Federal Rule of Evidence 706 Expert Report

ABARCA, RAUL VALENCIA, et al.
v.
MERCK & CO., INC., et al.

CASE NO. 1:07-cv-0388 OWW DLB

Prepared for

Judge Oliver W. Wanger
United States District
Eastern District of California
7801 U.S. Courthouse
2500 Tulare Street
Fresno, CA 93721

Prepared by

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November 19, 2010

SUMMARY OF OUR FINDINGS

We have summarized our findings in Table S-1 below regarding whether Sears used generally accepted scientific standards and principles to derive her air emission estimates with respect to eleven questions submitted to us by the Court. Our most serious criticisms of Sears's modeling relate to the inappropriateness of various aspects of the source emission analysis used by Sears to determine the required emission inputs to AERMOD.

Table S-1. Summary of Our Findings

Q	Topic	Scientific Basis*	Comments
1	AP42 Section 13.2.1	Yes	Most appropriate emission factor equation available
2	Rainfall	Yes	Appropriate data for input to emission factor equation
		No	No assessment of likely seepage of soluble chemicals through degraded asphalt and into soil
3	Forklifts	Yes	Reasonable analysis
4	Silt Loading	No	No basis for assuming that all drippage adds to silt size fraction of surface loading. No accounting for silt loading contributions from degraded asphalt, dirt track-on or dustfall unrelated to drippage. No basis for assuming uniform silt loading throughout 14-acre treated wood storage area (TWSA). No accounting for reduced silt loading along forklift travel routes as distinguished from areas beneath and adjacent to stacks of wood where most drippage occurs and where forklift activity is restricted.
5	Particle Size	No	No basis for assigning 5 microns to PM10 emissions
6	Periods/Hours of Operation	Yes	Reasonable analysis
7	Drippage Accumulation	No	Poor justification for assuming that drippage accumulates for 1 year
8	Valence of Chromium	No	Little discussion of potential conversion of Cr^{+6} to Cr^{+3}
9	% of Drippage Emitted into Air	NA	Not assumed but rather calculated by comparing estimated portion of drippage emitted to air with estimated drippage
10	Air Dispersion Model	Yes	Recommended by EPA for regulatory analysis
11	Other	Mixed	We are unable to comment on the validity of Sears adjusting the wind speed data. We view Sears's scaling factors as rough estimates.

*Complies with generally accepted scientific standards and principles.

INTRODUCTION

In the matter of ABARCA, Raul Valencia, et al. Plaintiffs v. MERCK & CO., INC., et al. Defendants, the Court appointed Dr. Countess and Dr. Cowherd as experts to assist in evaluating the methodology used by the plaintiffs' expert Camille Sears to derive her air emissions estimates for the former BAC site. This document summarizes our analysis and findings.

At the outset, it is instructive to describe the roles of the two experts, Dr. Countess and Dr. Cowherd, in performing this analysis. These roles were agreed upon by the two experts to increase the efficiency of the work performed, taking into account (a) the large volume of information to be reviewed and evaluated in a short period of time, (b) the other commitments of the experts during this time period, (c) the respective capabilities and the prior experience of the experts, and (d) the working relationship developed during prior collaborations of the experts.

Dr. Countess reviewed most of the 7,000 pages of documents (as well as relevant information associated with Sears's emission estimates on a CD) provided to the experts and evaluated the portions of the most relevant information at a high level of detail that included cross-checking of calculations in an effort to resolve significant differences in model input quantities derived by Sears and experts who supported her work and by those who disagreed with her work. An example is examination of the calculation of the mass of contaminants imbedded in the soil as derived from the soil contaminant profiles taken in the treated wood storage area (TWSA).

Dr. Cowherd took a broader perspective in looking at the technical approach and information used in the Sears modeling effort as compared with the approach and information that from his experience complies with generally accepted scientific principles and practices in this field. In this role Dr. Cowherd reviewed a limited number of documents that directly described the methods and assumptions used by Sears, as contrasted with the methods and assumptions proposed by those who disagreed with Sears. Dr. Cowherd consulted with Dr. Countess in deciding which documents to review in detail. Dr. Cowherd also reviewed the analyses derived by Dr. Countess and provided feedback on the clarity of presentation. The reverse process also occurred in the case of analyses prepared by Dr. Cowherd.

Both Dr. Countess and Dr. Cowherd concluded that the most critical aspect of Sears modeling was the inappropriateness of source emission analysis used by Sears to determine the required emission inputs to AERMOD. There was little reason to dispute the use of AERMOD as an appropriate dispersion model for this application, and this was reflected by the lack of contention on this issue evident in the documents reviewed.

Court Exhibits Reviewed We received 44 documents (listed below in Table 1) to review from the Court including Sears's files associated with her emission estimates and air dispersion model runs that were provide on a CD.

Table 1. Court Exhibits Submitted to Drs. Countess and Cowherd

Court Exhibit #	DOCUMENT	Date	# of Pages
A-1	IT's Closure Plan Development Review Meeting	2/4/93	38
A-2	Correspondence to T. Pinkos from I. Thierer	5/5/95	3
A-3	Sears Report	12/3/09	123
A-4	Sears Rebuttal Report	3/12/10	116
A-5	Sears Declaration w. Exhibits A-O	9/24/10	543
A-6	Sears Deposition w. Exhibits E298 & E299	4/13/10	467
A-7	Agardy Expert Report	12/3/09	81
A-8	Agardy Rebuttal Report	3/11/10	23
A-9	Agardy Deposition Vol. 1	3/29/10	551
A-10	Agardy Deposition Vol. 2	3/30/10	310
A-11	Agardy Declaration	9/24/10	59
A-12	Sullivan Rebuttal Report	3/11/10	40
A-13	Sullivan Deposition plus Exhibits E325 to E327	4/20/10	238
A-14	Sullivan Declaration	9/24/10	41
A-15	Sert Rebuttal to Fendorf's Report	No date	7
A-16	IT's Risk Assessment	Oct-94	248
A-17	Sears Model Files	2010	
A-18	IT's 1999 Draft Wood Storage Report	8/20/99	29
A-19	Exhibit 35 from the Daubert Hearing	5/16/91	9
A-20	Photographs of BAC site	1989-1991	21
A-21	Acardis' Soil Remediation Work Plan	7/21/06	66
A-22	Exhibit 39 from the Daubert Hearing	6/24/94	4
A-23	Exhibit 53 from the Daubert Hearing	Oct-10	1
A-24	Exhibit 54 from the Daubert Hearing	Oct-10	1
A-25	Exhibit 55 from the Daubert Hearing	Oct-10	1
A-26	Exhibit 56 from the Daubert Hearing	Oct-10	1
A-27	Exhibit 57 from the Daubert Hearing	Oct-10	4
A-28	Exhibit 59 from the Daubert Hearing	Oct-10	1
A-29	Status of Site Characterization	5/15/01	34
A-31	Zannetti's Declaration	8/16/10	119
A-32	Zannetti's Deposition & Exhibits	3/25/10	251
A-33	Stephens' Declaration	8/16/10	218
A-35	Fendorf's Declaration	8/16/10	86
A36	Barnes' Expert Report, Tables & Figures	2/19/10	43
A-37	McIntyre's Expert Report, Tables & Figures	2/19/10	76
A-38	El-Shoubary's Determination of Partioning Coefficient, Kd	6/21/03	68
A-39	Zavain's Deposition & Exhibits	1/20/10	556
A-40	Espada's Deposition & Exhibits	1/20/10	947
A-41	Arcadis' Soil Remediation Completion Report - Shallow Soil	9/11/08	1187
A-42	ERM's Summary Report for Surface Soil & Water Sampling	3/10/09	43
A-43	Daubert Hearing Transcript - Day 2 (Sears testimony)	10/7/10	22
A-44	Daubert Hearing Transcript - Day 3 (Sears testimony)	10/13/10	117
A-45	Daubert Hearing Transcript - Day 4 (Zannetti and Sears testimony)	10/14/10	135
A-47	Zannetti's Exhibit J from Daubert Hearing - Day 4	10/14/10	4

Instructions from the Court

As Court appointed Federal Rule of Evidence 706 experts, we were asked by the Court to provide written responses to eleven questions regarding air emission estimates in reports prepared by Sears The purpose of our appointment is to assist the Court in determining whether or not the methodology and assumptions employed by Sears and supporting experts as detailed in the materials provided to us were in compliance with generally accepted scientific standards and principles. This report presents our findings and includes the reasons that support our opinions.

The eleven questions of interest are stated as follows:

1. Was Sears's use of USEPA AP-42 Section 13.2.1 (paved road emission factor) in compliance with generally accepted scientific standards and principles for calculating hexavalent chromium and arsenic fugitive dust emissions at the Site?
2. Did the Sears model account for rainfall at the Site in compliance with generally accepted scientific standards and principles?
3. Were Sears's assumptions regarding forklifts and their use at the Site in compliance with generally accepted scientific standards and principles?
4. Were Sears's assumptions about silt loading at the Site in compliance with generally accepted scientific standards and principles?
5. Were Sears's assumptions about hexavalent chromium and arsenic particle size at the Site in compliance with generally accepted scientific standards and principles?
6. Were Sears's assumptions about the periods and hours of operations of the wood treating activities at the Site in compliance with generally accepted scientific standards and principles?
7. Were Sears's assumptions about the drippage accumulation of hexavalent chromium and arsenic on the surface at the Site in compliance with generally accepted scientific standards and principles?
8. Were Sears's assumptions about the valence state of hexavalent chromium at the Site in compliance with generally accepted scientific standards and principles?
9. Was Sears's assumption of 27 percent emissions to the air of hexavalent chromium and arsenic in compliance with generally accepted scientific standards and principles?
10. Are there generally recognized standards and practices for validating and confirming the accuracy and reliability of an air model?
11. Were all the assumptions, data, and inputs utilized by Sears to reach her opinions, in compliance with generally accepted scientific standards and principles?

Background Information

In order to be able to respond to the 11 questions identified above, we first needed to understand the conditions at the former BAC site and the steps involved with the pressure treatment of wood at this site. This section of our report addresses the site characteristics and the wood treatment/preservation process.

Site Characteristics

Court Exhibit A-16 (IT Corporation's 1994 Risk Assessment for the BAC facility) contains the following information:

- Site consisted of a 40.5-acre trapezoidal shaped parcel.
- Wood was pressure treated with CCA (Type A) from 1969 to 1980 and with ACC after 1980 until May 1991.

- Most of the structures including the retort basin were located on the southwestern portion of the facility.
- Wood storage area covered the northern portion of the facility.

The treated wood storage area (that we have abbreviated in our report as TWSA) is depicted in Court Exhibit A-23.1 and is reproduced below as Figure 1.
According to Court Exhibit A-9, the chromated copper arsenate (CCA) treatment solution contained 2% solids by weight, and the acid copper chromate (ACC) treatment solution contained 2% - 4% solids by weight. The facility used 1,500-2,000 gallons of treatment solution per "charge" for five charges per day for a total of approx. 8,000 gallons per day. Liquid dripped off the treated lumber when removed from the retort and left for 5-6 hours over the concrete pad in the retort basin area where drippage was captured and recycled. Then the treated lumber was moved to a paved storage area by forklift.

Table 2-6 in the USEPA final report supporting AP42 Section 10.8 that addresses wood preserving lists the composition of CCA (Type A) as 59.4% to 69.3% hexavalent chromium as CrO_3, 14.7% to 19.7% arsenic as As_2O_5, and 16.0% to 20.9% copper as CuO. It also lists the composition of ACC as 63.3% to 68.2% hexavalent chromium as CrO_3, and 28.0% to 31.8% copper as CuO. CrO_3 is chromium trioxide (commonly referred to as "chromic acid"), As_2O_5 is arsenic pentaoxide; and CuO is cupric oxide (Handbook of Chemistry and Physics).

To be consistent throughout our report, we will refer to hexavalent chromium as Cr^{+6} and to trivalent chromium as Cr^{+3}, and we will use Cr and As to designate the elements chromium and arsenic, respectively, to distinguish them from their corresponding oxides. This will help to avoid the apparent confusion in chemical referencing between plaintiffs' experts and defendants' experts.

Wood Preservation Process
Section 10.8 of AP42 (last updated in August 1999) addresses emissions from wood preserving and provides a general description of the process used in the pressure or thermal impregnation of waterborne salts into wood. Excess moisture in the wood is first removed by vacuum and/or heat by one of three primary methods. The Boulton process, which involves boiling-under vacuum, is used primarily for Douglas fir and hardwoods and is usually performed in the same steel cylinder (called a retort) used to treat the wood. A "charge" of wood is loaded on to special tramcars and moved into the retort, which is then closed. An initial vacuum is applied for about 30 minutes to remove as much air as possible from the wood and from the cylinder. Then preservative solution either heated or at ambient temperature depending on the system, is fed to the retort without breaking the vacuum. After the retort is filled, it is pressurized until no more preservative will enter the wood or until the desired preservative retention is obtained (a process that lasts 1 to 24 hours). The pressure is released and the preservative that has not impregnated the wood is returned to a work tank. In some facilities, a final vacuum may be applied to remove excess preservative that would otherwise drip from the treated wood. The final steps in the process are unloading the retort and storage of the treated wood.

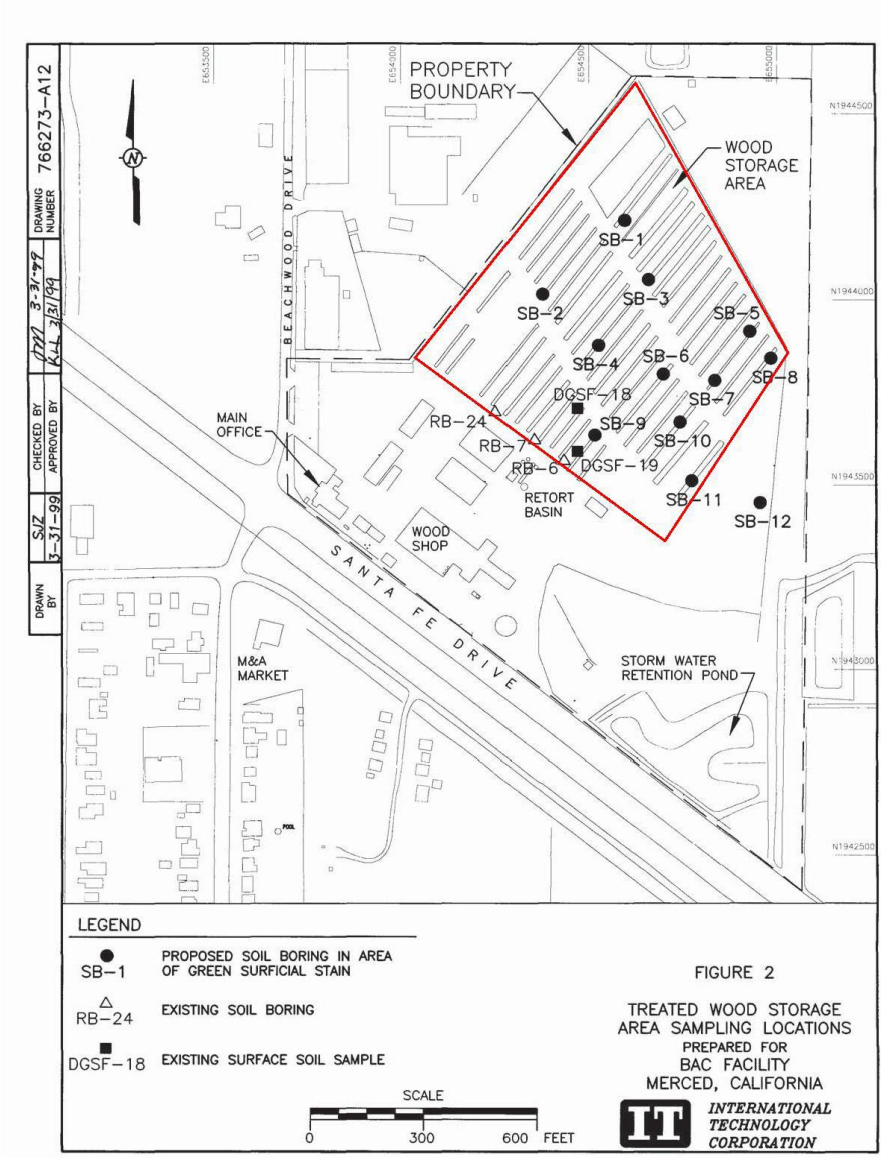


Figure 1 (Court Exhibit A-23): Treated Wood Storage Area

OPINIONS AND BASES OF OPINIONS

Basis for Scientific Analysis

Prior to preparing responses to the eleven individual questions, we found it appropriate to outline the elements of an air quality impact analysis that would be applicable to the specific case in point, such that the analysis would comply with generally accepted scientific principles and procedures. We concur with Sears that the most significant source of PM10 containing treatment chemicals was the operation of forklifts in the TWSA. With this in mind, the desired analytical scheme is summarized below in Table 2.

Table 2. Scientific Assessment of Cr^{+6} and As Emissions from Wood Treatment Drippage

Source Analysis

(A) Identify air entrainment mechanism mostly likely to dominate the release of contaminated PM10.

a. Most likely mechanism appears to be mechanical suspension from operation of forklifts on contaminated surfaces in a paved area used for storing treated wood.

b. Wind erosion is less important in the paved storage area because of low wind speeds and shielding effect of wood storage piles.

c. Even though the surface area subject to drippage is mostly paved, deterioration of asphalt over time is likely to contribute to generation of loose aggregate on the paved surface.

d. Unpaved surfaces in adjacent areas not subject to vehicle traffic are typically protected against wind erosion by vegetation and other non-erodible elements on the surface.

(B) Utilize most suitable predictive equation for dust emissions found in AP-42.

a. AP-42 equation for paved roads is most suitable even with applicable limitations.

i. Developed for freely flowing traffic rather than stop-and-go traffic.

ii. Applicable to vehicle speeds exceeding 10 mph.

iii. Requires knowledge of vehicle weight.

iv. Requires knowledge of silt loading (<75 microns) in path of vehicle.

v. Requires knowledge of vehicle miles traveled (VMT) for silt loading activity over period of interest (based on number of loads transferred and transfer distance per load).

vi. Does not contain vehicle speed as correction parameter because of inverse correlation between vehicle speed and silt loading.

b. Requires selection of a k-factor corresponding to particle size range of interest (e.g., PM10).

c. Although it is likely that EPA will develop a new paved road emission factor equation for stop-and-go traffic (again using silt loading as one of the primary correction factors), this equation is not currently available.

(C) Develop representative estimates of silt loading, recognizing that measured values are unavailable.

a. Requires consideration of the contributions of contaminants to silt loading along with the contributions of degraded asphalt and soil or sawdust tracked into the area or deposited from upwind sources.

b. Requires consideration of silt loading values applicable to forklift travel routes as distinguished from areas primarily occupied by stacked lumber, recognizing that portions travelled by forklifts at higher speeds will have lower silt loadings.

c. Requires consideration of changes in silt loading with time.

i. Typically only a short period of time (of the order of days) is needed to establish an "equilibrium" silt loading. The equilibrium is achieved when silt losses from (a) air emissions and (b) dissolution soluble surface residue and runoff or surface penetration of during rainfall events are balanced by additions of silt from track-on, local deposition (such as drippage and sawdust), and atmospheric dustfall from upwind sources.

ii. This estimate of equilibrium time is based on the "return time" observed for industrial paved surfaces that have been cleaned by broom or vacuum sweeping and subsequently return to the prior dusty condition.

(D) Develop representative estimates of contaminant concentrations in the silt loading resulting from drippage of treatment chemical containing Cr^{+6} and As, recognizing that measured values are unavailable.

a. Calculations would be aided by knowledge of amounts of treatment chemical used and portions recycled, if records were available.

b. Could be partially inferred from contaminant amounts penetrating into the soil beneath the paved asphalt layer.

i. Requires sufficient soil contaminant profiling to determine characteristics of contaminant plume within the soil, taking into account the intensities and overall distribution of any hot spots as well as background concentrations in uncontaminated soil.

ii. Does not account for amounts entrained into the air, or amounts contained

in the host matrix for contaminants on the paved surface (asphalt particles and soil).

c. Requires consideration of the time periods for development of "equilibrium" values when amounts of contaminants emitted to the air or penetrating the asphalt surface are matched by the deposition of new contamination from drippage.

   i. During extended dry periods it is likely that the time necessary to achieve an equilibrium contaminant concentration in the silt loading will be extended possibly to a period of weeks or even months.

   ii. During wet periods the equilibrium contaminant concentrations may be much lower because of increased penetration of soluble contaminants into the soil, and the time to achieve equilibrium will be much shorter.

d. Requires consideration of potential conversion of Cr^{+6} to less toxic Cr^{+3} on the paved surface.

e. Requires consideration of the proportion of contaminants attached to particles on the surface that are larger than 75 microns and not subject to entrainment.

(E) It is customary to assume that the concentration of a contaminant in emitted PM10 is the same as the concentration of contaminant in the silt loading (<75 microns), unless there is evidence that the contamination is preferentially contained in a sub-range of particle size within the silt loading.

Transport Modeling

(F) Requires the use of an approved air pollutant dispersion model that has been assigned an acceptable level of verification for use in regulatory applications.

(G) AERMOD has been deemed the preferred model for calculation of the air quality impacts of point and area sources.

(H) There are generally recognized methods for model validation, but they go far beyond the scope of most environmental assessments because of the requirement for contemporaneous measurements of source conditions (including, in this case the silt loading values and the levels of contaminants in the silt) and the observed air quality impacts at target receptor locations.

Inputs and Assumptions Used in Sears Assessment

In performing her analysis of airborne emissions of PM10 containing chemical constituents of wood preservative solutions, Sears used a number of inputs and made a series of important assumptions. These inputs and assumptions are summarized as follows:

1. CCA preservative containing Cr^{+6} and As was used at the former BAC facility for 12 years from 1969 through 1981.
2. ACC preservative containing Cr^{+6} was used at the former BAC facility for 10.4 years from 1981 through May 1991.
3. Preservative solution dripped from treated wood onto the paved surface of the TWSA.
4. Sears assumed that dried deposits of the CCA preservative chemicals remained on the paved surface of the TWSA for two years (1982 and 1983) beyond the time that this preservative was discontinued.
5. Sears assumed that dried deposits of the ACC preservative chemicals remained on the paved surface in the TWSA for two years (1992 and 1993) beyond the time that this preservative was discontinued.
6. Agardy and Sears assumed that the amount of preservative solution that dripped on to the paved surface of the TWSA for the period 1969-1991 and subsequently leaked into the soil beneath this paved surface could be estimated from the concentrations of chromium measured in shallow soil samples taken from beneath the TWSA.
7. Sears assumed that all of the Cr^{+6} and As in the preservative solution that dripped onto the paved surface of the TWSA and did not penetrate into the soil below the TWSA became available as dust (silt loading) on the paved surface.
8. Sears assumed that all of the Cr^{+6} and As in the dust on the surface was present as silt (particles smaller than 75 microns in size).
9. Sears assumed that the Cr^{+6} and As dust was uniformly deposited on the entire surface of the 14 acre TWSA.
10. Sears assumed that all the Cr^{+6} and As dust accumulated for one year and over succeeding years remained at the same "steady-state" level.
11. Sears assumed that Cr^{+6} did not convert to a more chemically stable (and less toxic) Cr^{+3} during the one-year accumulation period.
12. Sears assumed that the silt loading on the paved surface did not contain significant amounts of any other components such as degraded asphalt, saw dust, or soil tracked into the area or deposited as dustfall from upwind sources.
13. Sears assumed that one or more forklifts disturbed the accumulated dust on a daily basis (24-hours per day) for 250 days per year from the entire 14 acre TWSA with a portion of this dust resuspended in to the air as fugitive dust.
14. Sears based her fugitive dust emission estimates on an equation published by the USEPA for calculating emissions of paved road dust. That equation requires four input parameters, namely silt loading (sL in g/m^2), average weight of vehicles on the road (W in tons), number of days per year with at least 0.01 inches of precipitation (p), and vehicle miles traveled (VMT).
15. Sears based her estimates of silt loading (sL) for the paved surface of the TWSA on Agardy's estimates of the amounts of Cr^{+6} and As that had dripped on to the paved surface during the CCA era and the amount of Cr^{+6} that had dripped on to the paved surface during the ACC era. She also included the California Air Resources Board's default silt loading value of 0.32 g/m^2 for local roads to represent the silt loading on the

paved surfaces of the TWSA in her estimates of the total "steady-state" silt loading values for the CCA and ACC eras.

16. Sears assumed that the average weight (W) of the forklift(s) that traveled over the paved surface of the TWSA was 9.5 tons. She based this estimate on the average weight of the empty forklift(s) and loaded forklift(s) that she assumed to be 7 tons and 12 tons, respectively.
17. Sears used precipitation records for 1948-2006 from the Merced municipal airport, which is located approx. 5 km from the former BAC facility, as her basis for the number of days per year with at least 0.01 inches of precipitation (p).
18. Sears assumed that the annual vehicle miles traveled (VMT) by the forklift(s) on the paved surface of the TWSA was 1,000 miles based on her assumption that the daily VMT was 4 miles.
19. Sears assumed that the PM10 component of the airborne fugitive dust was carried by the wind as 5-micron particles in a manner that can be mathematically represented by the air dispersion model AERMOD.
20. Sears added her estimates of airborne emission rates of Cr^{+6} and As to Agardy's estimates of drippage of Cr^{+6} and As for the TWSA (where Agardy's estimates only represent the amount of Cr^{+6} and As that either leaked through the paved surface or was leached from the surface by rain water into the underlying soil) to estimate the total amounts of Cr^{+6} and As that was lost to the environment.

Analysis and Findings Regarding the Eleven Questions

The following subsections address the eleven questions in sequence. The format for each subsection starts with a statement of the question, followed by a presentation of information that supports or refutes input information used by Sears in her assessment, and concludes with a statement of our findings regarding whether the information, methods and assumptions used by Sears in her assessment complied with generally accepted scientific standards and principles.

QUESTION 1

> *Was Sears's use of USEPA AP-42 Section 13.2.1 (paved road emission factor) in compliance with generally accepted scientific standards and principles for calculating hexavalent chromium and arsenic fugitive dust emissions at the Site?*

The use of the AP42 emission factor equation for calculating fugitive dust emissions from vehicles traveling on paved surfaces at wood treatment plants is presented in the 2010 Handbook of Pollution Prevention and Cleaner Production (see Exhibit "G" with Sears's declaration Court Exhibit A-5). This document states that older facilities that have been operating for many years, especially those predating the RCRA rules, are likely to have soil on the property that is contaminated from historical spills and poor house keeping practices such as drippage of preservative on to surfaces. Vehicular traffic over these surfaces is a source of fugitive dust emissions that contain arsenic and chromium from the residues. It further states that: *"The basic argument that has been adopted in support of AP42 methodology for emissions quantification is that application of recommended emission factors on average is believed to represent the mass emissions from any one facility*."

The input parameters for calculating PM10 emission rates in units of g/VMT (where VMT stands for vehicle miles traveled) from heavy vehicles traveling on paved surfaces are:

- surface silt loading (sL) with units of g/m^2
- average weight of vehicles traveling across the surface (W) in tons
- number of days with at least 0.01 in. of precipitation (p) in the averaging period

One multiplies the PM10 emission rate (in units of g/VMT) by the daily VMT to get PM10 emission estimates with units of grams per day.

No tests of "stop-and-go" traffic or vehicles traveling less than 10 mph were included in the tests performed to develop the AP42 predictive emission factor equation. Thus, EPA cautions users about the application of the prediction emission equation for vehicles traveling below 10 mph and with stop-and-go traffic since the emission estimates will have a high level of uncertainty. In these situations, EPA encourages users to consider alternative methods that are equally or more plausible. A draft AP42 version for paved surfaces that includes a speed term is currently being evaluated for vehicles traveling at less than 10 mph. However, EPA has received negative comments about the use of the equation as proposed.

Daily VMT: Sears's estimate of 4 miles for the daily VMT is equivalent to 21,112 feet of forklift travel per 24-hour workday. This works out to approximately 1,000 feet per hour. If the round trip distance from the drip pad at the retort area to the TWSA was 500 feet, then the forklift (or forklifts) made two round trips per hour.

Emissive area of treated wood storage yard: On page 267 of Court Exhibit A-43, Sears states that *"The area that I considered in my model was basically the treated wood storage area and also basically the area that was known as the thin asphalt covered area."* It is not clear to us what she meant by this statement.

Silt Loading and Forklift Weight: Sears notes that the AP42 emission estimation equation is relatively insensitive to silt loading and more sensitive to the weight of the vehicle. Doubling her original silt loading estimate of 4.01 g/m^2 for the CCA era increased her total PM10 emissions estimate by 57%, whereas doubling her average forklift weight estimate of 9.5 tons for the CCA era increased her total PM10 emissions estimate by 183%. It should be pointed out that doubling Sears's silt loading estimate of 4.01 g/m^2 for the CCA era to account for larger amounts of silt deposits on the paved surface without increasing the contribution from Cr^{+6} or As will double the total PM10 emissions but decrease the Cr^{+6} emissions by 21%.

Our Finding for Question 1: We believe that Sears has made reasonable scientific judgment in selecting the paved road equation to project emissions from forklift traffic in the TWSA. The errors associated with applicability problems (low speed, "stop and go" motion) are probably small compared with errors and uncertainties associated with other items in her analysis as detailed below. If a separate equation were available for application to stop and go activity, it would be advisable to use it.

QUESTION 2

Did the Sears model account for rainfall at the Site in compliance with generally accepted scientific standards and principles?

Our review of Merced Municipal Airport precipitation records from 1948 to 2006 (Court Exhibit A-17, Folder Q) indicates that there is an average of 52 days per year with at least 0.01 in. of precipitation. Sears used this value of 52 for the parameter "p" in the AP42 emissions estimate equation.

Our Finding for Question 2: The Sears model accounted for rainfall at the Site in compliance with generally accepted scientific standards and principles. There might be some advantage to accounting for seasonal variation in rainfall, but the impact on the results would probably be small.

QUESTION 3

Were Sears's assumptions regarding forklifts and their use at the Site in compliance with generally accepted scientific standards and principles?

Our review of forklift specifications (Court Exhibit A-17, Folder Q) indicates that small model forklifts weigh 6.3-7.9 tons, can handle loads of 4-5.5 tons and have a top speed of 12.1 mph, whereas a medium sized forklift weighs about 10.4 tons, can handle loads up to 7.8 tons and has a top speed of 17.1 mph. Photos A-20.19 and A-20.20 (included in Court Exhibit A-20) show two of the forklifts used during operation of the BAC site. Photo A-20.20 shows a smaller forklift than the one depicted in Photo A-20.19. In her estimates of PM10 emissions from forklifts traveling over the paved surface at the TWSA, Sears assumed that all of the forklifts were small models with an empty weight of 7.0 tons and a loaded weight of 12.0 tons.

Our Finding for Question 3: We believe that Sears made reasonable judgments in estimating the specified parameters for forklifts (e.g., daily vehicle miles traveled, VMT, and the weight of forklift, W). A more serious issue is the separation between the stacks of treated wood and the travel routes for the forklifts. It would appear from photographs that most of the drippage would fall on the areas underneath the stacks of wood rather than on the travel routes for the forklifts.

QUESTION 4

Were Sears's assumptions about silt loading at the Site in compliance with generally accepted scientific standards and principles?

Sears used Agardy's drippage estimates of 285 pounds of Cr present as Cr^{+6} and 61 pounds of As for the CCA era and 304 pounds of Cr present as Cr^{+6} for the ACC era to estimate silt loading. (As noted below in our assessment for Question 7, these values appear to be inflated by about a factor of 5.) Sears assumed that all of the Cr deposited on the paved surface for the TWSA was present as Cr^{+6}. This is incorrect. Instead, she should have based her estimates of silt loading on chromium trioxide and arsenic pentaoxide rather than elemental chromium or arsenic. The CrO_3/Cr and As_2O_5/As ratios are 1.95 and 3.07, respectively. Furthermore she should have

included copper oxide (CuO) from the preservative as well as degraded asphalt particles, sawdust, soil particles carried onto the surface by vehicle tires, and dustfall from upwind sources in her estimates of silt loading.

Our Finding for Question 4: Sears's assumptions about silt loading are seriously flawed. There is no precedent for assuming that the silt loading is comprised almost entirely of Cr^{+6} and arsenic. Sears should have based her estimates of silt loading on chromium trioxide and arsenic pentaoxide as well as (at the very least) deterioration of the asphalt pavement that would produce particles in the silt size range.

QUESTION 5

> *Were Sears's assumptions about hexavalent chromium and arsenic particle size at the Site in compliance with generally accepted scientific standards and principles?*

[Note: In this question, we assume that reference is being made to the size of airborne particles rather than particles on the surface.] Sears calculated the silt loading as consisting of 90% contaminants combined with only 10% soil. Even if virtually all of the contaminants on the surface consisted of particles smaller than 75 microns, emissions from the surface would span a wide range of particle size. Only emissions of particles smaller than about 30 microns are normally categorized as suspended particulate matter. The emissions of airborne particles in specified particle size ranges including PM10 can be estimated using the AP42 equation. AP42 indicates that the PM10/PM30 ratio in the emissions generated by vehicle travel on paved surfaces is 0.19. Because the PM10 emissions encompass a particle size range extending from less than 1 micron up to 10 microns, it is problematic to assume PM10 emissions can be represented as 5 micron particles in the dispersion process. In addition, because the settling tendency of particles increase with particle size, the ratio of contaminant lost by deposition from the emission plume to that remaining airborne across the community would be much larger than that estimated by Sears.

Our Finding for Question 5: Sears's assumed particle size for airborne hexavalent chromium and arsenic particle is seriously flawed.

QUESTION 6

> *Were Sears's assumptions about the periods and hours of operations of the wood treating activities at the Site in compliance with generally accepted scientific standards and principles?*

In our opinion, the emission calculation is relatively insensitive to whether the hours of operation assumed by Sears are 24 hours or 18.5 hours (or even 20 hours if one assumes two 10-hour shifts per day). Instead, in terms of estimating air emissions, it is more important that Sears's estimate of the VMT (vehicle miles traveled) per day be accurate, because of the much larger possible range of forklift VMT. As was pointed out above, Sears's estimate of 4 miles for the daily VMT is equivalent to 21,112 feet of forklift travel per 24-hour workday. This works out to approximately 1,000 feet/hour. If the round trip distance from the drip pad at the retort area to the TWSA was 500 feet, then the forklift (or forklifts) made two round trips per hour.

Our Finding for Question 6: Sears's assumptions about the periods and hours of operations of wood treating operation are not as important as her assumption of the daily VMT for the forklift (or forklifts). Her estimates of 4 miles for the daily VMT and 1,000 miles for the year appear to be reasonable as a first estimate.

QUESTION 7

> *Were Sears's assumptions about the drippage accumulation of hexavalent chromium and arsenic on the surface at the Site in compliance with generally accepted scientific standards and principles?*

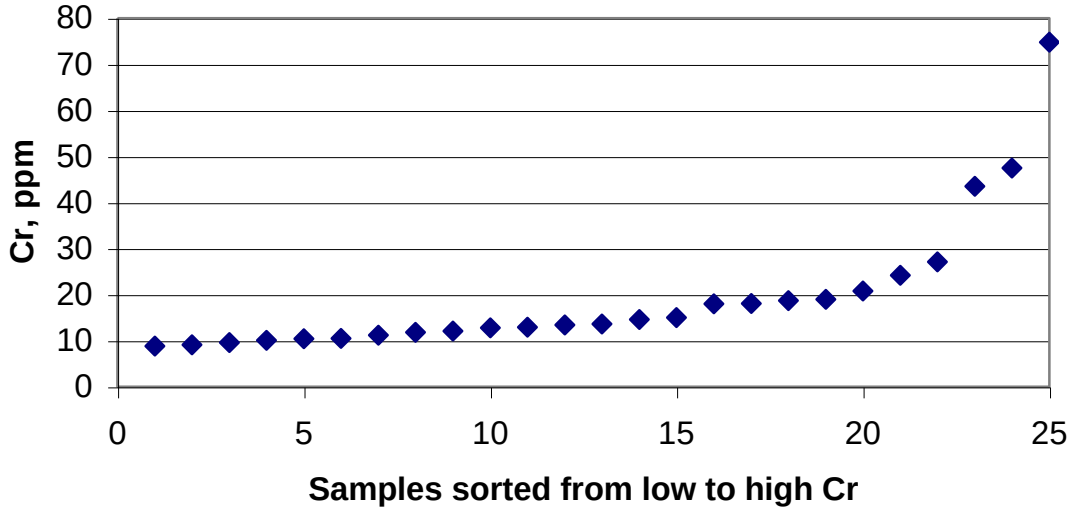
Sears used Agardy's drippage estimates for the TWSA of 285 pounds of Cr and 61 pounds of As for the CCA era and 304 pounds of Cr for the ACC era as inputs for her emissions estimates. These drippage estimates were based on the chemical analysis of 12 separate soil borings taken throughout the TWSA (see Figure 2 of IT's November 1999 shallow soil sampling report). Agardy multiplied the affected soil depth (1.676 m) by the area of the TWSA (57,993 m^2) to estimate the volume of affected soil beneath the TWSA (97,196 m^3) that he then multiplied by a soil bulk density of 1,333 kg/m^3 to yield his estimate of the affected soil mass for the TWSA (1.29×10^{11} grams; see Court Exhibit A-28).

Agardy derived his estimate of the total amount of Cr that had dripped into the soil beneath the TWSA during the 22.5 years that the site used either CCA of ACC preservative by multiplying the geometric mean Cr concentration of 16.4 ppm measured in the TWSA soils (from Table 2 of IT's November 1999 shallow soil sampling report) by the mass of affected soil. This gave him an estimate of 6,587 pounds of Cr present in TWSA soils before the limited remediation that took place in 2007/2008. Agardy also estimated the amount of As present in TWSA soils by multiplying the ratio of arsenic pentoxide to chromium trioxide in CCA (0.164/0.65) by the ratio of years that CCA was used to total years of operation (12/22.5) that yielded an arsenic loss rate that was 13.5% of his chromium loss rate (Court Exhibit A-7.10). This calculation yielded an estimated 341 pounds of As present in TWSA soils prior to the limited remediation that took place in 2007/2008.

However, Agardy should have taken into account the background concentration of 12.8 ppm Cr (Court Exhibit A-8.22) in his drippage calculations. Correcting the measured Cr concentrations for a background concentration of 12.8 ppm Cr, we calculate that the geometric mean concentration of Cr in TWSA soils is approximately 4.8 ppm. [Note: several of the soil samples had a concentration of Cr that was less than 12.8 ppm resulting in a negative net Cr concentration. Thus, the net Cr concentration for these samples was set to zero in order to be able to calculate a geometric mean concentration.] Multiplying the mass of affected soil (i.e., 1.29×10^{11} grams) by the geometric mean net Cr concentration of 4.8 ppm (i.e., corrected for background), we estimate that the total amount of Cr that dripped into the shallow soils beneath the paved surface of the TWSA would have been 1,362 pounds based on the following calculation: $1.29 \times 10^{11} \times 4.8 \times 10^{-6} = 6.19 \times 10^{5}$ grams = 1,362 pounds of Cr.
Thus, we conclude that Agardy's estimate of 6,587 pounds of Cr present in TWSA soils due to drippage of preservative is overestimated by about a factor of five.

The Cr concentrations measured in the shallow soil below the TWSA are shown in Figure 2 below. (This excludes the first result for sample SB-4-1 with a concentration of 145 ppm Cr, which is obviously an outlier since the duplicate analyses of this sample is more in line with the other results.) One can see from this figure that almost half of the soil samples have a concentration of Cr that is close to the background level of 12.8 ppm.

Figure 2. Chromium in TWSA Shallow Soil Samples



With respect to Agardy's drippage estimates, Sears states in her rebuttal report that *"These figures, however, do not take into account the fraction of the material lost to the air before it had migrated to the underlying soil and groundwater."* Thus, she corrected Agardy's drippage estimates to account for air emissions.

Sears's assumption of a one-year accumulation period is unreasonable because it assumes that no losses such as runoff from the paved surface due to rainfall occur during that period. Because of the solubility of the contaminants in original form, any precipitation would undoubtedly cause the contamination to wash off the paved surface and/or penetrate the thin layer of asphalt into the soil below the paved surface, so that the equilibrium time would be much shorter, especially during the rainy season. Our review of Merced Municipal Airport precipitation records from 1948 to 2006 (Court Exhibit A-17, Folder Q) indicates that the wettest months are November through April with 5-10 days per month with at least 0.01in. of precipitation. During this six-month period there are 3-6 days per month with at least 0.1in. of precipitation, and an average of one day per month with at least 0.5in. of precipitation. The driest months are May through October with an average of one day per month with at least 0.01in of precipitation. Thus, we conclude that a more reasonable accumulation period would range from one month to six months for the six-month period May through October, and a maximum of several weeks for the six-month period November through April.

In addition, there should be different drippage rates and accumulations under the stacks of wood as compared to the forklift travel routes. Furthermore, Sears assumes that the entire 14 acres is constantly emitting at the same rate during working hours. This would mean that drippage occurs regularly over the entire area and that forklift traffic occurs over the entire area, all of which is certainly unlikely.

Our Finding for Question 7: Sears's assumptions about drippage accumulation of Cr^{+6} and As on to the surface at the Site are neither reasonable nor in compliance with generally accepted scientific standards and principles. Furthermore, Sears used drippage rate estimates that are seriously overestimated to calculate air emissions.

QUESTION 8

> *Were Sears's assumptions about the valence state of hexavalent chromium at the Site in compliance with generally accepted scientific standards and principles?*

Agardy states that one should be concerned with the amount of amount of Cr^{+6} in drippage not whether Cr^{+6} is converted to Cr^{+3} in treated wood. Sears assumes that 100% of the Cr in the material that drips on to the ground is Cr^{+6} based on her discussions with Agardy. This is reasonable for freshly dripped CCA or ACC preservative and drippage that doesn't come into contact with organic material, or iron- or sulfide-containing soil deposited on a paved surface. Furthermore, there is no disagreement between the experts for both parties that Cr^{+6} in the treated wood can be converted to Cr^{+3} as the treated wood ages. Thus, if there is any transfer to the ground of sawdust created from cutting treated wood or crystallized preservative formed on the outside of treated wood, the paved surfaces at the plant will contain Cr^{+3} from these sources as well as Cr^{+6} from drippage. [Note: The shallow soil samples from the TWSA indicated that most of the chromium in the soil was present as Cr^{+3}; the Cr^{+6}/Cr ratio for these samples before correcting for background was 0.0051.]

Our Finding for Question 8: Sears's assumption that 100% of the Cr in the preservative that drips on to the ground is Cr^{+6} is reasonable for fresh deposits but not for preservative that has been in contact for several weeks or longer with soil deposited on a paved surface.

QUESTION #9

> *Was Sears' assumption of 27 percent emissions to the air of hexavalent chromium and arsenic in compliance with generally accepted scientific standards and principles?*

Our Finding for Question 9: This is not an assumption. It is a calculated value where Sears has divided her estimates of air emissions by Agardy's drippage rate estimates (which as indicated above in our assessment for Question 7 are overestimated by about a factor of five) that Sears has corrected to account for these air emissions.

QUESTION 10

Are there generally recognized standards and practices for validating and confirming the accuracy and reliability of an air model?

Sears states in Court Exhibit A-44 *"these emission inventory reports and the risk assessments that were submitted did not take into account that there were also air monitoring around the facilities. It was something that EPA was doing and another branch, the South Coast Air Quality Management District was doing."* She then goes on to say *"I gathered those data and compared them to the modeling results. And we found that the monitoring data were 30, 40 times higher than the peak modeled impacts. And what we found was that they either omitted or grossly underestimated the fugitive dust emissions, such as from a parking lot."*

Both parties' experts accept AERMOD as an approved EPA dispersion model. However, as Sears points out AERMOD will underestimates the impact of PM emissions at receptor sites if one neglects some of the sources.

Our Finding for Question 10: There are generally recognized methods for validation of air dispersion models such as AERMOD that require simultaneous measurements of emissions and ambient air concentrations of the pollutants of interest at target receptor locations.

QUESTION 11

Were all the assumptions, data, and inputs utilized by Sears to reach her opinions, in compliance with generally accepted scientific standards and principles?

"All" covers a very broad range of topics. Since we discovered major flaws in the assumptions, methods and input data utilized by Sears to reach her opinions, we have limited our evaluation in response to this question to several parameters associated with her AERMOD modeling runs, and to her uncertainty analyses.

For inputs to her AERMOD modeling runs, Sears used meteorological data for 2005-2008 from the Mercer municipal airport (located about 5.3 kilometers south of the BAC site) and upper air data from twice-daily radiosonde measurements at Oakland, CA for 2004-2008. Sears adjusted the wind speed data by replacing calms with "valid" wind speeds (these are her words) since she claims that airfield wind data typically under predict downwind impacts by about a factor of three.

Furthermore, Sears states that she adjusted her long-term average emission flux estimates by scaling factors to reflect the different time periods when either CCA or ACC were used at the former BAC site. She assumed the following scaling factors: 50% for both Cr^{+6} and As emissions for 1969, 50% for As emissions for 1981, 25% for As emissions for 1982, 12.5% for As emissions for 1983, 71% for Cr^{+6} emissions for 1991, 25% for Cr^{+6} emissions for 1992, and 12.5% for Cr^{+6} emissions for 1993.

Sears's confidence limits, which were presented as part of her uncertainty analyses, cover such a large range of possibilities, it may be difficult for the jury to determine whether the plaintiffs

were exposed to toxic levels of contaminants or not. Also it is still necessary to rely on the most probable values.

Our Finding for Question 11: Sears's use of wind speed data from the local airport and upper air data from Oakland as inputs for her AERMOD modeling runs are reasonable. However, since neither of us are meteorologists, we are unable to comment on the validity of Sears adjusting the wind speed data to account for calm periods. We view Sears's scaling factors for emissions in certain years with less than full operation as rough estimates. We are also concerned that members of the jury will not understand the results of Sears's uncertainty analyses.

Materials Considered and Relied On

In addition to the Court Exhibits sent to us by the Court for our review, we also considered and relied on the following materials in forming our opinions:

Handbook of Chemistry and Physics, Chemical Rubber Publishing Co., Cleveland, Ohio, 1963.

USEPA, AP-42 Section 10.8*Wood Preserving*, Research Triangle Park, NC, August 1999.

USEPA, AP-42 Section 13.2.1 *Paved Roads*, Research Triangle Park, NC, November 2006.

USEPA, AP-42 Draft Section 13.2.1 *Paved Roads*, Research Triangle Park, NC, June 2010.