Evaluation of Cancer Risk Levels Underlying Final Cleanup Levels at Superfund Sites in USEPA Region 6

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PREPARED FOR:

Sabine Lange, Ph.D., DABT
Section Manager and Project Manager
Toxicology, Risk Assessment, and Research Division
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, TX 78753

PREPARED BY:

ToxStrategies, Inc.
9390 Research Blvd.
Suite 100
Austin, TX 78759

Table of Contents

List of Tables

Acronyms

ADEQ	Arkansas Department of Environmental Quality
ARARs	applicable or relevant and appropriate requirements
COC	chemical of concern
COPC	chemical of potential concern
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
ECRL	excess cancer risk level
ESD	Explanation of Significant Differences
HI	hazard index
LDEQ	Louisiana Department of Environmental Quality
MCL	maximum contaminant level
MO	management option
NCI SEER Program	National Cancer Institute's Surveillance, Epidemiology, and End Results
NMED	New Mexico Environment Department
ODEQ	Oklahoma Department of Environmental Quality
OU	operable unit
PCE	tetrachloroethylene
PCL	protective concentration level
PRG	preliminary remediation goal
R6	Region 6
RAGS	Risk Assessment Guidance for Superfund
RBCL	risk-based cleanup level
RDX	1,3,5-trinitro-1,3,5-triazine
RECAP	Risk Evaluation/Corrective Action Program
ROD	Record of Decision
RSLs	USEPA's Regional Screening Levels
SO	screening option
SSLs	soil screening levels
TCE	trichloroethylene
TCEF	Texas Campaign for the Environment Fund
TCEQ	Texas Commission on Environmental Quality
TEQ	toxicity equivalence for dioxins and dioxin-like compounds
TNT	2,4,6-trinitrotoluene
TRRP	Texas Risk Reduction Program
USAF	U.S. Air Force
USEPA	U.S. Environmental Protection Agency

1 Executive Summary

Under the TCEQ's Texas Risk Reduction Program (TRRP) Rule, chemical-specific protective concentration levels (PCLs) are used as cleanup values for remediation of contaminated sites. For those PCLs that are based on cancer, the individual chemical PCLs are set at a 1-in-100,000 ($1x10^{-5}$) cancer risk level. The TCEQ has been criticized by some for not applying a more conservative cancer risk level (i.e., 1-in-1,000,000 [$1x10^{-6}$]) for individual chemicals of concern (COCs) based on a presumption that final cleanup levels relied upon by the USEPA and other states in USEPA Region 6 (i.e., Arkansas, Louisiana, New Mexico, and Oklahoma) are based on a cancer risk level of $1x10^{-6}$. It is common for risk assessors to use the more conservative $1x10^{-6}$ cancer risk level to *screen* chemicals of potential concern (COPCs) at a site (e.g., while conducting a baseline risk assessment or in the development of USEPA Regional Screening Levels [RSLs]). At the time of drafting of the TRRP Rule, the TCEQ determined that final cleanup levels actually used by USEPA as the basis for remedial action were based on cancer risk levels ranging from $1x10^{-4}$ to $1x10^{-6}$, with most typically based on a cancer risk level that was less stringent than $1x10^{-6}$. To expedite remediation of contaminated sites within the State of Texas, with the promulgation of the TRRP Rule, the TCEQ eliminated the baseline risk assessment and adopted a $1x10^{-5}$ excess cancer risk level for development of PCLs for all individual carcinogenic COCs.

In accordance with Work Order Under Umbrella Contract #582-20-10533 Between TCEQ and ToxStrategies, Inc., Records of Decision Risk Levels from Remediation Sites, Work Order No.: 01 (PCR 14560), Contract No.: 582-20-10533, Scientific Expertise and Research Contract, ToxStrategies was charged with evaluating Records of Decision for Superfund Sites within all USEPA Region 6 states to determine the cancer risk level that was used as the basis of final cleanup levels for individual COCs across sites in Region 6 states. This work was conducted through the following two tasks: Task 1 – performing a comprehensive review of the basis of final cleanup levels established in RODs for Region 6 Superfund sites between 2000-2019, and Task 2 – reviewing and summarizing the applicable guidelines/rules for establishing cleanup levels set forth by the environmental regulatory agencies in the Region 6 states outside of Texas. This report summarizes the findings for these two tasks.

A search of the USEPA ROD Database identified over 130 relevant ROD documents published for Region 6 Superfund sites between 2000-2019. These documents represented nearly 100 Operable Units (OUs) across 75 Superfund sites in USEPA Region 6 (n=35 in Texas), of which 32 reported cancer risk level information for chemical-specific cleanup levels considered as a part of the remedial action decision. The specific cancer risk levels used to establish the final cleanup levels were identified in the ROD documents for these 32 OUs. Overall, there were 108 cleanup levels based on cancer, representing 41 carcinogenic COCs. The USEPA was clearly identified in the ROD documents as the lead agency for site remediation for 28 of the 32 OUs. The cancer risk

levels underlying the 108 cleanup levels ranged from $1x10^{-6}$ to $2x10^{-4}$, with a large majority of cleanup values (78%) based on a cancer risk level of ≥ $1x10^{-5}$. The average cancer risk level across the 108 cleanup values for carcinogenic COCs (i.e., $1.4x10^{-5}$) exceeded the TCEQ cancer risk level used to establish the PCLs, while the median cancer risk level was equal to the TCEQ cancer risk level ($1x10^{-5}$).

A review of the documentation related to the remediation of contaminated sites for the Region 6 states outside of Texas indicated that most of the states employ a tiered approach involving an initial screen using conservative screening levels, followed by the development of site-specific remediation goals. Documentation of Louisiana's Risk Evaluation/Corrective Action Program (RECAP) demonstrates a preference for management options predicated on $1x10^{-6}$ cancer risk level, whereas remediation guidance documents for New Mexico apply a chemical-specific cancer risk level of $1x10^{-5}$, similar to TCEQ. While Oklahoma's policy is to use a cancer risk level of $1x10^{-5}$, available information indicates that cumulative excess cancer risk should not exceed the same risk level. Arkansas does not appear to have an established default target cancer risk level for carcinogenic COCs, although the examples provided in their guidance documentation involved a cancer risk level of $1x10^{-5}$.

In conclusion, based on a comprehensive review of Superfund RODs for Region 6 states, as well as documentation related to risk-based corrective action programs in other Region 6 states, the cancer risk level used by the TCEQ to develop PCLs for individual COCs is demonstrably as protective as – or more protective than – that used to develop final cleanup levels that serve as the basis of remedial action in the majority of cases.

2 Background

In addressing contaminated sites, USEPA typically identifies COCs for a given site through a screening process in which the measured levels of the COPCs identified at the site are compared to highly conservative chemical specific RSLs. These screening levels are typically based on conservative exposure assumptions and are derived using applicable carcinogenic and/or non-carcinogenic chemical-specific toxicity values. In developing the RSLs for carcinogenic chemicals, the USEPA uses a $1x10^{-6}$ cancer risk level. Those COPCs with measured concentrations that exceed the USEPA RSLs are identified as COCs and are carried forward into the baseline risk assessment. As a part of the baseline risk assessment, cancer risks and noncancer hazards posed by the COCs are characterized using assumptions concerning human exposures (i.e., "exposure scenarios") that are predicated on the current and future land uses (e.g., industrial versus residential land use activities, where expected exposures can be distinguished by who is exposed, how often and for how long they are exposed, and by what routes they might be exposed). Predictions of the human health impact of exposures to carcinogenic and noncarcinogenic chemicals are quantified using "excess cancer risk levels" (ECRLs) and "hazard indices" (HI), respectively. For carcinogenic COCs, the risk estimates are coined "excess cancer risks" because they represent cancer risks in addition to those an individual in the general population already experiences (e.g., from sun exposure, diet, smoking, etc.). That is, in addition to what the National Cancer Institute's Surveillance, Epidemiology, and End Results Program (SEER) reports to be the approximately 2-in-5 chance for a man or woman in the United States of developing cancer at some point in their life (NCI, 2020). As a general policy, USEPA uses the baseline risk assessment to determine the need for remedial action. The 1990 National Contingency Plan (NCP) (55 Fed. Reg. 8665-8865; Mar. 8, 1990) defines the acceptable cancer risk level as ranging from $1x10^{-4}$ to $1x10^{-6}$. As outlined in the USEPA OSWER Directive 9355.0-30 (USEPA, 1991), when the baseline risk assessment indicates that the cumulative cancer risk exceeds $1x10^{-4}$, remedial action is warranted. When remedial action is taken at sites posing cancer risks in the range of $1x10^{-4}$ to $1x10^{-6}$, the ROD must explain the reason why remedial action was warranted.

Under the TCEQ's TRRP Rule, chemical-specific PCLs are used as final cleanup values for contaminated sites, and for those PCLs that are based on cancer, the individual chemical PCLs are set at a 1-in-100,000 ($1x10^{-5}$) cancer risk level. The TCEQ has been criticized by some for not applying a more conservative cancer risk level (i.e., 1-in-1,000,000 [$1x10^{-6}$]) for individual COCs based on a presumption that final cleanup levels relied upon by USEPA and other states in USEPA Region 6 (i.e., Arkansas, Louisiana, New Mexico, and Oklahoma) are based on a cancer risk level of $1x10^{-6}$. A 2018 report by the Texas Campaign for the Environment Fund (TCEF) titled "Missing the Mark" (hereafter referred to as the "TCEF Report") asserts that the TCEQ PCLs for carcinogens are "1,682% weaker" than federal Superfund thresholds, and "substantially weaker than those used in other nearby states" (TCEF, 2018). The TCEF Report goes on to state that "Texas tolerates cancer risks 10 times higher than most of these agencies" and asserts

that Texas PCLs would be safer and more protective of human health and the environment if they were instead based on the more conservative target cancer risk level of $1x10^{-6}$ used by the USEPA in developing their RSLs and by other Region 6 states like Oklahoma, Arkansas, and Louisiana. This specific criticism appears to be the basis of a legislative proposal in a new Texas State House Bill (House Bill No. 858).

While the USEPA and some Region 6 states use the $1x10^{-6}$ cancer risk level to *screen* COPCs (e.g., while conducting a baseline risk assessment or in the development of USEPA RSLs), at the time of drafting of the TRRP Rule, the TCEQ determined that final cleanup levels actually used by USEPA as the basis for the remedial action were in fact based on cancer risk levels ranging from $1x10^{-4}$ to $1x10^{-6}$, with most typically based on a cancer risk level that was less stringent than $1x10^{-6}$. In order to expedite remediation of contaminated sites within the State of Texas, with the promulgation of the TRRP Rule, the TCEQ eliminated the baseline risk assessment and adopted a $1x10^{-5}$ excess cancer risk level for development of PCLs for all individual carcinogenic COCs.

In order to address concerns raised in the TCEF Report, ToxStrategies was charged with evaluating RODs for Superfund Sites within all USEPA Region 6 states to determine the cancer risk level that was used as the basis of final cleanup levels for individual COCs across sites in Region 6 states. This effort involved the following two tasks: Task 1 – performing a comprehensive review of the basis of final cleanup levels established in RODs for Region 6 Superfund sites between 2000-2019, and Task 2 – reviewing and summarizing the applicable guidelines/rules for establishing cleanup levels set forth by the environmental regulatory agencies in the Region 6 states outside of Texas. The methodology employed to carry out these two tasks, along with the findings of these analyses, are presented the sections that follow.

3 Approach and Methods

3.1 Process for Identifying, Downloading, Processing, and Evaluating Documents from the USEPA's Online Superfund Records of Decision Database (Task 1)

USEPA is required to draft Records of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). In accordance with CERCLA/SARA, RODs present the remedial action(s) determined for federal Superfund sites based on remedial investigations/feasibility studies and public comments/community concerns (USEPA, 1999). A ROD may describe the remedial decision(s) for the Superfund site as a whole (assessed as a single "operable unit", or "OU"), or the site maybe divided into two or more OUs depending on the complexity of contamination issues present at the site. The decisions described in ROD documents can be revisited by the lead agencies (typically USEPA) for various reasons, including the revision of remedial actions and/or updating cleanup levels prescribed in the original ROD. Such changes to the ROD are described in ROD Amendments and Explanation of Significant Differences (ESDs) documents. Thus, any given Superfund site may have one or more relevant ROD documents depending on how many OUs were defined by the lead agency and/or how many subsequent changes have been made to the RODs.

Task 1 involved the identification, collection, extraction, and evaluation of RODs and/or related documents (e.g., ROD Amendments, ESDs, etc.) publicly available in the USEPA ROD Database for federal Superfund sites in USEPA Region 6 (i.e., Arkansas, Louisiana, New Mexico, Oklahoma, and Texas) for the years 2000-2019. The USEPA's ROD Database is publicly accessible at: https://www.epa.gov/superfund/search-superfund-decision-documents. By applying the "Region" database filter to select only Region 6 site entries, ToxStrategies was able to download all pdf files from the USEPA ROD Database that fell within the date range of 1/1/2000 – 12/31/2019, which was of interest to the TCEQ. This download from the USEPA ROD Database was executed on August 14, 2020. For the purposes of organization, the pdf files were binned based on the year they were completed and approved by the USEPA (i.e., twenty bins, one for each year from 2000-2019).

A database was then created for Region 6 Superfund site decision documents using Microsoft Excel to document key site and cleanup/remediation information from each of the downloaded pdfs (Supplemental Excel file 1). While the focus of the assessment was to document the cancer risk level that served as the basis for the final cleanup levels for carcinogenic COCs at each of the USEPA Region 6 Superfund sites, additional information was captured to provide context for each Superfund site decision document. As each of the documents were reviewed, the following categories of

information were extracted into the Region 6 database (if presented in the relevant ROD document(s)):

- pdf filename (USEPA designation for each file based on download)
- USEPA site identification number
- State where superfund site resides
- Superfund site name
- Operable unit(s) (OUs)[1]
- Document date
- Document type
- Document title
- Number of document pages
- Lead agency for site remediation as designated in document
- Statement of basis and purpose
- Description of selected remedy
- Media being remediated
- Exposure scenario driving cancer risk
- Chemical(s) driving cancer risk
- Individual chemical target cancer risk level(s) for COPC screening criteria
- Individual chemical target cancer risk level(s) for final cleanup value(s)
- Relevant excerpts from the document describing/supporting the decision basis for the cancer risk level underlying the final cleanup level
- Notes providing additional context

[1] Several Region 6 Superfund site ROD documents did not identify the OU by number (e.g., OU1, OU2, etc.) but stated that the site was not divided into separate OUs. For the purposes of this assessment, the whole site was designated as OU1* when this was clearly stated. In cases where no OU number was identified and this site characterization was not clearly stated, it was noted as "not reported".

The most recent ROD document was used for purposes of determining the final cleanup levels and cancer risk level ultimately relied upon in completing the remedial action. In some cases, "post-ROD" documents represented the most recent ROD document available for a contaminated site or operable unit (e.g., ROD Amendment, ESD, etc.). In cases where post-ROD documents (e.g., ROD Amendment, ESD, etc.) did not include information concerning the cancer risk level underlying the amended cleanup level where applicable, but which referenced pre-2000 ROD documents that may have presented such information, those earlier ROD documents were noted in the Region 6 database.

In the course of reviewing the ROD documents, it became apparent that the reporting structure and level of detail provided varied substantially across the documents. The more recent ROD documents typically provided more detailed information regarding the basis for remedial actions and cleanup levels (if applicable) than did the older documents for the period of interest (i.e., 2000-2019). In addition, during the course of the review, it became apparent that the USEPA ROD Database for Region 6 is incomplete. For example, there was at least one instance where a ROD document referenced a prior ROD document contained within the 2000-2019 date range, however, that document was not included in the USEPA ROD Database. In such cases, an effort was made to search the USEPA's online Superfund resources to locate the missing ROD document(s). In addition, there were instances where the ROD documents were misidentified or mislabeled in the Database. In some cases, these represented duplicates of other ROD documents relevant to this assessment; in other cases, the USEPA ROD Database misidentified ROD documents that were older than the analysis data range or were not relevant to Region 6 states. Such instances were documented in the Region 6 database.

Overall, this assessment is limited to the completeness and integrity of the USEPA's ROD Database. The Database errors and limitations noted above suggest the possibility that the RODs captured and evaluated for this report may not represent a complete library of the relevant RODs for USEPA Region 6 Superfund sites for the years 2000-2019, though the volume of documents reviewed as a part of this assessment is substantial and provides considerable evidence concerning the cancer risk levels underlying the final cleanup levels for sites across all of USEPA Region 6.

3.2 Process for Identifying, Downloading, and Processing ROD Documents Relevant to State Superfund Sites (Task 2)

As outlined in the original Workplan, Task 2 involved identifying ROD documents for state Superfund sites across USEPA Region 6 states and collecting information concerning the cancer risk level underlying final cleanup levels established by these states. Subsequent research indicated that ROD documents are prepared by USEPA regardless of whether the USEPA or the state serves as the lead. As such, based on discussions with the TCEQ, it was decided that it would be more useful to collect and

summarize information (e.g., applicable guidance documents, rules, etc.) concerning the risk-based corrective action programs in place in the Region 6 states outside of Texas. To this end, the following state agencies and their websites were searched:

1. Arkansas Department of Environmental Quality (ADEQ)

2. Louisiana Department of Environmental Quality (LDEQ)

3. New Mexico Environment Department (NMED)

4. Oklahoma Department of Environmental Quality (ODEQ)

General Google searches also were performed to identify any other relevant materials for each of these states. The guidance materials were downloaded from the websites for each of these Region 6 state environmental regulatory agencies, and text was mined for information relevant to the cancer risk levels used in the development of final cleanup values at state sites. Relevant text was extracted and incorporated into a spreadsheet and is also summarized in Section 4 below.

4 Summary of Cancer Risk Levels Underlying Final Cleanup Levels for Carcinogenic COCs Documented in USEPA ROD Database

A search of the USEPA ROD Database for documents published between 2000 and 2019 for Region 6 Superfund sites yielded a total of 133 relevant documents. These 133 documents included RODs, as well as ROD Amendments and ESDs. Table 1 provides a summary of the number of relevant ROD documents by state, the specific number of sites represented by those documents, and the number of OU-specific ROD documents represented by those sites.

Table 1. USEPA ROD Database inventory for Region 6 Superfund sites for the period of interest (i.e., 2000-2019)

State	No. Documents for R6 Superfund Sites in ROD Database (2000-2019)	No. Unique R6 Superfund Sites in ROD Database (2000-2019) *	No. OU-Specific ROD Documents Across Unique R6 Superfund Sites †
Arkansas	8	6	7
Louisiana ^	22	11	16
New Mexico ‡	17	12	12
Oklahoma §	24	11	16
Texas #	62	35	46
Total	**133**	**75**	**97**

* Defined by unique site name and corresponding EPA site ID.

† Each unique Superfund site can have multiple operable units (OUs). Depending on the decisions of the lead federal and state regulatory agencies for a given site, a single ROD can address all site OUs, or the site OUs can be addressed across separate and unique RODs.

^ Does not include a 2020 ROD captured in document collection stage.

‡ One ESD referenced an earlier ROD from 2002 that was not in USEPA ROD Database (AT&SF site). Because this ROD was within the date range designated for this analysis, the ROD document was retrieved from EPA's NPL page for this site and included in the analysis.

§ Two initial document entries for OK sites from USEPA ROD Database download were removed for either being a mislabeled duplicate of another OK site (2006 ESD Double Eagle Refinery document was actually a duplicate 2006 ESD of the Fourth Street Abandoned Refinery site) or a mislabeled 2006 ROD Amendment for a Region 7 site (Baxter Springs and Treece subsites in Cherokee Co, KS).

Two initial document entries for TX from the USEPA ROD Database download were removed for being outside of the 2000-2019 project date range. Both the Amended ROD for the Brio Refining site (tagged in the USEPA ROD Database with the date of 1/21/2016) and the ROD for the Crystal Chemical Co. site (tagged in the USEPA ROD Database with the date of 9/27/2000) referenced documents dated in 1997 and 1990, respectively.

Of the 97 OU-specific ROD documents identified in the USEPA ROD Database for Region 6 during the years 2000-2019, approximately one-third included risk-based cleanup levels for carcinogenic COCs (Table 2). There were over 100 chemical-specific risk-based cleanup levels for carcinogenic COCs across these 32 OUs. As indicated in Table 2, the majority of final cleanup levels for carcinogenic COCs (84 of 108, or 78%) were based cancer risk levels greater than or equal to $1x10^{-5}$. These include two cleanup levels each in Arkansas and Louisiana with risk levels equal to $1x10^{-4}$, and two cleanup levels in New Mexico greater than $1x10^{-4}$.

Table 2. Summary of risk level basis of ROD COC cleanup levels for carcinogens identified in Region 6 Superfund site RODs for the period of interest (i.e., 2000-2019)

State	No. OU-Specific RODs for R6 Superfund Sites	No. OUs Reporting Cancer Risk-Based Cleanup Levels (RBCLs)*	No. Chemical- and Media-specific RBCLs	RBCLs with risk levels >$1x10^{-4}$	RBCLs with risk levels from $1x10^{-4}$ – >$1x10^{-5}$	RBCLs with risk levels = $1x10^{-5}$	RBCLs with risk levels = $1x10^{-6}$
Arkansas	7	2	5	0	2	1	2
Louisiana	16	4	7	0	2	5	0
New Mexico	12	5	17	2	0	4	11†
Oklahoma	16	5	12	0	3	5	4 ^
Texas ‡	46	15	67	0	0	60	7 §
Total	**97**	**31**	**108**	**2**	**7**	**75**	**24**

* Cleanup levels are identified by various terms in the ROD documents. For the purposes of this analysis, Risk-Based Cleanup Levels (RBCLs) are defined as chemical-specific concentrations in site-specific environmental media (e.g., soil, sediment, groundwater, air) that have been designated as either "cleanup levels" or "remediation levels" or "action levels" and for which a specific target excess cancer risk level has been calculated.

† In New Mexico, most of the cleanup levels identified as 10^{-6} risk levels were for MCLs or soil protective of underlying groundwater at the MCLs.

^ Includes a Risk-Based Cleanup Level of $1x10^{-6}$ for "source material waste", as opposed to environmental media, as described in the 2018 Wilcox Oil Company (OK0001010917) site ROD.

‡ In Texas, the 2009 ROD for Malone Service Company has contradicting information regarding the cancer risks level basis used to the develop the remediation levels for 19 carcinogenic COCs ($1x10^{-5}$ vs $1x10^{-6}$). TCEQ scientists involved at this site confirmed the risk level basis was $1x10^{-5}$ for these chemical-specific remediation levels.

§ Includes a Risk-Based Cleanup Level of $4x10^{-6}$, which USEPA calculated for soil PCBs in the ROD for the Old ESCO Manufacturing site ROD (TXD980513808).

The Region 6 Superfund sites that were found to have final risk-based cleanup levels for carcinogenic COCs for the period of interest (i.e., 2000-2019) are listed in Table 3. As shown in Table 4, risk-based cleanup levels were developed for over 40 carcinogenic chemicals or chemical groups (e.g., dioxins, carcinogenic polycyclic aromatic hydrocarbons [cPAHs]) across Superfund sites in USEPA Region 6 for the period of interest (i.e., 2000-2019). As documented in the Region 6 database (see Supplemental Excel file 1), the most common carcinogenic COCs with risk-based cleanup levels across the Region 6 Superfund sites were PAHs (40 risk-based cleanup levels for cPAHs either as individual constituents or as a group), followed by arsenic (10 risk-based cleanup levels), tetrachloroethylene and trichloroethylene (6 risk-based cleanup levels each), vinyl chloride (4 risk-based cleanup levels) and pentachlorophenol (4 risk-based cleanup levels). The majority of risk-based cleanup levels for carcinogenic COCs were derived for soils or soils and sediments (n=67), followed by groundwater (n=20) and sediments only (n=12).

Table 3. Region 6 Superfund sites with risk-based cleanup levels for carcinogenic COCs for the period of interest (i.e., 2000-2019)

State	Superfund Site Identification No.	Superfund Site Name	State	Superfund Site Identification No.	Superfund Site Name
AR	ARD049658628	MOUNTAIN PINE PRESSURE TREATING	TX	TX0000605363	DONNA RESERVOIR AND CANAL SYSTEM
AR	ARD980745665	MIDLAND PRODUCTS	TX	TX4890110527	PANTEX PLANT (USDOE)
LA	LAD000239814	AMERICAN CREOSOTE WORKS, INC. (WINNFIELD PLANT)	TX	TX6213820529	LONGHORN ARMY AMMUNITION PLANT
LA	LAD008187940	CENTRAL WOOD PRESERVING CO.	TX	TXD007330053	GARLAND CREOSOTING
LA	LAD008473142	MARION PRESSURE TREATING	TX	TXD008056152	TEXARKANA WOOD PRESERVING CO.
LA	LAD981054075	HIGHWAY 71/72 REFINERY	TX	TXD008096240	JASPER CREOSOTING COMPANY INC.
NM	NM0000605386	MCGAFFEY AND MAIN GROUNDWATER PLUME	TX	TXD050299577	HART CREOSOTING COMPANY
NM	NM0007271768	GRANTS CHLORINATED SOLVENTS	TX	TXD068104561	PALMER BARGE LINE
NM	NMD001829506	EAGLE PICHER CAREFREE BATTERY	TX	TXD980513808	OLD ESCO MANUFACTURING
NM	NMD002899094	CHEVRON QUESTA MINE	TX	TXD980699656	PESSES CHEMICAL CO.
NM	NMD030443303	UNITED NUCLEAR CORP.	TX	TXD980810386	SOUTH CAVALCADE STREET
OK	OK0001010917	WILCOX OIL COMPANY	TX	TXD980864789	MALONE SERVICE CO - SWAN LAKE PLANT
OK	OK0002024099	IMPERIAL REFINING COMPANY	TX	TXD980873343	NORTH CAVALCADE STREET
OK	OKD082471988	HUDSON REFINERY	TX	TXD980873350	PETRO-CHEMICAL SYSTEMS, INC. (TURTLE BAYOU)
OK	OKD091598870	OKLAHOMA REFINING CO.	TX	TXN000606565	BANDERA ROAD GROUND WATER PLUME
OK	OKD987096195	TULSA FUEL AND MANUFACTURING	-	-	-

Table 4. Carcinogenic COCs with risk-based cleanup levels across USEPA Region 6 Superfund sites for the period of interest (i.e., 2000-2019)

1,1,2-trichloroethane	benzo(a)pyrene	1,2-dichloroethylene (aka DCE)	nickel
1,1,2,2-tetrachloroethane	benzo(b)fluoranthene	dibenz(a,h)anthracene	polychlorinated biphenyls (aka PCBs)
1,2-dibromoethane	benzo(k)fluoranthene	dieldrin	pentachlorophenol
1,2-dichloroethane	bis(2-ethylhexyl)phthalate	dioxins (as a group; aka dioxin TEQ)	radium-226
1,4-dioxane	bromoform	heptachlor epoxide	1,3,5-trinitro-1,3,5-triazine (aka RDX)
2,4-dinitrotoluene	cadmium	hexachlorobenzene	tetrachloroethylene (aka PCE, tetrachloroethene)
2,6-dinitrotoluene	carbazole	hexachlorobutadiene	trinitrotoluene (aka TNT)
aldrin	chloroform	indeno(1,2,3-cd)pyrene	trichloroethylene (aka TCE, trichloroethene)
arsenic	chrysene	methylene chloride	uranium-238
benz(a)anthracene (aka benzo(a)anthracene)	carcinogenic polyaromatic hydrocarbons (as a group; aka cPAHs)	naphthalene	vinyl chloride
benzene	-	-	-

In assessing the cancer risk levels underlying all of the risk-based cleanup levels across USEPA Region 6 Superfund Sites for the period of interest, it was determined that the average cancer risk level reported or described for specific carcinogenic COCs across the 32 OUs is greater than the cancer risk level used in the development of TCEQ's PCLs, and the median cancer risk level is equivalent to that used to develop the TCEQ PCLs (Table 5). This provides strong evidence that the PCLs derived under the TCEQ's TRRP Rule are not less protective than the cleanup levels developed by USEPA for federal Superfund sites within Region 6.

Table 5. Summary statistics for risk-based cleanup levels across Region 6 Superfund sites for the period of interest (i.e., 2000-2019)

Statistic	Excess Cancer Risk Level
No. unique RBCLs (n)	108
Average *	1.4×10^{-5}
Standard Deviation*	2.6×10^{-5}
Median*	1.0×10^{-5}
Minimum	1.0×10^{-6}
Maximum	2.0×10^{-4}

*Summary statistic accounts for 107 of the 108 chemical specific RBCLs. The cleanup level for groundwater arsenic selected for the Chevron Questa Mine site in New Mexico (NMD002899094) is based on the MCL for arsenic. It was included in the RBCL count but not included in the summary statistic calculations because while the information presented in the ROD showed excess cancer risk level calculations > 1.0×10^{-4}, it varied for multiple exposure scenarios.

As indicated in Table 2, of all of the operable units across USEPA Region 6 states for the period of interest, only about one-third reported final risk-based cleanup levels based on cancer. In most cases this was due to non-carcinogenic COCs driving remedial action or because final cleanup levels were based on applicable or relevant and appropriate requirements (ARARs) such as maximum contaminant levels (MCLs). In some cases, the ROD documents failed to report the cancer risk levels underlying the final cleanup level for a carcinogenic COC or referenced a pre-2000 decision document.

In addition to those USEPA Region 6 Superfund sites having risk-based cleanup levels for carcinogenic COCs, there were a number of sites that had carcinogenic COCs present above $1x10^{-6}$ but that USEPA ultimately concluded, based on the results of the baseline risk assessment, that no further action was necessary for those COCs because the cumulative cancer risk was with the Agency's acceptable cancer risk range of $1x10^{-4}$ to $1x10^{-6}$ as defined in the NCP. Those sites include the following:

1. Many Diversified Interests Superfund site in Texas (USEPA, 2005) – Excess cancer risk estimates associated with exposures to arsenic in soil ranged from $1.3x10^{-5}$ to $2.5x10^{-5}$ depending on exposure scenario; the USEPA concluded that because the total excess cancer risk estimates are within their acceptable cancer risk range of $1x10^{-4}$ to $1x10^{-6}$, remedial action was not necessary.
2. OU3 at the Tinker Air Base Superfund site in Oklahoma (USAF, 2007) – the baseline risk assessment indicated that both arsenic and pentachlorophenol were present in groundwater at concentrations that each resulted in excess cancer risk levels approximating $5x10^{-5}$. However, because the groundwater concentrations of both chemicals approximated their respective MCLs (only slight exceedances), the USEPA (a supporting agency for this site) concurred with the U.S. Air Force's conclusion that remedial action was not necessary.
3. Rockwool Industries Inc. site in Texas (USEPA, 2004) – the baseline risk assessment indicated that excess cancer risks associated with exposures to arsenic in soil ranged from $2x10^{-6}$ – $5x10^{-5}$ depending on the exposure scenario; USEPA concluded that the excess cancer risk did not exceed the acceptable level of $1x10^{-4}$ and, as such, did not develop a risk-based cleanup based on cancer but instead developed cleanup levels based on non-cancer.
4. Agricultural Street Landfill site in Louisiana (USEPA, 2002) – the baseline risk assessment indicated total cancer risk across three carcinogens (arsenic, cPAHs, dioxins) ranging from $1x10^{-4}$ (surface soil) to $5x10^{-5}$ (subsurface soil); however, the Agency concluded that no further action was necessary since the cancer risk was within their acceptable risk range.
5. Griggs & Walnut Ground Water Plume in New Mexico (USEPA, 2007a) – Cancer risk estimates to residents from perchloroethylene vapor intrusion

exposure exceeded $1x10^{-5}$ risk (up to $4x10^{-5}$), but USEPA considered these to be acceptable risk levels.

6. State Marine of Port Arthur in Texas (USEPA, 2007b) – the baseline risk assessment indicated that total excess cancer risks associated with consumption of Aroclor 1254 in fish due to bioaccumulation from contaminated sediments was $2x10^{-4}$; USEPA concluded that no further action was necessary because the excess cancer risk estimates were determined to be too uncertain.
7. Longhorn Army Ammunition Plant in Texas (U.S. Army Corps of Engineers, 2016) – the baseline risk assessment indicated an excess cancer risk associated with exposures to arsenic in soil of $8.1x10^{-6}$. USEPA concluded that because the total excess cancer risk estimates are within their acceptable cancer risk range of $1x10^{-4}$ to $1x10^{-6}$, soil remedial action was not necessary.
8. Mallard Bay Landing Bulk Plant in Louisiana (USEPA Region 6, 2003) – Cleanup levels were not calculated for groundwater, because groundwater was not expected to be used as potable water. Some contaminant concentrations were left in place as they were determined to be within the acceptable risk range. Carcinogens with exceedances included benzene (within risk range, exceeded the MCL) and chloroform (exceeded the risk range at $2.8x10^{-4}$ risk, but below the trihalomethane MCL).
9. Hudson Refinery in Oklahoma (USEPA Region 6, 2010) – USEPA determined that no action was needed for surface water, since benzo-a-pyrene cleanup levels were not exceeded; cleanup levels were based on $1x10^{-5}$ risk.
10. Y-Line Facility Soils (OU8) at Louisiana Army Ammunition Plant in Louisiana (U.S. Army Industrial Operations Command, 2000) – USEPA (a supporting agency for this site) determined no action was needed, even though risks for hypothetical future residents to soil exceeded the acceptable cancer risk range of $1x10^{-4}$ to $1x10^{-6}$ (at $3.7x10^{-4}$); the worker risks were within the acceptable range. Chemicals of primary concern were arsenic and PAHs; risks for individual carcinogens were not presented.
11. OU4 at Louisiana Army Ammunition Plant in Louisiana (U.S. Army Environmental Center, 2006) – USEPA (a supporting agency for this site) determined no action was needed, as the total risk range is within the range of $1x10^{-4}$ to $1x10^{-6}$. Individual risk levels were not presented.
12. San Jacinto Waste Pits in Texas (USEPA Region 6, 2017) – Remediation was planned to address dioxin/furan contamination. While the ROD cites a cleanup level based on a noncancer hazard of 1, the ROD noted that the cleanup level was equivalent to an estimated cancer risk of $2.1x10^{-5}$ for sediment ingestion/dermal contact and ingestion of fish/shellfish combined.

Language noted in several RODs further supporting final cleanup levels for carcinogenic COCs at Superfund sites includes the following:

1. Louisiana Highway 71/72 Superfund site ROD (USEPA, 2000): *"The use of $1x10^{-6}$ expresses EPA's preference for remedial actions that result in risks at the more protective end of the risk range, but this does not reflect a presumption that the final remedial action should attain such a risk level. Factors related to exposure, uncertainty, and technical limitations may justify modification of initial cleanup levels that are based on the $1x10^{-6}$ risk level. The ultimate decision on what level of protection will be appropriate depends on the selected remedy."*
2. Texarkana Wood Preserving Co. ROD (USEPA, 2011): *"An EPA directive provides guidance on the role of the HHRA in supporting risk management decisions, and in particular, determining whether remedial action is necessary (EPA 1991). Specifically, the guidance states, "Where cumulative carcinogenic risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10-4, and the noncancer HQ is less than 1, action generally is not warranted unless there are adverse environmental impacts."*

5 Summary of Relevant Findings Concerning Risk-Based Corrective Action Programs in Other USEPA Region 6 States: Regulatory Guidelines on Risk Level Basis for Developing State Cleanup Levels

5.1 Task 2 – Cancer Risk Levels Underlying Risk-Based Cleanup Levels in Other USEPA Region 6 States

Task 2 entailed identifying and reviewing relevant risk-based remediation rules and/or guidance documents available online for each of the other USPA Region 6 states. As described in Section 2 above, as a part of the revised scope of work for this task, ToxStrategies reviewed the relevant Region 6 state (Arkansas, Louisiana, New Mexico, and Oklahoma; excluding Texas) environmental regulatory agency websites and extracted key information related to the cancer risk level used to develop final cleanup levels for use in remediating contaminated sites. This task involved performing general Google searches, as well as specific searches of the individual states' environmental regulatory agencies' websites to identify relevant guidance documents and/or rules governing remediation of contaminated sites, searching specifically for documentation concerning the cancer risk levels used for the development of the risk-based cleanup levels used as the basis for remediation.

Supplemental Excel file 2 provides titles, dates, and weblinks for the relevant documents identified. Regulatory websites providing relevant information are also included. Summaries for each state are provided in the subsequent sections.

5.1.1 Arkansas

Arkansas Department of Environmental Quality (ADEQ) generally relies on USEPA guidance, including Risk Assessment Guidance for Superfund (RAGS) documents and recommends USEPA RSLs for screening (ADEQ, 2015). Arkansas does not have default cleanup levels. Depending on the affected media, cleanup goals may be based on background concentrations, detection limits, drinking water standards, USEPA RSLs, human health risk assessment-based levels, or a combination of these options (ADEQ, 2010, 2015).

Arkansas requires that total cancer risk be within the range of $1x10^{-6}$ to $1x10^{-4}$ (APC&E 2015). There were a few mentions of individual chemical risk levels in some potentially relevant guidance documents, all referring to $1x10^{-5}$ risk. These include: 1) for boilers/industrial furnaces, dioxin/furan emissions are limited to excess lifetime cancer risk of $1x10^{-5}$ (APC&E, 2015), 2) for metals emissions to air, risk-specific doses for individual carcinogenic metals are set at $1x10^{-5}$ (APC&E, 2015), and 3) human health water body criteria are provided for six carcinogens; each is based on $1x10^{-5}$ risk (APC&E, 2020).

5.1.2 Louisiana

Remediation activities governed by the Louisiana Department of Environmental Quality (LDEQ) are outlined in their Risk Evaluation/Corrective Action Program (RECAP). RECAP has four options: Screening Option (SO), Management Option 1 (MO-1), Management Option 2 (MO-2), and Management Option 3 (MO-3) (LDEQ 2003a). Default standards for each option are presented in a tabular format; the values are indicated to be based on individual risk levels of $1x10^{-6}$. Some groundwater standards are MCLs. SO, MO-1, and MO-2 have an acceptable risk for individual carcinogens of $1x10^{-6}$ (LDEQ, 2003a, b, c, d, e).

MO-3 has an acceptable risk for individual carcinogens of $1x10^{-6}$ to $1x10^{-4}$. For MO-3, a target risk level above $1x10^{-6}$ may be approved if warranted based on site-specific conditions, and other factors such as the level of certainty in nature and extent of impact and confidence in the risk assessment results; and provided the total cancer risk does not exceed $1x10^{-4}$ (LDEQ, 2003a).

5.1.3 New Mexico

New Mexico Environment Department (NMED) uses an individual chemical risk level of $1x10^{-5}$ (NMED, 2001). NMED states that their soil screening levels (SSLs) are based on $1x10^{-5}$ individual risk. The SSLs are intended for screening, and, as such, do not represent cleanup levels and do not trigger the need for a response action or indicate unacceptable risk (NMED, 2006).

If a NMED SSL is not available for particular chemical, the USEPA RSL multiplied by 10 (to achieve a $1x10^{-5}$ risk level) is recommended. However, if multiple carcinogens are present and the total site risk exceeds $1x10^{-5}$, further evaluation of the site concentrations is warranted (NMED 2019). The acceptable individual risk level for carcinogens in water is also $1x10^{-5}$; some of the standards are MCLs (NM Water Quality Control Commission, 2018).

5.1.4 Oklahoma

Oklahoma Department of Environmental Quality (ODEQ) relies on USEPA RAGS and USEPA Region 6's corrective action strategy. USEPA RSLs are recommended for screening. ODEQ uses a risk level of $1x10^{-5}$ and indicates that total site risk should also not exceed $1x10^{-5}$ (ODEQ, 2004, 2020).

However, it is unclear from the available documentation if individual chemicals are set to a $1x10^{-5}$ risk level or not. ODEQ guidance also states that, depending on site-specific factors, the allowable risk may be higher ($1x10^{-4}$) or lower ($1x10^{-6}$) (ODEQ, 2004). Oklahoma Water Resources Board has water quality standards; if a standard is not available, ODEQ will use a MCL if available. As a next tier, ODEQ may use other criteria, including USEPA health advisories or published risk-based levels (Oklahoma Water Resources Board, 2017; ODEQ, 2019).

6 Conclusions

A review of the available information concerning the cancer risk level underlying risk-based cleanup levels for carcinogenic COCs across USEPA Region 6 Superfund sites having final ROD documents published between 2000-2019 and readily available in the USEPA ROD Database demonstrates that the large majority of risk-based cleanup levels for carcinogenic COCs are associated with cancer risk levels equal to or greater than $1x10^{-5}$. These findings demonstrate the TCEQ PCLs as just as protective as – if not more protective than – the majority of cleanup levels for carcinogenic COCs developed for federal Superfund sites by the USEPA. This should not be surprising given the process outlined in USEPA's RAGS documents: initial screening based on conservative RSLs, use of the baseline risk assessment to determine the need to develop preliminary remediation goals (PRGs), use of ARARs such as MCLs and PRGs, and modification of the PRGs based on site-specific information on exposure, uncertainty, and technical feasibility factors. Based on these and other considerations, the final cleanup values for carcinogenic COCs range from $1x10^{-4}$ to $1x10^{-6}$, the acceptable risk range defined within the NCP. Furthermore, there were several examples identified where the Agency determined that no further action was necessary, or final cleanup levels were determined to not be necessary even though cancer risk levels estimated in the baseline risk assessment exceeded $1x10^{-5}$.

A review of the documentation related to the remediation of contaminated sites for the Region 6 states outside of Texas indicated that most of the states employ a tiered approach involving an initial screening using conservative screening levels, followed by the development of site-specific remediation goals. Documentation of Louisiana's RECAP demonstrates a preference for management options predicated on $1x10^{-6}$ cancer risk level, whereas remediation guidance documents for New Mexico apply a chemical-specific cancer risk level of $1x10^{-5}$, similar to TCEQ. While Oklahoma's policy is to use a cancer risk level of $1x10^{-5}$, available information indicates that cumulative excess cancer risk should not exceed the same risk level. Arkansas does not appear to have an established default target cancer risk level for carcinogenic COCs, although the examples provided in their guidance documentation involved a cancer risk level of $1x10^{-5}$.

In conclusion, based on a comprehensive review of Superfund RODs for Region 6 states, as well as documentation related to risk-based corrective action programs in other Region 6 states, the cancer risk level used by the TCEQ to develop PCLs for individual COCs is demonstrably as protective as – or more protective than – that used to develop final cleanup levels that serve as the basis of remedial action in the majority of cases.

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