CHEMICAL COMMODITIES, INC.
OLATHE, KANSAS
TECHNICAL MEMORANDUM
FOR SITE CHARACTERIZATION
AND RISK ASSESSMENT

GTI Project 042500193

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1.0 INTRODUCTION

This Technical Memorandum describes the technical approach for proposed site characterization and baseline risk assessment at the former Chemical Commodities, Inc. (CCI) site in Olathe, Kansas. The purpose of this document is to facilitate a consensus between Rockwell International Corporation and the regulatory agencies on the methodologies for site characterization and risk assessment that will be applied at the site. The concept of developing technical memoranda, such as this document, for risk assessment was originally defined in OSWER Directive 9835.1a entitled *Supplemental Guidance on Performing Risk Assessments in Remedial Investigation, Feasibility Studies (RI/FS) Conducted by Potentially Responsible Parties (PRPs)*, July 2, 1991. This memorandum is not meant to be a workplan. Site characterization and risk assessment workplans will be prepared and submitted after agreement is reached on the methodologies described in this memorandum. As an alternative, this technical memorandum for the risk assessment may be used in lieu of a risk assessment workplan.

The site characterization and risk assessment will be performed by applying the Data Quality Objectives (DQO) process. Through the use of the DQO framework, the site characterization plan and the risk assessment plan will establish site-specific decision criteria prior to implementing the field investigations. By setting the DQOs, the data collected will be of sufficient quantity and quality so that the requirements of a valid and defensible risk assessment are fulfilled.

Implementation of a DQO-based approach that has regulatory consensus via the Technical Memorandum will reduce the iterations of workplans, field mobilizations, reports, etc., and will therefore save time, cost, and resources. Regulatory consensus on the technical approach and site-specific parameters of the risk assessment will also facilitate the establishment of site-specific remedial goals because the criteria applied in the baseline risk assessment may be applied in establishing alternative remedial goals.

This memorandum discusses the following topics:

- The DQO process
- The DQOs specific to the CCI site
- The Site Characterization and Risk Assessment Processes
- The Presentation of Results
- The Deliverables and Schedule

2.0 DATA QUALITY OBJECTIVES (DQO) PROCESS DESCRIPTION FOR THE SITE CHARACTERIZATION AND BASELINE RISK ASSESSMENT

The Quality Assurance Management Staff (QAMS) of the United States Environmental Protection Agency (EPA) developed and published an interim Final Guidance on the Data Quality Objectives Process in October 1993. While the purpose of the document is to provide guidance so that the data collected will support defensible decision making, the DQO process may also be applied in establishing decision criteria for site characterization and risk assessment. Through the DQO process, the parameters that influence the risk evaluation of a site are discussed and agreed upon before initiating the field investigations and risk assessment. By reaching a consensus with the regulatory agencies on the methodologies to be used, the site characterization and risk assessment can be performed according to the criteria that have already been agreed upon.

The DQO process consists of seven steps. Each step comprises specific parameters within the size characterization and risk assessment processes, and derives information from the preceding step. The seven steps of the DQO process are:

- State the Problem
- Identify the Decision
- Identify the Inputs to the Decision
- Define the Boundaries of the Study
- Develop a Decision Rule
- Identify the Acceptable Limits on the Decision Error
- Optimize the Design

3.0 DQOs FOR THE CHARACTERIZATION AND RISK ASSESSMENT OF THE CCI SITE

3.1 Step 1: State the Problem

Problem: The risk to human health from chemicals in soil and groundwater is undefined for the Chemical Commodities, Inc site in Olathe, Kansas.

3.1.1 Background

The CCI site is now an inactive facility. Historically, the site's chemical handling and storage practices generated the release of chemicals that contaminated surface and subsurface soils, ambient air, and groundwater at the site (ATSDR, August 1990). A site assessment completed in

February 1989 showed chemicals stored within seven buildings and on exterior grounds, two 40-foot long storage trailers, two truck boxes, four vertical storage tanks, and an open pit where underground storage tanks were once located.

Metals (lead, mercury, and chromium) were also present in floor sweep samples (EPA, 9/90) collected within the main warehouse. Some areas of the subsurface of the site have been contaminated with chlorinated solvents and the contaminant groundwater plume is spreading radially from the site (EPA, 8/90). Samples taken from monitoring wells indicated the presence of volatile organic compounds (VOCs).

EPA Region VII's proposed removal action consisted of three phases. The first two phases included the segregation, packaging, and subsequent transportation and disposal of hazardous chemicals present at the site. Phase III included decontamination of the warehouse, excavation and off-site disposal of soils where contaminants exceed 300 ppm; on-site removal and consolidation of contaminated soil with levels between 50 ppm and 300 ppm; installation of an interceptor trench as a source control of the solvent in the subsurface; and/or collection, treatment, and off-site disposal of contaminated groundwater; and site grading to promote surface water runoff (EPA, 9/90). Three sampling events, from 1989 through 1991, supported the excavation and disposal of contaminated soil. A limited amount of flooring material that exceeded the RCRA TCLP limit for chromium (detected at concentrations at or greater than 1,500 ppm) was combined with the VOC-contaminated soil in the consolidated pile (JEG, 1995).

The baseline risk assessment conducted in April 1995 by Jacobs Engineering Group, Inc. (JEG, 1995) at the Former Chemical Commodities, Inc. (CCI) facility, Olathe, Kansas, evaluated numerical risks due to potential exposure to soil under the warehouse, to soil in the consolidation pile, and to the subsurface soil (on-site and off-site). The analytical data used in the risk assessment were selected from three previous field investigations completed in 1989 and 1991. The results of the risk assessment had uncertainties partly due to analytical detection limits in on-site soil that were generally higher than EPA Region III's screening risk-based concentrations. Additional uncertainties in the calculated on-site risks were attributed to the following assumptions:

- Soil under the warehouse has the same extent of contamination as the surface soil sampled during the 1991 removal action;
- The chemical levels in the consolidation pile and in the subsurface soil are similar to the levels in 1991;
- The contamination is homogeneously distributed in the soils under the warehouse, in the consolidation pile, and in the subsurface;

- The volume of contaminated soil under the warehouse, in the consolidation pile, or in the subsurface, is sufficient to uniformly cover an area equivalent to a residential lot or playground to a depth of 6 inches; and

- If the CCI site should be converted to a residential area or playground, the soil under the warehouse, in the consolidation pile, and in the subsurface, will be spread on the surface so that the evaluated receptors will be routinely exposed.

The risk assessment performed by Jacobs (JEG, 1995) concluded that the CCI site does not have any adverse ecological influences. Based on this information, the decision to remediate or not will be based solely on the results of the human health evaluation of on-site soil and groundwater.

3.1.2 Conceptual Site Model

The sources of chemical release, mechanisms of release, exposure routes, and potential receptors that will be evaluated in the risk assessment are illustrated in the conceptual site model (Fig.1). The conceptual model may be modified when the data from this phase of investigations is available. In the risk assessment that was performed (JEG, 1995), the potential exposures of a resident and the recreational user/trespasser were deemed unlikely under the current scenario due to the assumption that the soil chemicals of potential concern (COPCs) consist of VOCs which would have volatilized. However, if the new data should indicate detectable concentrations of metals in the surface and/or subsurface soil, then the exposure of a current resident and recreational user/trespasser to soil COPCs will be potentially complete.

3.1.3 Types of Chemicals

The nature and extent of contamination will be ascertained through media-specific analyses of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals. At the site, VOCs in soil are present in the adsorbed phase and the vapor phase. Historically, liquid phase VOCs were observed in soil. VOCs in groundwater are present in the dissolved phase. Historically, liquid phase VOCs were observed in groundwater. VOCs have been detected as vapor in ambient air in crawl spaces, basements, and above ground. SVOCs have been reported in the vapor phase. Metals occur in the soil and dissolved in groundwater.

3.2 Step 2: Identify The Decision

There are two possible decisions that can be reached to address the stated problem. The decisions and their associated actions are listed below:

Decision 1: Chemicals in soil and groundwater at the CCI site do not pose a significant risk.
Action: No further remedial action needed.

Decision 2: Chemicals in the soil and groundwater at the CCI site do pose a significant risk.
Action: Set health-protective cleanup levels and remediate the site to those levels.

3.3 Step 3: Identify The Inputs To The Decision

3.3.1 Input 1: Evaluation of collected data in order to determine its useability in risk assessment

A significant data gap in the previous investigations is the failure to evaluate the analytical detection limits relative to the RBCs, ARARs, or to site-specific remedial goals (if RBCs are not available). A chemical that is qualified as a non-detect due to high detection limits implies that the chemical may actually be present but the concentration cannot be quantified because it is present below the detection limit. A detection limit that is higher than a risk-based value has one of the following consequences: (a) a potential overestimation of risk if the chemical is assumed to be present at concentrations equivalent to one-half the analytical detection limit; or (b) a potential underestimation of risk due to the chemical being eliminated from the risk assessment because it is considered not present.

Analytical methodologies will be chosen that will provide method detection limits at or below the USEPA Region VII RBCs, chemical-specific ARARs, or site-specific remediation goals. Methodologies will be designed to achieve the lowest reporting limits possible based on the specific sample matrix. The possibility exists that, for specific samples, undiluted concentration values may not be possible due to matrix effects or high concentration levels of one or more compounds. The laboratory will use multiple techniques to achieve the lowest reporting limits possible for each sample and compound. The methodologies and techniques will be presented in the site Quality Assurance Project Plan.

3.3.2 Input 2: Complete Site Characterization

The site characterization activities will include a field investigation of impacted media at the CCI site so that a risk assessment can be performed. Sampling plans will be based on existing data and data collected during the initial phases of the proposed characterization. The sampling plan will discuss the:

- Selection of appropriate analytical methodologies for each matrix to provide adequate reporting limits
- Determination of the number of samples needed to represent statistically-significant populations
  - onsite: cluster sampling of known source area, and systematic sampling of intersource areas
  - offsite: systematic sampling to determine limits and infill data gaps
- Collection of accurate, precise, representative, comparable and complete data for all media, for both background and contaminant compounds

Prior to performing the risk assessment the data collected during site characterization will first be used to define site geology and hydrogeology. Information will be collected on:

- Soil and bedrock composition
- Stratigraphy
- Structure
- Soil and bedrock petrophysical attributes
- Surface water hydrology
- Meteorology

3.3.3 Input 3: Identify Chemicals of Potential Concern (COPCs)

The method for considering detected analytes as COPCs depends on whether the analyte is organic or inorganic.

- An organic chemical with a maximum detected concentration that exceeds USEPA Region VII's screening risk-based concentration (RBC) or available Applicable or Relevant and Appropriate Requirements (ARARs) will be identified as a COPC.
- An inorganic constituent with a concentration that exceeds the background concentration and USEPA Region VII RBC will be identified as a COPC.

- An inorganic constituent with a concentration that exceeds the background concentration but is below the USEPA Region VII RBC or available ARARs will not identified as a COPC.
- A chemical with a frequency of detection that is at or less than 5 percent will be eliminated as a COPC.
- The background concentrations of all organic chemicals are assumed to be zero. Therefore, detected organic chemicals will not be compared to background concentrations.
- Chemicals without available ARARs or RBCs will be evaluated as a COPC.

3.3.4 *Input 4: Current and Future Land Use*

The site is currently inactive. The areas adjacent to the site have residences. The future land use of the site has not been determined. For comprehensiveness in the risk assessment, the potential reuse of the site, either as an industrial facility, a housing development, or a recreational area, will be evaluated.

3.3.5 *Input 5: Exposure Pathways and Potential Receptors*

The exposure pathways that will be evaluated are represented in the conceptual site model (Fig. 1) . As stated in Step 1, new data may suggest potential exposure of trespasser, the current resident, and the future commercial/construction worker to surface and subsurface soil COPCs via incidental ingestion, dermal contact, inhalation of dust-borne particulates, if metals are detected. The current resident will also be evaluated for exposure to groundwater via inhalation of volatiles through vapor intrusion into their homes. There is no current exposure to groundwater via incidental ingestion and dermal contact because groundwater is not being used as a source of water supply. The site is currently inactive, therefore, there is no potential exposure of a commercial/construction worker to soil and groundwater COPCs.

The hypothetical future resident, recreational user, and commercial/construction worker will be evaluated for potential exposure to soil COPCs through incidental ingestion, dermal contact, inhalation of dust-borne particulates and volatiles. The residents are not currently using the groundwater as a potable water source and are unlikely to use it in the future because it is not a potable source. However, vapor transport from groundwater will be evaluated.

3.3.6 Input 6: Exposure Parameters

The matrix of exposure parameters for the resident, recreational user/trespasser, commercial worker, and construction worker is presented in Table 1. Some of the exposure parameters are based on site-specific conditions. Chemical-specific values are indicated in Table 1.0 and will be presented in a separate table in the risk assessment document.

3.3.7 Input 7: Algorithms for Calculating Exposure Dose

The algorithms for calculating the intake through ingestion, dermal contact, and inhalation are presented below.

Ingestion Algorithm

$$\text{Ingestion Dose}_a = \frac{Cs \times IR \times EF \times ED \times CF}{BW \times AP}$$

$$\text{Ingestion Dose}_{adj} = \frac{Cs \times IR_{adj} \times EF \times CF}{AP}$$

where:

Ingestion $Dose_a$	=	adult ingestion dose (mg/kg-day)
Ingestion $Dose_{adj}$	=	age-adjusted soil ingestion dose (mg/kg-day)
IR_{adj}	=	age-adjusted soil ingestion rate (mg-yr/kg-day)
Cs	=	chemical concentration in soil (mg/kg)
IR	=	ingestion rate (mg/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AP	=	averaging period (period over which exposures are expected to produce an effect) (days)
CF	=	unit conversion factor (10^{-6} kg/mg)

Inhalation Algorithm. For inhalation exposure to soils, the soil-to-air volatilization factor and the particulate emission factor were calculated according to equations presented in USEPA's Technical Background Document for Soil Screening Guidance (USEPA, 1994b). The inhalation algorithms are as follows:

$$Inhalation\ Dose_a = \frac{C_s \times IR \times ET \times EF \times ED \left[\frac{1}{VF} + \frac{1}{PEF}\right]}{BW \times AP}$$

$$Inhalation\ Dose_{age\text{-}adj} = \frac{Cs \times IR_{age\text{-}adj} \times EF \left[\frac{1}{VF} + \frac{1}{PEF}\right]}{AP}$$

where:

Inhalation $Dose_a$	=	adult inhalation dose (mg/kg-day)
Inhalation $Dose_{adj}$	=	age-adjusted soil inhalation dose (mg/kg-day)
AP	=	averaging period (period over which exposures are expected to produce
IR	=	inhalation rate (m^3/hr)
$IR_{age\text{-}adj}$	=	age-adjusted inhalation rate (m^3-yr/kg-day)
BW	=	body weight (kg)
C_s	=	constituent concentration in soil (mg/kg)
ED	=	exposure duration (years)
EF	=	exposure frequency (days/year)
ET	=	exposure time
VF	=	volatilization factor (m^3/kg); chemical-specific
PEF	=	particulate emission factor (m^3/kg); chemical-specific

$$PEF = \frac{Q}{C} \times 3500/[0.036\ (1-G)\ (W/U)^3\ F(x)]$$

where:

			Parameter
Q/C	=	inverse of the mean concentration at the center of a 0.5-acre square source area (g/m^2 - sec/kg/m^3)	site-specific (USEPA, 1994b)
G	=	fraction of vegetative cover (unitless)	0.5
W	=	mean annual windspeed (m/sec)	site-specific (USEPA, 1994b)
U_t	=	equivalent threshold windspeed at a height of 7 meters (m/sec)	11.32 (USEPA, 1994b)
F(x)	=	function dependent on W/U_t (unitless) derived using Cowherd (1985)	0.194 (USEPA, 1994b)

$$VF = \frac{Q}{C}\left\{\frac{(3.1416 \times \alpha \times ED \times CF_3)^{1/2} \times 0.0001)}{[2 \times D_{ei} \times P_a\ (H \times 41/K_d)]}\right\}$$

			Parameter
where:	Q/C	= inverse of the mean concentration at the center of a 0.5-acre square source area (g/m^2 - $sec/kg/m^3$)	site-specific (USEPA, 1994b)
	α	= Convenient collection of variables (cm^2/sec); calculated as follows: $\alpha = D_{ei} \times P_a/(P_a + [p(1-P_a)K_d/Hx41])$	
	p	= soil particle density	2.65 (USEPA, 1994b)
	D_{ei}	= effective diffusivity (cm^2/sec) $D_{ei} = D_i(P_a^{3.33}/P_t^2)$	chemical-specific
	D_i	= diffusivity in air (cm^2/sec)	chemical-specific
	P_a	= air-filled porosity (unitless)	0.28 (USEPA, 1994b)
	P_t	= total soil porosity (unitless)	0.43 (USEPA, 1994b)
	H	= Henry's Law Constant constituent-specific; ($atm\text{-}m^3/mol$)	chemical-specific
	K_d	= partition coefficient; constituent-specific (cm^3/g)	chemical-specific
	ED	= exposure duration (years)	
	CF_3	= conversion factor 3 (31,500,000 sec/yr)	

Dermal Algorithm. The algorithm for calculating the intake through dermal contact is the following:

$$Dermal\ Dose_a = \frac{Cs \times SSA \times ABS \times SAR \times EF \times ED \times CFI}{BW \times AP}$$

where:	Dermal $Dose_a$	= adult dermal dose (mg/kg-day)
	C_s	= chemical concentration in soil (mg/kg)
	SAR	= soil adherence rate (mg/cm^2)
	SSA	= skin surface area exposed (cm^2/day)
	ABS	= absorption fraction of chemical from soil (unitless)
	BW	= body weight (kg)
	AP	= averaging period (period over which exposures are expected to produce an effect) (days)
	EF	= exposure frequency (days/year)
	ED	= exposure duration (years)
	CF	= unit conversion (10^{-6} kg/mg)

3.3.8 Input 8: Toxicity Assessment

The toxicity assessment examines information concerning the potential human health effects of exposure to chemicals of potential concern. Its goal is to provide, for each listed COPC, a basis for the risk characterization.

For carcinogens, it is assumed that no threshold exists, and that any dose may result in cancer induction. The probability of cancer development is described by the slope of the dose response curve. The doses from the various known or suspected carcinogens are assumed to be additive.

For noncarcinogens, it is assumed that a dose exists below which no adverse health effects will be seen (i.e., threshold dose). Compounds that affect reproduction are also considered to have threshold doses unless the mechanism of action of the compound has been confirmed as one for which no threshold exists. Compounds with short-term, acute effects are generally considered to have a threshold dose.

3.3.9 Input 9: Toxicity Values

The cancer slope factor (SF) is the toxicity value used to quantitatively express the carcinogenic risk of cancer-causing constiuents. The slope factor is expressed in units of $(mg/kg/day)^{-1}$. The SF is the upper 95 percentile confidence limit of the linear term of the dose response curve. The product of the lifetime average daily dose and the SF is the incremental risk, above background, of developing cancer over a lifetime. The lower limit of the SF is often zero and therefore lifetime incremental cancer risk is most appropriately reported as ranging from zero to the reported upper bound value.

The RfD is the toxicity value used to quantitatively express the hazard of noncarcinogenic constituents. The RfD is expressed in units of mg/kg/day and represents a daily intake of chemical per kilogram of body weight that is not sufficient to cause the threshold effect for the chemical. The RfD is the toxicity value used to quantitatively express the hazard of noncarcinogenic constituents. The RfD is expressed in units of mg/kg/day and represents a daily intake of contaminant per kilogram of body weight that is not sufficient to cause the threshold effect for the chemical. The ratio of exposure to the RfD is called the hazard quotient (HQ). The primary sources of toxicity values are the Integrated Risk Information System (IRIS) compiled by USEPA and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1994a).

3.4 Step 4: Define the Boundaries of the Study

There are two site boundaries: One applies to the investigation (i.e the vertical and lateral extent of contamination) and the other is for the risk assessment (i.e. where the exposure point concentrations (EPCs) will be estimated). EPCs may be outside the area of physical investigation, but still be important for estimating potential health effects. An example would be estimating future downgradient groundwater concentrations beneath a house which might have a vapor migration pathway leading to exposure.

For purposes of this project the following definitions will be used. *On-property* areas consist of land where CCI operated. *Near-property* areas are the adjacent lands that may have been impacted by CCI operation. The on-property and near-property areas together will be described as the *CCI site*. Drainage areas and surface water systems will be considered *off-site*. The characterization and risk assessment will focus on the on-site areas.

Investigation boundaries will be determined as data is obtained and evaluated. Evaluation of data sets as they are obtained will indicate the need (or lack thereof) for "step out" sampling, or variations in sampling density.

The exposure boundaries determine the sample points that will be included in calculating the exposure point concentrations. The risk assessment will evaluate the cumulative site-wide risk posed by the COPCs detected in the different media within the property boundaries. Carcinogenic risk and noncarcinogenic hazards will be calculated for COPCs present in surficial soil, subsurface soil, and groundwater. For the hypothetical future resident, the calculated risk may be based on an exposure unit that is the typical size of a residential lot in Olathe, Kansas.

The geographic delineation of potential near-property risk will be determined by transport models that will evaluate the migration of chemicals from on-site soil to groundwater and eventual movement of these COPCs to near-property locations that present detectable concentrations. The model will also estimate the concentrations of chemicals that may volatilize from the on-site soils and off-site groundwater. The model will be calibrated with filed data collected during site characterization.

The quantity of chemicals leaching from the soil and impacting the groundwater will be dependent upon several factors. These factors include the partitioning coefficient of each chemical, the location of the chemicals within the soil column, the position of high and low permeability units in relationship to each other and the water table; the amount and duration of precipitation; and, the amount of water that moves through the soil column to recharge the aquifer. In addition, chemical specific degradation and volatilization will be important in the natural attenuation of compounds. Thus, the

model selected for this modeling project must be capable of adapting to the conditions outlined in the conceptual site model. A brief summary of these conditions includes:

- variable permeability with depth
- variable f_{oc} with depth
- variable precipitation values with time
- variable chemical starting depth
- the ability to accurately simulate water movement and loss
- degradation
- volatilization

3.4.1 Model Selection

A list of vadose models is presented in "Identification and Compilation of Unsaturated/Vadose Zone Models" (van der Heidje, 1994). Van der Heidje presents a summary and review of vadose zone models as compiled by the International Ground Water Modeling Center (IGWMC). More than 80 flow, solute transport and heat transport models are presented in this compilation. More specifically, 23 flow models; 42 flow and solute transport; seven solute transport requiring a given head distribution; five flow and heat transport; and eight flow, solute and heat transport models are documented.

Based upon the requirements of the conceptual model, the ability to model the fate of volatile organic compounds, availability, support, ease of use, familiarity, and suggestions by the U.S. EPA, two models were identified for more detailed evaluation: VLEACH (Ravi and Johnson, 1993) and SESOIL (Bonazountas, 1986) with modifications by Oak Ridge National Laboratory. Both VLEACH and SESOIL can simulate the fate and transport of organic compounds downward through a soil column to the water table.

VLEACH was developed by CH2M Hill for the U.S. EPA for use on the Phoenix-Goodyear Airport Superfund site in 1990 and has been used on many other projects since 1990. Groundwater Technology reviewed and considered VLEACH Version 2.1 in this evaluation.

SESOIL was developed by Arthur D. Little, Inc., for the U.S. EPA's Office of Water and the Office of Toxic Substances (OTS) in 1981. SESOIL has undergone extensive testing and verification. As a result of the testing and verification, SESOIL has been extensively modified by the Oak Ridge National Laboratory. The model was incorporated into PCGEMS for the U.S. EPA/OTS, and is now incorporated into the RISKPRO (General Science Corporation [GSC], 1990) exposure modeling package. Groundwater Technology reviewed and considered the SESOIL model incorporated in the DOS version of RISKPRO in this evaluation. In addition, a SESOIL users guide recently prepared by

the Wisconsin Department of Natural Resources (Hetrick, et al., 1994) was also used during the evaluation.

Both models can incorporate sorption and three-phase equilibrium. However, SESOIL can also incorporate vertical heterogeneities in soil parameters, variable recharge evapotranspiration and surface water runoff through time (hydrologic cycles), and degradation. VLEACH can not incorporate these features. A comparison of each model's features and capabilities is summarized in Table 2.

Degradation, variable permeability with depth, and variable f_{oc} with depth are critical parameters for this conceptual model. Therefore, SESOIL has been selected for use in this project. Other models may be used if site conditions warrant.

3.5 Step 5: Develop a Decision Rule

There are three inputs to the decision rule for the characterization and risk assessment of the CCI site. These are (1) comparison of metals with background, (2) estimation of EPC, and (3) action levels for the decision. These are described below.

3.5.1 Input #1 - Comparison to Background Concentrations

Soil samples will be collected from unimpacted areas to determine background concentrations of metals. The number of background samples will be statistically based.

A statistical calculation will be performed to estimate the upper bound of naturally occurring levels of metals in the area where the former CCI site is located. Tolerance limits statistically estimate levels between, above, or below which a prescribed proportion of individual items of a population can be confidently expected to be found. For purposes of this assessment, the 95 percent upper tolerance limit (UTL) will be calculated. The 95 percent UTL is the level (concentration) below which 95 percent of the background level population is found. By definition, 5 percent of the population should fall above this UTL as a result of natural variability. The calculation for the UTL is as follows:

$$X = a + Ks$$

where: X = Upper tolerance limit
a = Arithmetic mean
s = Standard deviation
K = Factor for upper tolerance limit

K factors are based on the desired level of confidence, the percentage of the population to be included within the calculated range, and the number of background samples included in the sample set. Both the desired level of confidence and the percentage of the population to be included within the calculated range will be established at 95 percent.

3.5.2 Input 2: Estimation of Exposure Point Concentration

In a deterministic risk assessment, the exposure point concentration (EPC) that will be used to calculate risk is determined according to guidelines in the OSWER Directive 9285.7-08, "Supplemental Guidance to RAGS: Calculating the Concentration Term" (USEPA, 1992). The EPC is based on a "reasonable maximum exposure" (RME) and is the 95 percent upper confidence limit (UCL) of the arithmetic mean of a normally distributed data set. A test of the distribution of the sample points will be performed. If the distribution is determined to be lognormal, the data will be transformed to a normal distribution prior to calculation of the 95 percent UCL.

3.5.3 Input 3: Action Level for the Decision

The cumulative risk posed by the COPC concentrations will be calculated. If cumulative risk exceeds 10^{-4} (1 in 10,000 individuals) then remediation will be required. If cumulative risk is 10^{-6} (1 in 1,000,000) or below, then no remediation is required. If cumulative risk is between 10^{-4} and 10^{-6}, a risk management decision based on site-specific conditions and a cost-benefit analysis will be made.

3.6 Step 6: Specify Limits on Decision Errors

This step defines the tolerable decision error rates based on a consideration of the consequences of making incorrect decisions. The decision criteria are defined in terms of a null and alternative hypothesis. For the CCI site, we have selected the following hypotheses:

- Null Hypothesis (H_o): The site poses an unacceptable risk to human health and the environment.
- Alternative (H_a): The site does not pose an unacceptable risk to human health and the environment.

Three statistical parameters need to be defined for the site to evaluate if adequate sampling has been conducted to meet the needs of the decision maker. Two of the statistical parameters include the probability of a decision error: (1) the false positive rate and (2) the false negative rate. The false positive rate (Type I error) is the probability of accepting the alternative hypothesis (H_a) when

the null hypothesis is true, or stating that the site is clean when in fact it is dirty. The false negative (Type II error) is the probability of accepting the null (H_o) when the alternative (H_a) is true, or stating that the site is dirty when in fact it is clean. For this site, the Type I error rate has been selected to be 5 percent and the Type II error rate to be 10 percent. EPA has indicated that the maximum error rate should not exceed 10 percent for Type I errors and not exceed 20 percent for Type II errors. Thus, the error rates that have been selected are well within the acceptable limits for EPA.

The last parameter is referred to as the relative percent difference factor or the acceptable difference between the true site parameter and the respective estimated parameter. In risk assessment, this is the true average exposure point concentration relative to the estimated or modeled concentration. For most risk assessments, a value between 25 and 50 percent is usually selected. The sensitivity of this parameter will be addressed in the risk assessment in the evaluation of uncertainties. The equation used to estimate the number of samples needed to meet these uncertainty constraints is presented in the equation below:

$$N = \frac{\sigma^2(Z_{(1-\alpha)} + Z_{(1-\beta)})^2}{RPD^2}$$

where:
- N = number of samples required
- σ^2 = variance
- Z = standardized normal probability
- α = uncertainty goal for Type I error
- B = uncertainty goal for Type II error
- RPD = relative percent difference

Current site data for the most significant parameters (i.e., those that potentially pose the greatest risk) will be used to estimate the variance and relative percent difference (RPD) parameters in the equation. The uncertainty goals established for Type I (α) and Type II (β) will be used to obtain values for Z from a standard cumulative normal probability function. The resulting equation will then determine the number of samples needed to meet the objectives of the site investigations.

3.7 Step 7: Optimize the Design

Design optimization will occur on the two major components of this project: site characterization and risk assessment. These are described in the following sections.

The site characterization plan will apply a phased approach. The existing laboratory data, field notes, and file information on potential source areas will be used to determine the grid size and

sample numbers for specific areas. Following this initial step, the new data will be evaluated and, if needed, new data needs and sampling strategies will be proposed. As each new phase is proposed, a summary letter discussing relevant data and decisions will be forwarded to EPA for concurrence.

The sampling plan will outline appropriate analytical methodologies for each matrix to provide adequate reporting limits. It will outline the number of samples needed to represent statistically-significant populations both on and offsite. Both cluster and systematic sampling are anticipated to evaluate source areas and interplume areas and boundaries. The sampling plan will emphasize the collection of accurate, precise, representative, comparable and complete data for all media, for both background and contaminant compounds.

Characterization area boundaries will be determined as data is obtained and evaluated. Evaluation of data sets as they are obtained will indicate the need (or lack thereof) for modifications/additions to the sampling plan.

The risk assessment has inherent uncertainties in the exposure assessment, the toxicity assessment and consequently in the numerical risk estimates. The amount of uncertainty in each of these parameters can have a dramatic effect on the estimate of the overall risk. The goal of estimating reasonable maximum exposure is to estimate a conservative exposure that is still within the range of possibility. In a report generated by the Scientific Advisory Board (SAB) in 1993, the SAB concluded that the RME would be better estimated by using a Monte Carlo risk assessment approach which incorporate the varying degrees of uncertainty of the input parameters to the risk model.

The premise in using the 95 percent UCL is that there is a small probability (i.e., less than 5 percent) that the true risk is greater than the estimated value. Unfortunately, the statistics used to estimate the risk does not equate to a 95 percent coverage. The true 95 percent value is typically significantly less than the straight multiplication procedure presented in Step 3, Input 5. A probabilistic approach is recommended to represent more accurately the upper bound acceptable risk. The probabilistic approach uses Monte Carlo simulation to estimate the various parameters in the risk assessment model. Simulation allows all possible outcomes of the various parameters to be assessed and still preserve the underlying probability functions for the various parameters. The resultant value from the simulation is a probability function instead of a single value as would be expected from the more classical deterministic approach. After the simulation is complete, the RME can be obtained from the resulting distribution using recommended percentiles . In addition, a sensitivity chart can be obtained to define the particular influence the various assumptions have on the overall risk model.

The output probability function can be used to estimate, for example, the probability of an excess cancer risk greater than 10^{-6}, 10^{-5}, and 10^{-4} as typically estimated in risk assessments. Using the Monte Carlo or probabilistic approach, the results from the simulation present the entire range of possible outcomes and the likelihood of achieving each of them. In effect, an accurate statistical representation of the possible risk range is estimated based upon the assumption of the risk model.

4.0 CHARACTERIZATION METHODS

Soil, bedrock, and groundwater will be sampled. Soil samples will be collected using hollow stem auger, or push-sampler(Geoprobe) methods. The samples will be collected in sleeves. Bedrock samples will be collected with mud rotary equipment using a core barrel. In situ downhole bedrock inspection may be performed with a wireline camera or acoustic televiewer. Groundwater samples will be collected from existing wells, from temporarily installed 2-inch diameter, PVC wells, and, if possible HydroPunch samplers. All samples will be preserved in compliance with applicable regulations.

Soil samples will be analyzed for physical properties including moisture content, porosity, grain size distribution, and permeability. Chemical analyses will be performed for a wide range of known site contaminants, pH, and organic carbon. Analyses will be performed to provide detection limits sufficiently low to allow the use of the results for risk assessment.

Soil vapor sampling may also be conducted. The decision to obtain soil vapor data will be made pending final review of existing data and perhaps after review of soil and groundwater data obtained in the initial phase of the proposed field investigation.

All site notes will be recorded in a permanently bound, detailed field log book. All entries will be made in ink. The logbook will remain with the sampling team leader. Daily photocopies will be made of the days entries and this information will be kept in the office file.

Details of the site characterization methods will be described further in the Workplan/Sampling and Analysis Plan which will be submitted separately from this memorandum.

5.0 PRESENTATION OF RESULTS

5.1 Presentation of Site Characterization Results

The site characterization report will include a brief history of the site, the geology and hydrogeology, an outline of the sampling workplan, and revisions made in the field. The results of the field work will be presented in tables and on maps. Maps will be provided for specific related suites of analytes, and will include tabulated data and, where appropriate, concentration contours. Cross sections illustrating site characteristics will be included in the report.

5.2 Presentation of Risk Characterization

The estimated risks posed by the COPCs in the soil and groundwater (on-site and off-site) will be presented in tabulated format. The results of both the deterministic and probabilistic approaches will be presented.

The results of the deterministic risk assessment will be presented in tables showing the risk per pathway (ingestion, dermal contact, inhalation) and the additive risk for each chemical. The tables will also show the cumulative risks for all the chemicals evaluated for the site and off-site. The format of the tables will enable the reader to identify the chemical that contributes significantly to the over-all risk and through which specific exposure pathway. This mode of presentation facilitates the evaluation of the results of the risk assessment.

Crystall Ball 3.0 will be used in conjunction with Microsoft Excel to conduct the Monte Carlo simulations. Output from the simulation will include a list of the input parameters, assumed probability functions, resulting risk distribution curve based on the input parameters, and the sensitivity analysis. Detailed documentation of the process will be maintained so the results can be readily duplicated, if needed.

6.0 WORKPLANS AND SCHEDULE

Separate workplans will be submitted for the site characterization and the risk assessment. The workplan for site characterization (i.e. the Sampling and Analysis Plan) will be submitted to the USEPA on October 23, 1995. It will contain both a Field Sampling Plan and a Quality Assurance Project Plan. A site-specific Health and Safety Plan covering field investigation efforts will also be prepared and submitted at this time. It is understood that the USEPA will review and respond to these plans by October 31, 1995, when field work is scheduled to begin.

7.0 REFERENCES

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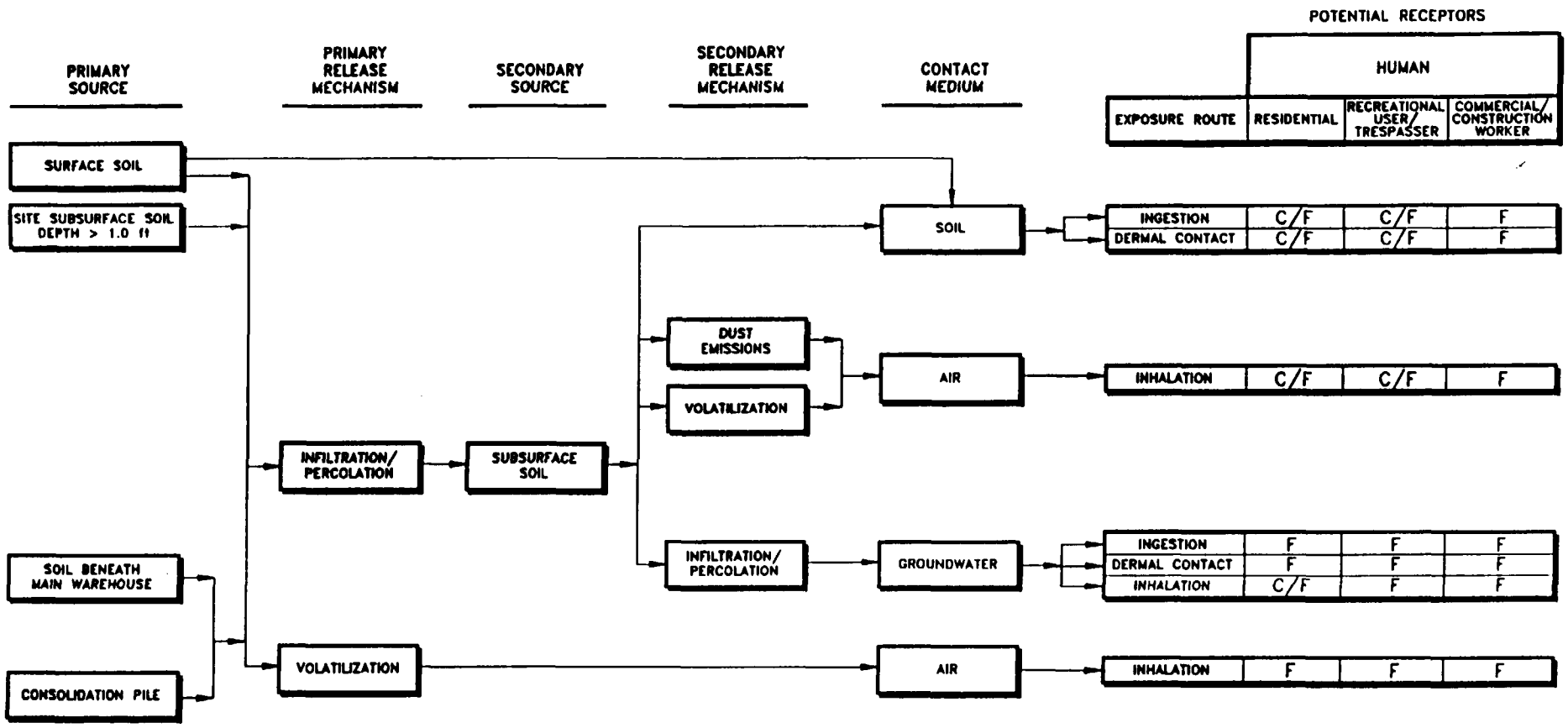

C = CURRENT
F = FUTURE

GROUNDWATER TECHNOLOGY

CLIENT: ROCKWELL INTERNATIONAL CHEMICAL COMMODITIES, INC

LOCATION: 320 S. BLAKE OLATHE, KANSAS

CONCEPTUAL SITE MODEL

FILE:	PROJECT NO.:	PM:	PE/RG:	FIGURE:
0193CSM (1:1)	04250 0193			1

REV.:	DES.:	DET.:	DATE:
	RS	JC	10/4/95

Table 1

EXPOSURE PARAMETERS

Parameter	Resident Adult/Child	Commercial/ Construction Worker	Recreational User/ Trespasser Adult/Child
Body weight (kg)[a]	70/15	70	70/15
Inhalation rate (m^3/hour)[a]	use age-adjusted	2.5	NA
Age-adjusted inhalation rate (m^3-yr/kg-day)[b]	11	NA	11
Soil ingestion rate (mg/day)[a]	use age-adjusted	50	use age-adjusted
Age-adjusted soil ingestion rate (mg-yr/kg-day)[b]	114	NA	114
Skin surface area assumes long pants, short sleeves, and shoes (cm^2)	5,000/2,000[c]	5,000	5,000/2,000
Volatilization factor	chemical-specific	chemical-specific	chemical-specific
Dermal absorption fraction: (unitless)	chemical-specific	chemical-specific	chemical-specific
Exposure time (hrs/day)	24[f]	8[e]	2[e]
Exposure frequency (days/yr)	350[f]	130[e]	120[e] (5 dys/wks; May thru Oct)
Exposure duration (yrs)	30[a]	1[a]	30[h]
Averaging $period_{cancer}$ (days)[f]	25,550 (70 yrs)	25,550 (70 yrs)	25,550 (70 yrs)
Averaging $period_{noncancer}$ (days)[f]	10,950	365	2,190[i]
Adherence rate (unitless)	0.2/1.0	1.0[e]	0.2/1.0[e]
Fraction of vegetative cover[g]	0.5	0.5	0.5

[a] USEPA, 1991a
[b] USEPA, 1995
[c] USEPA, 1992
[e] JEG, 1995
[f] USEPA, 1989
[g] USEPA, 1994

Table 2

COMPARISON OF VLEACH AND SESOIL MODEL CAPABILITIES

Model Requirements	VLEACH	SESOIL
Solute Transport	X	X
Volatile Organic Compounds	X	X
Adsorption	X	X
Degradation		X
Variable Permeability with Depth		X
Variable f_{oc} with Depth		X
Variable Recharge Rates with Time		X
Variable VOC starting Depth	X	X
Soil Moisture Variation		X