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TECHNICAL MEMORANDUM

DATE: June 11, 2013

SUBJECT: Chemical Look-Up Table Technical Memorandum,
Santa Susana Field Laboratory, Ventura County, California

The California Department of Toxic Substances Control (DTSC) has completed preparation of a chemical Look-Up Table per the Orders that DTSC entered into with the US Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA.) The Look-Up Table values are the chemical-specific values used to assess if the DOE and NASA Santa Susana Field Laboratory (SSFL) cleanup objectives have been achieved.

The Look-Up Table (Attachment 1) provides values for over 130 chemicals. These include chemicals that were assessed during DTSC's chemical background study as well as those chemicals most frequently identified as contaminants at SSFL or of interest to DTSC. DTSC is currently developing Look-Up Table values for the remaining chemicals that have been looked for at SSFL; this second group of Look-Up Table values will be based on laboratory reporting limits. DTSC will append the Look-Up Table with the additional chemical values in Summer 2013. An e-mail blast will be sent when the additional values are posted.

Overview

The California Department of Toxic Substances Control (DTSC) is the lead state agency overseeing the investigation and cleanup of the Santa Susana Field Laboratory. DTSC entered into agreements with the responsible parties, The Boeing Company (Boeing), DOE, and NASA, regarding the investigation methodologies, cleanup approaches, and remediation standards. Boeing's cleanup of soils at SSFL is conducted under a 2007 Consent Order, and utilizes a risk-based evaluation. In 2010, DTSC entered into separate Administrative Orders on Consent (AOC) with DOE and NASA. Both AOCs require a cleanup that will result in no contaminants remaining in soil above local background levels (except for exemptions specifically expressed in the AOC, such as the use of method reporting limits for chemicals that do not have background concentrations.)

In addition to honoring the requirements set forth within the respective Orders, DTSC is responsible for interpreting the Orders (and the documents that are incorporated therein either directly or by reference,) in accordance with DTSC's core mission, mandated by law, to protect human health and the environment. As the issuing authority, DTSC ensures that the Orders are properly and effectively implemented and that the investigation and cleanup activities are consistent with the Orders.

The AOCs specify that *"Upon completion of the DTSC-led chemical background study, a 'look-up' table of the chemical cleanup levels will be prepared, which will include both local background concentrations as well as minimum detection limits for specific contaminants whose minimum detection limits exceed local background concentrations."*

The AOC also includes: *"The acceptance and exercise of ... the following exception(s) is subject to DTSC's oversight and approval, and the resulting cleanup is to be as close to local background as practicable:..."*

The key elements that DTSC considered in the chemical Look-Up Table development and described in this Chemical Look-Up Table Technical Memorandum include:

- practical implementation consistent with the AOCs
- application of defensible chemical background values
- evaluation and assessment of laboratory method reporting limits
- addressing analytical measurement uncertainty

Look-Up Table Development

In November 2012, USEPA provided DTSC a copy of the Final Technical Memorandum Look-Up Table Recommendations Santa Susana Field Laboratory, Area IV Radiological Study (HydroGeoLogic, Inc., November 2012.) The document provides guidance and recommendations to develop a radionuclide Look-Up Table. Following the USEPA recommendations and guidance, in January 2013, DTSC presented a provisional Look-Up Table for radionuclides in soils. The radionuclide Look-Up Table is provisional because USEPA recommended not selecting final Look-Up Table values until a single laboratory is selected to conduct the radionuclide analysis, and the selected laboratory can demonstrate its ability to meet EPA's defined measurement quality objectives for the cleanup confirmation sampling.

Based on USEPA's recommendations and guidance in developing the provisional radionuclide Look-Up Table, DTSC began to develop the chemical Look-Up Table. The chemical Look-Up Table is not provisional because it provides analytical goals for multiple laboratories to report and use when establishing data quality objectives.

In developing the Look-Up Table values for dioxins and furans DTSC applied the World Health Organization toxicity equivalency approach (Van den Berg *et. al.*, 2006.) Additional information on that approach is provided in DTSC's separate technical memorandum regarding use of the toxicity equivalency approach. DTSC also applied the toxicity equivalency approach to a carcinogenic subset of the poly-aromatic hydrocarbons.

Developing Chemical Background Threshold Values

In December 2012, DTSC issued the final chemical background study report. After completion of the chemical background study, DTSC evaluated the data and established background values using data from the two different geologic formations (Chatsworth and Santa Susana Formations) sampled during the study. As with the USEPA radiological background evaluation, DTSC determined that given the soil-moving activities that occurred at SSFL during its construction and development, it would be difficult to assess if a particular on-site sample is from the Chatsworth or Santa Susana Formations, or even a combination of both. DTSC decided that it would be most appropriate to develop chemical background threshold values (BTVs) based on the combined background data from the different formations.

For use under the AOCs, the 95% Upper Simultaneous Limit (95USL) was the recommended BTV for each chemical. The 95USL represents an estimate of the upper limit of concentrations expected to be found in the background population, and includes the variability of sampling. The BTVs provide the basis for calculating the associated Look-Up Table values, but the BTVs are not the actual Look-Up Table values.

For Boeings efforts the 95% upper threshold limit, with 95% confidence (UTL95-95) was recommended.

For more information on DTSC's statistical evaluation, see DTSC, Statistical Methods for Application in the Chemical Soil Background Study for the Modified Site Evaluation Approach of AOCs (DOE and NASA) and for Risk Assessment-Based Approach (Boeing), Santa Susana Field Laboratory, Ventura County, California, May 2013.

For more information on the 95USL, see HydroGeoLogic, Inc. (HGL), Final Radiological Background Study Report, Santa Susana Field Laboratory, Ventura County, California, Appendix B (October 2011). http://www.dtsc-ssfl.com/files/lib_doe_area_iv/bgstudy/66045_SSFL_Background_Study_-_Statistical_Methodology.pdf

Uncertainty

All measurements have some level of uncertainty. The act of collecting samples and processing samples for analysis has a level of uncertainty. In addition, there is uncertainty associated with the analytical methods used for chemical analysis. We work to identify and reduce uncertainties, but uncertainties cannot be eliminated.

Cleaning up contaminated media to background levels often means cleaning up to very low levels and it can be very difficult to differentiate impacted and non-impacted areas. At very low contaminant levels, the total measured concentration (contamination + background) may be less than, equal to, or higher than the highest background levels. Steps must be taken to manage sources of uncertainty so we can increase the level of confidence in our cleanup decisions.

The goal of the Look-Up Table decision process is to assess if a sample is or is not contaminated and determine if remediation is require. To establish Look-Up Table values, DTSC applied laboratory standard practices to account for the quality of laboratory analytical data and DTSC's tolerance for decision errors.

To ensure an acceptable decision error rate, the USEPA technical memorandum provided guidance that background threshold values should account for method uncertainty, so the Look-Up Table values would be the BTV, or background method reporting limit as appropriate, with method uncertainty added.

To improve confidence in our cleanup decisions using the Look-Up Table approach, we specify a type 1 (false positive) decision error rate of 5% for the measurement uncertainty at the BTV or MRL. A false positive means the measured laboratory result exceeds the action value (Look-Up Table value), but in reality the true soil concentration is less than the BTV or MRL. Another way to look at it is these false positive results (e.g., up to 5%) would be cleaned up because the laboratory results will be above the Look-Up Table value, but the true soil concentration is actually less than the BTV or MRL. Even though there are many different types of uncertainty, the uncertainty we are incorporating into the Look-Up Table is analytical measurement uncertainty (U_m) and only for the chemicals included in DTSC's chemical background study.

The HydroGeoLogic, Inc., Final Technical Memorandum Look-Up Table Recommendations Santa Susana Field Laboratory, Area IV Radiological Study (November 2012) describes method uncertainty in greater detail.

Analytical Measurement Uncertainty

Using a Look-Up Table approach to assess cleanup actions requires high quality, precise, and accurate laboratory data. DTSC and USEPA provide guidance to ensure laboratory data meets project requirements and is reliable and defensible.

Continuing calibration acceptance criteria values for various laboratory methods are used to address analytical measurement uncertainty and to ensure the quality, precision, and accuracy of analytical results. These published values represent industry-wide requirements for data acceptability. DTSC used these values to account for analytical measurement uncertainty when developing the Look-Up Table values. Table 1 (attached) shows the continuing calibration acceptance criteria values by method. Note: Continuing calibration acceptance criteria values are usually higher when analytical instruments are trying to detect a chemical at very low levels. Because background levels for many chemicals are low (e.g. perchlorate), DTSC used the higher calibration value in developing the analytical measurement uncertainty.

Analytical Method Reporting Limits

A method reporting limit (MRL) is the minimum level that an analytical instrument can report and provide a reliable (accurate and precise) result. For chemicals without a background threshold value, the MRL is the Look-Up Table value. MRLs can vary by sample due to numerous reasons — interferences from other compounds in the sample itself, different instrument sensitivities, sample preparation procedures, operator qualifications and knowledge, etc. Different labs using the same method for sample analysis often have different MRLs.

All three responsible parties will require large numbers of samples to confirm the cleanup. Being able to maintain proper quality control while depending on a single laboratory for all three responsible parties is problematic due to capacity constraints. Use of a single laboratory also create a single point of failure and can increase the risk of project delays. Because of the size and scope of the SSFL cleanup, several analytical laboratories will be required to meet the sampling demands to confirm that SSFL cleanup objectives are achieved. DTSC reviewed and evaluated the MRLs from several different laboratories and from the results of recent and current investigation work conducted on the site (multi-lab MRL study).

For all the chemicals that were not part of DTSC's chemical background study (e.g., volatile organic compounds), the Look-Up Table value is the chemical-specific MRL from the multi-lab study. Because the multi-lab MRLs are routine and practicable, DTSC has not included an adjustment for measurement uncertainty in the multi-lab MRL results.

For chemicals analyzed in DTSC's chemical background study, but the background sampling results did not allow for derivation of a background threshold value (e.g. low percentages of detection), DTSC used the respective measurement reporting limit from the background study, adjusted for analytical measurement uncertainty, as the Look-Up Table value. DTSC included the analytical measurement uncertainty adjustment to the background study MRLs, as the background study programmatic needs were unique (e.g., non-routine) and resulted in very low MRLs which are likely not routinely achievable.

Addressing Uncertainty

When reported laboratory results exceed Look-Up Table values, action is required. Chemical Look-Up Table values were calculated as follows:

$$\text{Look-Up Table value} = \text{Cleanup Level} + 1.645 * U_M$$

Where:

Cleanup Level = the greater of the BTV or the DTSC background Study method reporting limit

U_M = the analytical measurement uncertainty (See Table 1)* BTV or MRL

1.645 = the normal distribution quantile consistent with 5% Type I decision error (see MARLAP (US EPA 2004) for more information.)

The Look-Up Table

During the cleanup, all individual sample results will be compared to the respective Look-Up Table values. If the individual sample result is greater than the Look-Up Table values then two options are available; 1) the suspect sample may be re-analyzed to verify the original result; or 2) additional soil may be cleaned up and additional confirmation samples taken.

In regard to metals, some elevated values may be attributed to localized mineralized zones. DTSC will consider a lines-of-evidence approach (e.g., fracture fill of pyrite where minerals are visible, appropriate iron/arsenic ratios, spatial distribution of samples, etc.) in evaluation of elevated metals that appear to be attributed to local mineralization.

References

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Van den Berg, M., *et al*. 2006. "The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds." Toxicological Sciences 93(2): 223-241. http://www.who.int/foodsafety/chem/2005_WHO_TEFs_ToxSci_2006.pdf

DTSC Chemical Look-Up Table for DOE NASA at SSFL

June 2013

Chemical Constituent	Units	Look-Up Table Value	Basis
Alcohols - EPA Method 8015B			
Ethanol	mg/kg	0.7	BG MRL
Methanol	mg/kg	0.7	BG MRL
Anions - EPA Methods 300.0 / 9056A			
Fluoride	mg/kg	10.2	BTV
Nitrate	mg/kg	22.3	BTV
Cyanide - EPA Method 9012A			
Cyanide	mg/kg	0.6	BG MRL
Dioxin-Furans - EPA Method 1613B			
1,2,3,4,6,7,8-HpCDD	pg/g	see note[1]	---
1,2,3,4,6,7,8-HpCDF	pg/g	see note[1]	---
1,2,3,4,7,8,9-HpCDF	pg/g	see note[1]	---
1,2,3,4,7,8-HxCDD	pg/g	see note[1]	---
1,2,3,4,7,8-HxCDF	pg/g	see note[1]	---
1,2,3,6,7,8-HxCDD	pg/g	see note[1]	---
1,2,3,6,7,8-HxCDF	pg/g	see note[1]	---
1,2,3,7,8,9-HxCDD	pg/g	see note[1]	---
1,2,3,7,8,9-HxCDF	pg/g	see note[1]	---
1,2,3,7,8-PeCDD	pg/g	see note[1]	---
1,2,3,7,8-PeCDF	pg/g	see note[1]	---
2,3,4,6,7,8-HxCDF	pg/g	see note[1]	---
2,3,4,7,8-PeCDF	pg/g	see note[1]	---
2,3,7,8-TCDD	pg/g	see note[1]	---
2,3,7,8-TCDF	pg/g	see note[1]	---
OCDD	pg/g	see note[1]	---
OCDF	pg/g	see note[1]	---
2,3,7,8-TCDD TEQ			
2,3,7,8-TCDD TEQ[1]	pg/g	0.912 (see note[1])	BTV-TEQ
Energetics - EPA Method 8330			
RDX	µg/kg	300	M-L MRL
Formaldehyde - EPA Method 8315A			
Formaldehyde	µg/kg	1,870	BG MRL

Chemical Constituent	Units	Look-Up Table Value	Basis
Herbicides - EPA Method 8151A			
2,4,5-T	µg/kg	1.2	BTV
2,4,5-TP	µg/kg	0.63	BTV
2,4-D	µg/kg	5.8	BTV
2,4-DB	µg/kg	2.4	BG MRL
2,4-DP (Dichloroprop)	µg/kg	2.4	BTV
Dalapon	µg/kg	12.5	BG MRL
Dicamba	µg/kg	1.3	BTV
Dinoseb	µg/kg	3.3	BG MRL
MCPA	µg/kg	761	BTV
MCPP (Mecoprop)	µg/kg	377	BTV
Pentachlorophenol	µg/kg	170	M-L MRL
Metals - EPA Methods 6010B/6020A			
Aluminum	mg/kg	58,600	BTV
Antimony	mg/kg	0.86	BTV
Arsenic	mg/kg	46	BTV
Barium	mg/kg	371	BTV
Beryllium	mg/kg	2.2	BTV
Boron	mg/kg	34	BTV
Cadmium	mg/kg	0.7	BTV
Chromium	mg/kg	94	BTV
Cobalt	mg/kg	44	BTV
Copper	mg/kg	119	BTV
Lead	mg/kg	49	BTV
Lithium	mg/kg	91	BTV
Manganese	mg/kg	1,120	BTV
Molybdenum	mg/kg	3.2	BTV
Nickel	mg/kg	132	BTV
Potassium	mg/kg	14,400	BTV
Selenium	mg/kg	1	BTV
Silver	mg/kg	0.2	BTV
Sodium	mg/kg	1,780	BTV
Strontium	mg/kg	163	BTV
Thallium	mg/kg	1.2	BTV
Vanadium	mg/kg	175	BTV
Zinc	mg/kg	215	BTV
Zirconium	mg/kg	19	BTV
Hexavalent Chromium - EPA Methods 7199/7196A			
Hexavalent Chromium	mg/kg	2	BTV
Mercury - EPA Methods 7471A/7470A			
Mercury	mg/kg	0.13	BG MRL
Methyl Mercury - EPA Method 1630 (Mod)			
Methyl Mercury	µg/kg	0.05	M-L MRL

DTSC Chemical Look-Up Table for DOE NASA at SSFL

June 2013

Chemical Constituent	Units	Look-Up Table Value	Basis
PCBs / PCTs - EPA Method 8082			
Aroclor 1016	µg/kg	17	M-L MRL
Aroclor 1221	µg/kg	33	M-L MRL
Aroclor 1232	µg/kg	17	M-L MRL
Aroclor 1262	µg/kg	33	M-L MRL
Aroclor 1254	µg/kg	17	M-L MRL
Aroclor 1260	µg/kg	17	M-L MRL
Aroclor 1268	µg/kg	33	M-L MRL
Aroclor 1242	µg/kg	17	M-L MRL
Aroclor 1248	µg/kg	17	M-L MRL
Aroclor 5432	µg/kg	50	M-L MRL
Aroclor 5442	µg/kg	50	M-L MRL
Aroclor 5460	µg/kg	50	M-L MRL
Perchlorate - EPA Methods 6850/6860			
Perchlorate	µg/kg	1.63	BTV
Pesticides - EPA Method 8081A			
Aldrin	µg/kg	0.24	BG MRL
Alpha-BHC	µg/kg	0.24	BG MRL
Beta-BHC	µg/kg	0.23	BTV
Chlordane	µg/kg	7	BTV
Delta-BHC	µg/kg	0.22	BTV
Dieldrin	µg/kg	0.48	BG MRL
Endosulfan I	µg/kg	0.24	BG MRL
Endosulfan II	µg/kg	0.48	BG MRL
Endosulfan Sulfate	µg/kg	0.48	BG MRL
Endrin	µg/kg	0.48	BG MRL
Endrin Aldehyde	µg/kg	0.7	BTV
Endrin Ketone	µg/kg	0.7	BTV
Gamma-BHC - Lindane	µg/kg	0.24	BG MRL
Heptachlor	µg/kg	0.24	BG MRL
Heptachlor Epoxide	µg/kg	0.24	BG MRL
Methoxychlor	µg/kg	2.4	BG MRL
Mirex	µg/kg	0.5	BTV
p,p-DDD	µg/kg	0.48	BG MRL
p,p-DDE	µg/kg	8.6	BTV
p,p-DDT	µg/kg	13	BTV
Toxaphene	µg/kg	8.8	BG MRL

DTSC Chemical Look-Up Table for DOE NASA at SSFL

June 2013

Chemical Constituent	Units	Look-Up Table Value	Basis
Semi-Volatiles (SVOCs)/PAHs - EPA Method 8270C(SIM)			
Acenaphthylene	µg/kg	2.5	BG MRL
Anthracene	µg/kg	2.5	BG MRL
Benzo(a)anthracene	µg/kg	see note [2]	---
Benzo(a)pyrene	µg/kg	see note [2]	---
Benzo(b)fluoranthene	µg/kg	see note [2]	---
Benzo(g,h,i)perylene	µg/kg	2.5	BG MRL
Benzo(k)fluoranthene	µg/kg	see note [2]	---
Bis(2-Ethylhexyl)phthalate	µg/kg	61	BTV
Butylbenzylphthalate	µg/kg	100	BTV
Chrysene	µg/kg	see note [2]	---
Dibenz(a,h)anthracene	µg/kg	see note [2]	---
Diethyl phthalate	µg/kg	27	BG MRL
Dimethyl phthalate	µg/kg	27	BG MRL
Di-n-butylphthalate	µg/kg	27	BG MRL
Di-n-octylphthalate	µg/kg	27	BG MRL
Fluoranthene	µg/kg	5.2	BTV
Fluorene	µg/kg	3.8	BTV
Indeno(1,2,3-cd)pyrene	µg/kg	see note [2]	---
Naphthalene	µg/kg	3.6	BTV
Phenanthrene	µg/kg	3.9	BTV
Pyrene	µg/kg	5.6	BTV
1-Methyl naphthalene	µg/kg	2.5	BG MRL
2-Methylnaphthalene	µg/kg	2.5	BG MRL
Acenaphthene	µg/kg	2.5	BG MRL
Benzo(a)pyrene Equivalent			
Benzo(a)pyrene TEQ[2]	µg/kg	4.47 (see note[2])	BTV-TEQ
Other SVOCs			
Benzoic Acid - EPA 8270	µg/kg	660	M-L MRL
N-Nitrosodimethylamine - 8270C(SIM)	µg/kg	10	M-L MRL
Phenol - EPA 8270	µg/kg	170	M-L MRL
TPH - EPA Method 8015			
TPH EFH (C15-C20)[3]	mg/kg	5 (see note[3])	M-L MRL
Terphenyls - EPA Method 8015			
o-Terphenyl	mg/kg	7	M-L MRL

Chemical Constituent	Units	Look-Up Table Value	Basis
VOCs - EPA Method 8260			
1,1-Dichloroethene	µg/kg	5	M-L MRL
1,4-Dioxane - EPA 8260 (SIM)	µg/kg	10	M-L MRL
2-Hexanone	µg/kg	10	M-L MRL
Acetone	µg/kg	20	M-L MRL
Benzene	µg/kg	5	M-L MRL
cis-1,2-Dichloroethene	µg/kg	5	M-L MRL
Ethylbenzene	µg/kg	5	M-L MRL
Hexachlorobutadiene	µg/kg	5	M-L MRL
Methylene chloride	µg/kg	10	M-L MRL
Tetrachloroethene	µg/kg	5	M-L MRL
Toluene	µg/kg	5	M-L MRL
Trichloroethene	µg/kg	5	M-L MRL
Vinyl chloride	µg/kg	5	M-L MRL

Notes:

mg/kg: milligrams per kilogram (parts per million)
µg/kg: micrograms per kilogram (parts per billion)
pg/g: picograms per gram (parts per trillion)
BTV: Background threshold value
BG-MRL: Background method reporting limit
M-L MRL: Multi-Lab method reporting limit
PAH: Polyaromatic hydrocarbon
PCB: Polychlorinated biphenyl
PCT: Polychlorinated terphenyl
RDX: Research Department Explosive
SIM: Selective ion monitoring
SVOC: Semi-volatile organic compound
TEQ: Toxicity equivalency
TPH EFH: Total petroleum hydrocarbon - extractable fuel hydrocarbon
VOC: Volatile organic compound

[1] DTSC applied the World Health Organization's 2,3,7,8-TCDD toxicity equivalence approach for dixoin-furans. To evaluate 2,3,7,8-TCDD equivalence, dixoin-furans need to meet respective background study MRLs.

[2] Benzo(a)pyrene equivalence developed based on sum of carcinogenic PAHs. In order to evaluate Benzo(a)pyrene equivalence, carcinogenic PAHs need to meet respective background study MRLs.

[3] For locations where TPH is the sole contaminant, a cleanup strategy will be considered based on the findings of soil treatability study.

Table 1
Continuing Calibration Acceptance Criteria
and Chemical Method Uncertainty Values

Chemical Class [a]	Analytical Method	Continuing Calibration Acceptance Criteria [b]	Analtyical Method Uncertainty
VOCs [c]	8260c	+/- 20% mid-level, +/- 30% low range	30%
SVOCs [c]	8270d	+/- 20% mid-level, +/- 30% low range	30%
Perchlorate [c]	6850/6860	+/- 15% mid-level, +/- 50% low range	50%
Metals	6010c	+/- 10%	10%
Metals	6020b	+/- 10%	10%
Mercury	7470a/7471a	+/- 20%	20%
Hexavalent Chromium [c]	7199	+/- 10%	10%
Ammonia	350.1	+/- 10%	10%
Anions	300.0	+/- 10%	10%
Cyanide	9012b	+/- 10%	10%
PCBs	8082a	+/- 20%	20%
Formaldehyde/Hydrazine	8315	+/- 15%	15%
TPH	8015d	+/- 20%	20%
Energetics	8330a	+/- 20%	20%
Pesticides	8081a	+/- 20%	20%
Herbicides	8151a	+/- 20%	20%
Dioxins & Furans	1613	+/- 20%	20%

Notes:

a - This table includes chemical classes where analytical measurement uncertainty is applicable for Look-Up Table development.

b - Continuing calibration uncertainty is the method specific acceptance criteria for instrument performance for contiuing the analysis of samples by comparing an analyte response to the response established in the intital calibration of the instrument.

c - For methods with continuing calibration acceptance criteria at the low end of the calibration range and at the middle of the calibration range, the criteria at the low end of the calibration range as it is most representative of the uncertainty near the reporting limit.

d - For Hexavalent Chromium, the more conservative of the two methods' continuing calibration uncertainty is provided.