RAS 4161

RELATED CORRESPONDENCE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
PRIVATE FUEL STORAGE, LLC	)	ASLBP No. 97-732-02-ISFSI
(Independent Spent Fuel Storage Installation)	)	March 18, 2002

STATE OF UTAH'S PREFILED TESTIMONY FOR CONTENTION UTAH O (Hydrology)

The State has one direct case witness for contention Utah O, Don A. Ostler. Attached for filing is the pre-filed testimony of Mr. Ostler and a list of exhibits (State Exhibit Nos. 85 through 90). As the State has only one witness for this contention, it has combined the Key Determinations and Preface to Pre-filed Testimony into one document, which is also attached for filing.

DATED this 18th day of March, 2002.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a copy of STATE OF UTAH'S PREFILED TESTIMONY FOR CONTENTION UTAH O (Hydrology) was served on the persons listed below by electronic mail (unless otherwise noted) with conforming copies by United States mail first class, this 18th day of March, 2002:

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STATE OF UTAH'S PREFILED TESTIMONY OF DON A. OSTLER, P.E., REGARDING CONTENTION UTAH O

Q. 1: Please state your name, affiliation, and qualifications.

A. 1: My name is Don A. Ostler. I am the Director of the Division of Water Quality, Utah Department of Environmental Quality. I am also a registered Professional Engineer in Utah, with 30 years' experience as an engineer. My education and professional experience are summarized in my curriculum vitae, included with this testimony as State's Exhibit 85, and the most pertinent areas are more fully described below.

I have over 29 years' experience reviewing, revising, and approving hundreds of water pollution control plans for actual and potential water pollution sources. In the context of reviewing those plans, I have evaluated and overseen evaluation of engineering plans and pollution control practices, and I have evaluated and researched, and overseen evaluation and research of, best available pollution control practices and technologies. I have performed or overseen those evaluations for such entities as Envirocare, a low level radioactive waste disposal facility located in Tooele County and permitted by both the State of Utah and the NRC; International Uranium Corporation; Sumo USA Corporation Copper Project; A.F. Phosphates; Monticello, Moab, and Vitro Uranium Mill tailings removal projects; Western Zirconium; Kennecott Copper; Geneva Steel; Thiokol Corporation; and many others. Contaminants of concern have included Uranium 233-238, Thorium 230 and 232, Radium 226 and 228, gross alpha and beta, Technitium 99, tritium, and all manner of non-radiological contaminants, including copper, lead, zinc, petroleum products, acidity, ammonia, nitrate, dissolved salts, and many others.

I oversaw the creation and implementation of the Utah Ground Water Protection Program. That program establishes standards for ground water and requires ground water discharge permits of facilities that have the potential to discharge pollutants to ground

water.[1] During the process of creating and implementing this program, I became familiar with ground water protection programs in other states and the federal government under Resource Conservation and Recovery Act ("RCRA"), Comprehensive Reponse, Compensation and Liability Act ("CERCLA"), Underground Injection Control ("UIC") of the Safe Drinking Water Act, and other programs. I have experience with industry operating practices, containment technology, liners, impoundments, and ground water cleanups.

I have issued hundreds of permits regulating facilities that discharge to surface water, and dozens of ground water discharge permits. Both of these types of permit reviews involve the evaluation of engineering plans and pollution control practices, and the evaluation and research of best available pollution control practices and technologies.

I have provided testimony before Congressional Committees regarding the federal Clean Water Act and the Resource Conservation and Recovery Act in my capacity as President of the Association of State and Interstate Water Pollution Control Administrators and as a State lead for the Western Governors' Mining Waste Task Force. The Utah Division of Water Quality is routinely requested to provide data and information to assist agencies prepare Environmental Impact Statements under the National Environmental Policy Act ("NEPA") and to review such documents. These activities are also conducted under my supervision.

In my capacity as Director of the Division of Water Quality, I have also developed or supervised development of State rules for installation of septic tanks and drain (leach) fields to protect ground water and public health. I have issued dozens of permits for construction of such systems and have been involved in correcting system failures.

In performing the work described above, I have had experience in numerous aspects of hydrology, including surface and ground water quality in the State of Utah; the chemistry of surface and ground waters; the fate and transport of chemical constituents, including pollutants, in surface and ground waters; the hydrogeology of soils and unconsolidated geologic formations; compliance with state and federal regulations pertaining to surface and ground waters; and health and environmental risk assessments.

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[1] Many of these facilities are designed and intended to have zero discharge of water pollution to ground water. They are nonetheless regulated as potential sources of water pollution under R317-6 and ground water permits require installation of best available technologies ("BAT") to minimize or prevent discharge. Ground water monitoring is also required to evaluate performance of BAT.

Q. 2: What materials did you review in support of your evaluation and opinion?

A. 2: I have reviewed the water resources sections of NUREG 1714, *Environmental Impact Statement for the Construction and Operation of an Independent Spent Fuel Storage Installation on the Reservation of the Skull Valley Band of Goshute Indians and the Related Transportation Facility in Tooele County, Utah* (December 2001) ("FEIS"), PFS's Environmental Report ("ER"), and Safety Analysis Report ("SAR"). I have reviewed the Applicant's June 29, 2001 Motion for Summary Disposition of Utah Contention O – Hydrology, and all attachments thereto, the State's and NRC Staff's July 19, 2001 responses to PFS's motion, and the State's July 30, 2001 reply to the Staff's response, as well as the Board's ruling on PFS's motion (LBP-01-40). I have also reviewed the deposition transcripts of PFS's witnesses Donald W. Lewis (April 19, 2001) and Dr. George H. C. Liang (April 17, 2001), as well as my deposition transcript of April 19, 2001. Additionally, I have reviewed the letter from Elyana Sutin, EPA, to David Meyer, NRC, re EPA's Comments on the Final EIS for the Construction and Operation of an ISFSI, Skull Valley Band of Goshute Indians, Tooele County, UT; CEQ # 020019.

Q. 3: What is your primary concern about the PFS facility?

A. 3: My primary concern about the Applicant's proposed facility has been and continues to be its failure to take basic precautions to prevent contamination of hydrological resources in the event of an accidental release of radiological or other contaminants. There are many facilities for which I have issued ground water permits which are designed and intended to be operated without a discharge of pollutants. However, when the nature and quantity of potential pollutants are significant, the containment methods and operational practices are routinely incorporated into a regulatory process and ground water monitoring is instituted to verify the success of both technology and operating procedures. A number of these facilities have detected failures of their technology or operating procedures and have detected contamination of ground water. In these cases, because they do have a detection mechanism, they have been able to isolate the problem and keep the impacts manageable.

I believe that a responsible facility with the types and magnitudes of wastes at the PFS facility should have performance monitoring of ground water. I recognize, however, that the radiologic concerns are not before this Board now, as a result of its December 28, 2001 decision on summary disposition on Utah Contention O (LBP-02-40). I acknowledge that my remaining concerns about the facility are less significant, but if the non-radiologic issues are not addressed properly, they can also result in ground water pollution.

Q. 4: What environmental controls does PFS intend to install or implement at the Skull Valley site?

A. 4: As a basis for failing to install and implement basic environment controls for

an industrial facility, PFS resorts to a belief that its operation will "start clean" and, during its 40 year life, it will "stay clean." Apparently, the NRC Staff has accepted this belief. FEIS at 2-28. The entire discussion of "Contamination Transport Analysis" in the Environment Report is contained in two sentences:

> The nature and form of the material stored (spent fuel rod assemblies) and the method or storage (dry casks) preclude the possibility of a liquid contaminant spill. Discussion of potential contamination of ground water is not applicable.

ER at 2.5-12, Rev. 14.

At the PFS site, there will be no on-site ground water monitoring program; no water collection system from the 500 storage pads that will be built; and no lining of the retention pond at the north end of the storage pads. PFS will initially receive fuel in transportation casks that have traveled from reactor sites cross country to the PFS site. PFS intends to check only for radiological contamination on the casks. PFS will move storage casks onto the pad with a diesel-fueled cask transporter. PFS will also have an on-site laboratory, a facility for vehicle operations and maintenance, storage tanks for diesel fuel, and liquid propane tanks. Furthermore, PFS will have two septic tank and leach field systems for disposal of domestic sewage. June 28, 2001 Declaration of H.C. "George" Liang and Donald Wayne Lewis ("Lewis and Liang Dec."), at 7[2].

PFS and the Staff seem to be operating on the premise that if there is contamination of soils and ground water, then NRC will have PFS take site cleanup actions. The NRC is relying on 10 CFR Part 20, Standards for Protection Against Radiation, for cleanup standards. FEIS at 9-15. The NRC cites none of its regulations as applicable to cleanup of non-radiological contamination. The FEIS does indicate that 40 CFR 112.7, which requires preparation of an oil Spill Prevention Control and Countermeasure Plan, applies. Id.

The NRC, to some extent, is relying on PFS's Best Management Practices Plan "for properly responding to fuel leaks or spills to minimize . . . contamination of groundwater," FEIS at 4-14, but to date the Staff has not received any such plan from PFS. *See* Staff Response to State's 19th Set of Discovery dated February 13, 2002 at 6.

It is reasonably foreseeable that at the PFS facility – like any other industrial facility – human error and misconduct will cause accidental spills and contaminant release to soils, surface water and ground water. In my opinion, the PFS facility is not a state-of-the art industrial facility when it comes to environmental controls. There are no secondary

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[2] Attached to Applicant's Motion for Summary Disposition of Utah Contention O - Hydrology (June 29, 2001).

containment or ground water monitoring controls at PFS. Instead, protection of public health and water resources is based on the hope that there will be no human error or accidental spills.

Q. 5: Have the Applicant and the Staff demonstrated that there will be no impacts or insignificant impacts from non-radiologic pollutants?

A. 5: No, they have not. PFS and the Staff rely largely on a combination of unproven assumptions of soil consistency, impermeability and infallible operating procedures as stated in the Lewis and Liang Dec. and in the FEIS Section 4.2, Water Resources.

Q. 6: Please discuss soil permeability first. What do the Applicant and the Staff say about soil permeability?

A. 6: The hydraulic conductivity/permeability which Applicant and the Staff assumes for the native soils is 1.4×10^{-4} cm/sec. to 4.2×10^{-4} cm/sec (0.2 to 0.6 in/hr). FEIS at 4-13; ER at § 2.5.5. They have relied largely on that assumption for their conclusion that there would be no hydrologic connection between any surface contamination and contamination of ground water. *See e.g*, Applicant's Motion for Summary Disposition of Utah O at 11.

Q. 7: Why do you dispute that?

A. 7: I agree that determining the hydraulic conductivity/permeability of the native soils at the site is a critical first step in determining whether the surface waters at the site are hydrologically connected to ground water, and whether spills and releases at the site have the potential to reach ground water. I disagree that the Applicant and the Staff have demonstrated that hydraulic conductivity/permeability is low enough to prevent hydrological connection.

The basis of the Applicant's and the Staff's assumptions is the generalized United States Department of Agriculture ("USDA") soil maps.[3] This information is based upon very little actual soil data to represent a very large land area. Because of the natural variability of soils in nature, it is widely accepted that this information is insufficient to characterize a specific site. Specific soil exploration must be done on the actual site with sufficient coverage to characterize the type and permeability of soils at the site.

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[3] The FEIS relies on a regional study by Hood and Waddell, a 1968 study for United States Geological Survey and Utah Department of Natural Resources, Division of Water Rights. *See* FEIS at 3-13 and references at FEIS 12-5.

In addition to the inappropriate use of this generalized information, the Applicant's assumed hydraulic conductivity/ permeability for the site soils is three orders of magnitude greater (1000 times more permeable) than that considered acceptable by the EPA for clay confining layers. For the native surface soils to act as a low permeability confining layer, they should have a hydraulic conductivity of no greater than 1 x 10^{-7} cm/sec. and be uniform and continuous across the entire site. This is consistent with EPA Guidance for constructing clay confining layers to minimize infiltration. *See* State Exhibit 86, Seminar Publication: *Requirements for Hazardous Waste Landfill Design, Construction and Closure*, EPA/625/4-89/022; and State Exhibit 87, Technical Guidance Document: D. Daniel and R. Koerner, *Quality Assurance and Quality Control for Waste Containment Facilities*, EPA/600/R-93/183, September 1993.

I understand that the Applicant's assumed hydraulic conductivity/permeability rates described previously are for saturated soil conditions. The degree of saturation of a soil is important in estimating the ability of a soil to transmit water. Interestingly, soils with low water content, such as those in arid and semi-arid zones, may have a greater hydraulic conductivity than saturated soils of a coarser texture. This paradox arises because the unsaturated hydraulic conductivity of fine soils tends to decrease much less rapidly as pressure head decreases, compared to coarse-texture soils. So soils with associated low intrinsic (saturated) permeabilities can have high unsaturated hydraulic conductivities. A detailed explanation of this phenomenon can be found in Daniel B. Stephens, Vadose Zone Hydrology (CRC) (Lewis Publishers, 1996) at p. 21, State's Exhibit 88. For this reason, the hydraulic conductivities/permeabilities assumed by Applicant are likely much slower than would actually exist at the site, *i.e.*, the unsaturated native surface soils at the site have a greater ability to transmit water than the estimates Applicant is using.

The FEIS and ER do not present any site-specific soil permeability tests or other site-specific measurement to support any conclusion regarding the native surface soils; *i.e.*, there is insufficient data to come to any supportable conclusion. Soil permeability tests are easily conducted, commonly performed by environmental consultants during facility assessments, and are relatively inexpensive to conduct.

The Staff's and Applicant's conclusions that the soils at the site are "relatively" impermeable (Lewis and Liang Dec. at 10) are misleading because the permeability of the silty clays and sands identified in samples collected from geotechnical boreholes at the site can vary by many orders of magnitude and are considered moderately permeable in comparison to other soils and rock formations. In addition, for any native soil layer to act as a confining layer, it must be of sufficient thickness, must extend across the entire area to be capped, and be uniformly impermeable across the entire site. The FEIS and SAR indicate the native silts and clays are composed of interfingered lenses and zones, and therefore are not consistent across the site. Surface waters have the potential to migrate downward much more readily than if the soils were of a uniform soil type.

It is also inconsistent and contradictory for PFS to claim on the one hand that the natural site soils are of such low permeability as to prevent flow to ground water and on the other hand propose those same soils as suitable for percolation of sanitary wastewater into the ground through a septic system. Site specific soil testing would eliminate the question and inconsistency.

Q. 8: Are you aware of any facilities with soils that were claimed to be relatively impermeable, but which have proven to be otherwise?

A. 8: Yes, I am: Grassy Mountain, a waste disposal facility also located in the west desert of Tooele County. The operators of the facility initially proposed that no ground water monitoring was needed because the soils were impermeable. They had site-specific data showing that soils had a conductivity/permeability of approximately 10^{-6} to 10^{-7} cm/sec, more impermeable than PFS is claiming for its soils. They nevertheless did implement ground water monitoring, and that monitoring has since confirmed contamination of ground water. Although there may be other factors, it appears that a significant factor in this contamination is the existence of desiccation cracks, a feature of soils that is not unusual in desert climates such as at Grassy Mountain and at PFS's proposed site.

Q. 9: Do you have other concerns about Applicant's and the Staff's claim that there is no hydrological connection between potential surface water contamination and ground water?

A. 9: The borehole logs presented in the SAR indicate that approximately two dozen three to six-inch plus diameter boreholes were drilled across the site. *See* State's Response to Summary Disposition of Utah O, Material Facts ¶ 12. In the absence of proper backfilling, these holes will act as conduits for surface waters to migrate directly into the deeper subsurface formations, *i.e.* below 30 feet below ground surface, including the reported 125 foot depth to ground water.

Most of the borehole logs in Appendix 2A of the SAR are silent as to backfilling, but those which describe any backfilling activity indicate that "soil," probably the drill cuttings, were shoved down the borehole. This, of course, would not constitute proper backfilling for persons intending to use native soils as a cap or confining layer. *See e.g.* Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. EPA, (May 1996, includes 1977 revisions), Section 6.10.6 "Backfilling" (the use of soil cuttings to backfill boring not acceptable if boring has breached a "confining" layer.). *See* State's Exhibit 89 ("Environmental Investigations Manual").

When intending to preserve the integrity of a confining layer, proper backfilling would be the same as for abandoning or sealing drinking or monitoring wells. This would, at a minimum, include sealing the surface soils from the subsurface soil, by backfilling the borehole with a bentonite seal, and a cement and expandable clay (*e.g.* bentonite) mixture.

See id., Environmental Investigations Manual, p. 6-14, sections 6.9 and 6.9.1 ("When a decision is made to abandon a . . . well, the borehole should be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly abandon a well, the preferred method is to . . . backfill with a cement or bentonite grout, neat cement, or concrete."). The Applicant properly sealed one borehole, CTB-5, when it completed it as a well with a bentonite seal and cement/bentonite mixture.

Q. 10: **Why are you concerned about reliance upon operating procedures at the PFS site?**

A. 10: The Applicant is not providing any additional containment or monitoring of ground water, but instead is relying largely upon the "start clean stay clean" procedures and upon the proper conduct of employees in managing the various contaminants over 40 years of operation. The Staff has accepted this approach.

In my 29 years' experience in reviewing practices at industrial facilities, I am aware of numerous incidents where employees have accidentally or intentionally released pollutants or contaminants, or placed same into a septic system. Even companies with best management practices cannot control accidents that occur onsite. Without adequate ground water monitoring systems, PFS will be unaware if such accidents occur. Also PFS does not have adequate contingency plans or containment systems to address possible accidents. It is credible that a facility operator would assume that spills and releases as a result of human error and misconduct can and do occur at industrial and commercial facilities, such as the PFS facility.

It is foreseeable, based on experience with other industrial facilities, that there will be accidents. There may even be deliberate acts, *e.g.*, failure to do a test and unauthorized disposal of pollutants.

Q. 11: **Do you have any other concerns about the Applicant's proposed project related to your areas of expertise?**

A. 11: Yes. I am also concerned about the Applicant's proposal to construct two septic systems for disposal of domestic waste. The basic information necessary to design a proper septic system (on-site disposal system/leach field) have not been collected by PFS and therefore the proposed system cannot be assumed to function properly. The Uniform Plumbing Code, EPA On-site Wastewater System Design Manual, and Utah's Subsurface Wastewater Rules all require site specific soil characterization to design a system. These include soil exploration at the site of the drain field to an appropriate depth, soil classification by depth, and percolation tests. This information has not been obtained. The design of such a system based on generalized regional soil information is pure speculation. Soil conditions routinely vary with both depth and horizontal distance. If the system is not

designed properly with site specific data, it will either percolate too rapidly allowing inadequate treatment of the wastewater, thus causing ground water pollution, or too slowly, causing ponding at the surface resulting in health hazards and runoff.

Q. 12: Do you have other concerns about the proposed septic systems?

A. 12: Yes. It is important that nothing other than conventional sanitary waste be disposed of in the system. It is not designed to provide treatment of other contaminants and therefore may pollute ground water if they are introduced. I realize PFS is proposing operational controls to prevent unauthorized releases to the septic system. However, my experience has shown that these types of releases still occur. This is another reason for site ground water monitoring. In addition, according to 40 CFR 144.84(b)(2), floor drains from the operations and maintenance building where maintenance of vehicles and equipment is performed are prohibited from discharging to a drain field. No information has been provided to show that this requirement will be met.

The FEIS and ER fail to adequately 1) determine whether each expected waste stream (*e.g.*, domestic wastewater, cleaning chemicals, laboratory wastes), or potential waste streams (*e.g.*, diesel, solvents, pesticides and herbicides, etc.) placed in the sewer system will be adequately treated by the septic system; 2) ascertain where the fluids placed in the septic system will end up; and 3) consider the possibility that the many hazardous substances stored or used onsite will be introduced, intentionally or unintentionally, into the septic system during its forty years of operation.

Septic systems are designed to introduce waste waters into the subsurface with the expectation that domestic wastes will be treated by settling in a septic tank, and later, through natural percolation into the subsurface soils. The ultimate disposition of most septic system fluids is usually ground water.

PFS and the Staff have asserted that the surface soils at the site are of a low permeability and will act as a confining layer and minimize infiltration of surface waters into the subsurface and to ground water. I disagree. However, if it were true, it would effectively prevent a septic system from working as it is normally designed, *i.e.*, to accept waters into the subsurface.

Whether the system will adequately treat the different contaminants in the wastewater before the wastewater reaches its ultimate destination depends on various factors, including the ultimate destination of the wastewater (see discussion above), the organic and inorganic contaminants in the waste stream, and the effectiveness of the soil as a treatment medium. The FEIS fails to adequately address any of these three factors. Therefore, in my opinion, the FEIS cannot reach a conclusion that the system will adequately treat the wastewater.

If a domestic waste septic system does not work, it will either contaminate ground water, or it will be a health hazard by ponding on the surface of the ground.

Q. 13: What are the potential contaminants and contaminant pathways for this facility?

A. 13: Potential contaminant sources include laboratory waste; diesel fuel tank for on site vehicles; diesel fuel tank for emergency generator; liquid petroleum tanks for building heating; lubricants, solvents, automotive fluids, janitorial supplies and other equipment and operation and maintenance products and wastes; liquids collected by the sump in the Canister Transfer Building ("CTB"); truck wash down waste; drain, sink, and toilet waste in the CTB and the Safety & Health Physics Building; waste from a concrete batch plant; and waste from an asphalt plant.

Specific pathways for contaminant migration from the sewer/wastewater system will depend upon the design and construction of the system, and the FEIS does not describe the specific system design and construction. The general description of PFS's wastewater system precludes anything other than a general response. There are two general pathways of concern. The first is the migration of the sewer/wastewater discharge through the vadose zone to the ground water, and then the resurfacing of the water, most likely by pumping of the ground water to the surface for domestic or other use. The second general pathway of concern is resurfacing of the wastewater above the leach field, *e.g.*, if the leach field is unable to accept the quantity of wastewater discharged, the contaminants breach the surface untreated. But site-specific data is necessary to reach a supportable conclusion.

Pathways associated with routine industrial type activities include the spilling and releasing of hazardous substances and hazardous wastes which are used or generated at the facility. Those spills and releases can result from numerous different activities, including accidents during transfers or use of the substance or waste; leaking tanks or storage containers; leaking piping; unauthorized disposal, etc. Once the substance or waste comes in contact with surface soils, the contaminant can also contaminate surface waters, and infiltrate into the subsurface. Subsurface releases may migrate to the ground water where they may be pumped to the surface via wells, or resurface downgradient as springs or seeps. Humans or wildlife may be exposed to the released substance or waste once it reaches the surface.

The FEIS does not adequately describe the transport and ultimate fate of spills and releases of chemical compounds and materials. It merely surmises that a " large fuel spill would be required to adversely impact ground water quality at the site because the ground water table is approximately 38 m (125 ft) below the ground surface and soil retention would hold up the liquid." FEIS 4-9. No specific analyses or modeling have been done to support this claim, or any claim, regarding the infiltration of surface waters and spills to ground water. The FEIS does not conclude that large spills will not occur, only that it would take a

large spill to really contaminate the ground water. Also, cumulative small spills may have an effect similar to that of a large spill. In addition, the conclusion that spills will not migrate downward over time into the ground water does not address the dissolving of hazardous constituents contained in spilled and released materials into surface waters and the infiltration of these contaminated rain waters or snow melt waters into the subsurface and ground water.

The FEIS focuses its surface water concerns on the berm which will reportedly be built upgradient of the facility with the purpose of diverting storm waters during and after construction. Rain water falling within the facility, along with any spills and releases of hazardous substances and hazardous wastes within the facility area, will reportedly be drained, flushed, or directed downgradient into a retention pond.

The FEIS does not describe the transport or fate of the hazardous substances, hazardous wastes, and pollutants which may be released at the facility. The presence of these spills or releases on the surface presents pathways of exposure to humans and the environment through direct exposure and ingestion. The most likely destination of substances that are released to, or leach into, the subsurface is the ground water directly under the facility. Direct exposure and ingestion of ground water produced from wells downgradient of the facility, even hundreds of years in the future, are the likely pathways of exposure. Any pond or pooling of water in the desert will attract and expose wildlife to the contaminated water. In addition, the pond will create a hydraulic head which promotes infiltration of the pond water into the subsurface and to the ground water under the site.

Q. 14: Please describe any additional concerns you have with the information presented in the final EIS?

A. 14: It is indicated, at FEIS 2-28, that the Canister Transfer Building will contain sumps which will collect any water that drips or drains from the transport vehicle and casks. This water would be sampled only for radiologics prior to its release if contamination is not indicated. The FEIS does not indicate where this water be released to. Other samples or observations must also be made to insure that non radiologic contaminants are not present. If this is not done, or if radiological sampling is ignored or done improperly, contaminants will be released onsite with no contaminnment or ground water monitoring to detect a failure in procedures or methods.

The FEIS, at 2-30, indicates that preoperational monitoring of ground water will be done to establish background levels of radiation.[4] This is a wise and necessary first step.

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[4] Even for radiologics that PFS proposes to monitor, neither the FEIS nor the ER contain sufficient information to determine whether background radiological levels in ground water below the site will be adequately established by PFS. To establish background levels of

However, establishment of background concentrations for more than radiologic contaminants is equally necessary for a complex, long-term, and sensitive site such as this. It makes sense from a business and environmental standpoint to identify pre-existing conditions thoroughly. No information is provided on how extensive background monitoring will be or how it will be accomplished. In addition to background monitoring, operational monitoring should be provided.

The FEIS, at 2-31 to -32, identifies best management practices ("BMPs") to be implemented to protect the environment during construction. Details of the BMPs are sketchy or absent, however, and no specific BMPs are mentioned for concrete and asphalt batch plants.[5] Any water discharge from these operations would need an NPDES permit. There can be significant quantities of water used with these operations and there are various pollutants of concern, including lime, cement and petroleum products. These facilities must not release pollutants to the ground or surface waters even under extreme storm conditions. The information provided is inadequate to determine their acceptability.

The Applicant and the Staff rely on the "start clean - stay clean" philosophy as an basis for avoiding additional ground water protection measures and monitoring for both non-radiologics and radiologic contamination. Experience with large scale industrial operations within Utah and the United States indicates that site ground water monitoring and seepage controls are common for other industries where technologies and practices are employed with the goal of preventing any release. It should be provided here. PFS has provided plans and strategies for addressing unexpected contamination in receiving casks and decommissioning pads, etc., but has failed to provide assurance through ground water monitoring that their procedures work and are being followed.

The FEIS, at 4-9, predicts that spills of petroleum products or other contaminants could adversely affect ground water, but concludes this is unlikely because of the depth to ground water, tightness of the soils and arid climate. As described previously, neither PFS nor the Staff has any site-specific soil permeability or modeling information to support this prediction. It is well documented that soils are expected to have fingers of higher and lower permeability materials. Site specific information, which PFS does not have, is needed to characterize the site and draw these conclusions.

The FEIS, at 4-9, describes above ground fuel storage tanks and a leak and spill

---

contamination, there must be an adequate number of appropriately located wells, monitored over at least 12 months. I am unaware of any plans such as the foregoing that PFS has to establish background levels in ground water below the site.

[5] NRC Staff has acknowledged it does not have any better documentation of BMPs. *See* NRC Staff Response to State's 19th Set of Discovery dated February 13, 2002 at 6.

response procedure to avoid ground water contamination. These measures alone are inadequate. The fueling area and tank themselves should be enclosed by an impermeable containment berm of sufficient size to contain the entire contents of the tank.

The FEIS, at 4-9, indicates that potential impacts to surface water will be small. I disagree with this assessment of potential contamination from the site because of the nature of the facility, the expected long life, and both the non-radiologic and radiologic pollutants on site. I believe these concerns are supported by 40 CFR 122.26(b)(14) where this facility would be classified as an industrial facility, trucking and warehousing, Industrial Category 8 (Sector P). This includes storm water discharges from transportation facilities that have vehicle and equipment maintenance and equipment cleaning operations. As such, it will require an NPDES storm water permit from EPA. The absence of perennial streams does not obviate this need as the FEIS has documented periodic flows from the area. The State also considers intermittent streams to be jurisdictional waters.

In addition, an NPDES permit is required for the site during construction. This position has been confirmed by the United States Environmental Protection Agency in comments on the DEIS. *See* State's Exhibit 90, February 19, 2002 letter from Elyana Sutin, Acting Director, NEPA Program, Office of Ecosystems Protection and Remediation, U.S. EPA Region VIII, at 2.

PFS has not provided information to indicate planning is in place for this storm water permit. The placement of this facility within a federal category that requires issuance of a discharge permit substantiates the State's concern about the potential for contaminants to enter surface or ground waters. Performance ground water monitoring of the site and issuance of an NPDES storm water discharge permit are essential.

The FEIS at 4-12 indicates potential impacts to ground water quality from the surface water detention basin would be small because of operational procedures, low precipitation, and assumed tight soils in the basin. PFS has no site specific soil information to predict possible seepage or the behavior of native materials after construction compaction. This information is easy to obtain and essential to predicting seepage. Also the FEIS fails to consider the impact of a four to five foot head on the pond bottom which dramatically increases seepage. The entire pond area must be characterized by site specific soils information.

To assume that the pond will protect ground water from contaminated seepage, it must have a properly engineered and installed liner having a coefficient of permeability of $1x10^{-7}$ cm/sec. In addition, ground water monitoring should be provided to measure performance. A liner must be protected from dessication, root penetration, cracking, and frost. These are standard engineering practices for runoff from a waste storage site.

The FEIS at 4-13 discusses drainage to the two septic systems. It is indicated that

there will be no drains for the Health Physics Building to the septic system. How will drainage from the laboratory be handled? The absence of drains increases the likelihood of intentional dumping of chemicals into sinks and toilets. Furthermore, EPA regulations 40 CFR 144.84(b)(2) prohibit floor drains from the vehicle and equipment maintenance area to be connected to the septic system. How will this waste be managed?

The FEIS at 4-14 indicates that non-radiological chemicals would be "managed" in such a manner to prevent introduction of these materials into the wastewater system. This is much easier said than done over a 40 year operating life of a major industrial/waste storage facility. Ground water monitoring is needed to gauge the success of these measures.

Q. 15: Is there anything else you would like to add?

A. 15: Yes. I have found over the years that the controls I have suggested, in addition to being good for the environment, are good corporate policy because they protect the future viability of an ongoing concern. I am surprised and concerned that PFS does not recognize this.

Q. 16: Does this conclude your testimony?

A. 16: Yes.

March 18, 2002

STATE OF UTAH'S KEY DETERMINATIONS FOR CONTENTION UTAH O AND PREFACE TO PRE-FILED TESTIMONY OF DON A. OSTLER

The Issue: Does the PFS facility lack controls and systems necessary to adequately protect public health, prevent ground water contamination or detect problems in time to make the impacts of contamination manageable but rather the Applicant relies upon soil permeability and fallible operating conditions?

State's Witness Don Ostler is a Well-Qualified Expert

Director, Division of Water Quality - State's regulatory official responsible for protecting public health and evaluating the effects of water pollution from industrial sources and approving controls for the protection of surface and ground water.

I. Almost 30 years' experience reviewing/approving hundreds of water pollution controls plans, engineering plans (e.g., liners, impoundments), operating procedures for actual and potential water pollution sources from radiological (Uranium 233, 238, gross alpha and beta, etc.) and non-radiological(copper, lead, zinc, petroleum products, acidity, ammonia, nitrate, dissolved salts, etc.) contaminants.

II. Issued hundreds of surface water permits, dozens of groundwater protection permits, and dozens of permits for construction of septic tanks/leachfields.

III. Oversaw creation and implementation of the Utah Ground Water Protection Program; became familiar with groundwater protection programs in other states and under federal statutes (RCRA, CERCLA, UIC).

IV. Hydrology expertise includes water quality; water chemistry; fate and transport of chemical constituents; hydrogeology of soils; and regulatory compliance.

Findings of Fact for the Board to Make

V. Permeability of surface soils and hydrologic connectivity.
   - A. There is a hydrological connection between surface and groundwater.
   - B. PFS and NRC rely on region-wide soils, evaporation and groundwater data - not site specific analysis.
   - C. In nature, soils are variable - can't characterize a specific site with regional data
   - D. Low permeability soils have hydraulic conductivity $\leq 1 \times 10^{-7}$ cm/sec. whereas PFS soils are 1000 times more permeable (1×10^{-4} cm/sec).
   - E. Conflicting position by PFS & NRC - soils sufficiently permeable to drain leach-field but impermeable enough to prevent groundwater contamination from spills.
   - F. Improperly filled boreholes (approx 2 doz.) provides a direct hydrological connection between surface and groundwater.

VI. Reliance on operating procedures rather than environmental controls.
   - A. Reliance on "start clean/stay clean" and unknown and ill-defined operating procedures are no substitute for monitoring and environmental controls.
   - B. It is credible to assume that spills and releases can and do occur as a result of human error or misconduct at commercial facilities such as PFS.
   - C. PFS does not have adequate contingency plans, monitoring or containment systems to address possible accidents from human error or misconduct.

VII. Lack of Information to Determine whether Septic Tank System will Function Properly
   A. Speculative to design system based on regional data - unknown if percolation will be too rapid (inadequate waste treatment will cause groundwater pollution) or too slow (ponding at surface causing health hazard and runoff).
   B. Septic tanks can only provide treatment for conventional sanitary waste
      1. Floor drain in the O&M Building may contain non-sanitary wastes or contaminants such as oils, solvents, maintenance chemicals, etc.
      2. PFS has no means to determine if unacceptable materials are discharged or disposed into the system through employee misconduct, accidents, etc.

VIII. Contaminant Sources and Pathways
   A. Contaminants include diesel fuel, liquid petroleum, laboratory waste, lubricants, motor fluids, solvents, residue for the CTB sump, waste from sinks, drains and toilets as well as from the concrete batch plant and asphalt plant.
   B. Sewer system pathways depend on its construction/design but includes:
      1. Migration of the sewer/wastewater discharge through the vadose zone to groundwater and resurfacing of the water (e.g., groundwater drinking wells)
      2. Resurfacing of untreated discharged waste above the leachfield.
   C. Contaminant pathways from operations and construction depend on the type of activity taking place - there is inadequate detail about specific activities at PFS but like other industrial operations there will be spills and releases from accidents, leaking tanks and piping, misconduct, etc.
      1. PFS has removed waste steams from connection to the drainfield (lab drains; CTB sump) but it is unknown how these waste streams will be managed.
   D. Neither PFS nor the FEIS describe the transport or fate of hazardous wastes and pollutants which may be released.
      1. Once a substance/waste comes in contact with surface soils, it can also contaminate surface waters and infiltrate into the subsurface.
         a. Pathways of exposure to humans and environment (including wildlife) through direct exposure and ingestion of surface contaminants.
         b. Direct exposure and ingestion of groundwater from wells downgradient of PFS even hundreds of years in the future.
   E. The FEIS concludes, without any site specific analyses or modeling, that it will take a large spill to contaminate the aquifer.
      1. FEIS ignores cumulative small spills -- could have similar effect to large spill.
      2. Ponding of water will create a hydraulic head which promotes infiltration.
      3. Dissolving hazardous constituents contained in spilled/released materials into surface water could infiltrate into the subsurface and groundwater through infiltration of rainwater or snow melt waters.

IX. Other Concerns
   A. Management/sampling of discharge water from CTB sump and retention pond.
   B. No details about BMPs; no BMPs for concrete and asphalt batch plants.
   C. Groundwater monitoring is essential to gauge the success of PFS's operational. procedures over the 40 year operating life of this major commercial facility.

In the Matter of: PRIVATE FUEL STORAGE, LLC
(Independent Spent Fuel Storage Installation)
Docket No. 72-22-ISFSI; ASLBP No. 97-732-02-ISFSI

State of Utah List of Hearing Exhibits - Contention Utah O

State Exhibit Number	Description	Witness	Contention
85	Resume of Don A. Ostler, P.E.	Ostler	O
86	Seminar Publication: *Requirements for Hazardous Waste Landfill Design, Construction and Closure*, EPA/625/4-89/022	Ostler	O
87	Technical Guidance Document: D. Daniel and R. Koerner, *Quality Assurance and Quality Control for Waste Containment Facilities*, EPA/600/R-93/183, September 1993	Ostler	O
88	Daniel B. Stephens, Vadose Zone Hydrology (CRC) (Lewis Publishers, 1996) at p. 21	Ostler	O
89	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. EPA, (May 1996, includes 1977 revisions), Section 6.10.6 "Backfilling"	Ostler	O
90	Feb. 19, 2002 letter from Elyana Sutin, EPA, to David Meyer, NRC, re EPA's Comments on the Final EIS for the Construction and Operation of an ISFSI, Skull Valley Band of Goshute Indians, Tooele County, UT; CEQ # 020019	Ostler	O

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PROFESSIONAL EXPERIENCE

Director, Utah Division of Water Quality Utah Department of Environmental Quality	1991 to Present
Executive Secretary, Utah Water Quality Board	1991 to Present
Director, Utah Bureau of Water Quality Utah Department of Health	1987 to 1991
Manager, Permitting and Financial Assistance Sections Utah Bureau of Water Quality	1975 to 1987
Review Engineer, Utah Bureau of Water Quality	1972-1987
Design Engineer, U.S. Bureau of Reclamation Salt Lake City and Denver Colorado	1972
Design Engineer, U.S. Forest Service Salmon, Idaho and Salt Lake City.	1971 to1972

RESPONSIBILITIES

My responsibilities during the last 14 years include the implementation and enforcement of the State's water quality program, which mandate is the protection and improvement of the quality of lakes, streams and groundwater by controlling the discharge of pollutants from both point and non-point sources. Additionally, during my employment with the State of Utah in the past 29 years, I have been responsible for the analysis and review of water pollution control plans from a great variety of sources. To that end, I have reviewed many hundreds of water pollution control plans from a variety of point and non-point pollution sources. This has included engineering plan review and writing surface water and ground water discharge permits. This work routinely requires evaluating activities by various industries and their potential to discharge pollutants to surface and ground water, as well as prescribing best available treatment or

containment systems, practices, and technology.

EDUCATION

Masters Degree, Civil Engineering 1975
University of Utah, Salt Lake City, Utah

Bachelors Degree, Civil Engineering 1971
University of Utah, Salt Lake City, Utah

PROFESSIONAL ORGANIZATIONS

Registered Professional Engineer in Utah;
Member of Tau Beta Pi and Chi Epsilon (National Engineering Honorary Fraternities);
President, Vice-President, governing Board Member (1987 to 1992),
and current member of National Association of State and Interstate Water Pollution Control Administrators;
Past Chairman (1989), current member, Western States Water Council, Water Quality Committee;
Member, Utah Soil Conservation Commission, 1987 to Present.

TRAINING

Attended countless workshops and seminars, many sponsored by the United States Environmental Protection Agency, relating to current and emerging water quality issues, during my 29 years of employment with the State of Utah.

TESTIMONY

Testified before Congress on water quality issues in 1988-1991.

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United States
Environmental Protection
Agency

Technology Transfer EPA/625/4-89/022

EPA

Seminar Publication

Requirements for Hazardous Waste Landfill Design, Construction, and Closure

2. LINER DESIGN: CLAY LINERS

Introduction

This chapter discusses soil liners and their use in hazardous waste landfills. The chapter focuses primarily on hydraulic conductivity testing, both in the laboratory and in the field. It also covers materials used to construct soil liners, mechanisms of contaminant transport through soil liners, and the effects of chemicals and waste leachates on compacted soil liners.

Materials

Clay

Clay is the most important component of soil liners because the clay fraction of the soil ensures low hydraulic conductivity. In the United States,however, there is some ambiguity in defining the term "clay" because two soil classification systems are widely used. One system, published by the American Society of Testing and Materials (ASTM), is used predominantly by civil engineers. The other, the U.S. Department of Agriculture's (USDA's) soil classification system, is used primarily by soil scientists, agronomists, and soil physicists.

The distinction between various particle sizes differs between ASTM and USDA soil classification systems (see Table 2-1). In the ASTM system, for example sand-sized particles are defined as those able to pass a No. 4 sieve but not able to pass a No. 200 sieve, fixing a grain size of between 0.075 millimeters (mm) and 4.74 mm. The USDA soil classification system specifies a grain size for sand between 0.050 mm and 2 mm.

The USDA classification system is based entirely upon grain size and uses a three-part diagram to classify all soils (see Figure 2-1). The ASTM system, however, does not have a grain size criterion for classifications of clay; clay is distinguished from silt entirely upon plasticity criteria. The ASTM classification system uses a plasticity diagram and a sloping line, called the "A" line (see Figure 2-2) to distinguish between silt and clay. Soils whose data

Table 2-1. ASTM and USDA Soil Classification by Grain Size

	ASTM	USDA
Gravel		
	4.74 (No. 4 Sieve)	2
Sand		
	0.075 (No. 200 Sieve)	0.050
Silt		
	None (Plasticity Criterion)	0.002
Clay		

points plot above the A line on this classification chart are, by definition, clay soils with prefixes C in Unified Soil Classification System symbol. Soils whose data points plot below the A line are classified as silts.

EPA requires that soil liners be built so that the hydraulic conductivity is equal to or less than 1 x 10^{-7} cm/sec. To meet this requirement, certain characteristics of soil materials should be met. First, the soil should have at least 20 percent fines (fine silt and clay sized particles). Some soils with less than 20 percent fines will have hydraulic conductivities below 10^{-7} cm/sec, but at such low fines content, the required hydraulic conductivity value is much harder to meet.

Second, plasticity index (PI) should be greater than 10 percent. Soils with very high PI, greater than 30 to 40 percent, are sticky and, therefore, difficult to work with in the field. When high PI soils are dry, they form hard clumps that are difficult to break down during compaction. On the Gulf Coast of Texas, for example, clay soils are predominantly highly plastic clays and require additional processing during construction. Figure 2-3 represents a collection of data from the University of Texas laboratory in Austin showing hydraulic conductivity as a function of plasticity index. Each data point represents a separate soil compacted in the

Table 1-5. Cover Design

Vegetative Cover

- Thickness ≥ 2 ft
- Minimal erosion and maintenance (e.g., fertilization, irrigation)
- Vegetative root growth not to extend below 2 ft
- Final top slope between 3 and 5% after settlement or subsidence. Slopes greater than 5% not to exceed 2.0 tons/acre erosion (USDA Universal Soil Loss Equation)
- Surface drainage system capable of conducting run-off across cap without rills and gullies

Drainage Layer Design

- Thickness ≥ 1 ft
- Saturated hydraulic conductivity ≥ 10^{-3} cm/sec
- Bottom slope ≥ 2% (after settlement/subsidence)
- Overlain by graded granular or synthetic filter to prevent clogging
- Allow lateral flow and discharge of liquids

Low Permeability Liner Design

FML Component:

- Thickness ≥ 20 mil
- Final upper slope ≥ 2% (after settlement)
- Located wholly below the average depth of frost penetration in the area

Soil Component:

- Thickness ≥2 ft
- Saturated hydraulic conductivity ≤ 1 x 10^{-7} cm/sec
- Installed in 6-in lifts

- Summary of CQA activities for each landfill component.

This report must be signed by a registered professional engineer or the equivalent, the CQA officer, the design engineer, and the owner/operator to ensure that all parties are satisfied with the design and construction of the landfill. EPA will review selected CQA reports.

The CQA plan covers all components of landfill construction, including foundations, liners, dikes, leachate collection and removal systems, and final cover. According to the proposed rule (May 1987), EPA also may require field permeability testing of soils on a test fill constructed prior to construction of the landfill to verify that the final soil liner will meet the permeability standards of 10^{-7} cm/sec. This requirement, however, will not preclude the use of laboratory permeability tests and other tests (correlated to the field permeability tests) to verify that the soil liner will, as installed, have a permeability of 10^{-7} cm/sec.

Summary of Minimum Technology Requirements

EPA's minimum technology guidance and regulations for new hazardous waste land disposal facilities emphasize the importance of proper design and construction in the performance of the facility. The current trend in the regulatory programs is to develop standards and recommend designs based on the current state-of-the-art technology. Innovations in technology are, therefore, welcomed by EPA and are taken into account when developing these regulations and guidance.

References

1. EMCON Associates. 1988. Draft background document on the final double liner and leachate collection system rule. Prepared for Office of Solid Waste, U.S. EPA. NUS Contract No. 68-01-7310, Work Assignment No. 66.

2. U.S. EPA. 1987a. Liners and leak detection for hazardous waste land disposal units: notice of proposed rulemaking. Fed. Reg. Vol 52, No. 103, 20218-20311. May 29.

3. U.S. EPA. 1987b. Hazardous waste management systems: minimum technology requirements: notice of availability of information and request for comments. Fed. Reg. Vol. 52, No. 74, 12566-12575. April 17.

4. U.S. EPA. 1987c. Background document on proposed liner and leak detection rule. EPA/530-SW-87-015.

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6. U.S. EPA. 1986b. Hazardous waste management systems: proposed codification rule. Fed. Reg. Vol. 51, No. 60, 10706-10723. March 28.

7. U.S. EPA. 1985a. Hazardous waste management systems; [illegible] rule. Fed. Reg. Vol. 50, No. 133, 28702-28755. July 15.

8. U.S. EPA. 1985b. Draft minimum technology guidance on double liner systems for landfills and surface impoundments - design, construction, and operation. EPA/530-SW-84-014. May 24.

9. U.S. EPA. 1982. Handbook for remedial action at waste disposal sites. EPA-625/6-82-006. Cincinnati, OH: U.S. EPA.

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[illegible]
September 1993

Technical Guidance Document:

QUALITY ASSURANCE AND QUALITY CONTROL FOR WASTE CONTAINMENT FACILITIES

by

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and

Robert M. Koerner
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RISK REDUCTION ENGINEERING LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

2.2.1.4 Maximum Particle Size

The maximum particle size is important because: (1) cobbles or large stones can interfere with compaction, and (2) if a geomembrane is placed on top of the compacted soil liner, oversized particles can damage the geomembrane. Construction specifications may stipulate the maximum allowable particle size, which is usually between 25 and 50 mm (1 to 2 in.) for compaction considerations but which may be much less for protection against puncture of an adjacent geomembrane. If a geomembrane is to be placed on the soil liner, only the upper lift of the soil liner is relevant in terms of protection against puncture. Construction specifications may place one set of restrictions on all lifts of soil and place more stringent requirements on the upper lift to protect the geomembrane from puncture. Sieve analyses on small samples will not usually lead to detection of an occasional piece of oversized material. Observations by attentive CQC and CQA personnel are the most effective way to ensure that oversized materials have been removed. Oversized materials are particularly critical for the top lift of a soil liner if a geomembrane is to be placed on the soil liner to form a composite geomembrane/soil liner.

2.2.1.5 Clay Content and Activity

The clay content of the soil may be defined in several ways but it is usually considered to be the percentage of soil that has an equivalent particle diameter smaller than 0.005 or 0.002 mm, with 0.002 mm being the much more common definition. The clay content is measured by sedimentation analysis (ASTM D-422). Some construction specifications specify a minimum clay content but many do not.

A parameter that is sometimes useful is the activity, A, of the soil, which is defined as the plasticity index (expressed as a percentage) divided by the percentage of clay (< 0.002 mm) in the soil. A high activity (> 1) indicates that expandable clay minerals such as montmorillonite are present. Lambe and Whitman (1969) report that the activities of kaolinite, illite, and montmorillonite (three common clay minerals) are 0.38, 0.9, and 7.2, respectively. Activities for naturally occurring clay liner materials, which contain a mix of minerals, is frequently in the range of $0.5 \leq A \leq 1$.

Benson et al. (1992) related hydraulic conductivity to clay content (defined as particles < 0.002 mm) and reported the correlation shown in Fig. 2.11. The data suggest that soils must have at least 10% to 20% clay in order to be capable of being compacted to a hydraulic conductivity $\leq 1 \times 10^{-7}$ cm/s. However, Benson et al. (1992) also found that clay content correlated closely with plasticity index (Fig. 2.12). Soils with PI >10% will generally contain at least 10% to 20% clay.

It is recommended that construction specification writers and regulation drafters indirectly account for clay content by requiring the soil to have an adequate percentage of fines and a suitably large plasticity index -- by necessity the soil will have an adequate amount of clay.

2.2.1.6 Clod Size

The term *clod* refers to chunks of cohesive soil. The maximum size of clods may be specified in the construction specifications. Clod size is very important for dry, hard, clay-rich soils (Benson and Daniel, 1990). These materials generally must be broken down into small clods in order to be properly hydrated, remolded, and compacted. Clod size is less important for wet soils -- soft, wet clods can usually be remolded into a homogeneous, low-hydraulic-conductivity mass with a reasonable compactive effort.

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VADOSE ZONE HYDROLOGY

Daniel B. Stephens

Cover illustration by:
Andrea J. Kron
cARTography by Andrea Kron
Los Alamos, New Mexico

CRC
LEWIS PUBLISHERS
Boca Raton New York London Tokyo

aquifers, and both terms have units of inverse length. In Figure 8, the water stored in unsaturated soil is due to changes in water content as a consequence of infiltration, drainage, capillary effects, or air-drying. In contrast, the specific storage in saturated soil accounts for water and matric compressibility (e.g., Neuman, 1973; Narasimhan, 1979). Later in this chapter, the full matrix storage properties combine compressibility effects with the specific moisture capacity for developing complete flow equations.

IV. DARCY'S EQUATION AND UNSATURATED FLOW PARAMETERS

Perhaps the most widely recognized equation among soil scientists, hydrologists, and petroleum engineers is Darcy's equation. In 1856 Henri Darcy, a French engineer, conducted laboratory experiments on porous filter materials that would be used for a sewage treatment system. These experiments were conducted under fully saturated conditions. Buckingham (1907), a soil scientist, demonstrated that Darcy's equation could be extended to unsaturated conditions as well. Darcy's equation also is used in the petroleum fields and hydrogeology for multiphase flow problems. We begin by discussing the more unfamiliar but more general form of Darcy's equation, which is relevant to a wide variety of fluid flow problems, including nonaqueous phase liquids. Subsequently, we introduce the less mathematically cumbersome equation for the flow of water in the vadose zone.

Darcy's equation for a fluid phase (i.e., liquid or gas), F, can be written as

$$q_{F_i} = -K_F(S_F)_{ij}\left(\frac{\partial h_F}{\partial x_i} + \rho_{r_F} u_i\right) \quad \textbf{(16)}$$

where q_{F_i} = specific discharge of fluid F in i direction (LT^{-1}), K_F = hydraulic conductivity of phase F (LT^{-1}), S_F = saturation percentage of fluid phase F (L^3L^{-3}), h_F = water height equivalent pressure head of fluid phase F (L), $P_F/g\rho_w$ where P_F = pressure in phase F ($ML^{-1}T^{-2}$), g = gravitational constant (LT^{-2}), and ρ_w = density of pure water (ML^{-3}), x_i = Cartesian space coordinate (i,j = 1, 2, 3) (L), $\rho_{r_F} = \rho_F/\rho_W$ = specific gravity of phase F, and $u_i = \partial z/\partial x_i$ = unit gravitational vector measured positive upward in direction z.

If only water is the fluid of interest, then Darcy's equation is written as

$$q_i = -K(\theta)_{ij}\left(\frac{\partial \psi}{\partial x_i} + \frac{\partial z}{\partial x_i}\right) \quad \textbf{(17a)}$$

where z is positive upward. Where the soil is homogeneous and isotropic, then in three dimensions in an x,y,z-coordinate system, Darcy's equation becomes:

$$q_x = -K(\theta)\frac{\partial \psi}{\partial x} \quad \textbf{(17b)}$$

$$q_y = -K(\theta)\,\frac{\partial\psi}{\partial y} \tag{17c}$$

$$q_z = -K(\theta)\left(\frac{\partial\psi}{\partial z} + \frac{\partial z}{\partial z}\right) = -K(\theta)\left(\frac{\partial\psi}{\partial z} + 1\right) \tag{17d}$$

Darcy's equation simply states that fluid flow is a function of the driving force called hydraulic gradient (pressure and gravity terms in brackets) and a constant of proportionality called the hydraulic conductivity, K. The hydraulic conductivity accounts for the viscous flow and frictional losses that occur as a fluid moves through the porous medium.

A. HYDRAULIC GRADIENT

The hydraulic gradient in the vadose zone exhibits interesting characteristics that contrast markedly with those that hydrogeologists are accustomed to in aquifers. In aquifer systems, flow is primarily horizontal and the regional hydraulic gradient is often in the range of 10^{-4} to 10^{-3}; it is rare that the hydraulic gradient ever exceeds 0.01, although there are exceptions such as where groundwater flows across faults, across aquitards, and very close to pumped wells. But in the vadose zone, hydraulic head gradients near one are common. Unit hydraulic gradients occur in deep vadose zones with uniform texture where the soil-water content is constant with depth. The same is true if the vadose zone is stratified, when the pressure head is averaged over many layers (Yeh, 1989). Where pressure head or mean pressure head does not vary spatially, the gradient of the pressure head ($\partial\psi/\partial z$) is zero. The only component of hydraulic head gradient that one must consider for this case is gravity, and its gradient, ($\partial z/\partial z$), is always unity in the vertical direction when soil-water potential is expressed in units of length. Therefore, the gradient of the total hydraulic head will be one, where the pressure head is everywhere constant. A unit hydraulic gradient indicates that the soil water is flowing vertically downward. When the gradient is unity, the magnitude of the flux, q, equals the hydraulic conductivity, $K(\theta)$.

Although the hydraulic gradient is often near unity, the hydraulic gradient can be many orders of magnitude larger near sharp wetting fronts in dry soils. On the other hand, the hydraulic gradient may also be much less than unity and, in fact, is zero where no flow occurs. Hydrostatic equilibrium is one condition of no-flow flow, but this is not often encountered in the field. Another instance where zero gradient could occur is where a pulse of water percolation downward is halted by an impermeable layer or coarse-textured capillary barrier. Another example is near land surface where there is a plane above which water flows upward due to evapotranspiration and below which flow is downward due to capillary and gravity effects. This plane is usually referred to as the plane of zero flux. From these examples, it is clear that the hydraulic gradient in the vadose zone can vary substantially in response to soil-water dynamics, although in many cases the gradient can be assumed to be near unity in the vertical downward direction, especially below the root zone.

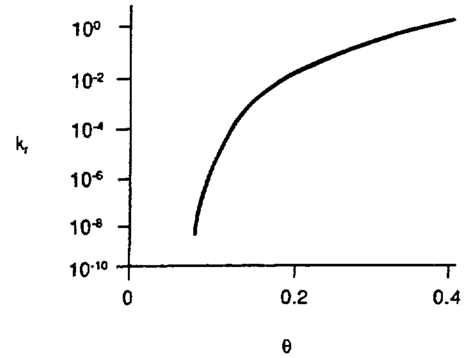

Figure 9 Relative hydraulic conductivity, K_r, vs. water content, θ. Porosity is 0.4 cm³/cm³.

B. UNSATURATED HYDRAULIC CONDUCTIVITY AND RELATIVE PERMEABILITY

The following equation further explains how the hydraulic conductivity is a function of the fluid properties, the media properties, and the water content, θ:

$$K(\theta) = \left(\frac{k\rho g}{\mu}\right) k_r(\theta) \tag{18}$$

where k = intrinsic permeability of the medium (L^2), ρ = density of fluid phase P (ML^{-3}), g = gravitational constant (LT^{-2}), μ = dynamic viscosity of fluid ($MT^{-1}L^{-1}$), and $k_r(\theta)$ = relative permeability (dimensionless, ranges from 0 to 1). In Equation 18, the quantity in brackets represents the familiar saturated hydraulic conductivity for isotropic conditions. The relative permeability, sometimes called relative hydraulic conductivity, is a dimensionless parameter that accounts for the dependence of the hydraulic conductivity on pressure head or water content, as shown in Figure 9. The maximum value of relative hydraulic conductivity is one, and at this point the pores are fully saturated with water. But in the field, the vadose zone seldom is fully saturated with water, due to entrapped air. Entrapped air is most likely to occur, for example, below a fluctuating water table or below irrigated fields and intermittently flooded arroyos. Consequently, under field conditions the maximum value of hydraulic conductivity may be only about half of the saturated hydraulic conductivity. Owing to the difficulty to achieve full saturation, the maximum field hydraulic conductivity is sometimes referred to as the satiated hydraulic conductivity.

The relative hydraulic conductivity decreases rapidly with decreasing water content. As drainage progresses, smaller and smaller pores are left holding water. As the water content decreases, the path of water flow becomes more tortuous and the cross-sectional area of water in the pores decreases. In the dry range, the relative hydraulic conductivity becomes very small, so at low water contents, the hydraulic conductivity may be perhaps more than a millionfold smaller than the saturated hydraulic conductivity. At moisture contents as small as a few percent, detailed laboratory experiments have shown liquid phase transport of water can still exist, although at this dry state vapor transport is much more important (Grismer et al., 1986).

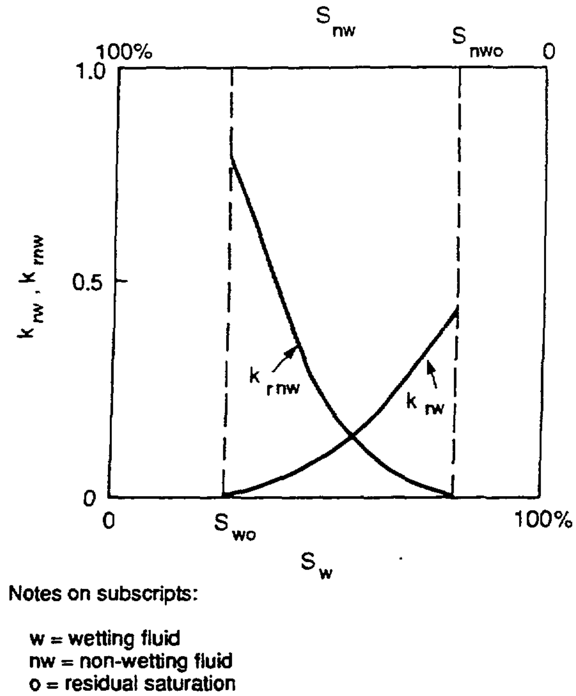

Figure 10 Relative permeability, k_r, vs. saturation, S, for two fluids. Notes on subscripts: w = wetting fluid, nw = non-wetting fluid, and o = residual saturation. (From Bear, 1975.™ With permission.)

Petroleum engineers deal extensively with relative permeability data, but there are important distinctions of interest to soil scientists and hydrologists. Compare the manner in which petroleum engineers sometime represent relative permeability curves (Figure 10) with the soil physicists' perspective (Figure 9). The most significant difference between Figures 9 and 10 is that for the two-phase fluid (e.g., oil and water) system in a petroleum reservoir, each of the phases is shown to reach residual saturation where the relative permeability of a fluid is zero. In contrast, the relative permeability for water in Figure 9 does not usually become zero. In the very dry range of interest to soil scientists and hydrologists, the water may move as thin films. In this state, the relative permeability will be very small, but not actually zero. For most practical problems in reservoir engineering and petroleum production, there is no need to be concerned with film flow. Consequently, relative permeabilities less than about 0.01 or 0.001 are considered negligible in an oil reservoir. Therefore, petroleum engineers often find it more convenient to express unsaturated hydraulic conductivity and relative permeability on an arithmetic scale, whereas soil scientists and hydrologists usually use a logarithmic scale spanning many cycles. Although extensive data exist on capillary properties of oil reservoir rocks, the lower range of the relative permeability test data often does not extend to sufficiently low values to adequately characterize dry conditions. For example, one problem that can arise is in using Darcy's equation to compute recharge. If relative permeability-water saturation curves derived for a petroleum engineering application (e.g., Figure 10) are applied to obtain hydraulic conductivity where field saturation is very low, the recharge may be incorrectly predicted as zero. An understanding of the manner in which petroleum engineers deal with relative permeability can be very important to hydrologists and soil physicists, especially for problems where both soil water and vapor movement

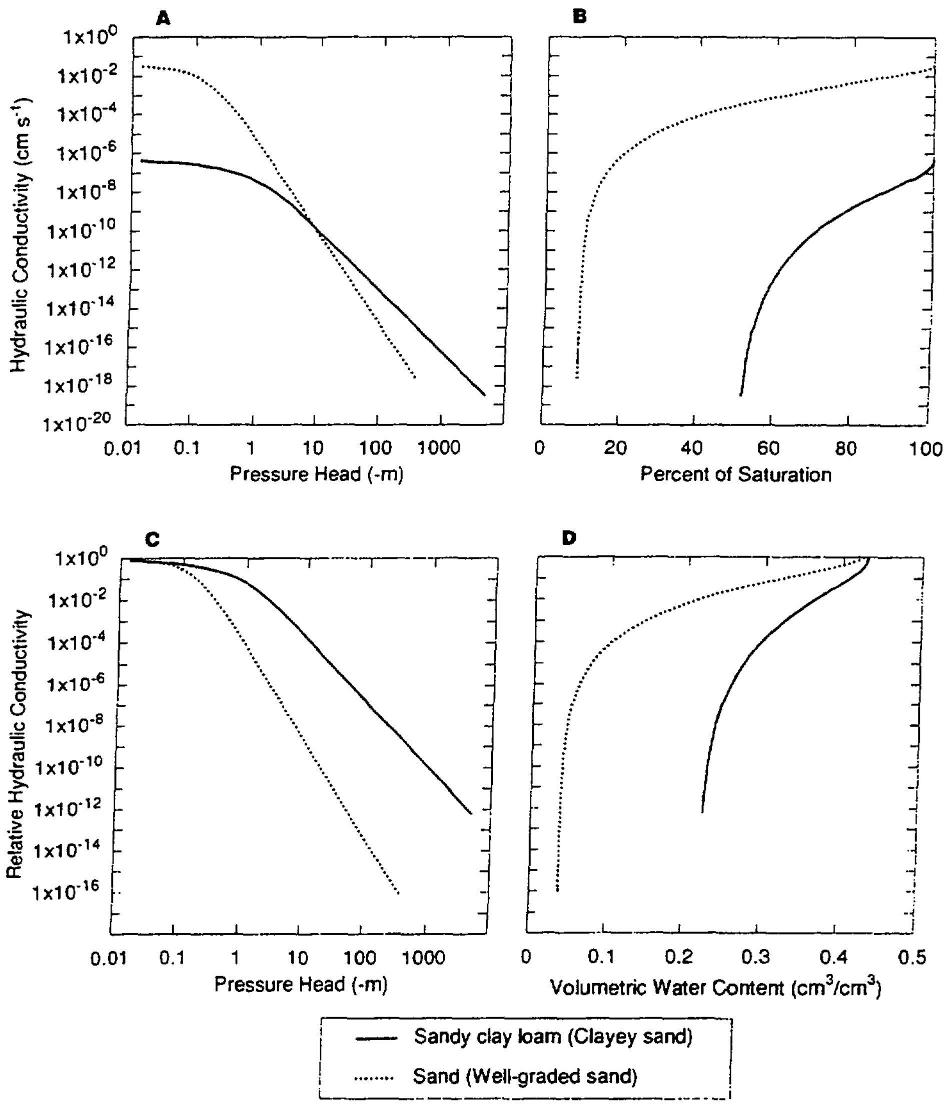

Figure 11 (A) Hydraulic conductivity, K, versus pressure head, ψ, for sand and sandy clay loam; (B) hydraulic conductivity versus water content; (C) relative hydraulic conductivity versus pressure head; and (D) relative hydraulic conductivity versus percent saturation. Water retention curves and specific moisture capacity for these soils are shown in Figure 8.

are significant or for problems of nonaqueous phase liquid migration through the vadose zone.

The hydraulic conductivity of variably saturated media is highly dependent upon soil texture (Figure 11). Hydrogeologists and engineers are well aware of the nature of spatial variability in saturated hydraulic conductivity that is attributed to variability in the intrinsic permeability (Equation 18) of the geologic material. For instance, well-sorted sand typically has a saturated hydraulic conductivity of about 10^{-2} cm/s, whereas clay may have a saturated hydraulic conductivity of about 10^{-6} cm/s. But over the range of water contents likely to be encountered in the vadose zone, the unsaturated hydraulic conductivity of a single soil sample may change by one-million- or one-billion-fold or more. There is even greater variability in the unsaturated hydraulic conductivity among samples of different soil textures.

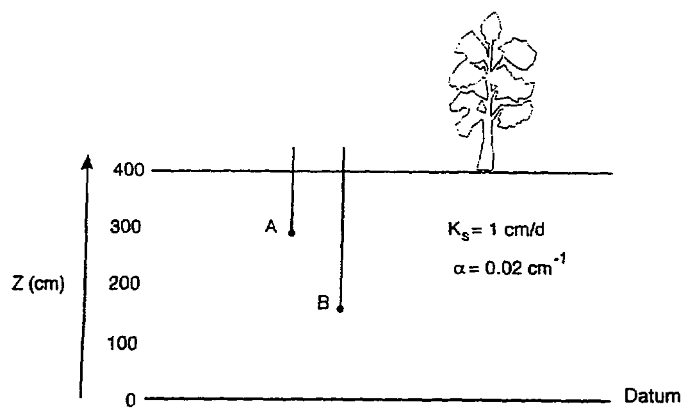

Figure 12 Example to calculate hydraulic gradient, flow direction, and flow rate.

It is especially important to recognize that at low pressure head or water content, the unsaturated hydraulic conductivity of a fine-textured soil may be greater than that of a coarse soil. Figure 11 illustrates this behavior for a sand and loam, with the loam having a greater hydraulic conductivity at pressure heads less than –10 m. This behavior arises because the unsaturated hydraulic conductivity of fine soil tends to decrease much less rapidly as pressure head decreases, in comparison to a coarse textured soil. For most hydrogeologists and engineers, this is a paradox, in that the soil with the highest intrinsic permeability (Equation 18) can have the lowest hydraulic conductivity. However, this fact can be very important in forming conceptual models about vadose zone processes of flow and transport, particularly in heterogeneous or layered media, as we demonstrate in a subsequent chapter discussing vadose zone processes.

The concepts of unsaturated flow presented thus far are summarized in the following example problem. The hypothetical problem is to determine the direction and rate of soil-water flow from *in situ* measurements of pressure head and hydraulic conductivity in a soil having a uniform texture. Figure 12 shows the location of two tensiometers for measuring pressure head. Table 2 indicates the pressure head measurements at the two depths. It has already been determined from laboratory analyses of cores that the saturated hydraulic conductivity is 1 cm/d. We assume that the unsaturated hydraulic conductivity fits the exponential model:

$$K(\psi) = K_s \exp(\alpha\psi) \qquad \textbf{(19)}$$

with $\alpha = 0.02$ cm^{-1} for this soil. (The exponential model means that on semilogarithmic paper, ln K–ψ fits a straight line having a slope α and an intercept K_s)

To solve this problem, we assume that the flow is vertical and apply Darcy's equation (Equation 17d). We also set the vertical axis as positive upward. The first step to compute the Darcy velocity (specific discharge), q_z, is to determine the hydraulic head gradient from the sum of the pressure head and total head gradients. In our problem, the pressure head decreases upward, so at first glance it may appear that flow is upward. But when the gravitational gradient is added to the pressure head gradient, the total hydraulic head decreases downward (Table 2). Recall it is the gradient of total

Table 2 Pressure Head and Total Head Measurements at Two Depths

	Measured pressure head ψ (cm)	Elevation head Z (cm)	Total head H (cm)
A	−100	300	200
B	−90	200	110

head, not pressure head, that is the water driving force. Consequently, the flow is downward and the magnitude of the total hydraulic head gradient is

$$\frac{dH}{dz} \cong \frac{H_2 - H_1}{Z_2 - Z_1} = \frac{200 - 110}{100} = 0.9 \qquad (20)$$

Note that by our choice of sign convention, the higher subscript refers to the location furthest from the origin.

The second step is to compute the unsaturated hydraulic conductivity. To do this, we determine the mean pressure head in the region between the tensiometers:

$$\frac{\psi_1 + \psi_2}{2} = -95 \text{ cm} \qquad (21)$$

Next, substitute this mean pressure head into Equation 19, along with our previously determined values of K_s and α. The result is $K = 0.15$ cm/d. The third step is to multiply the hydraulic head gradient by the unsaturated hydraulic conductivity to obtain the Darcy velocity:

$$q_z = -K\left(\frac{dH}{dz}\right) = -(0.15)(0.9) = -0.13 \text{ cm/d} \qquad (22)$$

The negative sign indicates flow is in the direction opposite to which z increases, that is, downward.

C. HYSTERESIS IN HYDRAULIC CONDUCTIVITY

When we discussed the soil-water retention curve, we noted that the relationship was hysteretic. As one may expect, the relationship between unsaturated hydraulic conductivity and pressure head also is hysteretic (Figure 13). The simplest explanation for this hysteretic behavior is that at any given pressure head, there is a corresponding value of moisture content on the main wetting curve and a slightly greater moisture content on the main drainage curve. The wetter the soil, the greater the hydraulic conductivity. Therefore, at a particular pressure head, one may find two corresponding hydraulic conductivities, such that the hydraulic conductivity during drainage will be greater than during wetting. Near saturation, entrapped air is the primary cause of hysteresis in hydraulic conductivity. There is little evidence that the unsaturated hydraulic conductivity is hysteretic with respect to moisture content to any practical extent.

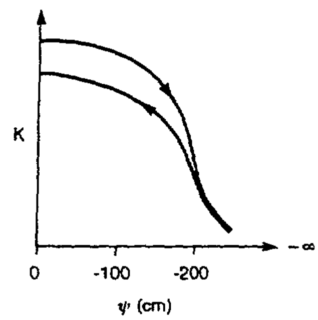

Figure 13 Effect of hysteresis on the hydraulic conductivity, K, vs. pressure head, ψ, relationship.

Problems in which hysteresis may be important to consider involve periods of both wetting and drying, such as can occur during infiltration and subsequent redistribution of a pulse of infiltrated water that is drawn both downward by gravity and capillarity and also upward due to evapotranspiration. As indicated by Rubin (1967) and Hillel (1980), the downward movement of a finite pulse of water cannot accurately be modeled by assigning as input parameters either the wetting or drying unsaturated hydraulic conductivity curves. In both bounding cases, the depth of wetting will be overestimated and the amount of moisture retained near the land surface will be underestimated. However, when the process involves either only wetting or only drying, then it is appropriate to apply the corresponding wetting or drying hydraulic conductivity curve. More is presented about the importance of hysteresis in Chapter 3 on vadose zone processes.

D. ANISOTROPY

Looking back on Equations 16 and 17a presented at the beginning of this section, we subscripted the hydraulic conductivity to indicate that in its most general form the hydraulic conductivity is anisotropic. Anisotropy is a property of the medium that reflects how the hydraulic conductivity varies with direction. That is, measurements of hydraulic conductivity in the vertical direction are different from those in the horizontal direction in an anisotropic medium. By contrast, at any point within an isotropic medium, hydraulic conductivity has the same magnitude in all directions. In a three-dimensional, anisotropic system, hydraulic conductivity is a second-rank tensor or matrix having nine components:

$$K_{ij} = \begin{vmatrix} K_{xx} & K_{xy} & K_{xz} \\ K_{yx} & K_{yy} & K_{yz} \\ K_{zx} & K_{zy} & K_{zz} \end{vmatrix} \tag{23}$$

The practical significance of this representation is that it allows one to compute the component of water flow in any direction, regardless of the orientation of principal bedding directions. In contrast to an isotropic medium, in an anisotropic system the direction of flow may not be in the same direction as the hydraulic head

gradient. The hydraulic conductivity tensor has nine components to account for cases in which the principal coordinate axes and bedding planes are not collinear. However, in many hydrogeologic environments the soil is horizontally stratified, so within the horizontal plane there may be no anisotropy. That is, $K_{yy} = K_{xx}$, and all off-diagonal terms in the conductivity matrix (Equation 23) would be zero, if our coordinate axes are in the horizontal and vertical direction. Consequently, anisotropy in hydraulic conductivity may be represented by the ratio of hydraulic conductivity in the horizontal to vertical direction, K_H and K_V, respectively:

$$A = \frac{K_{xx}}{K_{zz}} = \frac{K_H}{K_V} \tag{24}$$

In most cases, anisotropy is characterized as the ratio of saturated hydraulic conductivities obtained from oriented core samples. At saturation, anisotropy may commonly vary from 2 to 20, but values up to 100 or greater may occur.

In unsaturated media, hydrologists and soil scientists commonly have assumed that the anisotropy at moisture contents less than saturation is the same as at complete saturation. This assumption was questioned by Zaslavsky and Sinai (1981). Theoretical analysis based on stochastic methods (Yeh et al., 1985) suggests that in a steady flow field the anisotropy of a stratified heterogeneous soil should increase as the mean pressure head (and moisture content) of the soil decreases:

$$A(\overline{\psi}) = \exp\left(\frac{\sigma_f^2 + \sigma_\alpha^2\,\overline{\psi}^2}{1 + \overline{\alpha}\,\lambda_l \cos\delta_s}\right) \tag{25}$$

where σ_f^2 = variance of ln K_s (dimensionless),σ_α^2 = variance of slope of ln K-ψ (L^{-2}), $\overline{\psi}$ = mean pressure head (L), $\overline{\alpha}$ = mean slope of the ln K-ψ curve (L^{-1}), λ_l = vertical correlation scale (L), and δ_s = dip of stratification (degrees).

Laboratory experiments have subsequently confirmed that anisotropy is moisture dependent (Stephens and Heermann, 1988; Frederick, 1988). Field and numerical model investigations by McCord et al. (1991) showed that for a uniform dune sand that was nearly isotropic at saturation, the unsaturated anisotropy was as much as 20.

The primary consequence of anisotropy is that subsurface water movement may have strong lateral flow components especially where infiltration occurs into highly stratified, dry soils. We say more about how anisotropy influences flow in the vadose zone in the next two chapters.

E. SOIL-WATER DIFFUSIVITY

The final hydraulic property we discuss here is the soil-water diffusivity, D:

$$D(\theta) = \frac{K(\theta)}{C(\theta)} \tag{26}$$

The soil-water diffusivity embodies both the unsaturated hydraulic conductivity and, through the specific moisture capacity, the soil-water characteristic curve. This parameter is analogous to the hydraulic diffusivity in aquifers and has units of length

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Environmental Investigations
Standard Operating Procedures
and
Quality Assurance Manual

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

May 1996
Includes 1997 Revisions

U.S. Environmental Protection Agency
Region 4
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Athens, Georgia 30605-2720
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The following development procedures are generally used to develop monitoring wells:

1. Pumping;
2. Compressed air (with the appropriate organic filter system);
3. Bailing;
4. Surging;
5. Backwashing ("rawhiding"); and
6. Jetting.

These developmental procedures can be used, individually or in combination, in order to achieve the most effective well development. Except when compressed air is being used for well development, sampling can be initiated as soon as the ground water has re-equilibrated, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well. Wells developed with compressed air normally should not be sampled for at least 48 hours after development so that the formation can dispel the compressed air and restabilize to pre-well construction conditions. The selected development method(s) should be approved by a senior field geologist before any well installation activities are initiated.

6.9 Well Abandonment

When a decision is made to abandon a monitoring well, the borehole should be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly abandon a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. In order to comply with state well abandonment requirements, the appropriate state agency should be notified (if applicable) of monitoring well abandonment. However, some state requirements are not explicit, so a technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s).

6.9.1 Abandonment Procedures

As previously stated the preferred method should be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing should then be removed from the hole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). The top 2 feet of the borehole should be poured with concrete to insure a secure surface seal (plug). If the area has heavy traffic use, and/or the well locations need to be permanently marked, then a protective.surface pad(s) and/or steel bumper guards should be installed. The concrete surface plug can also be recessed below ground surface if the potential for construction activities exists. This abandonment method can be accomplished on small diameter (1-inch to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow-stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow-stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid-stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space and/or sound well casings can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case should be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing,

Double Filter Pack

The borehole is advanced to the desired depth. As with the "inner filter pack" the well screen is filled with filter pack material and the well screen and casing inserted until the top of the filter pack is at least 6 inches below the water table. Filter pack material is poured into the annular space around the well screen. This type temporary well construction can be very effective in aquifers where fine silts or clays predominate. This construction technique takes longer to implement and uses more filter pack material than others previously discussed.

Well-in-a-Well

The borehole is advanced to the desired depth. At this point, a 1-inch well screen and sufficient riser is inserted into a 2-inch well screen with sufficient riser, and centered. Filter pack material is then placed into the annular space surrounding the 1-inch well screen, to approximately 6 inches above the screen. The well is then inserted into the borehole.

This system requires twice as much well screen and casing, with subsequent increase in material cost. The increased amount of well construction materials results in a corresponding increase in decontamination time and costs. If pre-packed wells are used, a higher degree of QA/QC will result in higher overall cost.

6.10.6 Backfilling

It is the generally accepted practice to backfill the borehole from the abandoned temporary well with the soil cuttings. Use of cuttings would not be an acceptable practice if waste materials were encountered or a confining layer was inadvertently breached. If for some reason the borehole cannot be backfilled with the soil cuttings, then the same protocols set forth in Section 6.9 should be applied. Section 5.15 should be referenced regarding disposal of IDW.

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Ref: 8EPR-N

David L. Meyer
Rules Review and Directives Branch
Division of Freedom of Information and Publications Services
Office of Administration, Mailstop T-6D-59
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: EPA's Comments on the Final EIS for the Construction and Operation of an Independent Spent Fuel Storage Installation, Skull Valley Band of Goshute Indians, Tooele County, Utah
CEQ # 020019

Dear Mr. Meyer:

Pursuant to the Environmental Protection Agency's (EPA's) authority under Section 309 of the Clean Air Act, the NEPA Unit of EPA Region 8, with technical assistance from the Radiation Protection Division, Office of Radiation and Indoor Air, in EPA's Washington, D.C. office, has reviewed the Final Environmental Impact Statement (Final EIS) for the Construction and Operation of an Independent Spent Fuel Storage Installation (ISFSI). This Final EIS is for a proposed ISFSI in which Private Fuel Storage, L.L.C. (PFS) would store spent nuclear fuel (SNF) on the Reservation of the Skull Valley Band of Goshute Indians (the Reservation), in Tooele County, Utah. EPA offers the following comments for your consideration.

PFS proposes to receive, possess, store, and transfer spent nuclear fuel from nuclear power reactors at the proposed ISFSI. PFS would also build and operate a new rail line connecting the site with the existing Union Pacific railroad adjacent to Interstate 80. To build and operate the ISFSI and the associated rail line, PFS would need to obtain (1) rail line rights of way from the U.S. Bureau of Land Management (BLM), (2) a rail line license from the Surface Transportation Board, (3) a lease between PFS and the Tribe which the Bureau of Indian Affairs (BIA) would need to approve, and (4) a license pursuant to 10 CFR Part 72 from the Nuclear Regulatory Commission (NRC).

The purpose of the proposed action is, in large part, to provide interim storage of SNF until a permanent underground repository (such as the proposed site at Yucca Mountain, Nevada, which is scheduled to open by 2010) is available. The site would be capable of storing 40,000

metric tons of uranium, which could include all of the SNF from PFS' member utilities, as well as some SNF from other non-PFS utilities.

EPA's regulatory role

In addition to its role in reviewing the EIS, EPA administers various other environmental statutes that are pertinent to this proposed facility. These statutes include the Clean Water Act, the Safe Drinking Water Act, and the Resource Conservation and Recovery Act. For this proposal, EPA would be responsible for (1) issuing or denying all necessary National Pollutant Discharge Elimination System (NPDES) permits to control point sources of pollutants into waters of the United States, including any necessary storm water permits, (2) reviewing a spill prevention and control plan for above-ground diesel fuel tanks required by EPA's Oil Pollution Prevention Regulations at 40 CFR Part 112, (3) taking any appropriate actions under the Safe Drinking Water Act to assure that water in nearby drinking water wells is safe for human consumption, (4) issuing or denying any necessary permit(s) or, if applicable, issuing "authorization by rule" letter(s) for the septic leach field under EPA's Underground Injection Control regulations at 40 CFR Parts 144, 146, and 148, (5) overseeing the facility's compliance with the Resource Conservation and Recovery Act, including verifying whether it qualifies for treatment as a "small quantity generator" subject to the requirements set forth in 40 CFR Section 262.44. The Draft EIS described these components of EPA jurisdiction.

We are concerned with the statement on page 1-27 of the Final EIS that if a discharge is to ephemeral waters, PFS takes the position that no NPDES permit is required. An NPDES permit is required for any person discharging any pollutant from any point source into any water of the United States, "ephemeral" or not. Please also note that because building this facility will disturb more than an acre of land, it will be necessary for PFS to obtain an NPDES storm water permit if there will be a discharge from the site that reaches waters of the United States. For more details on the requirements for storm water permits, please see 40 CFR Section 122.26.

Similarly, we are concerned with the statement in the Final EIS that PFS provided information that there is no reasonable expectation, even in the absence of any oil containment or control equipment, that a discharge of oil from the proposed facility would reach a jurisdictional water of the United States, and thus the operator of the facility would not be required to prepare a Spill Prevention, Control, and Countermeasures (SPCC) plan. We have advised PFS that should the facility experience a discharge in violation of section 311 (b)(3) of the CWA, PFS could be subject to penalties under section 311(b)(6) or (7) of the Clean Water Act. Despite PFS's assertions that these regulations would not apply, we understand that PFS intends to construct secondary containment consistent with the requirements of the Clean Water Act.

The Record of Decision should acknowledge that any discharges to waters of the United States from the proposed facility must comply with all applicable water quality standards, including but not limited to, the protection of downstream beneficial uses. We recommend that the lead agencies contact us during preparation of the Record of Decision (ROD) to clarify the applicability of these CWA requirements for inclusion in the ROD.

In our comment letter on the draft EIS, EPA did not mention its role in establishing radiation protection requirements for transport and storage of SNF. EPA has neither a permitting/licensing nor an enforcement role for this type of storage facility. Because this facility falls under the coverage of the Atomic Energy Act, the Nuclear Regulatory Commission (NRC) will decide upon licensing the facility. However, Subpart A of 40 CFR Part 191, *Environmental Radiation Protection Standards for the Management and Storage of Spent Nuclear Fuel, High-level and Transuranic Radioactive Waste,* does cover the potential Skull Valley ISFSI and will be used by NRC to judge whether to issue a license. NRC must ensure that the general public's dose remains less than 25 mrem/year under these EPA-developed public health criteria.

Further financial liability information is needed in the Record of Decision

As stated in EPA's comments to NRC regarding the Draft EIS, we expected the Final EIS to evaluate mitigation in terms of sufficient financial assurance to protect the environment. The Final EIS should have explored the possibility of establishing a bond or a trust fund to pay for the government to operate the ISFSI facility in case of financial limitations of the applicant. Such a discussion would have disclosed the potential costs for which the government could be responsible.

The lease's requirements for liability insurance do not yet assure that PFS will be held liable for potential environmental and human health impacts. Unless there is neglect or misconduct on the part of PFS, the lease limits the PFS's liability to that of any other commercial facility. The lease also does not tie liability directly to the actual amount of potential damage. PFS is, of course, a limited liability company with no assets of its own. Has the NRC investigated whether each member utility company that forms PFS will be individually liable and whether the assets of each member utility will be available to cover any liability? According to the EIS, the NRC intends to require that PFS will demonstrate that it will be able to obtain sufficient funds to build, operate, and close the proposed facility, but NRC proposes to evaluate PFS's financial ability in a separate Safety Evaluation Report (SER). The information on financial ability from the SER should be included in the Record of Decision. There should be a further evaluation in the ROD on how the Tribe, BIA, and the Department of the Interior could incur financial responsibility if future actions by PFS results in environmental damage. Specifically, we suggest the Tribe and BIA consider holding a bond adequate to close the facility and to restore the environment in the event that PFS lacks the financial ability to do so.

Emergency response procedures for rail transport should be addressed

There is little information in the Final EIS on emergency response procedures for rail transport of spent nuclear fuel from utilities around the country. As you know, many community planners along the rail shipment routes are likely to have heightened concerns about emergency response, particularly since the 2001 rail tunnel fire near Baltimore, Maryland, and the possibility of terrorism. The Record of Decision should consider the infrastructure costs to communities

along the transportation routes because, in contrast to federally-sponsored shipments of SNF, private shipments of SNF are not required to set aside any funding for assessment of emergency response needs, local emergency response training, equipment for radioactive incidents, or additional training for medical personnel. The ROD should address emergency response plans, including notification of affected states and Tribes along the rail routes.

Thank you for providing an opportunity to participate in the scoping process and to provide comments on the Draft and Final EIS. Please call Weston Wilson of my staff at (303) 312-6562 if you would like further explanations or clarifications of our concerns with the Final EIS.

Sincerely,

Elyana Sutin, Acting Director
NEPA Program
Office of Ecosystems Protection and Remediation

cc: Chairman Bear, Skull Valley Band of Goshutes, Skull Valley, Utah
✓Dianne Neilson, Department of Environmental Quality, SLC, Utah
David Allison, Bureau of Indian Affairs, Ft, Duchesne, Utah
John Donnell, Private Fuel Storage, Greenwood Village, Colorado