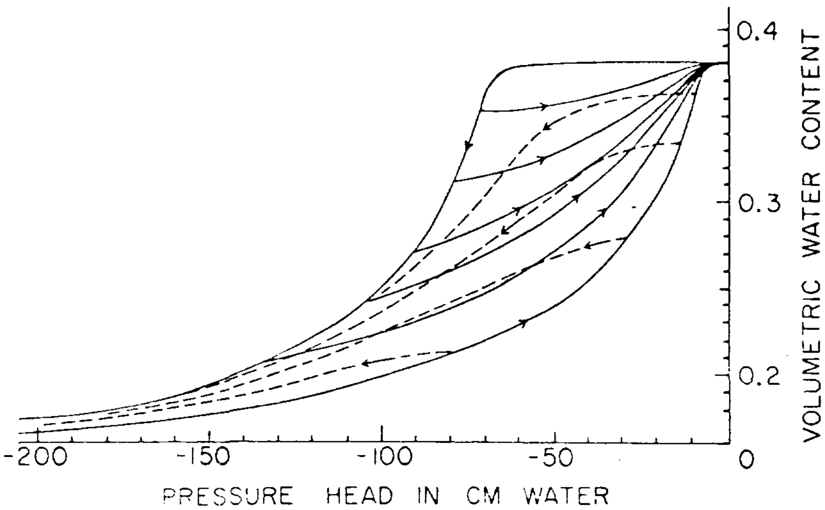

Figure 7.27 Hysteretic relations between h and θ for Rubicon sandy loam. (*From Topp, 1969, as redrawn by Watson, 1974.*)

[illegible] 1978, p. 238

FIGURE 2

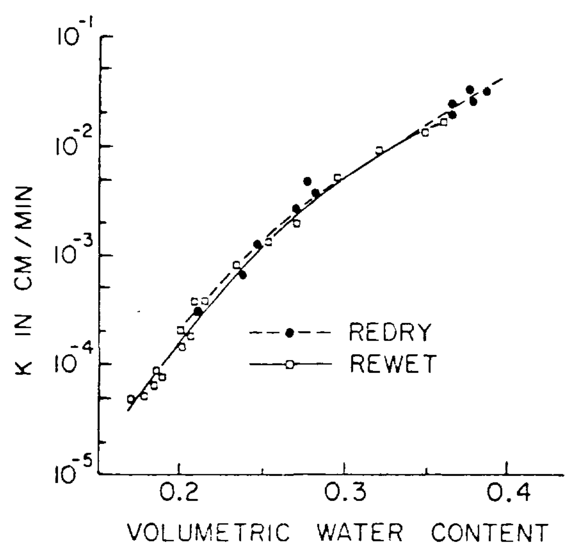

Figure 7.26 Relation between K_θ and θ for Rubicon sandy loam with different wetting and drying histories. (*Redrawn from Topp, 1969.*)

[illegible], 1978, p. 237.

FIGURE 3

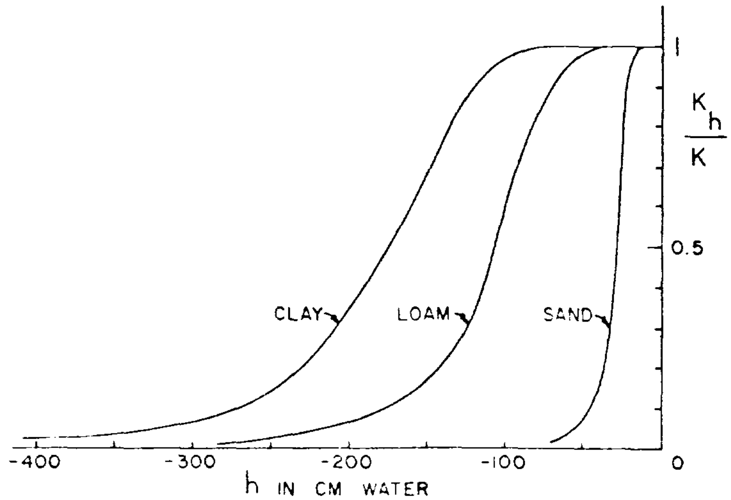

Figure 7.28 Schematic relations between K_h (expressed as K_h/K) and h for sand, loam, and clay.

[illegible] p. 228

K_h [illegible] ; [illegible] is the [illegible] and h is the hydraulic head.

References

Bouwer, H., 1978. Groundwater Hydrology. McGraw - Hill Book Company, New York, 480 pp.

Davis, S.N. and R.J.M. DeWiest, 1966. Hydrogeology, John Wiley & Sons, Inc. New York, 463 pp.

Hillel, D., 1971 Soil and Water. Academic Press, New York, 288 pp.

Wells, S.G. and W. Lambert, 1981. Environmental Geology and Hydrology in New Mexico. New Mexico Geol. Soc. Spec Publ No. 10, 152 pp.

Statement of Qualifications

NAME: Douglas Earp

EMPLOYER: New Mexico Environmental Improvement Division
Ground Water Surveillance Section
P.O. Box 968 - Crown Building
725 St. Michaels Drive
Santa Fe, NM 87504

EDUCATION: M.S., HYDROLOGY, University of Arizona, December, 1981. Course work included Hydrogeology, Surface Water Hydrology, Soil Water Dynamics, Subsurface Fluid Dynamics, Aquifer Mechanics, Development of Ground-Water Resources, Statistical Hydrology, Water Quality Dynamics, Pollution in the Hydrologic Environment, Geochemistry, Unsaturated Flow in Fractured Media, and Water Resource Policy and Administration.

Thesis research involved measurement and modeling of the diffusion of atmospheric fluorocarbon gases in unsaturated porous media.

B.A., BIOLOGY, (minor in Geology) University of New Mexico, December, 1972.

EXPERIENCE: WATER RESOURCE SPECIALIST, New Mexico Environmental Improvement Division (8/84 - present). Investigate existing and potential ground-water contamination problems; conduct area-wide ground-water quality studies.

STAFF RESEARCH ASSISTANT, University of Arizona (12/81 - 7/84). Project titled "Unsaturated Flow and Transport through Fractured Rock - Related to High-Level Waste Repositories". Responsibilities includeD laboratory and field development and evaluation of methods for measuring moisture potential in unsaturated fractured rock, field measurement of water content using electrical resistivity and neutron logging, data interpretation, and report preparation.

HYDROLOGIST, Aqua Science, Inc. (11/80 - 1/82). Project involved a basin-wide water quantity and quality assessment for an Indian Reservation in New Mexico. Responsibilities included study design and implementation, extensive literature review, data interpretation, report preparation, and proposal writing.

GRADUATE RESEARCH ASSISTANT, University of Arizona (1/79 - 12/80). Research involved measurement and modeling of the diffusion of fluorocarbon gases in unsaturated porous media.

GRADUATE RESEARCH ASSISTANT, University of Arizona (1/78 - 12/80). Project involved the development of a methodology for evaluating and comparing hydrologic features of potential nuclear waste burial sites.

ENVIRONMENTAL SCIENTIST, New Mexico Environmental Improvement Agency - Water Quality Division (1/75 - 12/77). Conducted water quality studies of rivers, lakes, and reservoirs. Work included field sampling, laboratory analyses, data analysis and interpretation, and report preparation.

ENVIRONMENTAL TECHNICIAN, New Mexico Environmental Improvement Agency - Air Quality Division (1/74 - 12/74). Set up and maintained a network of monitoring equipment of particulate, nitrous oxide, and sulfer dioxide pollutants.

PUBLICATIONS: Weeks, E. P., D. E. Earp, and G. M. Thompson, 1982. "Use of Atmospheric Fluocarbons F-11 and F-12 to Determine the Diffusion Parameters of the Unsaturated Zone in the Southern High Plains of Texas." Water Resources Research, 18:1365-1378.

BEFORE THE

OIL CONSERVATION DIVISION

NEW MEXICO DEPARTMENT OF ENERGY AND MINERALS

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION ON ITS OWN MOTION TO PROHIBIT THE DISPOSAL OF WATER PRODUCED IN CONJUNCTION WITH OIL AND NATURAL GAS IN UNLINED PITS, ON THE SURFACE OF THE GROUND, IN ANY WATER COURSE OR IN ANY BODY OF WATER, IN McKINLEY, RIO ARRIBA, SANDOVAL AND SAN JUAN COUNTIES, NEW MEXICO.

Case No. 8224

ENTRY OF APPEARANCE

Comes now, CAMPBELL & BLACK, P.A., and hereby enters its appearance in the above-referenced cause for Amoco Production Company.

Respectfully submitted,

CAMPBELL & BLACK, P.A.

By [signature]

William F. Carr
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(505) 988-4421

ATTORNEYS FOR AMOCO PRODUCTION COMPANY