6.0 Streamlined Human Health Risk Assessment

Because of the large size and complexity of the FTMC installation, a streamlined human health risk assessment (SRA) is developed using SSSLs. The SSSLs are medium-specific and receptor-specific, risk-based screening concentrations that are used to quickly and efficiently screen the site for potential cancer risk and noncancer hazards from residual chemicals in environmental media. The SSSLs address all significant exposure pathways and are sufficiently site-specific with regard to exposure assumptions that they are used to estimate risk with as much precision as a typical baseline risk assessment. The exposure assumptions and SSSL methodology are described in detail in the installation-wide work plan (IT, 2002). The SSSLs were updated with the most current toxicity values and are compiled in the *Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000c); this document also presents toxicity profiles, which are brief descriptions of the physical and toxicological properties of the chemicals that may be identified as contaminants at FTMC sites. In addition, the SSSL for vinyl chloride was revised to capture the August 7, 2000, cancer and noncancer toxicological evaluation updated by EPA (2002). The chemical-specific variable values used to calculate the SSSL are presented in the *Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000c).

6.1 Streamlined Risk Assessment Protocol

An SRA consists of the following steps, which are discussed in the following sections.

- Develop a conceptual site exposure model (CSEM)
- Select site-related chemicals
- Select chemicals of potential concern (COPC)
- Characterize risk
- Identify chemicals of concern (COC)
- Develop remedial goal options (RGO).

6.1.1 Develop a Conceptual Site Exposure Model

The CSEM identifies the potentially contaminated environmental media, contaminant migration pathways, exposure media, plausible receptors, and exposure routes. Three receptor scenarios are evaluated for the Former Small Weapons Repair Shop, Parcel 66(7): groundskeeper, construction worker, and resident. These receptor scenarios were selected based upon the information provided in the *Fort McClellan Comprehensive Reuse Plan, Implementation*

Strategy (EDAW, 1997) regarding the proposed future land use for this site. The residential scenario is not likely for this site but is included to provide additional information to risk managers. Residential exposure is generally considered the most conservative of all exposure scenarios. The CSEM for Parcel 66(7) is shown on Figure L-1 in Appendix L.

6.1.2 Select Site-Related Chemicals

Generally, chemicals are excluded from the SRA if they are essential nutrients, if they occur at such a low detection frequency that they are considered to be artifacts of sampling or laboratory analysis, or if they are present at concentrations comparable to background. The background data used in this SRA are presented in the *Final Background Metals Survey Report* (SAIC, 1998).

Background screening of metals may include several steps. The first step involves comparing the maximum detected concentration (MDC) from the site data with two times the mean of the background data set, consistent with EPA (1995a) Region 4 guidance. If the metal MDC is less than or equal to two times the mean, the chemical is not selected as a site-related chemical. If the MDC exceeds two times the mean, the MDC is compared with the 95 percent upper tolerance limit (UTL) of the background data set as a more refined statistical approach to comparing site data with background data. The UTL is the upper 95 percent confidence limit of the 95th quantile. The UTLs were calculated from the background metals data set (IT, 2002).

Comparison of the MDC with two times the mean or the UTL is a simple screen that relates the highest detection from site data to a reasonable upper bound for background. This comparison, however, does not relate the entire site data set to the entire background data set, which provides a more appropriate comparison when exposure is expected to occur randomly and uniformly over the entire site. Therefore, if the MDC from site data exceeds the UTL, the Mann-Whitney U Test is used to compare the site data set with the background data set. Geochemical considerations were also explored to determine the relationship between site and background concentrations (Appendix K).

Site-related chemicals are carried to the next step of the SRA.

6.1.3 Select Chemicals of Potential Concern

COPCs are chemicals that may contribute significantly to risk. They are selected by comparing the MDCs of site-related chemicals to their respective SSSLs. Since the SSSLs are receptor-

specific, COPCs are also receptor-specific. In other words, a chemical may be selected as a COPC for residential exposure but not for recreational site use. This occurs because the SSSL for residential exposure is lower than that for recreational site use, because the resident is more highly exposed. COPCs may be selected based on potential cancer risk, noncancer effects, or both. Source-term concentrations (STC) are estimated for the COPCs. The STC is a conservative estimate of the concentration of a COPC averaged over the entire site. COPCs are carried to the risk characterization step of the SRA.

6.1.4 Characterize Risk

The appropriate SSSL is applied to the STC to estimate an incremental lifetime cancer risk (ILCR) or hazard index (HI) for each COPC in each environmental medium, as explained in the installation-wide work plan (IT, 2002). The ILCRs and HIs are summed across all exposure routes and chemicals to yield a total ILCR or total HI for a given receptor exposed to a given medium. The total ILCRs and HIs for each medium are summed to yield a total ILCR and a total HI for a given receptor exposed to all media. Total ILCR estimates for a receptor below 1E-6 are considered to be negligible (EPA, 1990). ILCR estimates between 1E-6 and 1E-4 are considered to fall within a risk management range. ILCR estimates that exceed 1E-4 are considered to be unacceptable and trigger estimation of remedial goal options (RGO). HI estimates for a receptor above the threshold level of 1 raise concern for the occurrence of adverse noncancer effects (EPA, 1989). However, adding HI values for all chemicals may overstate the potential for adverse effects. EPA (1989) believes that the assumption of additivity is valid only for chemicals that operate by the same mechanism of toxicity; therefore, the HI values may be segregated on the basis of mechanism of toxicity. Data on mechanisms of toxicity are available for very few chemicals; therefore, target organs are used as surrogates, assuming that chemicals that act on the same target organ may operate by the same mechanism of toxicity.

ILCR and HI estimates are presented in the tables in scientific format with two digits to the right of the decimal to facilitate replication. ILCR and most HI estimates in the text are rounded to one significant figure to reflect the uncertainty about these values (EPA, 1989; 1995a). HI estimates greater than 1 are rounded to the nearest whole integer. For example, an ILCR of 1.49E-4 would be rounded to 1E-4 and interpreted as within, but not exceeding, the 1E-6 to 1E-4 risk-management range. Similarly, an HI of 1.49 would be rounded to 1 and interpreted as not exceeding the threshold level of 1.

6.1.5 Identify Chemicals of Concern

COCs are chemicals that contribute significantly to total ILCR or HI estimates for a receptor scenario that reach unacceptable levels, i.e., a total ILCR summed across all COPCs and media greater than 1E-4 or a total HI greater than 1 (after segregation by target organ).

6.1.6 Develop Remedial Goal Options

RGOs are risk- or hazard-specific concentrations developed for chemicals identified as COCs (EPA, 1995a). The cancer-based SSSLs are adopted as RGOs based on an ILCR of 1E-6; RGOs are also developed for target cancer risks of 1E-5 and 1E-4. The noncancer-based SSSLs are adopted as RGOs based on a noncancer HI of 0.1; RGOs are also developed for target HI values of 1 and 3.

6.2 SRA Results

Tables and figures for the Parcel 66(7) SRA are included in Appendix L. Surface soil, total soil (surface soil and subsurface soil combined), and groundwater are the media evaluated in this SRA. The receptor scenarios determined to be applicable for the site include the groundskeeper, construction worker, and resident.

6.2.1 Surface Soil

Three surface soil samples collected in January 1999 were evaluated as surface soil in the SRA (Table L-1 in Appendix L). The surface soil samples were collected from a depth interval of 0 to 1 foot. The samples were analyzed for chlorinated herbicides, chlorinated pesticides, metals, organophosphorus pesticides, PCBs, SVOCs, and VOCs. The groundskeeper is the only receptor assumed to be exposed to surface soil.

Eighteen metals, twelve SVOCs, four VOCs, and three chlorinated pesticides were detected in the surface soil samples (Table L-2). All the metals were determined to be present at levels comparable to background (Appendix K), or to be essential nutrients; therefore, none of the metals were determined to be site-related. The SVOCs were limited to the class of compounds known as PAHs, which are ubiquitous compounds formed from combustion of organic matter and are universally associated with coal tar and asphalt paving materials. All organic chemicals detected in surface soil at the site were selected as site-related chemicals and were carried forward to the COPC selection step.

Table L-3 presents the comparison of the surface soil site-related chemicals to the receptor-specific surface soil SSSLs for COPC selection. The groundskeeper is the only receptor evaluated for exposure to surface soil. Only one SVOC, benzo(a)pyrene, was selected as a COPC for the groundskeeper. It was selected based upon its cancer risk.

Table L-4 presents the cancer risk estimate for the groundskeeper exposed to surface soil. The resulting ILCR of 4E-6 is within the risk-management range of 1E-6 to 1E-4. Although this ILCR is within the risk management range, when the ILCRs for all media are added together for this receptor, the total ILCR is unacceptable; therefore, benzo(a)pyrene in surface soil is selected as a COC and RGOs are calculated (Table L-5). Further discussion regarding the summed ILCR across media for the groundskeeper is presented below.

6.2.2 Groundwater

Nineteen groundwater samples were evaluated in the SRA (Table L-6). Three groundwater samples were analyzed for chlorinated herbicides, chlorinated pesticides, metals, organophosphorus pesticides, PCBs, SVOCs, and VOCs. Sixteen groundwater samples were analyzed for VOCs only. The resident, groundskeeper, and construction worker were evaluated for their potential future exposure to groundwater.

Nine metals and eleven VOCs were detected in groundwater at the site (Table L-7). All the metals were determined to be present at levels comparable to background (Appendix K) or to be essential nutrients; therefore, none of the metals were determined to be site-related. All the VOCs were assumed to be site-related and were carried forward to the COPC screening.

Table L-8 presents the COPC selection for the resident, groundskeeper, and construction worker exposed to groundwater. Five VOCs were selected as groundwater COPCs for the resident: 1,1-DCE, 1,2-DCA, cis-1,2-DCE, TCE, and vinyl chloride. 1,1-DCE, 1,2-DCA, TCE, and vinyl chloride were all selected as COPCs for the resident based upon their cancer risk. 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride were selected as COPCs based upon their noncancer hazard.

Groundwater COPCs for the groundskeeper include 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride. 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride were selected based on their noncancer hazard. COPCs selected based upon their cancer risk include 1,1-DCE, TCE, and vinyl chloride (Table L-8). Groundwater COPCs for the construction worker are the same as those for the groundskeeper.

Resident. Table L-9 presents the cancer risk and noncancer hazard estimates for the resident exposed to COPCs in groundwater. The resulting HI for the resident is 31, which exceeds the threshold of 1. The resulting ILCR for the resident exposed to groundwater is 2E-3, which exceeds the risk management range and falls in the unacceptable category. Therefore, based upon these analytical data, groundwater at Parcel 66(7) presents an unacceptable noncancer hazard and cancer risk to a future resident.

Table L-10 presents the target organ table for the resident. All COPCs with individual HIs greater than 0.1 were carried forward to the target organ table. 1,1-DCE, TCE, and vinyl chloride were determined to be residential groundwater COCs based upon the target organ table. cis-1,2-DCE was determined not to be a COC.

Table L-11 presents the RGOs for the COCs based upon noncancer hazard. Maximum contaminant levels (MCL) are also presented for the noncancer groundwater COCs for the future resident.

Groundwater COCs for the resident, based upon cancer risk, were determined to be 1,1-DCE, 1,2-DCA, TCE, and vinyl chloride. Table L-12 presents the RGOs for the cancer-based COCs. The RGOs presented are based upon target cancer risks of 1E-6, 1E-5, and 1E-4. MCLs are also presented for the COCs.

Groundskeeper. Table L-13 presents the cancer risk and noncancer hazard estimates for the groundskeeper exposed to COPCs in groundwater. The resulting HI for the groundskeeper is 5, which exceeds the threshold of 1. The resulting ILCR for the groundskeeper exposed to groundwater is 4E-4, which slightly exceeds the risk management range and falls in the generally unacceptable category. Therefore, based upon these analytical data, groundwater at Parcel 66(7) appears to present an unacceptable noncancer hazard and cancer risk to a future groundskeeper.

Table L-14 presents the target organ table for the groundskeeper. All COPCs with HIs greater than 0.1 were carried forward to the target organ table. 1,1-DCE and TCE were determined to be groundwater COCs for the groundskeeper, based upon the target organ table. cis-1,2-DCE was determined not to be a COC.

Table L-15 presents the RGOs for the COCs based upon noncancer hazard. MCLs are also presented for the noncancer groundwater COCs for the future groundskeeper.

Groundwater COCs for the groundskeeper, based upon cancer risk, were determined to be 1,1-DCE, TCE, and vinyl chloride. Table L-16 presents the RGOs for the cancer-based COCs. The RGOs presented are based upon target cancer risks of 1E-6, 1E-5, and 1E-4. MCLs are also presented for the COCs.

Construction Worker. Table L-17 presents the cancer risk and noncancer hazard estimates for the construction worker exposed to COPCs in groundwater. The resulting HI for the construction worker is 5, which exceeds the threshold of 1. The resulting ILCR for the construction worker exposed to groundwater is 1E-5, which is within the generally acceptable risk management range. Therefore, based upon these analytical data, groundwater at Parcel 66(7) appears to present an unacceptable noncancer hazard but not an unacceptable cancer risk to a future construction worker.

Table L-18 presents the target organ table for the construction worker. All COPCs with HIs greater than 0.1 were carried forward to the target organ table. 1,1-DCE and TCE were determined to be groundwater COCs for the construction worker, based upon the target organ table. cis-1,2-DCE was determined not to be a COC.

Table L-19 presents the RGOs for the COCs based upon noncancer hazard. MCLs are also presented for the noncancer groundwater COCs for the future construction worker.

The construction worker had no cancer-based groundwater COCs; therefore, no cancer-based RGOs were calculated for the construction worker.

6.2.3 Total Soil

Six total soil samples were evaluated in the SRA (Table L-20). Total soil is a combination of the surface soil and subsurface soil data sets, to a total depth of 7 feet. All six soil samples were analyzed for chlorinated herbicides, chlorinated pesticides, metals, organophosphorus pesticides, PCBs, SVOCs, and VOCs. The resident and the construction worker were evaluated for their exposure to total soil.

Nineteen metals, three chlorinated pesticides, twelve SVOCs (all PAHs), and six VOCs were detected in total soil (Table L-21). After the background (Appendix K) and essential nutrient screens, none of the metals were determined to be site-related. All of the organics were carried forward to the COPC selection step.

Table L-22 presents the COPC selection for the resident and construction worker exposed to total soil. For the resident, four SVOCs (benzo[a]pyrene, benzo[b]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene), all of which are PAHs, were selected as COPCs, based on their cancer risk. No total soil COPCs were selected for the construction worker exposed to total soil.

Table L-23 presents the cancer risk and noncancer hazard estimates for the resident exposed to the COPCs in total soil. No chemicals were selected as COPC based on noncancer effects, so an HI was not estimated. The resident total soil ILCR of 2E-5 is within the cancer risk-management range. However, when the total ILCR for the resident is summed across media, the ILCR is above the risk management range. Therefore, all total soil COPCs with individual ILCRs greater than 1E-6 are selected as COCs. These are presented on Table L-24.

6.2.4 Future Groundwater Conditions

Soil leaching to groundwater was evaluated for Parcel 66(7). If a residential groundwater COPC was also detected in total soil, then the total soil MDC was compared to the EPA (1996) soil-screening level. The MDCs in total soil of chemicals identified as COPCs in groundwater were compared with the EPA (1996) soil screening levels based on a dilution-attenuation factor of 20. Chemicals in total soil with MDCs above their soil screening levels were evaluated for their future potential to leach to groundwater. Table L-25 presents the selection of chemicals for the future groundwater conditions evaluation. Based upon the screening in Table L-25, none of the current groundwater COPCs were selected as future groundwater COPCs, based upon each chemical's potential to leach from soil to groundwater.

6.2.5 Uncertainty Analysis

Uncertainty is a part of any risk assessment because of a long list of generic reasons, some of which are discussed in the installation-wide work plan. Generally, uncertainty is handled by making conservative choices when the data are incomplete or compromised by variability. One source of uncertainty in this SRA is the small number of surface soil and subsurface soil samples. Six soil samples were collected, three from surface soil and three from subsurface soil. They

were, however, analyzed for a wide range of chemicals and generally showed that contamination was low. Another source of uncertainty is that only three out of the nineteen groundwater samples were analyzed for metals and several classes of organic compounds. The data, however, clearly show that VOCs in groundwater are the risk drivers. Overall, the uncertainty about the SRA is not thought to have a major impact on the numerical results or to alter the conclusions.

6.2.6 Conclusions

Cancer risks and noncancer hazards for each medium, and summed across media for each receptor, are summarized in Table L-26. The total ILCR estimate for the construction worker fell within the risk management range. ILCR estimates for the resident and the groundskeeper fell above the risk management range and are considered unacceptable. Total HI estimates for the groundskeeper, construction worker, and resident fell above the threshold level of 1.

Soil at Parcel 66(7) is lightly contaminated with PAHs and VOCs. The PAHs selected as COPCs were present at concentrations consistent with anthropogenic background at FTMC (IT, 2000c), suggesting that their presence does not represent a significant site-related release. Although all the PAH COPCs were selected as COCs, their concentrations fell below RGOs based on a cancer risk of 1E-4, and it is concluded that the PAHs in soil do not represent a significant site-related threat to human health. None of the VOCs were present at concentrations sufficient to warrant their selection as COPCs.

Groundwater is clearly the significantly contaminated medium at Parcel 66(7), and VOCs are the risk drivers. VOCs selected as COPCs are limited to chlorinated solvents, including TCE and a number of dichlorinated ethenes that are probably TCE degradation products. The chlorinated solvents are responsible for ILCR and HI estimates exceeding acceptable or threshold levels.

It is concluded that exposure to soil does not represent a significant site-related threat to human health. Groundwater represents no threat to human health unless developed as a source of potable water, in which case the presence of chlorinated solvents would represent a significant threat to human health.