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Comments on the Pantex Plant Radiological Investigation Report

Prepared for Serious Texans Against Nuclear Dumping
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The following are the comments prepared by the Institute for Energy and Environmental Research on the January 2004 *Pantex Plant Radiological Investigation Report*, henceforth referred to as the RI report. We have prepared this analysis for Serious Texans Against Nuclear Dumping (STAND) pursuant to a Technical Assistance Grant made to STAND by the U.S. Environmental Protection Agency.

Main findings and recommendations

There is a substantial amount of evidence in the RI report that measurement protocols or analysis or laboratory techniques, or some combination of these factors have led to many of the reported measurements being anomalous or at odds with basic, established principles of uranium radiochemistry. Specifically, the isotopic ratios of U-235 to U-238 in soil samples and in groundwater samples appear to have significant errors. The tritium analysis is also unsatisfactory. The lack of a valid background for uranium, tritium, and plutonium for the Pantex site contributes to the fundamental deficiencies of the RI report. The RI report even provides soil screening results that violate basic physics. The RI report provides screening results that are literally incredible. The RI report screening levels imply that dumping vast amounts (millions or billions of tons) of *pure* plutonium, uranium, or tritium on the site would not threaten the groundwater. We find that the contractor and the DOE have failed to provide credible data or a credible analysis in this RI report. The RI report's authors review of process information complemented by worker interviews is an important part of producing a sound RI; however, despite the considerable effort, the final product is not scientifically sound in many essential aspects.

Our principal recommendation regarding the RI report is that this report needs to be redone with new field data based on samples that are properly analyzed by laboratories that have recently be certified by the Environmental Measurements Laboratory for the specific radionuclides at issue: uranium and plutonium isotopes, tritium, as well as some fission products that may have been used in experiments. Reliable background values for the Pantex site for uranium and plutonium should be established and published as part of the new RI report. A reliable background for

tritium in groundwater in the general area of the plant needs to be established for both perched aquifers and the Ogallala aquifer. The active oversight of the EPA in this process is needed. The fact that this final RI report that is so flawed could have been published, without the basic errors having been eliminated at the draft stage, indicates a failure of the quality assurance and quality control procedures. This means that far more active EPA oversight is needed in the preparation of a valid RI report. The EPA should require that the new RI report be published in draft form for public comment so that the kinds of severe problems that are in the current version do not recur in the new final Report. DOE and its contractors also need to strengthen their internal review procedures and their quality assurance and quality control processes.

The detailed basis for these statements are provided below, as are point-by-point recommendations.

I. Deficient Documentation of Waste Management Facilities and Practices

Throughout the RI report, the authors rely heavily on the assumption that a review of historical documentation and worker interviews is sufficient to characterize which sites were potentially impacted by radionuclide releases. A site walk-though was conducted based on this review; in addition, an aerial site survey was also undertaken. However, primary reliance was placed on the assumed knowledge of plant processes in order to identify which sites were potentially impacted and which radionuclides were contaminants of potential concern at those sites.There are a number of instances in which process knowledge and historical memory of waste management practices at the Pantex site were incomplete or inaccurate, raising questions about the completeness and accuracy of the RI report

Examples of such incomplete or inaccurate information are:

SWMU 57 - Landfill 6 (p. 5-43 to 5-45, F-19)
The date the landfill began operation is not known. More importantly, the landfill was thought to be located next to Building 12-95, however it was instead found "near" Building 12-94. This landfill is stated to be approximately 6,500 square feet in area.

SWMU 73 - Firing Site 15 (p. 5-80)
In 1977, one test shot "reportedly" involved strontium-89 (Sr-89) contaminated with some amount of strontium-90 (Sr-90). Interviews with employees led to the eventual conclusion by the authors that the test never, in fact, took place and that it "was probably confused with another test performed in 1956," involving radiolanthanum at the same site (Firing Site FS-15). This issue remains unresolved in our view. A failure to find Sr-90 at the site cannot be regarded as a reliable indicator of a conclusion that the report of the incident (whatever that was) was "probably" wrong and that the test did not happen. Sr-89 has a relatively short half-life (about 50 days), and would not be expected to be found at the site today if a test had been conducted in 1977. Since Sr-90 was admittedly a trace contaminant, it would require very detailed sampling to find traces of the test, especially as it may be difficult or impossible to separate the remaining traces from atmospheric testing fallout. It is also possible that the test was conducted at another Firing Site. The RI report does not give any citation as to what the term "reportedly" refers to in its statement that "In 1977, one test reportedly involved the use of explosive containing 89Sr as a

tracer…." (p. 5-80) To conclude that a test that supposedly happened in 1977 was confused with a test involving completely different radionuclides more than twenty years earlier at the same site is flimsy science at best. Even the personnel who were interviewed to conclude that the report about the test (whatever that was) was wrong are not identified. The lack of documentation does not allow any independent judgment to be made on the issue. The question whether this test was actually conducted, and whether there were other tests that may have been done should be investigated afresh, with all documentation and interviews published. We recommend that all documents and texts of interviews relating to this incident and its investigation be published.

SWMU 82 - NWAR (p. 5-84)
The waste storage trench in the Nuclear Weapons Accident Residue area was alternatively reported as being 15 x 15 x 165 feet or 14 x 8 x 100 feet in size. This is a difference in volume of almost 26,000 cubic feet (960 cubic yards). The upper volume estimate is more than 3.3 times the lower estimate. Here also there is a passive voice reference to the dimensions of the waste site which "have alternately been reported as…." This is an unacceptable way to present "data," if indeed it can be dignified with that name at all. We recommend that a more precise and scientifically defensible waste volume estimate be developed. Other waste site volumes should be verified and the methods for assessing waste volume should be published.

SWMU 135 : Building 12-44E Subsurface Leaching Beds (p. F-17 to F-18)
It was believed that there was a 100 x 50 ft leach bed to the southwest of Building 12-44E. This is the building where employees involved in the 1961 plutonium dispersal incident might have showered allowing plutonium to be washed down the drain. From site investigations and examinations of the building drawings, the authors of the RI report believe that the effluent went to the sewage plant instead and that no leach bed was ever built in the location. We do not agree that process knowledge and worker interviews are a sufficient basis to dismiss the potential for plutonium contamination in this area without additional sufficient radionuclide sampling throughout the site, especially in light of the evidence of other technical deficiencies and poor science that we discuss in our review. Further, the construction worker plutonium screening levels are very high (see discussion below) — more than ten times the levels used for cleanup in the Marshall Islands. The residential farmer scenario should be used throughout for evaluating screening levels and not just for the single case of the closed firing site for which it was applied in the RI report. Recommendations: This SWMU should be carefully sampled for plutonium. A sampling plan for plutonium in this and other areas where plutonium contamination is suspected should be published. The new draft RI report should reflect the resulting plutonium measurements.

SWMUs 37 to 44 : Landfills (p. F-56)
The Burning Ground Landfills "appear to have consisted of nine distinct unlined burial trenches" according to the authors. Landfills 16 and 17 are believed to potentially contain depleted uranium waste, which was allowed to be buried as non-radioactive waste if it had less than 500 disintegrations per minute of alpha per 100 cm2 prior to 1984. There is still significant uncertainty about the extent of these sites

Unassigned SWMU : Landfill 18 North of Firing Site 10 (p. F-68)
There was believed to be a landfill in the area of Firing Site 10, however, none was found

following a geophysical survey, the use of ground penetrating radar, and the examination of three soil borings. It was eventually concluded by the authors that no landfill was built in this area.

The opening dates are unknown or uncertain for SWMU 60 : Landfill 9, AOC 8c : Pad 11-17 Solvent Releases, Explosive Burn Pads, and SWMU 58 : Landfill 7. In addition there are also conflicting reports of when Landfill 7 was closed; one source says 1959 and another says 1977. Many of these sites are assumed to involve non-radioactive contaminants. (p. F-4, F-5, F-55, and F-72)

The volume of waste water sent into the ditches and playas is not known, but only estimated. Estimates for the release volumes are

Playa 1 from Zone 12 224,000 gallons per day (gpd) (p. 3-8)
Playa 1 from Zone 11 66,000 gpd (p. 3-8)
Pantex Lake from sewage plant 300,000 to 500,000 gpd (p. H-17)

Based upon these gaps or inaccuracies in the historical information concerning radionuclide and other toxic material disposal on site, it does not seem credible that a document review accompanied by interviews can be considered sufficient to determine the status of all areas of the Pantex site. Recommendations: Areas where there is a plausible pathway for contamination, for instance Pantex Lake which received treated waste water from the Old Sewage Treatment Plant that was involved with at least one possible plutonium release, should be treated as potential radiation sites and fully investigated. Such a full investigation should involve sufficient sampling points at various depths that screen for plutonium as well as uranium, thorium, and tritium. In addition, this expanded conception of what constitutes a potentially contaminated site should also be considered when a new sampling effort is undertaken to determine a meaningful background level for the site. Finally a survey using such techniques as ground penetrating radar must be undertaken to ensure that no landfills or other waste management areas goes undetected. Estimates should be made for all effluents to the various playas, including playas 2 and 4 before and after 1970 and reported in the RI report.

II. Calculation of Radiation Screening Levels

We have not had sufficient time or resources to review the details of the methodology or assumptions used in the calculation of the radiological risks associated with the exposure of Industrial or Construction Workers to the soils at Pantex, however, we do have a number of general comments concerning the results. First, Construction Workers at DOE sites are often asked to do radiological work, in addition to new construction in non-contaminated areas. This was not considered in the screening level calculation. The soil screening levels would be lower if this factor were included. Second, the exposure time of 60 days for Construction Workers should be discussed in the context of previous projects at Pantex and any potential future plans (such as the possibility of the Modern Pit Facility being located at the site). If Construction Workers are employed for a total of 3 years or more on a job, their calculated tolerance level for residual Pu-239, Th-232, and U-234 in the soil could drop below that of the Industrial Worker. (p. 5-28 to 5-29) Fourth, the reported total uranium limits and those for the uranium activity are in conflict in both the Industrial Worker and Construction Worker Preliminary Remediation Goal calculations.

For the Industrial Worker, the maximum amount of uranium allowed in the soil in order to meet the activity limits is 5.2 mg of U per kg of soil whereas the total uranium limit as listed is 613 mg/kg. The listed limit is nearly 120 times larger than that implied by the radiation limits. For the Construction Worker, the total uranium limit implies a maximum U-238 activity in the soil of 88 pCi/gm, whereas the limit given in the RI report's table is 138 pCi/gm. The listed value is more than 55% larger than that implied by the total uranium limit. (p. 5-34) Finally, the RI report's consideration of the permissible levels of the radionuclides is based on only the Industrial Worker and Construction Worker scenarios. (p. 5-28 to 5-30) This implicitly assumes that the land will never be put to other than industrial uses. Given the importance of the area surrounding the Pantex plant for agricultural production and the extremely long half-life of the contaminants of potential concern compared to human institutions, a calculation for a subsistence farmer family should be made and should be the reference scenario for all long-term calculations (beyond a few decades). A subsistence farmer calculation, was done for the Firing Site 5; it is discussed in a subsequent section.

In addition to the Preliminary Remediation Goals based on the worker scenarios, the authors also consider the screening levels appropriate to the protection of the groundwater based on migration of the radionuclides through the soil.

The sole use of analytical modeling for the transport of radionuclides is not adequate to insure the protection of groundwater. In Appendix E, the justification for the choice of the Kd values, which is the parameter that describes how quickly material in the soil moves into the water, is entirely based on using reported values for soils with similar clay content and pH. The values of Kd are known to be difficult to determine even with extensive measurements and that they are often variable over even fairly short ranges in natural soils. The choice of parameters without actual onsite measurements is not appropriate, and given the unphysical results of the models used for the soils screening levels (see below) the choice of all input parameters to their model as well as the model itself should be independently reviewed and supported by site specific measurements. Part of this external review should include a review of assumptions such as that the playas and ditches, which are the areas of greatest concern regarding groundwater contamination, were a "minor" pathway. Given that the playas and ditches were historically the dumping ground for vast amounts of industrial wastewater, it is not credible to assume *a priori* that the transport of potential contamination to these areas was "limited." (p. 4-4)

An additional comment concerning the Kd values is that Table E-7 reports a straight average value for the Blackwater Draw and upper Ogallala formations. However, on page E-18 the authors list the typical depths of the Blackwater Draw formation as 80 feet and that of the upper Ogallala as 170 feet. Using these numbers to calculate a weighted average for the Kd values would reduce those listed in TableE-7 by 31% for uranium and 35% for plutonium.

In addition to our general comments on the RI report technique for determining the soil screening levels appropriate to groundwater protection, the results of their numerical models are reported as values that have no physical meaning and demonstrate a level of carelessness in the writing and review of this document we have observed in several areas. Even if the transport is assumed to be very slow, and thus large amounts of contaminants are required to threaten the aquifers, the Soil Screening Levels should be cut off at the values appropriate for a pure material.

In other words, it does not make physical sense to speak of packing more than one kilogram of contaminant into one kilogram of total material. The only SSL that makes physical sense in this regard is that for tritium at the high recharge rate. All other values should have been limited to the following:

Radionuclide	**Reported SSL**	**Physical Cutoff Representing Pure Material**	**Ratio (SSL/Physical Cut Off)**
Tritium(*)	7.28×10^{21} pCi/gm	9.64×10^{15} pCi/gm	7.6E+05
Pu-239	5.78×10^{18} pCi/gm	6.13×10^{10} pCi/gm	9.4E+07
Th-232	5.10×10^{19} pCi/gm	1.11×10^{5} pCi/gm	4.6E+14
U-234	9.7×10^{18} pCi/gm	6.2×10^{9} pCi/gm	1.6E+09
U-235	9.7×10^{18} pCi/gm	2.2×10^{6} pCi/gm	4.4E+12
U-238	9.7×10^{18} pCi/gm	3.3×10^{5} pCi/gm	2.9E+13
Total Uranium	2.89×10^{22} mg/kg	1×10^{6} mg/kg	2.9E+16

(*) Recharge = 0.044 in/year

Another way to look at the reasonableness of these values is that the reported total uranium screening level is nearly 29 trillion tons of uranium per kg of soil. This value would be roughly equivalent to several million times the total proven recoverable uranium reserves in the entire world stuffed into a single kilogram of Texas soil, which literally make no sense. The fact that nonsensical screening values have been included in the RI report throws into question the entire quality assurance process as well as the scientific competence of the preparers and validators of these results. We have seen poor science in the DOE before, but nothing that remotely resembles the numbers in the above table. We are therefore making a recommendation that is unprecedented for the Institute for Energy and Environmental Research: We recommend that the qualifications of the contractor staff responsible for the technical work should be published as we are mystified how such numbers could be have wound up in a final official report.

Leaving the physical impossibility aside, the estimation of such high screening levels also throws into serious question the assumptions, such as rate of transport through the soil, on which these calculations are based. For instance, the calculations imply that even if vast amounts of pure plutonium, uranium, or tritium were disposed of in the soil, there would be essentially zero risk of any groundwater pollution. The entire set of assumptions, parameter values, and model runs should be published for independent evaluation. The calculations should also be repeated with more realistic values that take into account real-life experience in the migration of actinides through the environment. The above cited results are both wrong and literally incredible. We recommend that the EPA institute a process of quality assurance and quality control that is independent of the contractor and the DOE.

III. Determination of Uranium Background Levels

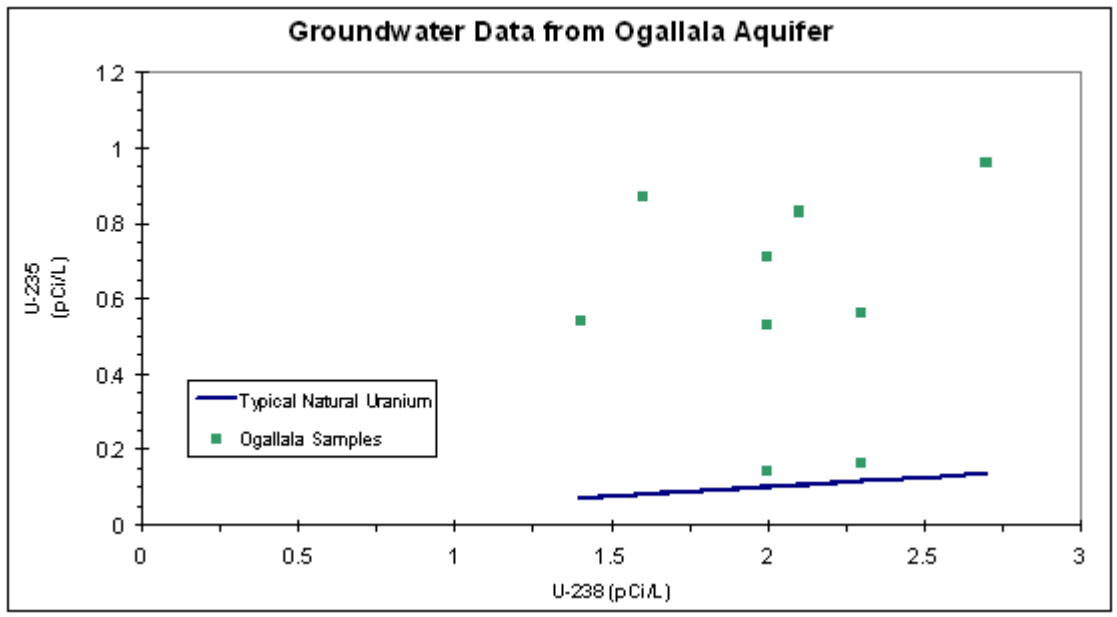
Given the nature of the operations and waste management at Pantex, the primary radionuclide of potential concern at the largest number of sites is uranium. This fact makes the determination of a credible background for the site particularly important. As the data is currently presented, we do not have confidence that the background levels used in the RI report are correct for the Pantex site. We will discuss the deficiencies of their soil and groundwater data separately, however, they both share many of the same concerns.

In Appendix C the authors discuss two significant concerns with their background soil data. The first is that the measurements of the total uranium concentration are not consistent with the measurements of the amount of U-238. When it is assumed that all the mass of the uranium is attributable to U-238, the total uranium data systematically underestimates the activity when compared to the measured values (Figure C-3). In addition to this measurement problem, many of the observed ratios of U-235 to U-238 are far too large. Typically, for natural uranium this ratio is a little less than 5 percent. It is even lower for depleted uranium. Further the reported ratios of U-238 to U-235 are spread out by nearly an order of magnitude (Figure C-4). Both of these problems with the soil data are noted in the text; however, their serious implications for the validity of the site investigation are ignored. There is no explanation offered for the inconsistency in the total uranium measurement. The authors simply decide not to report a background value for the site and use other considerations for examining the specific areas at Pantex. In the case of the U-235 activity, the anomalous ratios are attributed to a supposed difficulty in measuring the low levels of U-235 involved (p. C-9). This is despite the fact that the authors acknowledge in the Quality Control discussion that due to its strong, penetrating gamma radiation, U-235 is in general easier and more accurate to measure than U-238. (p. I-7). In our opinion, these two anomalies in the data set taken together call into question its correctness and the adequacy of the laboratories technique and quality control/quality assurance program. Recommendation: The DOE should publish all of the lab certification data for all radionuclides analyzed by various laboratories, including the result of any tests conducted by the Environmental Measurements Laboratory in which the laboratories have participated.

The data taken to determine a background for the groundwater also raises additional questions. First, there was no successful attempt reported of a measurement for the background level in the perched aquifers. Considering that this water is used by individuals and that it is likely to be the first affected by plant operations, it is important that it be analyzed as part of the overall site survey. For the measurements of water from the Ogallala aquifer, we note that they again have anomalous isotope activity ratios that call the validity of the data set into question. The observed average ratio of U-234 activity to U-238 is found to be approximately 2.2. For natural uranium in secular equilibrium this ratio should be approximately one. It is known that in water, however, this ratio can be larger than one due to the different solubility of the decay products and the influence of alpha recoil. For instance the ratios of U-234 to U-238 in the Snake River aquifer under the Idaho National Engineering and Environmental Laboratory have been reported as varying naturally from 1.5 to 3.1. [2 p. 1-2] These values would be consistent with the observed ratios in the Ogallala. But the U-235 to U-238 measurements are again inconsistent with the ratios expected under natural conditions. For instance, at location AW647, the U-235 activity is reported at 0.96 pCi/liter and for U-238 the value is given as 2.7 pCi/liter. A ratio of 0.36 for U-

235 to U-238 activity is completely outside the range of expected value of about 0.05 for natural uranium (table C-10, p. C-88 and C-89). The RI report has offered no explanation for this problem. Below is a plot of the activity ratios for the 9 locations listed in the data tables as having a U-235 detection.

Groundwater Data from Ogallala Aquifer



The solid line represents the expected ratios for natural uranium. Like for the soil samples, the ratios are too large and do not appear to show any obvious correlation. The activity ratios for the isotopes vary from 0.07 to 0.54, with an average of 0.3. This average ratio is 6 times that expected for typical natural uranium.

An additional concern regarding the groundwater data is that the values listed in Table C-10 are not consistent with the summary results given in Tables 3-5 (p. 3-23) and C-7 (p. C-31). In these two tables there are 26 measurements claimed for U-234 while only 11 distinct measurements are listed in Table C-10. These 11 reported data sample do, however, contain the minimum and maximum values reported in the summary tables (including the single data point considered to be an outlier). In addition, the summary tables list 11 out of 20 samples for U-235 as detections whereas Table C-10 lists only 9 samples as having a detection of U-235. The maximum U-235 measurement reported in the summary tables is 1.2 pCi/L whereas the maximum value listed in Table C-10 is 0.96 pCi/L. Finally, in Table C-7 the maximum value of U-234 should be listed as 8.8 pCi/L, not 7.2 pCi/L as reported.

These inconsistencies and anomalies in the measurements of uranium in both soil and groundwater are of significant concern considering the importance of this data to the site screening process and the fact that at least one site at the Burning Grounds requires further investigation due to uranium contamination. The data sets as they currently stand are

unacceptable for use in the RI report. The U-235 to U-238 ratios are completely incompatible with natural or depleted uranium. A lack of correlation between the values of the two isotopes makes the problem even worse, because one cannot attribute any particular enrichment of uranium to the samples. Moreover, the same problem afflicts soil and water data. This leads us to conclude that the entire procedure for taking and analyzing samples, including the certification of the laboratory needs to be thoroughly and independently reviewed. If there are duplicates of the samples for which data are reported in the RI report, these should be re-analyzed by an laboratory that has recently passed Environmental Measurements Laboratory (EML) certification for uranium. Further, the DOE and the site contractor must perform a credible, consistent, and reliable background assessment before considering which sites have been impacted. These background values should be independently verified. Both means and variances should be reported. All raw data should be published and laboratory uncertainties should be specified. The EPA also has a large job to do here given the unsatisfactory state of the data and the apparent lack of success in implementing quality assurance for the procedure by which the data are produced, analyzed and reported.

One additional concern regarding the acceptability of the RI report's treatment of uranium is that on page 2-20, the authors use a specific activity for the depleted uranium of 0.33 µCi/gm. This value is equal to the specific activity of pure U-238 as quoted by the Department of Energy. While it is correct that nearly all the mass in DU is attributable to U-238, a significant amount of activity continues to come from the remaining U-234. Due to this additional contribution, typical values for the specific activity of DU are 20% or more higher than the value they used in the RI report. Getting such an important and fundamental number incorrect is another example that demonstrates the need for the RI report to undergo a thorough external review by experienced individuals before it can be used for site screening and selection.

IV. Screening Levels for Non-Carcinogenic Risks of Uranium

An analysis of Firing Site 5, which had been closed for radiological hazards, but not for the chemical hazard of uranium is presented in the RI report. There was "little subsurface data" for FS-5 and therefore the RI used surface data, as well as what little subsurface data there was for the risk analysis. (p. K-2) A subsistence farmer scenario, which is an appropriate scenario to use, was adopted for the analysis.

The total cancer risk to the resident farmer was found to be 0.9×10^{-6} which is pretty close to the limit of 1×10^{-6}. This is important when looking at the combined risk from all other heavy metals (chemical) and uranium (radiological and chemical). (p. K-2) Different values of transport parameters may push this above the limit of one in a million risk.

In the calculation of the Construction Worker risk, an exposure duration of 0.23 years was used as well as an exposure frequency of 60 days per year resulting in a total exposure time of less than 14 days (i.e. 60 days/year x 0.23 years). Even if the total exposure time of 60 is accepted (which we have discussed before as needing to be justified in light of historical and projected future activity at Pantex) the Construction Worker risk as reported in the RI report should be multiplied by 4.35. (p. K-12) Making this correction for the total uranium risk would elevate it to an HI of 0.61 for the Construction Worker. If the same overall correction for the exposure time is

made to the cumulative risk from the contaminants listed in Table K-3 than the total HI would be 1.52, well in excess of one. (p. K-6)

Summary of total uranium at FS-5

	Max(mg/kg)	95% UCL (mg/kg)	Max (pCi/gm)	95% UCL (pCi/gm)
HAA	580	148	265	68
LAA	150	75	69	34
Berm/Gravel Pit	510	364	233	167
Entire Site	580	177	265	81

(p. K-3)

These values of residual uranium are rather high. They may also result in a significant contribution to the radiological risk. Given that the soil screening calculations appear to be wrong and the observed mistake in the Construction Worker risk calculation, we cannot a priori accept the risk results from the levels of uranium cited above. We recommend the publication of all the assumptions in the analysis. We also recommend that the EPA do an independent check on the DOE's work both in regard to radiological and non-radiological risks of uranium.

V. Plutonium

The RI report has several values of plutonium contamination in playas that appear to be above the background values one might expect from atmospheric testing fallout (pp. C-76 and C-77). These values appear to be above the detection limit. They cannot be presumptively dismissed as outliers. The "reasonable" lower limit for plutonium detection of 0.05 pCi/gm cited throughout the RI report is not adequately justified and is, in fact, well above the vast majority of the detection limits listed for plutonium in surface soil in Appendix C. (p. C-33 to C-86) In addition, as with the uranium results, the sample results cited in the text are not always consistent with those in the summary tables or the raw data. In Table 5-19 they list a total of 360 detections for plutonium out of 1156 samples in soils 0 to 2 feet below the surface. In the text discussing these results, however, they claim that "41 out of 494" results were above the 0.05 pCi/gm level, and that this represented "only 3% of the entire population." (p. 5-36 to 5-38) First of all, there were 1,156 samples taken with 360 reported detections, neither of which number is equal to 494. Forty-one is, in fact, 3.5% of the total number of samples, but is equal to 8.3% of 494. This carelessness with numbers casts further doubts on the results reported in the RI report.

Discharges of plutonium on to the site cannot be ruled out as sources of contamination of ditches and playa sediment. For instance, the 1961 plutonium dispersal event may have resulted in plutonium contamination being discharged on to the site via the laundry or the shower drain. Further, the primary high explosives were in contact with plutonium. We recommend a careful, properly validated review and analysis of possible plutonium contamination be undertaken as

part of a validated sampling plan, with the analysis done by a laboratory certified for plutonium analysis by the Environmental Measurements Laboratory. Fallout background for the site should be established and detection limits should be kept well below this level. The comparison of background levels should be made to surrounding offsite areas where there is high confidence that no contamination from Pantex operations exists. The comparison of Pantex to other DOE sites in very different locations relative to the Nevada Test Site is not a meaningful comparison for background fallout levels. We note here that the Colorado surface water standard for plutonium is 0.15 picocuries per liter, based on a monthly average. The annual average would be below this amount since the maximum contaminant limit must be met each month of the year. Further the DOE has adopted a residual soil action level at the Rocky Flats Plant in Colorado that requires remediation if the Colorado surface water level of 0.15 pCi/liter is exceeded. The Colorado surface water standard should also be adopted for Pantex investigations.

VI. Tritium

The four bays in Building 12-64 are used for testing and staging of tritium reservoirs. Tritium has been released to the soil from 8 of the 9 drip spigots on the south side of the building. The highest reported value was 1200 ± 100 pCi/ml. This is equal to 1.2 million picocuries per liter, which is very high compared to the drinking water standard of 20,000 picocuries per liter. The "offsite" value is reported as 2.64 pCi/ml, taken at Bushland, Texas. This is equal to 2,640 picocuries per liter, and is far higher than background tritium values for surface water. Naturally occurring tritium plus tritium in fallout (in the form of oxide — that is tritiated water) results in concentrations of a few tens of picocuries per liter in surface water. Any value of a thousand or more picocuries per liter, such as that reported for Bushland, Texas, cannot be considered *a priori* as background either for surface or groundwater. Interestingly, the RI report states that this is an "offsite" value but does not claim it as background, though this is implied. The background value for tritium needs to be established using methods that have detection limits of less than 5 picocuries per liter. The fact that tritium values "a few feet away from the drip spigots" are comparable to those at Bushland is not equivalent to a comparison to background. These values near the drip spigots are far too high and cannot be dismissed in the manner that they are in the report.

Tritium was also been detected in soil at a level of 22 pCi/gm is well above the PRG of 3.8 pCi/gm (p. 5-38). This sample has been dismissed as an artifact of the sampling since a reanalysis showed no tritium and a second sample from the same location also showed a non-detect.. The values at all site locations go up in 1996-97 and then go down and then go back up in 2001. The 1996 time is about right for the tritium from the 1989 accident to reach the perched aquifer, according to the transport model used in the RI report. (p. 5-41 to 5-42 and G-12 to G-13) However, elevated levels are also seen in Ogallala. The RI report states that the variation in measurements "may represent a consistent difference in analysis methods or laboratory procedures." (p. G-13) This statement appears to have a large element of speculation. No scientific basis for it has been provided and it casts further doubt upon the adequacy of the laboratory’s quality assurance procedures. The elevated levels of tritium should be thoroughly investigated, and a background level for should be established for surface water, offsite perched aquifers, and the Ogallala aquifer.

The tritium levels in 6 wells owned by 5 different individuals surrounding the facility have been measured at levels of 30 to 170 pCi/l. At least 2 of the wells are in the perched aquifer, including the wells with the highest and most consistent levels of tritium. [4 p. 5 to 6] Prior to weapons testing the level of tritium in lakes, rivers, and potable water was approximately 5 to 25 pCi/L. [3 p. 182] Given that a large fraction of U.S. potable water comes from underground sources, even 170 picocuries per liter cannot be considered as background *a priori*, let along 2,640 reported for Bushland, Texas. The current level of tritium background, including fallout, may be taken as a few tens of picocuries per liter for surface water. The elevated levels of tritium should be thoroughly investigated. Laboratory procedures should be validated, and the laboratories used should be certified for tritium by the Environmental Measurements Laboratory. Duplicate samples should be preserved. The tritium detection limit should be below 5 pCi/L for reliable establishment of background. The minimum detectable activity reported on pages C-91 and C-92 is hundreds of picocuries per liter. We note here that the Colorado standard for tritium in surface water affected by Rocky Flats is 500 picocuries per liter, based on a monthly average. The annual average would be below this amount since the maximum contaminant limit must be met each month of the year. Further the DOE has adopted a residual soil action level at the Rocky Flats Plant in Colorado that requires remediation if the Colorado surface water level of 500 pCi/liter is exceeded.

So far as the 1989 accident is concerned, we find that the official explanation that some tritium gas was converted to an oxide (water) form and scavenged by the rain is questionable. Tritium oxidation in the atmosphere is generally slow — far slower than the time for the tritium to be blown away from the site. Recommendations: The DOE should publish an analysis based on laboratory and field data on the oxidation rates of tritium for the analysis to be credible. A full material balance and a realistic analysis of the sources of tritiated water needs to be done. Specifically, the oxidation of the adsorbed tritium in the concrete, gravel dome, etc. needs to be evaluated as to whether it is a potential source term in the future. An investigation into small leaks of tritium during operations should be conducted to examine potential sources for the tritium measured on site. The Colorado surface water standard for tritium in surface water affected by Rocky Flats should also be adopted for Pantex investigations.

VI. Miscellaneous Comments

Appendix B details the possible mechanisms for the formation of depleted uranium oxide dust in the weapons. This is a source of potential material for the landfills. From the appendix it appears that two measurements of the volume of dust were used to generalize to all weapons disassembly activities. Why an assumption about the packing density of the uranium oxide dust was used instead of a direct measurement of its weight is not adequately explained. The higher activity of DU as noted in the above section would obviously increase their estimate for the total available uranium that might have ended up in the landfills by a proportional amount. In addition, the authors note that some weapons formed thorium oxide either in addition to or in place of uranium oxide. There is no discussion of where the thorium oxide could be coming from, however. If the thorium was used in bomb parts that were in contact with the high explosive then there is the potential that they were burned at the Burning Grounds as was the uranium contaminated explosives. There were two detections of above background Th-232 at the burning grounds, which were consistent with their placement in a landfill. [1 p. 5-47 to 5-48] If thorium

was burned at the Burning Grounds then the RI report should discuss the possible exposures and doses that would have been received from the thorium daughter products, and thus the source of this oxide dust should be more fully explained.

Acronyms

RSSI Radiation Survey Site Investigation
SWMU Solid Waste Management Unit
SVS Supplemental Verification Site
FS Firing Site
BWD Blackwater Draw formation
COPC Contaminant of Potential Concern
DU Depleted Uranium
UCL Upper Confidence Limit
NWAR Nuclear Weapon Accident Residue
PRG Preliminary Remediation Goal
SSL Soil Screening Level
UOG Upper Ogallala formation
OSTP Old Sewage Treatment Plant
HI Hazard Index

References

1 BWXT Pantex, LLC., "Burning Grounds Waste Management Group Final RCRA Facility Investigation Report Volume 2 of 3, Sections 5.2–5.3," March 15, 2002

2 Robert Roback, Thomas Johnson, Travis McLing, Michael Murrell, Shangde Luo, and The-Lung Ku, "Uranium isotopic evidence for groundwater chemical evolution and flow patters in the eastern Snake River Plain aquifer, Idaho,"*GSA Bulletin*, 113:9 1133-1141 (September 2001)

3 Merril Eisenbud and Thomas Gesell, *Environmental Radioactivity From Natural, Industrial, and Military Sources (Fourth Edition)*, Academic Press, San Diego (1997)

4 Texas Center for Applied Technology, "Results of the Drinking Water Sampling Program for Offsite Domestic/Residential Well Water, Conducted by the US Department of Energy Pantex Plant, September 2000–July 2003," October 6, 2003