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**CLARIFICATIONS TO DUPONT'S RESPONSE TO WDNR COMMENTS
REQUEST FOR TECHNICAL ASSISTANCE**

Derivation of Site-Specific Residual Contaminant Levels for the Former DuPont Barksdale Works
Town of Barksdale, Bayfield County, Wisconsin
WDNR BRRTS Activity #02-04-000156 and 02-04-550402

Dear Mr. Saari:

This letter is a follow-up to our meeting at the Barksdale Site on September 2, 2009 with you and Aresito Pelayo of the Wisconsin Department of Natural Resources (WDNR), Henry Nehls-Lowe of the Wisconsin Department of Health Services (WDHS), and Mr. Paul Bretting, the current property owner. During that meeting, we went through our previously submitted responses to WDNR's comments on the report entitled *Derivation of Site-Specific Residual Contaminant Levels for the Former DuPont Barksdale Works*. The text of these original responses is included as Attachment 1 to this letter. At the conclusion of the meeting, we agreed that DuPont would provide a follow-up letter that summarizes our discussions, and provides additional clarifying information to the Department, as necessary.

The remainder of this letter is organized to follow our original response letter of July 3, 2009. We provide a brief overview of the discussion related to each response, and then provide additional information, as needed.

Comment #1 – Regarding the Scope and Applicability of the Site-Specific Residual Contaminant Levels (SSRCLs):

It was noted in WDNR's comment that the original document was not clear as to the use of the SSRCLs, and specifically to which areas of the site they would be applied. As we described in our meeting, DuPont intends to use the SSRCLs as a tool to identify site constituents of potential concern (COPCs) within the recreational area of the site, and to identify portions of the recreational area that may require remediation prior to being released for such use by the current land owner. (A map depicting the proposed recreational area of the site is included as Figure 1 to this letter.)

As you recall, we analyzed the site soil samples for a wide range of inorganic, volatile, semivolatile and explosive compounds. However, since the only two analytes detected above the recreational SSRCLs were lead and arsenic, these are the only two COPCs within the recreational area.

WDNR requested that DuPont include a consideration of the lower explosive limit (LEL) and the saturated soil concentration (C_{sat}) for organic compounds. WDNR noted that these limits need to be applied in order to ensure that potentially explosive levels of constituents are not deemed to be otherwise “acceptable” based on potential health risk. While we do not think it is necessary at this point for WDNR’s approval of the SSRCLs, in the future, when industrial land use-based SSLs are developed for use in the former production area (where elevated concentrations of organic constituents may be present) we will include a review of this information as a part of the screening process.

Comment #2 – Regarding Potential Impacts to Groundwater:

In our meeting, DuPont reinforced its goal that constituents should not remain in soil at levels that will cause the existing groundwater contamination to increase in degree or extent. It appears that WDNR shares this goal, as well. However, WDNR expressed some concern over the lack of sentinel wells near the point of groundwater discharge into Lake Superior, noting that since the residential wells in this area have been decommissioned, there is no adequate way to judge whether groundwater conditions are, indeed, remaining stable. DuPont understands this concern, and we will work with WDNR to determine the best mechanism for monitoring and/or demonstrating that site soils are not having an ongoing impact to the groundwater.

Comment #3 – Regarding the 60 day/year Recreational Exposure Frequency:

The SSRCLs for the recreational area of the site have been developed based on the NR 720 non-industrial equations and exposure parameters, with the exception of a 60 day/year exposure frequency. This exposure frequency was developed based on information from the property owner, who had previously indicated that the site is used for recreational purposes 10-60 days/year. DuPont believes that this is a reasonable exposure frequency, in light of the usage history of the site and the local climate.

In our meeting, WDNR expressed some concern over the use of the recreational use exposure frequency, in that it could amount to “taking rights” from the owner to use the property. WDNR also acknowledged that the current statute does provide for use of alternate exposure conditions in setting the RCLs, contingent upon consultation with the WDHS. The property owners’ representative, Paul Bretting, who participated in our September 2, 2009 meeting did not object to the 60 day/year proposal, as discussed.

DuPont is confident that the current land use will remain in place for two reasons. First, by terms of the contractual agreements with the land owner the current land use cannot change without DuPont's written approval. Second, if the current land owner chooses to sell the property, DuPont has the right to first refusal. The importance of these safeguards was emphasized by Mr. Nehls-Lowe. Based on the discussion in our meeting, DuPont does not believe that further clarifying information, beyond a reiteration of the current proposal, is necessary to finalize the SSRCLs.

Comment #4 – Regarding Consideration of the Dermal Exposure Pathway in SSRCL Development:

It is our understanding that the original comment regarding the dermal exposure pathway originated with WDHS and that the intent of the comment was to make sure that the inputs were well documented. Members of the DuPont team explained that, although the standard equations for developing SSRCLs do not include the dermal pathway, DuPont felt it prudent to include this potential exposure route, considering the constituents of interest, and the potential for some nitroaromatic compounds to penetrate the skin. The basis for the exposure parameters, including the basis for the dermal penetration factor from *in-vitro* and *in-vivo* studies of site-specific compounds were also explained.

We continue to believe that a consideration of the dermal exposure pathway is relevant and prudent when evaluating past explosive manufacturing sites, and we propose to continue to include this in future RCL develop work at the former Barksdale Works. Based on the discussion in our meeting, DuPont does not believe that further clarifying information, beyond a reiteration of the current proposal, is necessary to finalize the SSRCLs.

Comment #5 – Regarding Consideration of Cumulative Risks Associated with Multiple Contaminants:

In WDNR's original comment, it was correctly noted that not only the risks from individual constituents must be considered, but also the cumulative risk from multiple constituents, as well. DuPont fully acknowledges this point. It is our intention to first screen the recreational area soils data for individual compounds against the respective individual screening criteria. Then we will include a cumulative evaluation of the data (multiple constituents) to ensure that the cumulative risks do not exceed the relevant risk management thresholds established in NR 720. Specifically, this will include an examination to make sure that the cumulative site cancer risk does not exceed 1.0E-05, and that the cumulative site noncancer hazard index does not exceed 1.0.

We anticipate that this will be a more relevant issue in the future, as we evaluate the former production areas. In these areas, there is a greater potential for multiple constituents to exceed their individual screening criteria. Based on the discussion in our meeting, DuPont does not

believe that further clarifying information, beyond a reiteration of the current proposal, is necessary to finalize the SSRCLs.

Comment # 6 – Regarding Use of RfDs and RfCs in Calculating the SSRCLs:

WDNR recommended that in the future that toxicity values used to derive SSRCLs should be presented in units that are consistent with the USEPA Regional Screening Level Table. We explained that the inhalation toxicity values (i.e., RfD_is and SF_is) that are included in the RCL Report are simply inhalation toxicity values expressed as a dose rather than as a concentration in air. This algebraic conversion of units does not affect the outcome of the calculations (see the examples in Attachment 1). Future reports that present toxicity values will use units that are consistent with the USEPA RSL table.

Based on the discussion in our meeting, DuPont does not believe that further clarifying information, beyond a reiteration of the current proposal, is necessary to finalize the SSRCLs.

Comment #7 – Regarding Use of the On-Line Calculator to Develop the SSRCLs:

In our meeting, DuPont reiterated the need to include the dermal pathway when developing the SSRCLs for the nitroaromatic compounds. Since the on-line calculator did not include the dermal exposure pathway, it was appropriate to use other, similar software that did. The software package used to develop the SSRCLs used the exact same algorithms and exposure factors (except for exposure frequency) as identified in NR 720.

Based on the discussion in our meeting, DuPont does not believe that further clarifying information, beyond a reiteration of the current proposal, is necessary to finalize the SSRCLs.

Comment #8 – Regarding Selection of Background Data for Lead and Arsenic:

The procedure for developing the lead background concentration was reviewed in our meeting. WDNR agreed that, given the number of proposed samples and their locations in areas where no previous manufacturing or storage activities took place, it is reasonable to use the 99th percentile or the maximum value of the background data set. DuPont agreed to provide a map (see Figure 1) showing the sampling locations for the background data set, a shape file that includes sample numbers and locations (see Attachment 2). In addition, there were questions about the background samples including, sample locations, sampling methodology, sample depth, and soil type.

The background samples were collected from historically undeveloped portions of the site, which was agreed to by WDNR. In addition, background samples collected in the recreational

land use and restricted access areas were also excluded from the data set. Background samples were collected on grids established across six undeveloped upland areas (i.e., not collected within drainage features that receive run-off from elsewhere). Grid points were staked by surveyors based on predetermined coordinates prior to mobilization of the sampling crew. Any stakes which fell on atypical ground (ditches, trails, cut banks, man-made mounds, filled area, non-native material, etc.) were offset from the predetermined grid point to adjacent locations typical of the surrounding area prior to sample collection.

The background samples cover the range of soil types present within the Barksdale site uplands which are primarily divided among four USDA classes as follows:

ID	Upland NRCS Soil Classes Sampled	% of Site
480B	Portwing-Herbster complex,	69.3%
580B	Sanborg-Badriver complex,	8.6%
481C	Cornucopia silt loam,	7.4%
479A	Lerch-Herbster complex,	2.2%
Total	Upland Soils	87.5%

The three primary soil types included in the background sample set (Portwing-Herbster complex, Sanborg-Badriver complex, Cornucopia silt loam) all have typical profiles that consist of 9 to 10 inches of silt loam over clay or silty clay sub-soils to a depth of 4-ft or more. The fourth (Lerch Herbster complex) is found in areas of surface ponding and contains a layer of muck rather than silt loam over the clay materials.

In collecting the samples, surficial vegetative materials (roots, leaves and detritus) were pushed aside prior to advancing the sampling device. This typically resulted in sampling beginning at about 1.0- to 1.5-inches below the surrounding surface. The soils recovered were screened (using Expray® and FIDO) to confirm the absence of site related compounds and then homogenized over the sample interval which in most cases extended to 2-ft below ground surface. As a result the sampled media was typically 8 parts silt loam and 15 parts clay.

This program resulted in the development of a background data set that is representative of the near surface soil column at the Barksdale site. The sampling methodology also eliminated the potential bias associated with collecting soil that was comprised primarily of fine grained material on the surface.

Based on this information provided to WDNR, the background value for lead is 13.9 mg/kg. A value of 13 mg/kg was originally presented in Table 2-2 of the October 24, 2008 report presenting the derivation of the SSRCLs. The concentration increased slightly as a result of excluding background samples that were collected in recreational land use areas.

DuPont had originally proposed to use a 5 mg/kg background concentration for arsenic, based on a Wisconsin Department of Agriculture, Trade and Consumer Protection fact sheet that indicated

that no action was required for concentrations below this level. However, Henry Nehls-Lowe indicated that he was not comfortable using this value, as it was intended for use in evaluating orchard contamination. Moreover, he indicated that the 5 mg/kg goal was originally based on the analytical detection limit for arsenic rather than on the distribution of detected data. WDNR representatives agreed that if the background data set was from undisturbed property that the 99th percentile or the maximum value would be an appropriate background value. DuPont agreed with this position, and proposed using the 99th percentile value of arsenic concentration from the background data set. The resulting 99th percentile value for arsenic is 3.7 mg/kg. Note that the number of samples in the background data set (103 samples) is less than the number of samples in the SSRCL Report and the DuPont's July 3, 2009 response to comments (Attachment 1) because all samples that were outside the unrestricted land use area were excluded from consideration and additional samples that were collected in UAT were added to the data set.

Once DuPont provides the information referenced above, we believe that we will have established background values that can be used to evaluate the presence of inorganic constituents at the site.

Summary

This letter and its attachments provide the information requested by WDNR at our Barksdale meeting on September 2, 2009. We believe that with the enclosed clarifications and supplemental information, that the original report on SSRCL is suitable for approval by WDNR.

We look forward to your action on this matter.

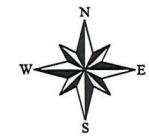
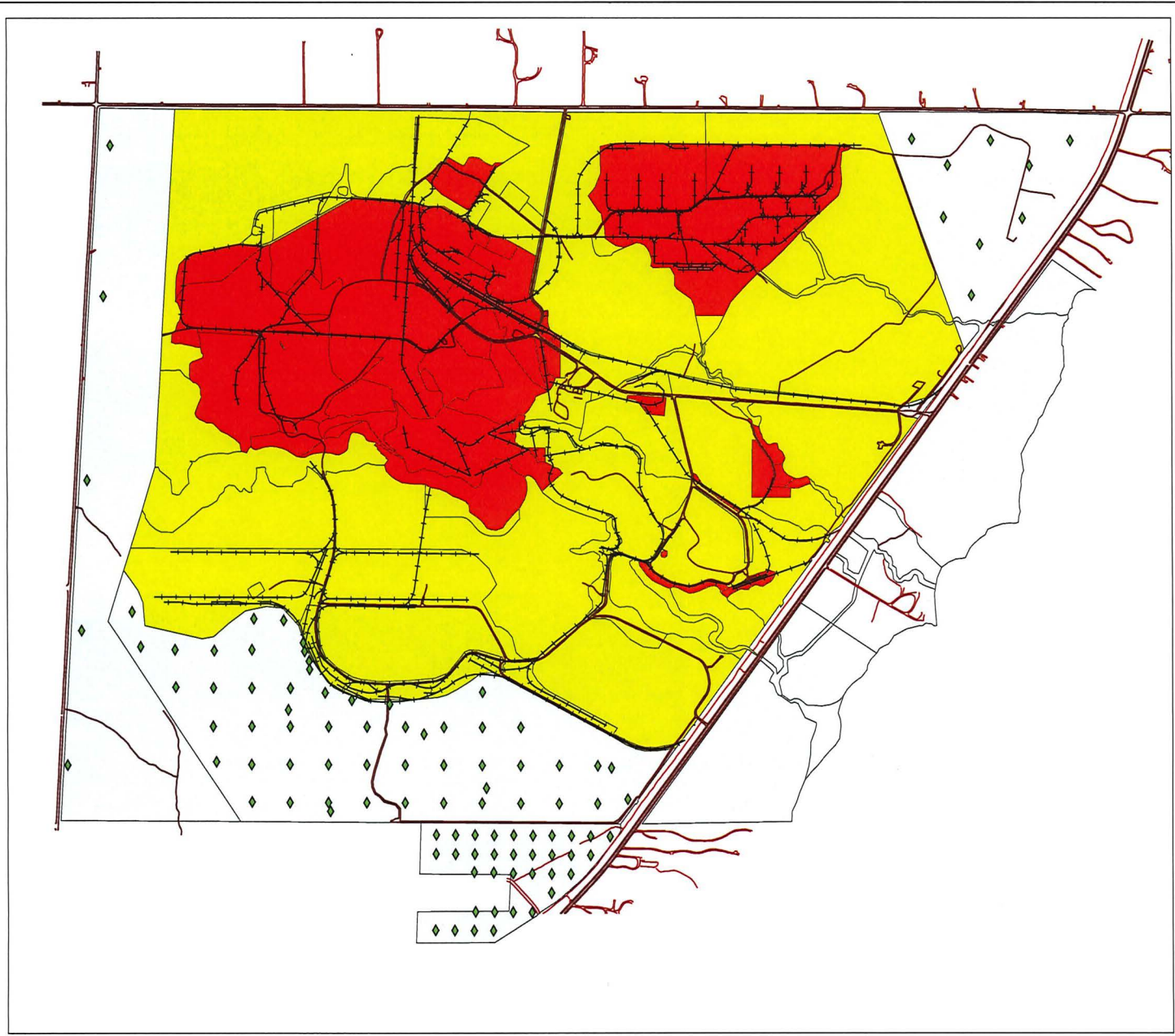
Sincerely,



Bradley S. Nave
Senior Site Director
DuPont Corporate Remediation Group
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Attachments: Figure 1 – Land Use Restrictions and Inorganic Soil Background Sample Locations
Attachment 1 – July 3, 2009 DuPont Response to WDNR Comments
Attachment 2 – CD ROM Containing GIS Shapefile of Inorganic Soil Background Sample Locations and Concentrations

cc: Mr. Paul Bretting – C.G. Bretting Manufacturing Co., Inc.
Mr. Cary Pooler – URS Corporation
Mr. Aristeo Pelayo – WDNR Madison RR/5
Mr. Henry Nehls-Lowe – Wisconsin Department of Health Services
Mr. Brad Grimsted – Pioneer Technologies



Legend

- ◆ Background Sample Locations
 - +—+— RailRoad
 - Roads
- Allowable Land Uses
- Access Restricted
 - Recreational
 - Unrestricted



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**Land Use Restrictions and Inorganic Soil Background Sample Locations
 Barksdale, Wisconsin**

DWN: KG	PROJECT:
DATE: November 2009	FIGURE NO.: 1



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July 3, 2009

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RESPONSE TO WDNR COMMENTS—REQUEST FOR TECHNICAL ASSISTANCE

Derivation of Site-Specific Residual Contaminant Levels for the Former DuPont Barksdale Works
Town of Barksdale, Bayfield County, Wisconsin
WDNR BRRTS Activity #02-04-000156 and 02-04-550402

Dear Mr. Saari:

This letter addresses the eight comments provided by WDNR on January 9, 2009 in response to E. I. du Pont de Nemours and Company's (DuPont's) October 24, 2008 report titled *Derivation of Site-Specific Soil Residual Contaminant Levels for the Former DuPont Barksdale Works Facility* (hereafter referred to as the RCL Report). The format of DuPont's responses to WDNR's comments is a restatement of the agency comments in italics followed by each of DuPont's responses in normal type.

WDNR Comment No. 1:

As an overall comment, it is still not clear to me what exactly you are looking for with this request. My previous understanding was that you would be seeking approval of SSRCLs for that portion of the former DuPont property known as the Southern Area, identified by the WDNR BRRTS Activity #02-04-550402. Your staff then indicated on our November 20 conference call that you are seeking WDNR review and concurrence with the proposed SSRCLs for recreational use areas across the entire former DuPont property and not just the Southern Area. Based on our previous discussions, it was my understanding that the contaminants of concern present in the Southern Area are lead and arsenic. However, the multiple production and waste disposal areas north of Boyd Creek, identified by the WDNR BRRTS Activity #02-04-000156, are impacted by different contaminants than are found in the Southern Area. The additional contaminants present north of Boyd Creek lead to a far more complicated evaluation of risk than with the Southern Area alone, as you will see discussed further in the specific comments below.

DuPont Response to Comment No. 1:

As you know, DuPont is taking a prioritized approach to address issues associated with the Former Barksdale Works. DuPont has prioritized investigations and response actions to address

all potential COPCs at the Former Barksdale Works. The list was broadly defined in order to ensure that no constituents in the recreational area were potentially overlooked during the initial data evaluation step, described above.

There are other portions of property within the security fence of the Former Barksdale Works (i.e., former production and waste management areas) where COPCs other than arsenic and lead are present. Additionally, there are areas within the security fence that are generally devoid of site-related constituents and that were not historically associated with past manufacturing, storage, or waste management activities (i.e., the southern half of the Southern Area in Figure 1). In the future, for these areas, DuPont will use SSRCLs that are consistent with the future land use to evaluate constituent concentrations in soil. Then, if/when individual constituent concentrations exceed their respective SSRCLs, they will be evaluated cumulatively to determine if the target risk goals are achieved or if a remedial action is necessary before a request for closure of these areas is submitted to WDNR.

WDNR Comment No. 2:

Groundwater Pathway RCLs: As I mentioned during the November 20 conference call, there appears to be a major disconnect between your interpretation of the requirements of ch. 160, Wis. Stats., and ch. NR 140, Wis. Adm. Code, and how the Department of Natural Resources enforces these requirements as they relate to the groundwater pathway. In Section 1.4 Groundwater Pathway, the report states, "As a result of the municipal water supply system, DuPont believes that it is not necessary to establish numeric RCLs for soils to be protective of the soil-to-groundwater pathway." While it is correct that DuPont's action of supplying municipal water to the area has mitigated future human exposure through the drinking water route, the groundwater resource itself must be accounted for in the evaluation of soil contaminants. It is not permissible for contaminants to leach from soil to groundwater at concentrations that will cause existing groundwater contamination to increase in degree or extent, regardless of whether receptors are currently being affected. Additionally, it is necessary for you to determine groundwater-protective RCLs even if you can not clean up to those levels. Specifically, s. NR 720.19(4), Wis. Adm. Code, requires their development, and if the RCLs are unattainable, you may opt to select a soil performance standard approach following s. NR 720.19(2), Wis. Adm. Code. These comments are more applicable to the contamination present on the property north of Boyd Creek, but they are included here because, as pointed out previously, the report provides SSRCL discussions for that contamination in addition to the arsenic and lead found on the Southern Area.

DuPont Response to Comment No. 2:

DuPont agrees that a long-term goal for the Former Barksdale Works should be that constituents will not remain in soil at levels that will cause existing groundwater contamination to increase in degree or extent, and it is encouraging to see that the WDNR shares this as a goal.

Based on the results of long-term (since 1997) sampling and analysis of groundwater beneath and in the vicinity of the Former Barksdale Works, all indications are that the two plume areas in groundwater that have been previously reported to WDNR are stable, at steady state, and not increasing in size or concentration. The steady state of these plumes indicates that soil conditions are no longer contributing to an increase in the degree or extent of groundwater contamination. There are likely a number of factors that have resulted in this situation including:

- There has been no manufacturing at the Former Barksdale Works since 1971. Thus, the potential for additional contaminants to be released to soils, and subsequently to groundwater, stopped nearly 38 years ago.
- Since 1997, over 2,700 pounds of trinitrotoluene (TNT) and dinitrotoluene (DNT), have been removed from soil. This total does not include the residual product that was removed during decommissioning between 1971 and 1985. Furthermore, DuPont intends to continue to manage material encountered in future investigations.
- Pilot-scale biodegradation studies in areas affected with DNTs have resulted in significant decreases in the concentration of this class of constituent within these test areas. It is anticipated that this program will be expanded to other areas on the Former Barksdale Works, thus further reducing constituents available to potentially affect groundwater.

With these points notwithstanding, groundwater underlying a very large portion of the recreational area at the Former Barksdale Works is unaffected by site-related constituents. For example, groundwater beneath the Southern Area has been shown to be unaffected from past manufacturing or product storage activities. Additionally, the majority of soil within the recreational area in the northern portion of the property is generally devoid of constituents at concentrations that could be expected to affect groundwater. As such, approval of the SSRCLs for the recreational portions of the Former Barksdale Works should not hinge on whether concentrations of constituents in other areas (i.e., former production areas) may affect groundwater.

WDNR Comment No. 3:

Direct-Contact RCLs: The key component of your direct-contact (D-C) SSRCL calculations involves reducing the standard non-industrial exposure frequency (EF) of 350 days per year (d/yr) to an alternative exposure frequency of 60 d/yr. This single factor alone provided a multiplicative factor of nearly 6 (~350/60) times for every RCL calculated value relative to standard-assumption RCLs. Even though the EF of 60 d/yr is based on information provided by the current property owners regarding their estimated use of the property, it is not acceptable as is for several reasons: a) The 60-d/yr use scenario would become a continuing obligation on the property under s. 292.12, Wis. Stats., and would apply in perpetuity, not just to the current property owners but to any future owners of the property. The point needs to be made very clearly to the current property owners that, if WDNR approves the SSRCLs, future use of the whole property would be restricted to the 60-day frequency specified in the SSRCLs, and this

restriction would need to be maintained as long as the contaminants remain at the site. Implementation of this type of restriction could be very difficult for both the property owners and the WDNR, and the only way the use frequency could be changed would be if some type of remedial action, such as removal or capping, was implemented. This continuing obligation would be spelled out in a final closure letter, and the requirements would run with the property as required by s. 292.12, Wis. Stats.; b) The 60-d/yr assumption may result in levels that are much higher than are now present at the site, higher than some of the most highly-contaminated sites in the state, or even higher than what may be physically possible. Site-specific RCLs should not be higher than what are currently present at the site, or their approval might theoretically allow for additional contaminants to be brought in to the site.

DuPont Response to Comment No. 3:

DuPont's intention in using the 60 days/year exposure frequency was to develop SSRCLs that are protective of human health in the recreational use areas of the Former Barksdale Works. The standard non-industrial exposure frequency of 350 days/year represents a residential exposure frequency, which would not be appropriate for the development of recreational land use SSRCLs. The clarifying note to NR 720.19(5)(c)(2)(b) states that the WDNR can approve alternate exposure assumptions based on consultation with the Department of Health and Social Services.

The 60 days/year exposure frequency used in calculating the SSRCLs proposed in the RCL Report reflects the current and potential future recreational land use pattern at the Former Barksdale Works, as provided by the current landowner. DuPont and the landowner recognize that by including this assumption it would effectively preclude portions of the property designated for recreational use from being used more frequently than 60 days/year or for other purposes. DuPont is confident that this restriction will remain for the following reasons. First, the current land use, which includes frequency of use, cannot change without DuPont's written approval. Second, if the current land owner chooses to sell the property DuPont has the right to first refusal.

In regards to comment b), the RCL Report (p. 1, Section 1.2) states that the purpose of the screening criteria are to "evaluate analytical data from the recreational portion of the Former Barksdale Works in order to identify areas where no further investigation is required, areas suitable for closure, and constituents of potential concern (COPCs)." In other words, if concentrations are above the RCLs then they would be evaluated on an area and constituent-specific basis.

It is common, if not routine, for risk-based screening values to be higher than site-related constituent concentrations. Residual contaminant levels are based on the toxicity of the material in combination with the exposure scenario. In some cases, this approach can result in seemingly excessive concentrations. For example, the default WDNR industrial soil ingestion RCL for chromium (III) calculated using the USEPA SSL tool is 1,530,000 mg/kg. Because a

concentration of 1,000,000 mg/kg represents 100%, it is not physically possible to have more than 1,000,000 mg/kg of a substance in soil. Thus, based on the current USEPA toxicity value and standard industrial exposure assumptions, chromium III could be present in soil at essentially any concentration without posing an unacceptable risk to human health based on an industrial exposure scenario.

The comment suggests that approval of SSRCLs above the current Former Barksdale Works conditions could serve as a basis for using the property for disposal purposes. DuPont strongly rejects the notion that the company has any intention of increasing the contamination present at the Former Barksdale Works. Since 1997 DuPont has spent considerable resources conducting the following actions at the Former Barksdale Works:

- Supplying drinking water to residents surrounding the Former Barksdale Works by constructing nearly 10 miles of municipal pipeline;
- Undertaking numerous phases of investigation to understand the nature and distribution of constituents in soil and groundwater from over 2,200 sampling points;
- Identifying, removing, and disposing of approximately 2,700 pounds of solid residual TNT and DNT present in soil;
- Researching and testing remedial technologies, and;
- Improving wildlife habitat.

The net effect of these actions has been an improved understanding of conditions at the Former Barksdale Works, the implementation of actions directly aimed at the protection of people and the environment, and plans to continue the furtherance of both of these activities. DuPont has no intention of bringing additional contaminants to the Former Barksdale Works. To do so would be counterproductive to our previous efforts and would be in direct opposition to our core values. The purpose of SSRCLs is to evaluate constituent concentrations in soil at the Former Barksdale Works. It is this productive purpose for which they will be used.

WDNR Comment No. 4:

Site-Specific Exposure Factors (Table 3-2, 3-3, & 3-4): Please clearly define acronyms, reference sources, supporting documentation, and calculations of all exposure factors used in these tables. For example, for the "Skin Surface Area" of 1,727 cm², we were unable to reconstruct this value using the U.S. EPA reference in the footnote. Also, the "soil-to-skin adherence factor" of 0.07 is listed in the draft document as the default residential value from the same EPA reference. However, after attempting to locate the specific source table it is implied this value is for "residential adult gardeners" on Exhibit 3-3, page 3-15. Please be explicit for such sources. It should be noted also that the "fraction from contaminated source" is an atypical exposure factor and, while the value appears to be a moot issue in deriving RCLs for this document, the value is listed with an improper unit (either a fraction of 1.0 or 100 percent). And finally, for Table 3-4, please cite the source of the default dermal absorption factor of 0.9.

DuPont Response to Comment No. 4:

Comment noted.

NR 720 does not specifically include the dermal exposure pathway in the derivation of RCLs. DuPont chose to include this exposure pathway because the nitroaromatic compounds present at the Former Barksdale Works are known to absorb across the skin. The inclusion of the dermal absorption exposure pathway resulted in lower (i.e. more protective) SSRCLs than if just the default exposure pathways of soil ingestion and inhalation were included in the evaluation.

Dermal exposure factor values were selected in order to evaluate a reasonable maximum exposure for a recreational exposure scenario. The dermal exposure parameter values were obtained from the USEPA Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment. As noted in the footnote to Table 3-4 in the RCL Report, the skin surface area was determined for a child based on the assumption that they are wearing shorts and a short-sleeved shirt. The value was determined as shown in the following table.

**USEPA Supplemental Guidance for Dermal Risk Assessment
Exhibit C-1, p. C-2
Body Part-specific Surface Area Calculations (Children)**

Body Part	Surface Area (cm ²)
Face	326
Hands	358
Forearms	393
Lower legs	650
Total:	1,727

Notes:

United States Environmental Protection Agency. July 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) – Final. EPA/540/R/99/005; OSWER 9285.7-02EP; PB99-963312. Office of Superfund Remediation and Technology Innovation U.S. Environmental Protection Agency, Washington, DC

Per the USEPA guidance (p. 3-17) there is no default soil-to-skin adherence factor (AF) for a recreational exposure scenario. An AF of 0.07 was selected because it is within the range of the recommended child residential central tendency and RME exposure scenario values of, 0.04 to 0.2, respectively (see p. 3-20), and it is the recommended value for the adult RME scenario. The residential RME soil-to-skin adherence factor value of 0.2 cited in the guidance is based on a zero to six year old, and would not be appropriate for a recreational exposure scenario.

The fraction from contaminated source exposure factor was set at 1 or 100%, and thus did not modify the RCL.

The dermal absorption factor of 0.9 or 90% was obtained from the literature for nitroaromatic compounds. Bronbaugh, et. al. tested the dermal permeability of five nitroaromatic compounds on the skin of humans and monkeys. The highest value observed was 76% in an *in-vivo* test of p-nitroaniline in monkeys. All other values, including those tested on human skin, were less than this value. Thus, based on information from the peer-reviewed scientific literature, the 0.9 (90%) value for absorption factor represents a conservative estimate of this parameter. A copy of the paper by Bronbaugh, et. al. is attached for your reference.

WDNR Comment No. 5:

Site-Specific Hazard Quotients and Risks: The procedure in the report determines “reference” D-C SSRCLs based on a target hazard quotient of 1 and a target cancer risk of 1e-06 and for each of the contaminant in Table 3-5. These reference RCLs are NOT the site-specific RCLs yet. To get D-C SSRCLs, the reference RCLs must be adjusted downward so that the resulting RCLs will have a hazard index (sum of individual hazard quotients) of 1 or less, and the resulting cancer-endpoint RCLs will have a cumulative cancer risk (sum of individual cancer risks) of 1e-05 or less. Several iterations may be necessary to determine SSRCLs from the reference RCLs.

With the exception of the EF assumption, the procedure in the report will readily provide site-specific cancer-endpoint RCLs if there are 10 or less carcinogens present at the site. But because there are more than 10 carcinogens at the site, downward adjustments are necessary. For a carcinogen, its RCL must not exceed a target cancer risk of 1e-06, and when multiple carcinogens are present, their cumulative risk must not exceed 1e-05. Since there are more than 10 carcinogens present, the cancer-endpoint RCLs listed under Table 3-5 need downward re-adjustments in order for the RCLs to become site-specific RCLs.

Likewise, the non-cancer end point RCLs in Table 3-5 need downward adjustment so that the hazard index for the site does not exceed 1. The cancer-endpoint RCLs will contribute to the hazard index, and must be included in the accounting of hazard quotients. Just an example on how to do this: Aniline in Table 3-5 is listed with a cancer-endpoint RCL of 571 ppm and noncancer-endpoint RCL of 3,331 ppm, so it (RCL of 571 ppm) contributes 0.17 (=571/3,331) to the hazard index, which means the sum of the hazard quotients assigned to the other contaminants must not exceed 0.83 (=1-0.17).

DuPont Response to Comment No. 5:

As stated in response to WDNR Comment No. 1, the screening values are used in the first step of a two-step process to evaluate Former Barksdale Works analytical data. Initially, the screening values are used to identify: (1) areas where no further investigation is required, (2) areas suitable for closure, or (3) COPCs. Then, for those constituents that exceed their respective screening values and are deemed to be COPCs, the cumulative risks will be evaluated. If the resulting cumulative cancer risks or noncancer hazards for an area are greater than the cumulative target

risks, then further evaluation would be undertaken per NR 722 (Standards for Selecting Remedial Actions).

The overarching cumulative target risk goals identified in NR 720 are a cumulative cancer risk of $1.0E-05$ and a noncancer hazard index of 1. It is also clear that many constituents have cancer and noncancer toxicity values, and that both will need to be accounted for when calculating cumulative risks. Consistent with the rule, the individual SSRCLs were calculated based on a target cancer risk of $1.0E-06$ and a noncancer hazard index of one. SSRCLs were developed for a comprehensive set of constituents; but, that should not be interpreted to mean that all of the carcinogenic or all of the noncarcinogenic constituents are present in any one sample or even in any one area.

As noted in your comment, several iterations could be required to derive a "final" SSRCL. In fact, SSRCLs could vary by sample location or area as different constituents are present at different concentrations. This could result in hundreds of iterations if one were to revise the SSRCLs each time the conditions change. The approach of first performing risk-based screening of *individual* constituents and then calculating *cumulative* risks and hazards for an area of uniform use type (as needed) will result in outcomes that are consistent with NR 720. This will be much more efficient than trying to continually re-calculate SSRCLs for each sample or study area at the Former Barksdale Works.

WDNR Comment No. 6:

Use of Consistent EPA IRIS Units for the Toxicity Values: Table 3-1 of the report lists the toxicity values used in determining the RCLs. The oral reference dose and the oral slope factors are both in units that are the same as those given in EPA IRIS documents. However, neither of the inhalation toxicity values is in the same units as provided in the IRIS documents. For ease in future review, use the inhalation toxicity values in EPA IRIS that are termed Inhalation Reference Concentration (RfC), and Inhalation Unit Risk Factor (IUR), which are in units of mg/m^3 and $[ug/m^3]^{-1}$, respectively.

DuPont Response to Comment No. 6:

Comment noted.

The inhalation toxicity values (i.e., RfD_s and SF_s) that are included in the RCL Report are simply inhalation toxicity values expressed as a dose rather than as a concentration in air. These standard conversions were made in SmartRISK®, the risk assessment modeling tool that was used to calculate the SSRCLs. This algebraic conversion of units does not affect the outcome of the calculations.

The RfC is converted to an inhalation RfD using the following equation:

$$[\text{RfC (mg/m}^3) \times 20 \text{ m}^3/\text{day}] / 70 \text{ kg} = \text{RfD}_i \text{ (mg/kg*day)}$$

The IUR is converted to an inhalation slope factor (SF_i) using the following equation:

$$\text{Unit risk (ug/m}^3)^{-1} \times 70 \text{ kg} \times (20 \text{ m}^3/\text{day})^{-1} \times 1000 \text{ ug/mg} = \text{SF}_i \text{ (mg/kg*day)}^{-1}$$

WDNR Comment No. 7:

Use of WDNR Guidance Documents: Several guidance documents from the Department's RR program are available to determine site-specific RCLs. For many of the contaminants listed in Table 3-5, their RCLs can be determined by following RR guidance documents. RR-682 (Determining RCLs Using the EPA Soil Screening Level Website) provides a procedure to determine RCLs by the use of an online calculator. Specifically, non-cancer endpoint site-specific D-C RCLs can be generated using the online calculator by plugging in site-specific hazard quotients. Either RR-682 or RR-523-03 (Use of Leaching Tests for Unsaturated Contaminated Soils to Determine Groundwater Contamination Potential) may be used to determine groundwater-pathway protective levels. RR-653 (Commonly Asked Questions about the Lead Soil Standard) must be used because lead (Pb) cleanup is under its own consideration, but any soil lead cleanup level will contribute to a site's hazard index. These guidance documents need to be followed first, and if they do not provide RCLs, then the procedure outlined in the report may be followed. In particular, the DNX toxicity values in the report are "new" information and since they are not in EPA's database to determine screening levels, the procedure in the report may be followed to calculate SSRCLs for them.

DuPont Response to Comment No. 7:

Our interpretation of WDNR's guidance documents is that they are intended to help users understand how to correctly implement the requirements identified in a rule. This interpretation was based on made from a statement made on the second page of RR-682 in the following purpose statement, "This guidance is intended for Department of Natural Resources staff and for the public, for use in understanding and applying the administrative rules that are applicable to the cleanup of soil contamination (NR 720, Wis. Adm. Code). This guidance does not contain mandatory requirements except where requirements found in statute or administrative rule are referenced." Our interpretation of the voluntary nature of the guidance is further reinforced on the first paragraph on page 3 of RR-682 where it says "One very useful web resource to determine soil residual contaminant levels (RCLs) is accessible at <http://risk.lsd.ornl.gov/epa/ssl1.htm>."

Although the web-based calculator was not used to develop the SSRCLs, they were calculated using the exact algorithms and exposure factor values (except for the recreational exposure frequency) identified in NR 720, Wis. Adm. Code. Dermal contact was included in the SSRCL

calculations, even though it is not required by NR 720. Since the USEPA SSL tool does not include dermal contact as an exposure pathway, it was not appropriate to use this tool.

Your review of the toxicity data for the “new” DNX materials is appreciated, and these values will be used to evaluate the presence of DNXs at the Former Barksdale Works, as needed.

WDNR Comment No. 8:

Background Soil Sample Data (Section 2.4, page 5): The report described a brief summary of background results based on 199 surface soil samples collected to establish background levels – very impressive for establishing site-specific background levels for inorganics. The background soil data table (2-2) in the final report should include a fuller range of descriptive statistics for this data, including the mean, median, and 95% upper confidence level (UCL). Unfortunately, this dataset was not used in developing SSRCLs. While RR-721 (Determining Soil Contaminant Background Levels) was referenced in the report, the upper 95% confidence limit of the mean – which the guidance document indicated to use as background level – was not included in the reported statistics of the background samples. Cleanup to background levels is allowed under NR 720, Wis. Adm. Code. When cleanup is done to the background level of a contaminant, then it is not included in the calculation of the total risk and hazard index for the site.

The draft report recommends using a default value for background arsenic levels in surface soils of 5 mg/kg. This default value is referenced to a March 2008 report from the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). However, this DATCP report did not issue a default target value for arsenic, but only indicated that background arsenic concentrations in Wisconsin surface soils “may be around 5 mg/kg.” Therefore, the use of 5 mg/kg as a default or site-specific action level for the former DuPont property is not supported by this report. While the current Wisconsin DNR default concentration for arsenic in surface soils under ch. NR 720, Wis. Adm. Code, is set at 0.039 mg/kg, this administrative code allows the development and use of site-specific background levels. Currently, State of Wisconsin agencies are completing a study that will provide background arsenic levels in surface soils throughout Wisconsin; however this data is not yet finalized or available. At this time, the final report should use the available and extensive background dataset for the DuPont property and derive a site-specific background arsenic concentration based on the 95% UCL.

DuPont Response to Comment No. 8:

Analytical results for soil samples obtained from the Former Barksdale Works were used to determine site-specific background concentrations for all constituents other than arsenic. A background arsenic concentration of 5 mg/kg was selected because it is consistent with Former Barksdale Works background data (i.e., the 99th percentile background arsenic value was 3.4 mg/kg). In addition, the Wisconsin Department of Agriculture, Trade and Consumer Protection state in their Lead and Arsenic in Soil of Old Fruit Orchards Fact Sheet (see attached) that “DATCP considers 5 ppm arsenic and 50 ppm lead to be general background levels for

adjacent residential sites first, then locations accessible to the general public, then areas used by the current site owner, and finally the former production areas which currently are restricted to use by only remediation team personnel. To focus investigation efforts, property formerly owned by DuPont was divided into multiple Use Areas. Each of these Use Areas within the site security fence where historical site operations are known to have occurred has been designated as either a recreational land use area or as a restricted area (e.g., former production areas or waste management areas). Additionally, there are areas within the security fence that are generally devoid of site-related constituents and that were not historically associated with past manufacturing, storage, or waste management activities (i.e., the southern half of the Southern Area in Figure 1) that have not yet been designated. Areas outside of the security fence, where no historical production, product storage, or waste management activity by DuPont is known to have occurred, are designated non-industrial (see Figure 1 attached).

DuPont submitted the RCL Report to WDNR in order to obtain approval of the methods and data used to generate the recreational land use site-specific residual contaminant levels (SSRCLs). Since large contiguous areas of recreational-use land exist in portions of the Former Barksdale Works north of Boyd Creek, as well as portions of the Southern Area (i.e., property south of Boyd Creek), the SSRCLs are intended to be used to evaluate data from all of these recreational areas. Once the SSRCLs have been approved, DuPont will incorporate these SSRCLs as part of a request for closure for the recreational areas of the former Barksdale Works. To reiterate, the subject recreational SSRCLs are intended exclusively for the evaluation of data from the portion of the site designated as "Recreational Land Use Area – Exposure Frequency of 60 days per year".

As stated in the RCL Report (p. 1, Section 1.2), the proposed SSRCLs will be used to evaluate analytical data from areas of the Former Barksdale Works that are used for recreational purposes in order to identify: (1) areas where no further investigation is required, (2) areas suitable for closure, or (3) constituents of potential concern (COPCs). In other words, if constituent concentrations in a recreational area are above their SSRCLs, then those constituents would be evaluated on an area and constituent-specific basis to determine if they are adequately characterized, and if the resulting cumulative cancer risks or noncancer hazards for the area are greater than the cumulative target risks. If the cumulative target risks are exceeded, then further evaluation and/or remediation would be undertaken per NR 722 (Standards for Selecting Remedial Actions).

To state the role of the SSRCLs another way, they are used in the first part of a two-step process. The first step is to identify *individual* COPCs within the recreational area by comparing detected constituent concentrations to the SSRCLs. The subsequent step (which was not explicitly identified in the RCL Report) would be to evaluate all COPCs *cumulatively* to determine if their collective concentrations represent an unacceptable cumulative risk.

It is correct that the only COPCs in the Southern Area are lead and arsenic. The list of constituents for which SSRCLs were developed was comprehensive, in that it included any and

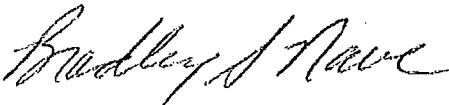
Mr. Christopher A. Saari
July 3, 2009
Page 12

Wisconsin soil. No action is required for concentrations below these levels." DuPont believes that an arsenic background concentration of 5 mg/kg is reasonable and represents a level below which remediation is not required to protect people and the environment.

RR-721 does suggest that if a background data set is available that statistics can be used to determine background concentrations. Specifically, on page six it states "One such approach would be to use the upper 95% confidence limit on the arithmetic mean of the individual sample concentrations." In fact, the 95% UCL is *not* an appropriate statistic for determining a representative background concentration because it is an upper bound estimate of the *average* concentration. Once a representative background dataset is determined based on Former Barksdale Works history and geology, by definition, any concentration that is within the range defined by the dataset would be considered background. For example, for the barium background results, the 99th percentile value in the background dataset is 177 mg/kg (see Table 2-2 of RCL Report). The maximum barium background concentration was 185 mg/kg, and the 95% UCL concentration was 92 mg/kg. Clearly, 92 mg/kg is not a representative barium background concentration since it is known, based on 193 background samples, that all barium concentrations up to 185 mg/kg are reflective of background conditions.

I believe that these responses should enable WDNR to approve the prior RCL Report submission with limited modifications. I would like to suggest that we meet to discuss your reaction to these responses in order to address any remaining issues that you may have.

Sincerely,

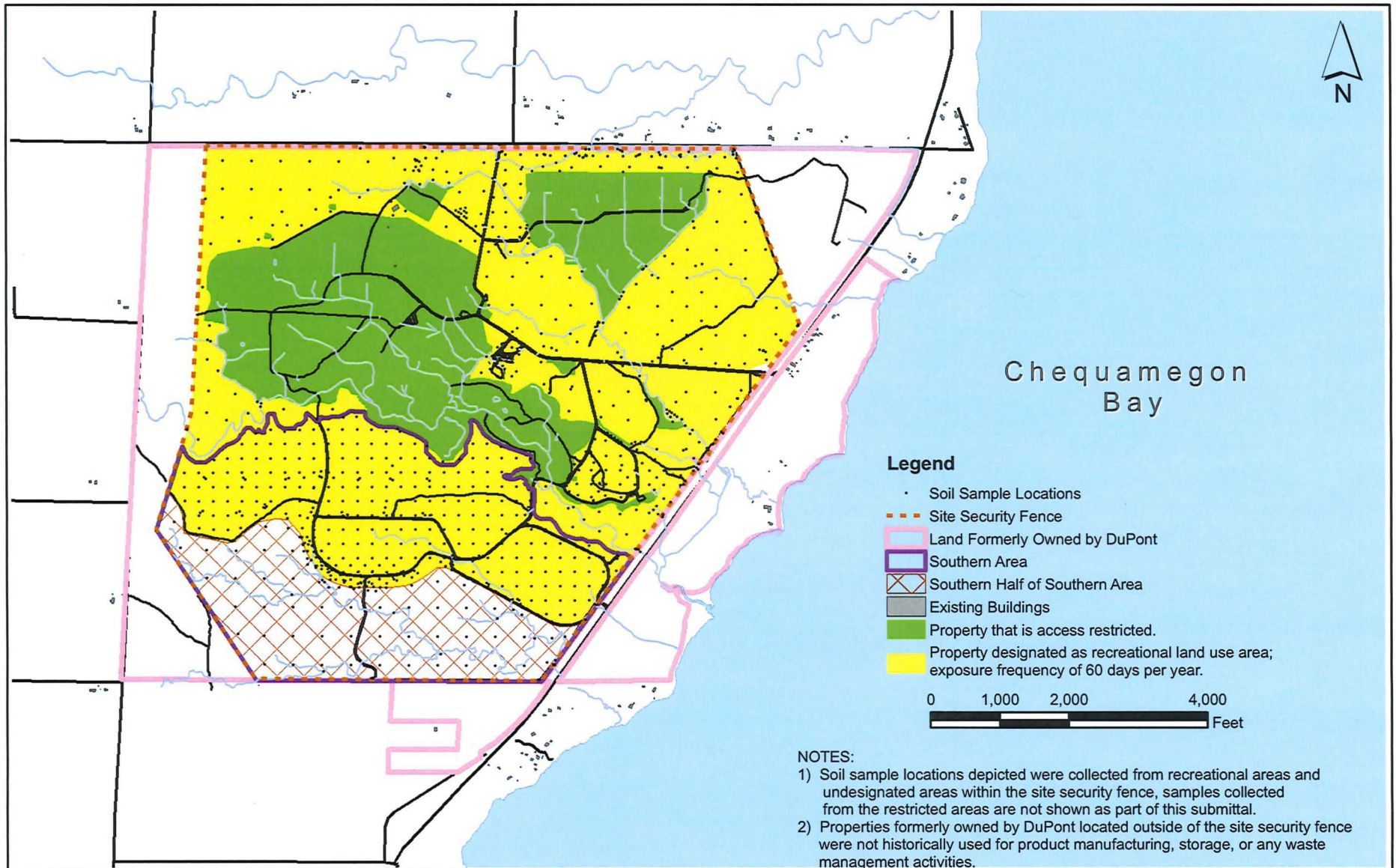


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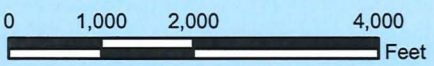
Attachments: Figure 1 – Former Barksdale Works Land Use Designations
Percutaneous Absorption of Nitroaromatics (Bronbaugh et. al.)
DATCP Fact Sheet - Lead and Arsenic in Soil of Old Fruit Orchards

cc: Paul Bretting – C.G. Bretting Manufacturing, Inc.
Cary Pooler – URS Diamond
Aristeo Pelayo – WDNR Madison RR/5
Henry Nehls-Lowe – Wisconsin Department of Health Services
Millie Lindsey – Bayfield County Health Department

FIGURE 1
Former Barksdale Works Land Use Designations



- Legend**
- Soil Sample Locations
 - - - Site Security Fence
 - Land Formerly Owned by DuPont
 - Southern Area
 - ▨ Southern Half of Southern Area
 - Existing Buildings
 - Property that is access restricted.
 - Property designated as recreational land use area; exposure frequency of 60 days per year.



- NOTES:**
- 1) Soil sample locations depicted were collected from recreational areas and undesignated areas within the site security fence, samples collected from the restricted areas are not shown as part of this submittal.
 - 2) Properties formerly owned by DuPont located outside of the site security fence were not historically used for product manufacturing, storage, or any waste management activities.



CORPORATE REMEDIATION GROUP
*An Alliance between
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Title:
**Land Use Designations
 Response to WDNR Comments—Request for Technical Assistance
 Derivation of Recreational Site-Specific Residual Contaminant Levels
 Former DuPont Barksdale Works
 Barksdale, Wisconsin**

Created: KJB	DuPont Project Number: 7419
Date: 06/29/2009	URSD Project Number: 18985645.09001
Revision Number: 0	Figure Number: 1
File Name: RCL_Letter_Fig_01.MXD	

PERCUTANEOUS ABSORPTION OF NITROAROMATICS
(Bronbaugh et. al)

Percutaneous Absorption of Nitroaromatic Compounds: In Vivo and In Vitro Studies in the Human and Monkey

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The percutaneous absorption of 2-nitro-*p*-phenylenediamine, 4-amino-2-nitrophenol, nitrobenzene, *p*-nitroaniline, and 2,4-dinitrochlorobenzene was measured through human and monkey skin. Human studies were performed with excised skin in diffusion cells. Absorption through monkey skin was measured by in vivo and in vitro techniques. Results were compared with those from previously reported human in vivo studies on 2,4-dinitrochlorobenzene and nitrobenzene. Rapid penetration was observed with all compounds, with maximum absorption occurring in the first few hours. No significant differences in absorption were found in values obtained by the different procedures except for the highly volatile (and therefore difficult to compare) compound nitrobenzene. A comparison of the human and monkey in vitro data showed a trend toward increased absorption through monkey skin, but the increase was not statistically significant. The monkey in vivo and in vitro results showed that absorption of all compounds except nitrobenzene was slightly less in the in vitro studies; however, the values were not significantly different. The relative volatility of these nitroaromatic compounds was measured by the loss of compound from epidermal discs at various time intervals. The greatest loss of applied material occurred with nitrobenzene; however, substantial amounts of the other compounds were lost, particularly during the first minute after application as the acetone vehicle evaporated. Monkey skin was found to be a good model for human skin for the determination of the percutaneous absorption of these compounds, and in vitro measurements of absorption agreed reasonably well with values obtained by in vivo techniques. A good correlation was not observed between the absorption of these compounds and their solubility properties.

A number of nitroaromatic compounds are of concern from a toxicologic standpoint because of their potential absorption through the skin of exposed individuals. Several nitroaromatic hair dyes that are carcinogenic in animal feeding studies are known to be absorbed through human skin [1]. The skin is a principal route of exposure of industrial workers to nitroaromatic compounds; even with exposure to only the vapor of nitrobenzene, about one-third of the absorbed dose in a clothed man was the result of skin penetration [2]. Because of dermal absorption, air sample analysis alone is insufficient to protect workers from the cyanogenic effect of nitroaromatic compounds [3].

The absorption of only a limited number of nitroaromatic compounds has been quantitated. Nitrobenzene penetration through human skin was measured from both the liquid [4] and vapor [5] states. Feldmann and Maibach [6] determined the

percentages of the applied dose absorbed in living humans for 2,4-dinitrochlorobenzene and nitrobenzene. 2,4-Dinitrochlorobenzene penetrated both protective gloves and skin to form methemoglobin in a human volunteer [7]. The absorption of several nitroaromatic hair dyes through human and animal skin has been measured [1,8,9].

Five common nitroaromatic compounds were chosen for study under similar conditions in human and monkey skin. In addition to obtaining information about the permeability of these compounds, other primary goals were to compare the permeability properties of human and monkey skin and to determine whether results obtained by in vivo and in vitro procedures were similar.

Dosing was performed using "finite" amounts of the compounds in an acetone vehicle for calculation of the percentage of the applied amount absorbed. This method was considered more relevant to exposure conditions than application of "infinite" amounts in solution for calculation of permeability constants. It is also the method of choice for comparing in vivo and in vitro absorption data, as permeability constants are difficult to obtain by in vivo techniques.

Absorption through human skin was measured by using excised skin in diffusion cells, and absorption through monkey skin was determined by both in vivo and in vitro techniques. The relative volatility of each compound was quantitated in separate experiments by measuring the loss of radioactivity from waxed paper or epidermal discs, and results were considered in the interpretation of percutaneous absorption data.

MATERIALS AND METHODS

¹⁴C-Labeled radioisotopes were utilized for both absorption and volatility measurements. New England Nuclear (Boston, Massachusetts) supplied 2-nitro-*p*-phenylenediamine (sp act, 1.32 mCi/mmol). ICN Inc. (Irvine, California) synthesized 4-amino-2-nitrophenol (10 mCi/mmol), Nitrobenzene (6.6 mCi/mmol), *p*-nitroaniline (15.4 mCi/mmol), and 2,4-dinitrochlorobenzene (13.3 mCi/mmol) were supplied by Pathfinder Laboratories (St. Louis, Missouri). The radiochemical purity of each compound was equal to or greater than 97%.

In vivo monkey skin absorption measurements were performed according to the procedure of Feldmann and Maibach [10]. Each compound was applied to a shaved area of abdominal skin in an acetone vehicle at a concentration of 4 µg/cm². Monkeys were restrained in metabolic chairs so that the amount of compound excreted in the urine in a 5-day period could be determined. Results were corrected for excretion by routes other than the urine by determining, in separate experiments, the percentage of a parenteral dose that was recovered in the urine in the same time period.

The absorption through excised human and monkey abdominal skin was measured by in vitro diffusion cell techniques. In some experiments, static diffusion cell methodology was used with aliquots removed periodically from the receptor of cells with a skin surface area of 1.13 cm² [11]. In other experiments, a newly designed flow-through cell [12] was used to obtain continuous monitoring for absorption profiles (Fig 1); normal saline was pumped through the cells (skin surface area, 0.64 cm²) at a rate of approximately 5 ml/h and collected in scintillation vials for counting. Similar absorption values are obtained with either diffusion cell procedure [12]. Monkey skin was lightly shaved with electric clippers as in the in vivo experiments, using care to prevent damage to the skin [13]. Dermatome sections of human and monkey skin were utilized in the permeability studies. The upper 350 µm of skin was removed from the skin surface with a Padgett Electro Der-

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Reprint requests to: Dr. Robert L. Bronaugh, Dermal and Ocular Toxicology Branch (HFF-164), Food and Drug Administration, Washington, D. C. 20204.

TABLE II. *Percutaneous absorption of nitroaromatic compounds*

Compound	Percent applied dose			
	Human		Monkey	
	In vivo ^a	In vitro	In vivo	In vitro
<i>p</i> -Nitroaniline		48.0 ± 11.0 (9)	76.2 ± 8.4 (4)	62.2 ± 6.1 (6)
4-Amino-2-nitrophenol		45.1 ± 8.0 (5)	64.0 ± 6.2 (6)	48.2 ± 7.8 (5)
2,4-Dinitrochlorobenzene	53.1 ± 6.2 (4)	32.5 ± 8.7 (8)	52.5 ± 4.3 (4)	48.4 ± 3.9 (11)
2-Nitro- <i>p</i> -phenylenediamine		21.7 ± 2.6 (7)	29.9 ± 6.9 (3) ^b	29.6 ± 4.3 (5)
Nitrobenzene	1.5 ± 0.3 (6)	7.8 ± 1.2 (6)	4.2 ± 0.5 (4)	6.2 ± 1.0 (6)
		41.1 ± 2.0 (3) ^c		

Values are the means ± SE of the number of determinations in parentheses. Only with nitrobenzene were there significant differences (Student's 2-tailed *t*-test, *p* < 0.05) among the values determined for the compounds by the 4 different methods; the value for the human in vivo study was significantly different than the results from the other 3 procedures, and there also was a significant difference between the human in vitro and the monkey in vivo values.

^a Values from [6].

^b Value from [9].

^c Diffusion cell tops were covered with Parafilm.

TABLE III. *Evaporation of nitroaromatic compounds*

Compound	Percent applied dose remaining at:					
	1 min ^a		3 h		24 h	
	P	E	P	E	P	E
<i>p</i> -Nitroaniline	53.4	84.3	49.9	72.8	55.0	77.5
4-Amino-2-nitrophenol	54.9	80.6	53.6	85.4	54.1	70.2
2,4-Dinitrochlorobenzene	98.8	65.0	33.0	68.3	19.1	57.0
2-Nitro- <i>p</i> -phenylenediamine	75.7	93.3	79.7	90.6	85.6	86.1
Nitrobenzene	19.8	75.8	8.6	30.4	7.8	21.9

Acetone solutions (3 μl) were applied to waxed paper (P) or human epidermal (E) discs. The amount remaining on the discs was measured at the indicated times. The results are the average of 3 determinations.

^a Acetone evaporates.

The compounds are listed in the general order of decreasing permeability. In only one case was there an exception to this similarity in the order of ranking and that occurred in the in vitro monkey data; 2,4-dinitrochlorobenzene absorption was barely (although not significantly) greater than the absorption of 4-amino-2-nitrophenol.

The time course of absorption of these compounds can best be seen in the absorption profiles from in vitro data obtained with human skin in the flow-through diffusion cells (Fig 1). The maximum absorption rate for all compounds occurred within the first 2 h after application to the skin. The absorption decreased rapidly in subsequent samples and was essentially complete by the end of 24 h.

Significant amounts of the applied compounds were unaccounted for and did not penetrate the skin. However, when diffusion cells were occluded with Parafilm to prevent nitrobenzene evaporation, total absorption was increased more than 5-fold (Table II). The relative volatility of these substances was therefore measured as an aid in interpreting the absorption data. The amount of radioactivity remaining on circles punched from waxed paper or human epidermis was determined at various times after application (Table III). The percentage of the applied dose remaining on the epidermis was generally greater than that on the paper disc, particularly at the longer time intervals. Evaporation of all the compounds occurred during the first minute as the acetone also evaporated. Substantial loss of nitrobenzene from the epidermal discs, however, occurred not only along with the acetone, but also during the remainder of the 24-h experiment.

DISCUSSION

In vivo absorption of the nitroaromatic compounds was determined in monkeys by the widely used parenteral dose correction technique of Feldmann and Maibach [10]. In spite of the indirect estimate of percutaneous absorption obtained, no

more relevant technique has been devised for estimating absorption in humans and expensive animals that cannot be sacrificed at the end of a study. For compounds excreted primarily in the feces (not the compounds in this study), a summation of the chemical found in the feces and urine may provide a more accurate estimate of absorption [14]. Shah and Guthrie [15] have recently obtained a good correlation in pesticide absorption measurements by using the parenteral correction technique and a direct method which consisted of the summation of compound found in the skin of the application site, urine, feces, blood, liver, and carcass.

The nitroaromatic compounds were rapidly, although not completely, absorbed through human and monkey skin. The absorption of the 5 compounds through human skin was measured only with excised skin in diffusion cells; the permeation of 2,4-dinitrochlorobenzene and nitrobenzene in vivo through human skin had previously been determined [6]. Values for the in vivo 2,4-dinitrochlorobenzene absorption more closely resembled results from the monkey skin experiments, but there was no significant difference among any of the values for this substance.

Values for nitrobenzene, the other compound evaluated by all procedures, were lower in the human volunteer study than with either human or monkey skin in the current study; however, comparison is difficult for several reasons. Nitrobenzene is highly volatile and the environment immediately around the application site can affect the amount absorbed. For this reason in particular, valid conclusions regarding in vivo and in vitro comparisons are difficult to make with this compound. In addition, there is evidence that the abdominal skin of humans is more permeable than forearm skin for several pesticides (malathion, 1.4 times; parathion, 2.1 times) [16]. Regional variability in skin permeation also occurs in the monkey [17], and we have found that 4-amino-2-nitrophenol is absorbed 1.3 times more readily through abdominal skin than through forearm skin in the monkey (data not shown). In the human volunteer studies (Table II), forearm skin was used but abdominal skin was used throughout the present study, so the lower absorption might be at least partially the result of this difference. A comparison of the in vitro data from humans and monkeys shows that penetration was greater through monkey skin for all compounds except the highly volatile nitrobenzene. The differences between the two types of skin, however, were not significant (except for nitrobenzene) and results support the opinion that monkey skin is a reasonable animal model for human skin. Comparisons of the permeability of human and monkey skin with other compounds have resulted in similar conclusions [13]. Unfortunately, the comparative data base still remains limited and additional studies need to be performed.

In vivo and in vitro results can be more thoroughly compared with the monkey skin data. Although the in vitro values were

slightly lower (except for nitrobenzene), there was no significant difference among the values determined for the 5 compounds. It should be noted that all the compounds tested are rapidly absorbed and that factors of difference between *in vivo* and *in vitro* values in humans and monkeys cannot be large when high percentage absorption occurs. These comparisons with additional compounds provide further evidence to support the conclusion reached in previous comparisons of *in vivo* and *in vitro* data [18,19]. Thus, reasonably accurate values for skin absorption of many compounds probably can be obtained by *in vitro* techniques. The permeation of certain types of chemicals can be difficult to measure accurately by *in vitro* procedures; for example, hydrophobic compounds may not partition freely into an aqueous diffusion cell receptor fluid. A nonionic surfactant solution has been used in the receptor to facilitate the measurement of absorption of this type of chemical [20].

The maximum rate of absorption of all the compounds, as measured *in vitro* with human skin, occurred within the first several hours (Fig 1), and for nitrobenzene an initial rate of 82 ng/cm²/h was calculated (105 ng at sample time/2h/0.64 cm² skin area). Salmowa and Piotrowski [4] applied 15 mg of nitrobenzene/cm² on skin of human volunteers and measured an absorption velocity of 0.25–3.19 mg/cm²/h during a similar time period. Therefore, the application of approximately a 4000-fold higher dose in their experiments resulted in a corresponding increase in absorption rate.

The volatility of at least some of these compounds was expected to have an effect on the amount of the applied dose that was eventually absorbed. Nitrobenzene was the only liquid used (see melting points, Table I) and is known to be a volatile compound. Occlusion of some of the diffusion cells in the human skin studies greatly increased absorption of this compound. The amount of the nitroaromatic substances lost after application in acetone to two different surfaces was determined (Table III). Initially, evaporation was measured from circular waxed paper discs that served as a readily available inert surface. The loss due to evaporation was subsequently determined after application to circular discs of human epidermis, which is a more physiologic surface allowing interactions to occur with the applied compound. In general, evaporation was less from the epidermal surface and these values were used for comparative purposes (Table III). Significant evaporation was observed with all 5 of the compounds at each of the measurement times; for the 4 solid substances, most of the loss due to volatility appeared to occur during the first minute as the acetone was evaporating. The loss of nitrobenzene, however, was also substantial at later intervals and only 22% of the applied dose remained on the epidermal disc at the end of 24 h.

The loss of these compounds from the surface of skin is an important consideration for several reasons. Nitrobenzene appeared to be a poorly penetrating compound based on the percentage of the applied dose that is absorbed through the skin (Table II). In fact, the nitrobenzene molecule would be expected to penetrate readily because of its solubility properties (Table I), and its poor penetration is likely due to substantial loss from the surface by evaporation. These results with the solid nitroaromatic compounds indicate that the possible loss of a portion of the compound as the vehicle evaporates should be a concern when substances in volatile vehicles are applied to skin. The frequency of the occurrence of this effect with other chemicals is not known.

In general terms, a correlation of lipid/water partition coefficients and skin permeability is known to exist [21]. When the octanol/water partition coefficients in Table I are compared with the percutaneous absorption values of Table II, a good correlation with these compounds does not appear to occur. This lack of correlation is partly the result of the volatility of these substances, as nitrobenzene should be ranked higher on its ability to penetrate skin. However, the comparison also indicates the limited usefulness of solubility data when used alone in predicting skin absorption.

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DATCP FACT SHEET
Lead and Arsenic in Soil of Old Fruit Orchards

background levels for Wisconsin soil. No action is required for concentrations below these levels.

If you have between 5 ppm and 100 ppm arsenic and/or 50 ppm and 400 ppm lead, your soil is considered to be contaminated at the "pesticide-use level." You can manage these levels with the measures listed at the top of this notice. You do not have to report these levels to DATCP, but we would appreciate hearing from you at 608-224-4513, so that we can gain a better understanding of the distribution of these compounds at old orchard sites.

If the concentration of arsenic exceeds 100 ppm or the concentration of lead exceeds 400 ppm, it is likely the result of a spill or the mixing and loading of pesticide, as opposed to application of pesticide. Contact DATCP, Agricultural Chemical Cleanup Program, PO Box 8911, Madison, WI 53708-8911 or call 608-224-4519 to report the situation. You will receive information about how to proceed.

Water

Your water results will probably be given in units of micrograms per liter ($\mu\text{g/L}$), which is the same as parts per billion (ppb). The Drinking Water standard for arsenic is 10 ppb and for lead 15 ppb. Contact the Drinking Water Specialist at your regional DNR office with questions about groundwater quality and to report concentrations that exceed the Drinking Water standards.

How does this affect my property value?

The effect of the lead arsenate contamination on property values will likely depend on the level of contamination and the availability of uncontaminated properties in your area. Your realtor will be the best source to ask about the economic consequences of lead arsenate use in your area.

Notifying future property owners

Under Wisconsin Statutes Chapter 709 "Disclosure by owners of residential real estate," you must notify the buyer of any property defects, which would include knowledge that the property was formerly an orchard during the period of lead arsenate use and may be affected by lead and arsenic. The buyer may choose to sample the soil before the purchase. A special disclosure form has been developed for properties on former orchards. Ask your realtor about this form. Likewise, if you are buying a property on a former orchard, the current owner should inform you if their property was a former orchard and should provide you with any sampling results they have obtained.