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Pollution Problems in the "Oil Patch"

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ABSTRACT

Throughout much of the "oil patch," water truly exemplifies the economic, sociologic, political and ecological lifeblood of the community. The permanent supply of usable water, on which the arid West depends for survival, faces many hazards. Currently, much available water exceeds or is rapidly approaching Public Health limits, and the tolerance level of the inhabitants.

Water enters an area as river flow or rainfall. It goes underground by natural seepage or irrigation where it percolates until it surfaces at natural springs or wells (domestic, irrigation - municipal or industrial) to re-enter surface flows. Normally, the cycle is repeated many times. Each cycle degrades the water quality. Although oil field operations contribute a small proportion to total degradation of the hydrologic system, each incident of oil field pollution is specific and highly newsworthy. When attempts to clean-up waters are made, the oil industry provides the first and most vulnerable target. Oil field practices can and do pollute water, mainly by increasing total dissolved solids (principally chlorides and sulfates), but also by releasing crude oil.

Ground water pollution is often difficult to prove and may not appear immediately. Conversely, its effects may persist for many years. Pollution may occur from:

1. Evaporation Pits. Regardless of the concentration of brine entering a pit, the only substance leaving the pit by evaporation is pure distilled water vapor. Everything else remains behind forever or enters the water system either by seepage through the bottom of the pit or overflow. In Colorado during 1969, 27,000,000 barrels of water (1,110 to 35,000 ppm salinity) went to unlined pits. A 1966 detailed study of a ground water basin in NE Colorado showed that one small brine pit contributed a 27 ppm per year salinity increase to the entire ground water basin.

2. Insufficient surface casing. Any surface casing which is not set below, and does not seal off all fresh water aquifers constitutes a pollution hazard.

3. Any injection system. Waste disposal or water floods constitute a hazard; not only from casing leaks but also from cross-formational flows through natural or induced fractures.

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4. Abandoned wells. Corroded casing and bad cement jobs afford opportunities for permanent cross-formational flow.

5. Oil Spills. Oil on pits or streams constitute a hazard to wildlife. Last year, a check of 31 pits in Colorado showed 310 dead ducks. Oil soaked dead ducks afford an inestimable publicity impact.

6. Seismic shot holes. In many areas, these can provide a ready admixing of salt and fresh aquifers.

The solution is attainable, but not simple. It requires a constant awareness of the value of fresh water, the habitat of ground water, and the pollution potential of each operation. Constant planning, monitoring and policing of the operation will not only prevent pollution, but will improve the industry's image and save your company money.

Throughout much of the "oil patch," water truly exemplifies the economic, sociologic, political and ecological lifeblood of the community. This is especially true in the arid West. My boyhood experiences on an irrigated ranch in Colorado indicate considerable truth to the statement: "You can kick my dog, and seduce my wife, but don't mess with my headgate." Strong feelings over water are also indicated by the fact that the last killing in Colorado over water rights' disagreements occurred in June 1970. The tremendous pendulum swing of ecological concern among the general public provides instant widespread publicity to even minor cases of pollution.

A 1967 study by the Federal Water Pollution Control Administration on the ground water pollution in the middle and lower South Platte River Basin is an excellent example of critical water supplies which could be repeated in most areas of the West. That small area of northeast Colorado included: 9,700 water wells (mostly irrigation wells), thirty-seven municipalities serving 37,300 people deriving their total water supply from ground water; 3,700 separate families with domestic wells; and 114 industries being supplied by wells. The permanent supply of usable water on which the arid west depends for survival faces many hazards. Currently, much of the available water exists or is rapidly approaching public-health limits and the tolerance levels of the inhabitants. In most areas, water quality is worsening annually. In the South Platte Basin, total dissolved solids range from 500 up to 4,000 ppm, and are increasing annually. U.S. Public Health standards set 500 ppm or less as desirable with water users are not aware of this, and continue to drink the water considerably above that level. The 4,000 ppm is approaching a detrimental level for even irrigation. Nitrates range from 20 to 60 ppm. These numbers become significant when we realize that 45 ppm nitrates are dangerous and can be lethal for infants. Four municipalities in the South Platte drainage use water above the dangerous limit.

In order to understand the overall problem of water quality and water pollution, one must understand the local hydrologic cycle. Water normally enters an area by river or stream flow and rainfall. The water enters the subsurface by natural seepage or irrigation and percolates through the subsurface until it resurfaces in natural springs or artificial wells - either domestic irrigation, municipal or industrial. The water then flows in surface streams or pipes re-entering the subsurface by irrigation or natural seepage. Normally, this cycle is repeated many times with each cycle degrading the quality of the water. Whenever water quality becomes degraded, it falls within Colorado's legal statutory definition of pollution which follows:

> "POLLUTION" means such contamination, or other alteration of the physical, chemical, or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational or other beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life."

Most water pollution results from an increase in nitrates, alkyl benzine sulfonate (ABS), or total dissolved solids. Nitrates normally come from domestic sewage, fertilizers or feed lots - ABS, whose manufacture was discontinued in 1965 but whose pollution will persist for several decades in the future, comes from sewage and septic tanks. Total dissolved solids are increased by irrigation - domestic and industrial uses - and by oil field practices. From the above, it is obvious that oil field operations contribute a small proportion to the total degradation of the hydrologic system, but each incident of oil field pollution is specific and highly newsworthy. In many areas, when attempts are made to clean-up the water, the oil industry provides the first and most vulnerable target.

lute water, mostly by increasing the total dissolved solids (principally, the chlorides and sulphates), but also on occasion by release or spillage of crude oil. Let's concentrate now on the oil industry's portion of our total pollution problem. One should realize that ground water pollution is often difficult to prove at the time it occurs, and its effects may not appear for several years. Conversely, those effects may persist for decades. Oil field operations which constitute major pollution hazards are evaporation pits, insufficient surface casing, waste disposal or water flood injection systems, abandoned wells, oil spills and seismic shot holes.

EVAPORATION PITS

Let's consider the problem of unlined or leaking evaporation pits. Figure "1" shows a typical evaporation pit. Waters of usually high salinity flow into the pit. This material can only leave the pit through three avenues. First, evaporation, which is the hoped for solution, actually rids the pit of only distilled water vapor. All of the salts are left behind to increase the salt concentration of liquid within the pit. Second, the liquids can overflow the pit which happens occasionally. Third, these concentrated liquors can, as often happens, seep through the bottom of the pit, and enter the ground water cycle. If the evaporation pit performs its function totally and properly, every ion of salt which entered the pit would remain there forever, and many operators would be faced with a pit full of salt before the pits were abandoned. Several states have enacted regulations forcing the operator to line every pit. In Colorado, which is typical of many states not having pit regulations, 27 million barrels of water ranging in salinity from 1,110 to 35,000 ppm was sent to unlined pits in 1969. 146 of the water producing fields in northeastern Colorado are located on the outcrops of fresh water aquifers and, thus, afford an easy opportunity for water pollution. The possible serious hazard from evaporation pits was underscored by a 1966 Colorado State University study for the Office of Water Resources Research on the Ground Water Quality of the Severance Basin, Weld County, Colorado (CER66NFW-DKS5). That small basin, two miles wide and eight miles long, is subject to all types of contamination: feed lots, intensive irrigation, septic tanks, ensilage pits - and contain three oilfield evaporation pits. Ground water quality is poor at the present time showing 2,000 parts per million total solids. Total salinity was increasing at a rate of 176 parts per million per year. One small brine pit servicing one well producing 200 BFD of salt water had been excavated into seven feet of pea gravel which lay directly upon the Fox Hills fresh water aquifer. This pit alone was contributing 27 ppm of the total increase to the entire ground water basin. Fortunately for the community and the industry, the well and pit have since been abandoned.

INSUFFICIENT SURFACE CASING

Although most states have regulations requiring surface casing to be set through and below all fresh water aquifers, a quick shuffle of electric logs in nearly any area will show that the regulations are not being adhered to. Any well bore which is open to a fresh water aquifer constitutes a pollution hazard which should be avoided. Although salt water movement from deeper aquifers up and into fresh water aquifers might be small, cumulative effects of numerous wells could be seriously damaging in any ground water province. The possibility also exists of present or future pressure differentials which could cause either serious leakage of the fresh water aquifer or large-scale movement of salt water into the aquifer.

INJECTION SYSTEMS

Any waste disposal or water flood injection system constitutes a serious hazard not only from casing leaks but also from cross-formational flows through natural or induced fractures. No casing system lasts forever, and all engineers realize that casing leaks occur and that, many times, water injection programmed for one aquifer often ends up in another. These hazards are increased by high pressures and high volumes of fluid.

ABANDONED WELLS

Corroded casing and bad cement jobs afford excellent opportunities for permanent damaging cross-formational flow between potable and salt water aquifers. Casing life of 5, 10 or even 20 years seems awfully short when one realizes that not only our children but all future generations will be relying on our ground water to an even greater extent than we do at present. The number of bad cement jobs which occur under the most carefully planned and engineered production completions indicate a high probability of leakage around the cement plugs set in abandoned wells. Too often on a well abandonment, the primary objective is to forget that dry hole and get the rig on to the next location as soon as possible.

OIL SPILLS

Oil spills, such as at Santa Barbara or South Louisiana, are so obvious they need not be discussed here. Even minor oil spills on pits, ponds or streams not only constitute a

(us hazard to wildlife, but provide an-ther opportunity to tarnish the image of the ndustry. Last fall, an efficient Game Warden n northeast Colorado noticed a number of dead ucks on an evaporation pit. A careful in-estigation of the 31 evaporation pits in his istrict revealed 310 dead ducks. Fortunate-y for the oil industry, the various state gencies involved met with representatives of he oil industry, and that problem was cleared p with little or no publicity. When one re-embers the understandable furor caused by the ead sea gulls at Santa Barbara, he can realize he magnitude of the problem faced by the oil ndustry in Colorado. The picture of one ead, oil-soaked duck, aptly portrayed in olor in a Sunday Supplement, can ruin the reakfast of many an oilman and blacken the ye of the entire industry.

EISMIC SHOT HOLES

In many areas, circumstances are such that seismic shot holes which now commonly each depths of 2- to 300 feet or more can provide a ready admixing of salt and fresh water aquifers. These holes often deplete the pressures of shallow artesian aquifers, often allow shallow polluted waters or alkaline waters to enter deeper potable aquifers. Again, no one hole may be a di-aster in itself, but the literally millions of shot holes collectively can seriously af-fect, for all time, fresh water aquifers in many areas.

The solution of these problems, though complex, is attainable within the present technological abilities of the oil industry. This solution requires a constant awareness of the high value of fresh water to our society as a whole. Secondly, it requires a knowledge of the habitat and characteristics of ground water not only on a regional basis but in detail at the particular location of each operation and, thirdly, it requires an awareness of the potential pollution possi-bilities of each oil field operation. Top management directives to avoid pollution can-not be effective until each field engineer and field geologist becomes aware of the prob-lem, and makes a dedicated effort to prevent such pollution during each and every field operation. Constant planning, monitoring and policing of every field operation will not only prevent pollution but will improve the industry's presently tarnished image and, in the long run, save the industry money.

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