RAS 9280

January 28, 2005

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of

Louisiana Energy Services, L.P.
National Enrichment Facility

Docket No. 70-3103

ASLBP No. 04-826-01-ML

DIRECT TESTIMONY OF GEORGE RICE ON BEHALF OF NUCLEAR INFORMATION AND RESOURCE SERVICE AND PUBLIC CITIZEN

NIRS/PC CONTENTION EC-1
REVISED JAN. 28, 2005

Q1: Please state your name and address.

A1. George Rice; 414 East French, San Antonio, Texas

Q2: What is your profession and educational background?

A2. I am a groundwater hydrologist; I have an MS from the University of Arizona. My resume has been filed in this case as an attachment to the Petition filed on April 6, 2004, and a copy is attached to this testimony.

Q3. What topics will be addressed in your testimony?

A3. I will discuss the questions of the environmental impacts of the proposed National Enrichment Facility (the "NEF") upon groundwater resources in the area. I am testifying in support of contention NIRS/PC EC-1, which states as follows:

NIRS/PC EC-1 -- IMPACTS UPON GROUND AND SURFACE WATER

CONTENTION: Petitioners contend that the Environmental Report contained in the application does not contain a complete or adequate assessment of the potential environmental impacts of the proposed project on ground and surface water, contrary to the requirements of 10 C.F.R. 51.45.

The Draft Environmental Impact Statement, NUREG-1790 (September 2004) ("DEIS") likewise does not contain a complete or adequate assessment of the potential environmental impacts of the proposed project on ground and surface water, contrary to the requirements of 10 C.F.R. Part 51 in that:

(A) The DEIS correctly notes that leakage from the stormwater detention basin and the septic leach fields will probably cause formation of perched bodies of groundwater at the alluvium/Chinle interface. (DEIS, 4-13, 4-14). The DEIS contains estimates of the dimensions of such water bodies, flow rates, and discharge areas. However, NRC provides no explanation of such calculations, and it is not possible to determine whether they are reasonable.

(B) The DEIS does not contain an estimate of the probability and frequency of leakage through the liners of the treated effluent basin or the stormwater detention basin. The basins are to be lined with geosynthetic materials (DEIS at 4-11, 4-12), such liners are known to leak (EPA, Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for Version 3, EPA/600/R-94/168a, Sept. 1994), and such information is necessary to demonstrate the impact of such leakage. The DEIS should contain an estimate of the leakage rate and should show the fate of water and contaminants that leak from the basins.

(C) According to the DEIS, "... no precipitation recharge (i.e., rainfall seeping deeply into the ground) occurs in thick, desert vadose zones with desert vegetation (Walvoord et al., 2002)" (DEIS at 3-35). However, cuttings from one of the borings drilled in September 2003 were "slightly moist" (ER Rev. 2 at 3.4-2). In addition, the clay at the bottom of boring B-2 was "moist" (SAR at Fig. 3.2-11). The DEIS should explain the presence of this moisture, which conflicts with its statements about lack of recharge.

(D) The DEIS states: "Although the presence of fracture zones that can significantly increase vertical water transport through the Chinle Formation has not been precluded, the low measured permeabilities indicate the absence of such zones." (DEIS at 3-35). Two permeability measurements have been made on the Chinle Formation at or near the site: laboratory measurement of core samples (ER Rev. 2 Table 3.3-2) and a slug test performed in MW-2 (Cook-Joyce, Hydrogeologic Investigation, Sec. 32, T. 21 R. 38, Nov. 19, 2003). Such extremely limited measurements, where faults are present, cannot describe the permeability of the entire site, and NRC should explain its reliance on such restricted data.

(E) The stormwater basin will discharge runoff containing numerous contaminants, which are not adequately identified in the DEIS, nor is their monitoring explained. LES has stated that the runoff will contain small amounts of oil and grease typically found in runoff from paved roadways and parking areas (RAI Response, May 20, 2004, at 33). However, other contaminants may be present, such as PAHs (USGS, Concentrations of PAHs and Major and Trace Elements in Simulated Rainfall Runoff from parking lots, 2003, Open File

Report 2004-1208), other organics such as aliphatic hydrocarbons and alcohols (Barrett, M.E, et al., Review and Evaluation of Literature Pertaining to the Quality and Control of Pollution from Highway Runoff and Construction, Tech. Report CRWR 239, April 1993), and other contaminants from spills and accidents. Their presence should be disclosed. Further, stormwater should be monitored for such contaminants.

Q4. Please summarize your conclusions.

A4. I conclude that the Draft Environmental Impact Statement (DEIS) (NIRS/PC Exhibit 41) and the Environmental Reports for the proposed National Enrichment Facility (NEF) are deficient. The Nuclear Regulatory Commission (NRC) and Louisiana Energy Services (LES) have not performed investigations necessary to properly characterize existing groundwater conditions. Nor have they performed investigations necessary to determine how the proposed facility will affect groundwater in the future.

Q5. What are your conclusions based on?

A5. My conclusions are primarily based upon a review of documents related to the proposed site, including reports produced by LES, and NRC's Draft Environmental Impact Statement (NIRS/PC Exhibit 41).

Q6. Briefly state how the proposed facility may affect groundwater.

A6. The NEF will generate wastewaters (treated effluent from the plant operations and sewage) and stormwater runoff. LES intends to discharge plant effluents and runoff to evaporation basins on the plant. Sewage will be discharged to a septic leach field. Leakage from the basins and sewage effluent may enter local groundwater systems.

Q7. Please describe the proposed site.

A7. The proposed National Enrichment Facility (NEF) site is in Lea County, southeastern New Mexico. It is approximately 20 miles south of Hobbs and one half mile from the Texas border[1].

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[1] NRC, 2004a, page xix (NIRS/PC Exhibit 41).

The proposed site is less than a mile west of the Waste Control Specialists (WCS) site[2]. The WCS site is licensed to dispose RCRA hazardous wastes and has submitted an application to dispose low-level nuclear wastes[3].

The site is underlain by about 20 to 60 feet of soil, dune sand, and alluvium[4]. The alluvium is underlain by the Dockum Group. The Dockum Group is composed of two subunits: the Chinle Formation and the Santa Rosa Aquifer. The Chinle immediately underlies the alluvium[5]. The Santa Rosa is about 1100 feet below land surface[6].

Groundwater has not been found in the alluvium at the proposed site. However, groundwater is known to exist in the alluvium at three places near the site: 1) about ½ mile north at the Wallach sand and gravel quarry[7], 2) about ½ mile northeast at Baker Spring[8], and 3) about 2/3 mile east at the WCS site[9].

At the proposed site, water exists in the Chinle at a depth of about 220 feet[10]. Near the site, water has also been reported in a 100 foot-thick sandstone layer at a depth of about 600 feet[11]. Water also exists in the Santa Rosa Aquifer[12].

A schematic geologic cross-section is shown in NIRS/PC Exhibit 39.

Q8: What is known about groundwater use in the area of the NEF site?

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2 Cook-Joyce Inc., 2003a, figure 5(NIRS/PC Exhibit 4).
3 NRC, 2004a, page 2-32 (NIRS/PC Exhibit 41).
4 NRC, 2004a, table 3-8 (NIRS/PC Exhibit 41); and Cook-Joyce Inc., 2003a, table 1 (NIRS/PC Exhibit 4). Alluvium is stream deposited clay, silt, sand, and gravel.
5 NRC, 2004a, table 3-8 (NIRS/PC Exhibit 41).
6 NRC, 2004a, page 3-36 (NIRS/PC Exhibit 41).
7 Louisiana Energy Services, 2003a, page 3.4-2; Louisiana Energy Services, 2003c.
8 Louisiana Energy Services, 2003a, pages 3.4-2 and 3.4-3; Louisiana Energy Services, 2003c.
9 Louisiana Energy Services, 2003a, pages 3.4-3 and 3.4-4; Louisiana Energy Services, 2003c.
10 NRC, 2004a, page 3-35 (NIRS/PC Exhibit 41).
11 Louisiana Energy Services, 2004a, page 3.4-5; and NRC, 2004a, page 3-36 (NIRS/PC Exhibit 41). Neither document specifies the location of any wells that encountered this water bearing unit.
12 NRC, 2004a, page 3-36 (NIRS/PC Exhibit 41).

A8. There are no downgradient groundwater users within two miles of the proposed site[13]. However, groundwater in the alluvium and the Dockum Group (Chinle Formation or the Santa Rosa Aquifer) has been used in the vicinity of the site[14].

Alluvial wells approximately three miles west of the proposed site have been used for domestic purposes[15]. The City of Eunice had an old public supply well in the Dockum. This well was about six miles west of the site[16]. The town of Oil Center, about 12 miles northwest of the site, obtains water from the Dockum Group[17]. According to the Lea County Water Plan, deeper aquifers such as the Dockum Group may be developed for future water supplies[18].

Q9. Why is it necessary to characterize existing groundwater conditions?

A9. Existing conditions must be characterized in order to predict how the proposed facility will affect groundwater in the future. In my opinion, LES and the NRC Staff have failed to characterize the site sufficiently to predict such impacts.

Q10. What have LES and NRC failed to do?

A10. Regarding existing conditions, LES and NRC have failed to perform several investigations. They have failed to:

1. Measure the hydraulic properties of the shallow materials underlying the site.
2. Explain the presence of moisture found in the shallow alluvium underlying the site. This moisture is probably an indication of recent recharge.
3. Investigate water-bearing units that may exist beneath the site.

[13] NRC, 2004a, page 4-13 (NIRS/PC Exhibit 41).
[14] The Santa Rosa Aquifer is used as a source of domestic and livestock water (Leedshill-Herkenhoff et al., 2000, page 6-12) (NIRS/PC Exhibit 24).
[15] Nicholson and Clebsch, 1961, page 80 and plate 2 (NIRS/PC Exhibit 37).
[16] Nicholson and Clebsch, 1961, page 80 and plate 2 (NIRS/PC Exhibit 37).
[17] Leedshill-Herkenhoff, 2000, page 6-12 (NIRS/PC Exhibit 24), and Nicholson and Clebsch, 1961, page 69 and plate 2 (NIRS/PC Exhibit 37).
[18] The plan recommends investigating areas where faulting may have fractured these aquifers (Leedshill-Herkenhoff, 2000, page 8-5) (NIRS/PC Exhibit 24).

4. Investigate the possibility that fractures may exist at the proposed site. Fractures may act as preferential flow paths.

Q11: What hydraulic properties should be measured in the shallow materials?

A11. LES and NRC have not performed any tests to determine the hydraulic properties of the alluvium or other shallow materials underlying the site[19]. At a minimum, the range of hydraulic conductivities should be determined. Hydraulic conductivities are required to estimate the flow rates of water that will leak from the proposed facility. Hydraulic conductivities could be measured by a number of techniques, including infiltrometer tests[20], and the reverse auger method[21].

Q12: What is the significance of the moisture found in the alluvium?

A12. LES and NRC claim that no groundwater recharge occurs at the proposed site[22]. In addition, LES appears to claim that no recharge has occurred for thousands of years[23], and that no recharge will occur after the facility is built[24]. However, moisture has been found in cuttings from two borings drilled at the site. This moisture was in the unsaturated (vadose) zone. At boring B-9, sand, silt, and gravel from depths of 6 – 14 feet were described as "slightly moist"[25]. At boring B-2, the clay at the alluvial/Chinle contact was described as "moist"[26].

[19] Harper and Peery, 2004a, page 54 (NIRS/PC Exhibit 17); and Louisiana Energy Services, 2004e, page 9.
[20] Hillel, D., 1971, pages 131 – 133 (NIRS/PC Exhibit 18).
[21] Bouwer, 1978, page 129 (NIRS/PC Exhibit 3).
[22] Louisiana Energy Services, 2004a, page 3.4-4; NRC, 2004a, page 3-35 (NIRS/PC Exhibit 41); and Harper and Peery, 2004a, page 35 (NIRS/PC Exhibit 17). This claim is based in part on a paper by Walvoord (Walvoord et al., 2002 (NIRS/PC Exhibit 48); NRC, 2004a, page 3-35 (NIRS/PC Exhibit 41); and Louisiana Energy Services, 2004a, page 3.4-4).
[23] Recharge being defined as the infiltration of water beneath the base of the root zone (Louisiana Energy Services, 2004a, page 3.4-4).
[24] Harper and Peery, 2004a, pages 35 – 37 (NIRS/PC Exhibit 17); and Louisiana Energy Services, 2004e, pages 3 - 5.
[25] Louisiana Energy Services, 2004a, page 3.4-2; and Cook-Joyce Inc., 2003a, appendix A (NIRS/PC Exhibit 4).
[26] Louisiana Energy Services, 2003b, figure 3.2-11 (note, this figure is not included in the latest version of the Safety Analysis report, Louisiana Energy Services, 2004f). Moist clay at depth of about 35 feet. Note, there are two borings designated as B-2 at the site. The boring B-2 referred to here is the one drilled on September 9, 2003.

The only explanation LES and NRC have offered for the existence of this moisture is the following: *LES judged this moisture to be from water trapped in the vadose zone.*[27] This statement is vague. LES does not explain how the water came to be trapped, how long it has been trapped, or whether the moisture will dissipate (i.e., will it flow in response to hydraulic gradients?).

The most straightforward explanation for the presence of this moisture is that it represents residual water from episodic recharge events. That is, from time to time, rainwater or snowmelt will flow downward from the land surface to the interface of the alluvium and the Chinle. Such recharge may enter the subsurface along preferential flow paths that result from water ponding in depressions or beneath sand dunes. Preferential flow paths may also result from variations in the permeability of the shallow materials underlying the site[28].

The moist clay in boring B-2 is likely to be the result of recharge that ponded along the interface between the alluvial materials and the relatively impermeable Chinle. The clay retains water longer than the overlying alluvium.

Moist clay at the alluvial/Chinle contact also occurs at the WCS site. In a study conducted in the early 1990s, moist clay was found in most of the borings that penetrated the contact[29].

This moisture found in the borings probably indicates that some recharge currently occurs at the site. There is no reason to believe that this recharge will not occur in the future.

This question of recent recharge might be answered by using radioisotopes to date the moisture found in the vadose zone. The absence of tritium and chlorine-36 would indicate that

[27] Louisiana Energy Services, 2004e, page 8.
[28] Walvoord et al. state that their method of assessing flow in the vadose zone assumes that preferential flow paths do not affect the system (Walvoord et al., 2002, pages 44-4 and 44-5) (NIRS/PC Exhibit 48).
[29] Holt, 1993 (NIRS/PC Exhibit 19), moist clay at the alluvial/Chinle contact reported in 16 of 25 available borehole logs.

the moisture entered the subsurface before the atmospheric testing of nuclear weapons. Low carbon-14 concentrations would also indicate that the moisture was not recent. However, the presence of high concentrations of these radioisotopes would not necessarily indicate that the moisture was recent. This is because water in the vadose zone may exchange water vapor and other gases with the atmosphere.

Q13: Have fractures been investigated at the proposed site? That is, fractures that could act as preferential flow paths for groundwater.

A13. LES and NRC have not adequately investigated the possibility that fractures may act as preferential flow paths. Such fractures could allow water to rapidly flow from the alluvium to the saturated zones in the Chinle, or from the Chinle to the Santa Rosa Aquifer.

LES and NRC have advanced several arguments against the existence of fractures in the Chinle at the proposed site. These include:

1. Fractures were not detected as boreholes were advanced[30].
2. The Chinle sediments are dry[31].
3. The permeability of the Chinle is low[32].

However, these arguments do not show that fractures do not exist. Taking them in order as presented above:

1. No fractures in boreholes: The borings advanced into the Chinle were vertical. Fractures may be spaced at intervals of five feet, ten feet, or more. Thus, the chances that vertical borings would intercept vertical, or near vertical, fractures may not be great. In addition, the borehole materials do not appear to have been examined in a manner that would reveal the

[30] Harper and Peery, 2004a, page 21 (NIRS/PC Exhibit 17).
[31] Harper and Peery, 2004a, page 22 (NIRS/PC Exhibit 17).
[32] Harper and Peery, 2004a, pages 22 and 23 (NIRS/PC Exhibit 17); and NRC, 2004a, page 3-35 (NIRS/PC Exhibit 41).

presence of fractures. Although borings through the Chinle were cored at the WCS site, it is not clear whether any cores were taken at the proposed NEF site, or if any were, whether the cores were continuous[33]. No descriptions of cores from the proposed NEF site were found in the geology report[34] or in any other documents that were reviewed. LES's hydrologist does not appear to have examined any cores for the presence of fractures[35].

However, in the early 1990s Holt examined cores from the Chinle at the WCS site[36]. Fractures were found in most of the boreholes[37]. Fractures were found at various depths, from the alluvial/Chinle contact[38] to more than 200 feet below ground surface[39]. In some cases the fractures had 'healed'[40]. In other cases mineral deposits indicate that the fractures have acted as groundwater flow paths[41].

2. Chinle dry: In response to episodic recharge events, water may flow along fractures only a few times each year, or perhaps only every few years[42]. Such episodic flows would wet the area immediately adjacent to a fracture, but would not be expected to wet large volumes beyond the fracture. Thus, the generally dry conditions found in the Chinle do not mean that fracture flow does not occur. It should be noted that the Chinle may appear to be dry even though it actually contains water. An example of this is WCS boring/monitor well B-20 (11-D). According to the boring log and well construction diagram, no water was encountered within the

[33] Three test borings and three monitor wells were drilled at the proposed site (Cook-Joyce Inc., 2004a, appendix B, page 3) (NIRS/PC Exhibit 5). The test borings were not cored (Cook-Joyce Inc., 2004a, page 3) (NIRS/PC Exhibit 5).
[34] Cook-Joyce Inc., 2003a (NIRS/PC Exhibit 4).
[35] Harper and Peery, 2004a, pages 22 – 24 (NIRS/PC Exhibit 17).
[36] Holt, 1993 (NIRS/PC Exhibit 19).
[37] Holt, 1993 (NIRS/PC Exhibit 19), fractures reported in 21 of 28 available borehole logs.
[38] Holt, 1993 (NIRS/PC Exhibit 19), see log of borehole B-45 (11-E), for example.
[39] Holt, 1993 (NIRS/PC Exhibit 19), see log of borehole B-4 (7-G), for example.
[40] Holt, 1993 (NIRS/PC Exhibit 19), see log of borehole B-49 (8-B), for example.
[41] Holt, 1993 (NIRS/PC Exhibit 19), see log of borehole B-36 (10-C), for example.
[42] At Yucca Mountain, Nevada, significant flow through fractures is believed to occur only every few years (DOE, 2000a, pages 20 and 21) (NIRS/PC Exhibit 7).

screened interval[43]. Yet, this monitor well was later found to contain water more than 100 feet of standing water[44]. The moisture contents of materials like those that make up the Chinle can be difficult to judge in the field. In the absence of laboratory measurements of moisture content, one cannot assume that an interval of the Chinle is dry merely because it was logged as dry in the field.

3. Low permeability: NRC states: "Although the presence of fracture zones that can significantly increase vertical water transport through the Chinle Formation has not been precluded, the low measured permeabilities indicate the absence of such zones."[45] However, the limited permeability measurements that were performed at the proposed site and the nearby WCS site are not likely to reveal the presence of fractures that may be spaced at intervals of five feet, ten feet, or more. Two types of permeability measurements were performed on the Chinle Formation near the site. First, laboratory measurements of core samples from the WCS site[46]. Second, a slug test performed at the proposed site in MW-2[47]. Laboratory measurements often underestimate the bulk permeability of a unit, because they do not account for fractures and other features that may act as preferential flow paths[48]. This is illustrated by the data shown in NIRS/PC exhibit B[49]. Permeabilities measured in the field may be more than a thousand times greater than the corresponding laboratory measurement. Slug tests only measure hydraulic

[43] Holt, 1993 (NIRS/PC Exhibit 19), log of borehole B-20 (11-D). This is also the case for borehole B-21 (9-G(3)).
[44] Holt, 1993, page 11 (NIRS/PC Exhibit 19); and Rainwater, 1996, table A-1 (NIRS/PC Exhibit 44). Borehole B-21 (9-G(3)) contained approximately six feet of water (Rainwater, 1996, table A-1) (NIRS/PC Exhibit 44).
[45] NRC, 2004a, page 3-35 (NIRS/PC Exhibit 41).
[46] Louisiana Energy Services, 2004a, table 3.3-2; and Harper and Peery, 2004a, page 22 (NIRS/PC Exhibit 17).
[47] Cook-Joyce Inc., 2003a, page 8 (NIRS/PC Exhibit 4).
[48] Linsley, Kohler, and Paulhus, 1958, page 131 (NIRS/PC Exhibit 25); Davis and DeWiest, 1966, page 165 (NIRS/PC Exhibit 6); Olson and Daniel, 1981, page 20 (NIRS/PC Exhibit 43).
[49] Source of data: Olson and Daniel, 1981 (NIRS/PC Exhibit 43).

properties in the area immediately surrounding the well[50]. Thus, the relatively low permeability estimates derived from these tests do not indicate that fractures are absent.

Whether fractures that may act as preferential flow paths exist at the site could be determined by closely examining cores from the Dockum Group. To maximize the chances of intercepting near-vertical fractures, cores should be collected from angled borings. In addition, the ages of groundwater in the saturated units beneath the site should be estimated. Relatively young water would indicate that water reaches these units along preferential flow paths.

Q14. In general, can water flow between the Dockum Group and overlying units?

A14. Yes, that is the conclusion of investigators who have studied this issue. According to Dutton, in some portions of the Southern High Plains, the Dockum Formation receives recharge from overlying aquifers[51]. Investigators studying the Dockum Formation and the Ogallala Aquifer near Portales New Mexico concluded that groundwater is probably flowing upward from the Chinle into the overlying Ogallala[52]. The amount of flow between the Dockum Formation and overlying units depends on site-specific conditions. In the absence of site-specific information, it is not reasonable to assume that the Dockum constitutes an effective barrier to flow from overlying units[53]. LES and NRC have not collected the information necessary to determine whether water from the alluvium may flow into the Chinle or the Santa Rosa at the proposed site. This information could be obtained through studies of fractures, measurements of stable isotope ratios in groundwater, and the dating of groundwater.

Q15. What kinds of discharges would the proposed facility generate?

[50] EPA, 1994b, page 1 (NIRS/PC Exhibit 11).

[51] Dutton and Simpkins, 1986, page 32 (NIRS/PC Exhibit 9); and Mehta et al., 2000, page 851 (NIRS/PC Exhibit 33).

[52] Langman et al., 2004. page 32 (NIRS/PC Exhibit 23).

[53] LES/NRC have stated that the Chinle Formation essentially "isolates the deep and shallow hydrologic systems." (Louisiana Energy Services, 2004a, page 3.4-15; and NRC, 2004a, page 3-35 (NIRS/PC Exhibit 41)).

A15. The NEF will generate wastewaters and stormwater runoff:

1. Treated effluent from the plant would be discharged to a double lined evaporation basin[54]. Approximately 2540 m^3 of effluent would be discharged to the basin each year[55].

2. Stormwater runoff from the uranium byproduct cylinder (UBC) storage pad and cooling tower blowdown would be directed to a single lined evaporation basin[56]. This basin would be able to hold approximately 77,700 m^3[57].

3. Stormwater runoff from the plant (except the UBC storage pad) would be directed to an unlined basin[58]. This basin will be able to hold approximately 23,350 m^3 of runoff[59]. Overflow from the basin would be discharged to ground surface[60].

4. Sewage would be discharged to six septic leach fields[61]. Approximately 7300 m^3 of sewage will be discharged annually[62].

Some of these discharges would seep into the shallow alluvial materials underlying the site.

Q16. Have LES and NRC performed the investigations necessary to determine how the discharges from the proposed facility will affect groundwater in the future?

A16. No. Moreover, LES appears to have made contradictory statements regarding the fate of the discharges.

Q17. What would happen to wastewaters and storm water runoff that enters the materials underlying the site?

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[54] NRC, 2004a, page 4-11 (NIRS/PC Exhibit 41).
[55] NRC, 2004a, page 4-12 (NIRS/PC Exhibit 41).
[56] NRC, 2004a, pages 4-11 and 4-12 (NIRS/PC Exhibit 41).
[57] Louisiana Energy Services, 2004b, page 5 of 36.
[58] NRC, 2004a, pages 4-12 and 4-13 (NIRS/PC Exhibit 41).
[59] Louisiana Energy Services, 2004b, page 4 of 36.
[60] NRC, 2004a, page 6-18 (NIRS/PC Exhibit 41).
[61] NRC, 2004a, figure 4-2 (NIRS/PC Exhibit 41).
[62] Louisiana Energy Services, 2004b, page 7 of 36.

A17. Some water from the basins and septic leach fields would infiltrate into the alluvium. A number of things may happen to the water after it enters the subsurface. It may:

1. be removed by evapotranspiration, or

2. pond on the surface of the Chinle Formation and flow along the alluvial/Chinle contact, or

3. flow through fractures to the water bearing units beneath the site, i.e., the saturated zone in the Chinle at about 220 feet, the 100 foot-thick sandstone layer at a depth of about 600 feet, or the Santa Rosa Aquifer.

NIRS/PC exhibit C is a schematic cross-section depicting subsurface discharge from the stormwater basin and a septic field.

Q18: Have NRC and LES evaluated the subsurface fate of wastewaters and runoff generated by the NEF?

A18. Not sufficiently. To determine where this water will go, they should answer the following questions:

1. How much water would infiltrate into the alluvium from:
   a. The treated effluent basin?
   b. The UBC storage pad and cooling tower blowdown basin?
   c. The stormwater basin?
   d. The septic leach fields?
2. Where would water flowing along the alluvial/Chinle contact be discharged?
3. How long would it take for water from the NEF to reach any discharge areas?
4. Could water flow to underlying water bearing units via fractures?

Q19: Have LES or NRC estimated the amount of water that would leak from the storm water detention basin?

A19. Yes, although the estimates are not adequate.

LES has made two estimates of leakage from storm water detention basin[63].

In one estimate, LES assumed that 50% of the water entering the stormwater basin would infiltrate into the underlying materials. No calculations or other analyses were provided to support this assumption[64].

In the other estimate, LES assumed that the minimum[65] leakage rate would be 1 mm/hr. The purpose of this estimate appears to be to determine whether the basin could handle expected inflows, not to determine the effects of leakage on groundwater[66].

NRC's estimate of leakage from storm water detention basin assumed that all water entering the stormwater basin would infiltrate into the underlying materials. No calculations or other analyses were provided to support the assumption[67].

Q20: Have LES or NRC addressed the fate of the water that would leak from the storm water detention basin and the septic leach fields?

A20. Yes. However, LES and NRC seem to disagree on the fate of the water that that would leak from the basin and the septic fields.

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[63] According to a statement by Lockwood Greene, no leakage would occur from the storm water basin because it would be lined (Areva, 2004a, pages 49 and 50 of 60, LES-05177 – LES-01578) (NIRS/PC Exhibit 1). It is not known whether this statement is an error, or whether LES once planned to line the stormwater basin.

[64] Louisiana Energy Services, 2004c, page 32; and Harper and Peery, 2004a, page 36 (NIRS/PC Exhibit 17).

[65] Areva, 2004a, pages 10 and 11 of 60 (NIRS/PC Exhibit 1). The use of a minimum leakage rate is conservative if the purpose of the estimate is to determine whether the basin could handle expected inflows. However, use of a minimum leakage rate is not appropriate for the purpose of estimating the effects of basin leakage on groundwater.

[66] Areva, 2004a, page 12 of 60 (NIRS/PC Exhibit 1). This estimate neglects factors that would control the amount of leakage from the basin. The neglected factors include: the hydraulic pressure (head) exerted by the water standing in the basin, and the hydraulic conductivity of the materials underlying the basin. In this case, the hydraulic conductivity of the materials would be a function of their degree of saturation.

[67] NRC, 2004b, page 8 (NIRS/PC Exhibit 42).

LES has stated that virtually all water that leaks from the stormwater basin will return to the surface via evapotranspiration[68].

In contrast to LES, NRC believes that leakage from the storm water detention basin and the septic leach fields is likely to result in the formation of perched bodies of groundwater at the alluvial/Chinle contact[69]. NRC also states that the downgradient transport of this water would be limited due to ... *the storage capacity of the soils and the upward flux to the root zone.*[70] However, NRC has not quantified either of these limiting factors.

I agree with NRC that leakage from the storm water detention basin and the septic leach fields is likely to result in the formation of perched bodies of groundwater at the alluvial/Chinle contact.

NRC has estimated the groundwater flow rate, and has identified potential discharge areas[71]. However, NRC's estimate of the flow rate is too low, and it has not adequately investigated potential discharge areas.

1. Groundwater flow rate: NRC estimated the groundwater flow rate along the alluvial/Chinle contact using Darcy's Law[72]:

$q = K\,(\Delta H/\Delta L)/n$

where:

K = hydraulic conductivity

$\Delta H/\Delta L$ = hydraulic gradient

n = effective porosity

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[68] Louisiana Energy Services, 2004e, pages 3 - 5; and Harper and Peery, 2004a, pages 35 – 37 (NIRS/PC Exhibit 17).
[69] NRC, 2004a, pages 4-13 and 4-14 (NIRS/PC Exhibit 41).
[70] NRC, 2004a, pages 4-13 and 4-14 (NIRS/PC Exhibit 41).
[71] One of the potential discharge areas, Custer Mountain, is approximately 20 miles south of the site (Nicholson and Clebsch, 1961, plate 2) (NIRS/PC Exhibit 37).
[72] NRC, 2004b, page 7 (NIRS/PC Exhibit 42).

NRC used the following values[73]:

$K = 0.01$ cm/s

$\Delta H/\Delta L = 0.02$

$n = 0.25$

These values resulted in a groundwater flow rate of 252 m/yr (0.15 mi/yr). The hydraulic conductivity and porosity values used by NRC were not based on measurements performed at proposed site. They were based on values found in the literature[74]. The hydraulic gradient was based on the slope of the alluvial/Chinle contact[75].

2. Discharge areas and potential groundwater use: According to the NRC, bodies of groundwater that form beneath the site may be discharged ... *in a minor seep at Custer Mountain or in the excavation 3.2 kilometers (2 miles) southeast of Monument Draw* ... .[76]

NRC's evaluation of potential discharge areas appears to be based on a review of the literature rather than on a field investigation. NRC has not explained why it believes water from the site may discharge at the locations given. Nor has it explained why it did not consider potential discharge areas that are closer to the site (e.g., Monument Draw[77]), or discharge to wells that may be along the flow path of groundwater emanating from the site.

[73] NRC, 2004b, pages 9 and 12 (NIRS/PC Exhibit 42).
[74] NRC, 2004b, pages 7, 8, 10, and 11 (NIRS/PC Exhibit 42); Louisiana Energy Services, 2004a, pages 3.4-14 and 3.4-15; and Harper and Peery, 2004a, page 54 (NIRS/PC Exhibit 17).
[75] NRC, 2004b, pages 8 and 10 (NIRS/PC Exhibit 42).
[76] NRC, 2004a, pages 4-13 and 4-14 (NIRS/PC Exhibit 41). Custer Mountain is approximately 20 miles from the site (Nicholson and Clebsch, 1961, plate 2) (NIRS/PC Exhibit 37).
[77] NRC's reference to " ... *the excavation 3.2 kilometers (2 miles) southeast of Monument Draw* ... " appears to be an error. NRC cites Nicholson and Clebsch, 1961 as the source of this information. However, the excavation mentioned in Nicholson and Clebsch is two miles southeast of the town of Monument, not Monument Draw (Nicholson and Clebsch, 1961, page 35 and figure 3) (NIRS/PC Exhibit 37).

LES and NRC should conduct an investigation to locate potential discharge areas downgradient of the proposed site. They should also estimate the time required for water from the NEF to reach the discharge areas[78].

It should be noted that the New Mexico Environment Department (NMED) has expressed concern regarding the possibility that leakage from the NEF may transport contaminants off site and pose a threat of contamination to ephemeral drainages or aquifers[79].

Q21: Have LES and NRC addressed the possibility the lined basins may leak?

A21. No. Treated effluent from the plant will be discharged to a double lined evaporation basin[80]. Stormwater runoff from the UBC storage pad and cooling tower blowdown will be discharged to a single lined evaporation basin[81]. The basins will be lined with geosynthetic materials (e.g., HDPE)[82]. LES assumes that these basins will not leak[83]. That is not a good assumption. Lined basins often leak. They leak because the liners contain defects. These defects exist for a variety of reasons:

1. Manufacturing defects: typical geomembranes contain 0.5 to 1 pinholes per acre[84].

2. Installation defects: these include unsealed seams, punctures from sharp objects, and damage caused by the operation of heavy equipment[85]. The number of defects can be reduced by careful installation. However, even with the best quality control during installation, one can expect 1 to 2 defects per acre[86].

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[78] Discharge areas may be natural features (e.g., springs or seeps) or wells.
[79] NMED, 2004a, pages 1, 2, and 4 (NIRS/PC Exhibit 35).
[80] NRC, 2004a, page 4-11 (NIRS/PC Exhibit 41).
[81] NRC, 2004a, page 4-12 (NIRS/PC Exhibit 41).
[82] Louisiana Energy Services, 2004b, pages 11 – 13 of 36.
[83] Louisiana Energy Services, 2004c, page 31; and Louisiana Energy Services, 2004e, pages 5 and 6.
[84] EPA, 1994a, page 34 (NIRS/PC Exhibit 10).
[85] Yazdani, 1997 (NIRS/PC Exhibit 49).
[86] Murphy and Garwell, 1998, page xii (NIRS/PC Exhibit 34).

3. Deterioration after installation: this includes rupture due to creep, stress cracking, and degradation due to exposure to chemicals and heat[87].

Laine and Miklas examined 61 geosynthetic-lined facilities[88]. The facilities included landfills and impoundments. Most of the geosynthetic liners were made of HDPE, but some were made of PVC (e.g., XR-5) or polyethylene. Leaks were detected in 58 of the 61 facilities. The average density of leaks at all facilities was about 13 per acre. The EPA recently released a report describing various methods for detecting leaks beneath lined landfills and impoundments[89].

Clearly, it is not reasonable to assume that the lined basins will not leak. NRC and LES should investigate this possibility and use the results to determine the fate of the water and contaminants (e.g., flow rates, discharge areas) that may leak from the basins. NRC and LES should also design monitoring systems to detect leakage from both lined basins[90]. The monitoring systems should include devices to detect leakage in the vadose zone, and along the alluvial/Chinle contact.

Q22: Has LES made contradictory statements regarding fate of water discharged to septic leach fields and basins?

A22. Yes. In its responses to interrogatories and questions during depositions, LES claimed that water which enters the subsurface from the septic leach fields and the stormwater runoff basin would be evapotranspired[91]. The responses did not mention the possibility that the water may recharge the underlying groundwater systems.

[87] Reddy and Butul, 1999, pages 19, 25, and 108 (NIRS/PC Exhibit 45).
[88] Laine and Miklas, 1989 (NIRS/PC Exhibit 22).
[89] EPA, 2004a (NIRS/PC Exhibit 13).
[90] LES does not plan to install a leak detection system beneath the UBC storage pad basin.
[91] Louisiana Energy Services, 2004e, pages 3 – 5; and Harper and Peery, 2004a, pages 35 – 37 (NIRS/PC Exhibit 17).

However, in its Groundwater Discharge Permit Application, LES made the following statement regarding discharged sewage:

> *The infiltrated waters are expected to potentially recharge the limited ground water system at the 214 to 222 foot depth or return to the atmosphere via evapotranspiration.*[92]

LES made the same statement regarding stormwater runoff[93]. The statements in the Groundwater Discharge Permit Application appear to contradict LES's contention that all water which enters the subsurface will be evapotranspired. LES has not explained this apparent contradiction.

Also, in its responses to an NIRS/PC interrogatory regarding leakage from the lined basins, LES stated:

> *The basins will be designed to preclude water from infiltrating into the subsurface. Therefore, no estimates on how much water will infiltrate into the subsurface have been, or need be, made.*[94]

However, in its Groundwater Discharge Permit Application, LES makes the following statement regarding leakage from the UBC storage basin:

> *Any minor leakage past the liner will infiltrate into the ground under the basin. The infiltrated waters are potentially expected to recharge the limited ground water system at the 214 to 222 foot depth or return to the atmosphere via evapotranspiration.*[95]

This statement appears to contradict LES's contention that infiltration from the lined basins will be precluded. LES has not explained this apparent contradiction.

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[92] Louisiana Energy Services, 2004b, page 19 of 36 (NIRS/PC Exhibit 27).
[93] Louisiana Energy Services, 2004b, page 17 of 36 (NIRS/PC Exhibit 27).
[94] Louisiana Energy Services, 2004e, page 6 (NIRS/PC Exhibit 30).
[95] Louisiana Energy Services, 2004b, page 18 of 36 (NIRS/PC Exhibit 27).

Q23: Have LES and NRC presented a clear groundwater monitoring plan?

A23. No. LES and NRC have not clearly stated which groundwater zones will be monitored. The DEIS states that groundwater in the 220-foot zone will be monitored[96]. However, it does not state whether wells will be installed to monitor the perched bodies of groundwater that may form at the alluvial/Chinle interface[97]. All groundwater zones beneath the site, from the Santa Rosa Aquifer to land surface, should be monitored.

Q24: Have LES and NRC explained how they will distinguish groundwater contamination caused by the NEF from other potential sources of contamination?

A24. No. NRC and LES have not explained how they will distinguish between groundwater contamination caused by the NEF and contamination caused by other potential sources (e.g., Wallach Concrete, Sundance Services, WCS site, Lea County Landfill[98]).

NRC claims that contaminants from Wallach Concrete and Sundance Services would consist primarily of hydrocarbons[99]. NRC also claims that the proposed NEF would not emit hydrocarbons in detectable quantities[100]. However, NRC has not provided the basis for these claims. LES and NRC have not addressed potential contamination from WCS or the Lea County Landfill.

Q25: Is the planned Stormwater Monitoring Program adequate?

A25. No. The water discharged to the stormwater runoff basin may contain a wide variety of contaminants. According to LES, the discharge to the stormwater basin:

[96] NRC, 2004a, page 6-13 (NIRS/PC Exhibit 41).
[97] The NMED has stated that it will probably require LES to install additional wells to monitor any leakage from the basins or septic systems that perches on the alluvial/Chinle contact (NMED 2004a, pages 4 and 5) (NIRS/PC Exhibit 35).
[98] The Lea County Landfill is less than 500 feet from the southeast corner of the proposed NEF site (NRC, 2004a, figure 3-2) (NIRS/PC Exhibit 41).
[99] NRC, 2004a, page 6-13 (NIRS/PC Exhibit 41).
[100] NRC, 2004a, page 6-13 (NIRS/PC Exhibit 41).

... will be typical of runoff from building roofs and paved areas from any industrial facility. [101]

The discharge will include:

... small amounts of oil and grease typically found in runoff from paved roadways and parking areas, ... [102]

The discharge may also contain pesticides and fertilizers that will be applied around the facility[103].

In addition to constituents identified by LES, the discharge may contain other contaminants associated with roads, parking lots and industrial facilities. These include: polycyclic aromatic hydrocarbons[104] (PAHs), other organic compounds (e.g., aliphatic hydrocarbons, alcohols)[105], and miscellaneous contaminants resulting from spills and accidents. However, the Stormwater Monitoring Program[106] does not include monitoring of PAHs, pesticides, or other organics. These potential contaminants should be included in the Stormwater Monitoring Program.

It should be noted that the Regional Environmental Officer of the United States Department of the Interior has expressed concern that wastewater in the UBC stormwater basin may contain nutrients, heavy metals, organic chemicals, petroleum, solvents, or pesticides; and that these contaminants may pose a risk to migratory birds and other wildlife[107].

Because the stormwater basin is expected to leak, groundwater should be monitored for all contaminants detected in the Stormwater Monitoring Program.

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[101] LES, 2004c, page 33 (NIRS/PC Exhibit 28).
[102] LES, 2004c, page 33 (NIRS/PC Exhibit 28).
[103] Lockwood Greene, 2004a, page 4 (NIRS/PC Exhibit 32).
[104] USGS, 2004a, table 3 (NIRS/PC Exhibit 47).
[105] Barrett et al., 1993, table 3.5 (NIRS/PC Exhibit 2).
[106] NRC, 2004a, page 6-18 (NIRS/PC Exhibit 41).
[107] USDOI, 2004a, page 2 (NIRS/PC Exhibit 46).

Q26: Please summarize your major points.

A26. The work performed by LES and NRC is deficient. They have not performed investigations necessary properly to characterize existing groundwater conditions. Nor have they performed investigations necessary to determine how the proposed facility will affect groundwater in the future.

LES and NRC should be required to:

1. Measure the hydraulic properties of the shallow materials.
2. Investigate and monitor all water-bearing units that may exist beneath the site - from the surface to the Santa Rosa Aquifer.
3. Investigate the possibility that fractures capable of acting as preferred flow paths may exist at the proposed site.
4. Estimate the amount of water that would leak from:
    a. The treated effluent basin.
    b. The UBC basin.
    c. The stormwater basin.
    d. The septic leach fields.
5. Determine where water that leaked from the NEF facility would go, i.e., identify discharge areas.
6. Estimate the time it would take for water from the NEF to reach discharge areas.
7. Develop a groundwater monitoring plan that clearly identifies all units to be monitored.
8. Monitor stormwater runoff for all contaminants that the proposed plant is expected to generate.

The work described above is necessary to determine whether:

1. The NEF can be built as planned.
2. Plans will have to be modified (e.g., additional environmental controls, additional monitoring).
3. The proposed site is not suitable.

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George Rice
Groundwater Hydrologist

414 East French Place
San Antonio, TX 78212
(210) 737-6180
jorje44@yahoo.com

General

More than 20 years experience in hazardous waste investigations.

Education

M.S. Hydrology, University of Arizona, 1991
B.S. Hydrology, University of Arizona, 1979

Employment History

1993: Consultant
1988 - 1993: The MITRE Corporation, Brooks Air Force Base, Texas
1983 - 1988: SHB Geotechnical Engineers, Inc., Albuquerque, New Mexico
1980 - 1983: University of Arizona, Tucson, Arizona
1979 - 1980: U.S. Forest Service, Gifford Pinchot National Forest, Vancouver, Washington

Experience

- Design and install monitor well networks.
- Design, perform, and analyze aquifer tests.
- Design and install vadose zone monitor networks.
- Design and conduct groundwater sampling programs.
- Apply groundwater flow and contaminant transport models to predict the fate of groundwater contaminants (MODFLOW, MT3D, MOC3D).
- Participate in multidisciplinary teams to select and design hazardous waste disposal sites.
- Conduct third party reviews of environmental documents and field programs.
- Expert Witness.

Representative Projects

Site Characterization - Principal hydrologist responsible for the hydrologic characterization of low-level radioactive and hazardous waste sites throughout the western United States. The goals of these studies were to determine the extent and intensity of any metals or radionuclide contamination, estimate the rate and direction of contaminant movement, and predict future concentrations at receptor sites. Achievement of these goals required the installation of monitor well networks, installation of vadose zone monitoring instruments, groundwater sampling, the performance and analysis of aquifer tests, and the integration of data into a coherent conceptual model of each site.

Contaminant Transport Modeling - Used two and three-dimensional models to design pump and treat systems and estimate the effects of proposed remedial actions on future water quality. Conducted studies to estimate the time required for contaminants to reach potential receptors and estimate contaminant concentrations after plumes reached receptors.

Waste Repository Design - Principal hydrologist responsible for estimating the effects of remedial designs on future groundwater quality at low-level nuclear waste repositories in Arizona and Colorado. This required working closely with geotechnical and civil engineers to produce designs that incorporated the hydrologic characteristics required to meet water quality standards.

Field Methods Instructor - Member of a team that taught environmental field techniques to Air Force personnel. The four-day course consisted of lectures and field trips. It focused on monitor well design, monitor well construction, sampling program design, and groundwater sampling techniques.

Quality Assurance Manager - Manager of hydrology group responsible for evaluating environmental work performed at Air Force bases throughout the United States. Evaluated reports, hydrologic analyses, and field work related to Preliminary Assessments and Site Inspections (PA/SI), Remedial Investigations and Feasibility Studies (RI/FS), and Remedial Actions (RA). These evaluations usually resulted in recommendations for improving overall program design, analytical techniques, or field procedures.

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CERTIFICATE OF SERVICE

Pursuant to 10 CFR § 2.305 the undersigned attorney of record certifies that on January 28, 2005, the foregoing Direct Testimony of George Rice on behalf of Nuclear Information and Resource Service and Public Citizen, NIRS/PC Contention EC-1, Revised Jan. 28, 2005, was served by electronic mail and by first class mail upon the following:

G. Paul Bollwerk, III
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
e-mail: gpb@nrc.gov

Dr. Paul B. Abramson
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
e-mail: pba@nrc.gov

Dr. Charles N. Kelber
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
e-mail: cnk@nrc.gov

James Curtiss, Esq.
David A. Repka, Esq.
Winston & Strawn
1400 L St.
Washington, D.C. 20005-3502
e-mail: jcurtiss@winston.com
drepka@winston.com
moneill@winston.com

John W. Lawrence, Esq.
National Enrichment Facility
100 Sun Avenue, N.E.
Suite 204
Albuquerque, NM 87109
e-mail: jlawrence@nefnm.com

Office of the General Counsel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
Attention: Associate General Counsel for Hearings, Enforcement, and Administration
e-mail: OGCMailCenter@nrc.gov
lbc@nrc.gov
abc1@nrc.gov
jth@nrc.gov
dmr1@nrc.gov
dac3@nrc.gov

Office of Commission Appellate Adjudication
Mail Stop O-16C1
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Tannis L. Fox, Esq.
Deputy General Counsel
New Mexico Environment Department
1190 St. Francis Drive
Santa Fe, NM 87502-1031
e-mail: tannis_fox@nmenv.state.nm.us

Glenn R. Smith, Esq.
Christopher D. Coppin, Esq.
Stephen R. Farris, Esq.
David M. Pato, Esq.
Assistant Attorneys General
P.O. Drawer 1508
Santa Fe, NM 87504-1508
e-mail: ccoppin@ago.state.nm.us
dpato@ago.state.nm.us
gsmith@ago.state.nm.us
sfarris@ago.state.nm.us

Secretary
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
Attention: Rulemakings and Adjudications Staff (original and two copies)
e-mail: hearingdocket@nrc.gov

Lindsay A. Lovejoy, Jr.
618 Paseo de Peralta, Unit B
Santa Fe, NM 87501

(505) 983-1800
(505) 983-0036 (facsimile)
e-mail: lindsay@lindsaylovejoy.com