ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

DEPARTMENT OF HEALTH & HUMAN SERVICES - USA

Public Health Assessment for

EVALUATION OF EXPOSURES TO CONTAMINANTS FROM THE FORMER ABEX/REMCO HYDRAULICS FACILITY
WILLITS, MENDOCINO COUNTY, CALIFORNIA
EPA FACILITY ID: CAD000097287
AUGUST 2, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

Evaluation of Exposures to Contaminants from the Former Abex/Remco Hydraulics Facility, Willits, Mendocino County, California

CERCLIS No. CAD000097287

Prepared by

California Department of Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Summary

The Environmental Health Investigations Branch (EHIB) within the California Department of Health Services (CDHS), under cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), is conducting a public health assessment (PHA) related to the Abex/Remco Hydraulics site in Willits, California. The PHA will include a review of existing environmental data to evaluate the potential health impact from exposures to site-related contaminants. The PHA process helps to determine what follow-up activities are needed: additional site characterization, health education, health study, or specific measures to reduce or eliminate exposure. Specifically, we will address the following exposure pathways (situations): contamination in off-site soils; site-related contamination in private wells; soil gas migration from contaminated groundwater; water and sediments in Baechtel Creek; site-related contamination in fruits and vegetables; historic air releases of volatile organic compounds (VOCs); and airborne contaminants generated/released during interim remedial activities conducted between 2000 and 2004. In 2003, CDHS completed a PHA evaluating the exposure from historic releases of airborne hexavalent chromium (Cr +6). The PHA evaluating historic air releases is available to interested individuals and will not be replicated in this document.

In June 2000, due to ongoing community health concerns about the Remco site, the U.S. Environmental Protection Agency (USEPA) requested assistance from CDHS to evaluate the potential health impact posed by the facility. Since that time, CDHS has been conducting PHA activities and working with the Willits community.

In January 2006, a public comment draft of the public health assessment was released to the public and other stakeholders for review and comment. The comments and CDHS responses are provided in Appendix E.

The Remco site is located at 934 South Main Street, in the City of Willits, in Mendocino County. Ownership of the facility changed several times in its 55-year history, with MC Industries (parent company of Remco Hydraulics, Inc.) becoming the last owner in 1988. Remco Hydraulics, Inc. and MC Industries declared bankruptcy in 1995. Whitman Corporation/Pepsi Americas, Inc. has been identified as the party responsible for funding the clean-up (remediation) activities at the site, as result of various acquisitions and/or corporate mergers. In 1997, as a result of a lawsuit filed by the City of Willits against the former owners of the site, the Federal District Court for Northern California ordered a Consent Decree[1]. In December 2000, the Consent Decree was amended, establishing the Willits Remediation Trust (henceforth referred to as the Willits Trust). The Willits Trust is responsible for site investigation and clean-up activities, as required by the “Final Amended Consent Decree”. Under the Final Amended Consent Decree, site investigation and cleanup must follow the National Contingency Plan (NCP) rules (see Appendix A—Glossary). The “Final Amended Consent Decree” also includes a provision for medical monitoring.

1 A Consent Decree is the legal document, approved and issued by a judge, that formalizes an agreement reached between the plaintiff and the former owners (potentially responsible parties [PRPs]) of a site, where PRPs will conduct the cleanup action; cease or correct actions or processes that are polluting the environment; or otherwise comply with initiated regulatory enforcement actions to resolve site contamination. The Consent Decree describes actions that PRPs are required to perform, that may be subject to a public comment period.

In addition to the Consent Decree clean-up activities, the Remco site is currently under investigation by the North Coast Regional Water Quality Control Board (RWQCB), for contamination of the soil and groundwater.

The Remco facility operated between 1940 and 1995 as an industrial machine shop, and in 1959, began manufacturing hydraulic cylinders (2). In 1963, operations were expanded to include electroplating of hydraulic cylinders, and continued until the facility closed in 1995. Various chemicals used during these operations were released to the environment. Those chemicals include solvents (VOCs) for cleaning machines and parts, metal and acids for plating operations, coolants and lubricants for milling and lathing machines, petroleum hydrocarbons for fuel, and paints for finishing parts. CDHS used environmental data to evaluate potential exposure to the community to site-related contaminants in various media (water, surface water, soil, air, and edible produce).

The PHA process includes an evaluation of existing environmental data and identification of exposure pathways to determine whether the release of contaminants (chemicals) from a hazardous waste site or industrial facility impacts or has impacted the health of people in the surrounding communities. An important element of the PHA process is documenting and responding to community health concerns. CDHS has conducted a number of community outreach activities in an effort to collect and understand health concerns that community members believe are related to operations and/or contamination from the Remco facility. Community members have expressed health concerns about various types of cancer, reproductive issues, and a number of other noncancer health effects. In this PHA, CDHS responds to these concerns by indicating whether the contaminant(s) in the exposures pathways/activities evaluated is/are associated with the health concern expressed and at levels where health effects have been seen.

CDHS evaluated the possible exposure pathways/activities (past, current, and future) from Remco-related contaminants. On the basis of available data, CDHS concludes that the following pathways/activities pose no apparent public health hazard:

- private well usage for irrigation purposes (past, current);
- exposure from breathing VOCs in indoor air from soil gas (past, current);
- swimming or wading in Baechtel Creek (current and future);
- contact with sediment in Baechtel Creek (past, current, and future);
- playing or coming into contact with off-site soil (except on Franklin Avenue), including Baechtel Grove School, Blosser Lane Elementary School and the future Boys and Girls Club (past, current, and future);
- eating blackberries and fruit from trees grown in areas near the Remco site and other areas in the community (past, current, and future);
- breathing VOCs released during Remco operations between 1988 and 1991;
- breathing contaminants from interim remedial activities completed at the Remco site (2000–2003); and
- soil contact in the Willits community (past, current, and future).

Four timeframes within an exposure pathway could not be evaluated due to insufficient data or a potential exposure pathway exists in the future. As a result, CDHS concludes that the following activities pose an indeterminate public health hazard:

- breathing VOCs released during Remco operations (past – prior to 1988);
- swimming or wading in Baechtel Creek (past);
- private well usage for consumption or irrigation purposes (future) and;
- exposure from breathing VOCs in indoor air from soil gas migration/vapor intrusion (future).

One exposure pathway, air releases of hexavalent chromium, was the focus of an earlier PHA and is not replicated in this document (3). CDHS used air modeling data to evaluate exposure to airborne hexavalent chromium (released during chromium plating) because there were no actual samples taken during the time period Remco conducted chrome plating (1963–1995). Exposure to hexavalent chromium is currently known to cause both cancer and noncancer health effects.

Noncancer health effects include asthma, bloody nose, nasal septum scarring and perforation, runny nose, mild decreased lung function, bronchitis, gastric irritation, and subtle changes in kidney function (affects primarily the proximal tubule). Lung cancer is the primary cancer associated with hexavalent chromium exposure; other cancers (nasal and stomach) have been suggested, but are not well studied. (Exposure to hexavalent chromium is not the only cause of these cancer and noncancer health effects.) On the basis of air modeling data, CDHS concludes that residents and workers could have experienced noncancer health effects and some increased risk of cancer (primarily lung) from breathing hexavalent chromium over a large area of Willits (3). As a result, CDHS classifies the site as posing a public health hazard in the past (1963–1995), from exposure to airborne hexavalent chromium.

Since 1988, the California Cancer Registry has collected information on the number of people who get cancer. In order to evaluate cancer occurrence in Willits, CDHS reviewed the number of cancer cases for lung and other cancers between 1988 and 2000 (the years data are available). The review showed that the number of cancer cases in Willits during those years was not higher than expected for that population. The number of lung cancer cases was somewhat higher, although not statistically greater, than expected. Due to limitations with this type of data, the cancer review is not an effective tool for studying and characterizing how exposure to site-related contaminants, primarily hexavalent chromium, increased the risk of cancer in the Willits community. Thus, CDHS concludes that community members experienced some increase in their risk of developing cancer.

On the basis of these findings CDHS and ATSDR recommend the following actions:

- Remediation of the groundwater to prevent future impacts to private wells and prevent exposure from breathing VOCs in indoor air from soil gas migration/vapor intrusion.
- Mendocino County Department of Environmental Health work with the California Regional Water Quality Control Board to provide education to the citizens of Willits, notifying people of areas where contamination sources have been identified.
- The feasibility of medical monitoring/clinical evaluations should be considered for Willits residents and people who worked in Willits, who may have been exposed to air releases of

- Counseling and stress support services should be considered for impacted residents and workers, as needed. These activities could fall under the medical monitoring provision of the Consent Decree.
- The Willits Trust should implement adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the site. This should be conducted in conjunction with air monitoring, using detection limits adequate to protect public health.

Background and Statement of Issue

The Environmental Health Investigations Branch (EHIB) within the California Department of Health Services (CDHS), under cooperative agreement with the federal Agency for Toxic Substance and Disease Registry (ATSDR), is conducting a public health assessment (PHA) related to the Abex/Remco Hydraulics site in Willits, California. The PHA will include a review of existing environmental data to evaluate the potential health impact from exposures to site-related contaminants. The PHA is an evaluation of the site to help determine what follow-up activities are needed: additional site characterization, health education, health study, or specific measures to reduce or eliminate exposure. Specifically, we will address the following exposure pathways (situations): contamination in off-site soils; site-related contamination in private wells; soil gas migration from contaminated groundwater; water and sediments in Baechtel Creek; historic air releases of volatile organic chemicals (VOCs); hydrogen sulfide gas formation during the pilot study in 2000; exposure to VOCs during soil removal activities in 2003; and site-related contamination in fruits and vegetables. In 2003, CDHS completed a PHA evaluating the exposure from historic releases of airborne hexavalent chromium (Cr+6). The PHA evaluating historic air releases is available to interested individuals and will be summarized, but not be replicated in this document (3).

In June 2000, because of ongoing community health concerns about the Remco site, the U.S. Environmental Protection Agency (USEPA) requested that CDHS assist with evaluating the potential health impact posed by the facility. Since then, CDHS has been conducting PHA activities in the Willits community.

In January 2006, a public comment draft of the public health assessment was released to the public and other stakeholders for review and comment. The comments and CDHS responses are provided in Appendix E.

The Remco site is located at 934 South Main Street in the City of Willits, in Mendocino County (Appendix B, Figure 1). The Remco facility operated between 1940 and 1995 as an industrial machine shop, and in 1959 began manufacturing hydraulic cylinders (2). In 1963, operations were expanded to include electroplating of hydraulic cylinders, and continued until the facility closed in 1995. Electroplating is the process of applying a metal coating to an object by placing the object in an electrolyte solution and passing an electric current through the solution. Chromium electroplating was the primary plating operation at the site, with cadmium, phosphate, manganese, and zinc plating occurring at a lesser extent (4). The plating operations consisted of five underground vertical tanks (ranging from approximately 20-70 feet deep) and two aboveground horizontal tanks. During these operations, various chemicals were used, including solvents (VOCs) for cleaning machines and parts, metal and acids for plating operations, coolants and lubricants for milling and lathing machines, petroleum hydrocarbons for fuel, and paints for finishing parts (4).

Ownership of the facility changed several times in its 55-year history, with MC Industries (parent company of Remco Hydraulics, Inc.) becoming the last owner in 1988. Remco Hydraulics, Inc. and MC Industries declared bankruptcy in 1995. Whitman Corporation/Pepsi Americas, Inc. has been identified as the party responsible for funding the clean-up (remediation) activities at the site, as result of various acquisitions and/or corporate mergers. In 1997, as a result of a lawsuit filed by the City of Willits against the former owners of the site, the Federal District Court for Northern California ordered a Consent Decree[1]. On December 22, 2000, a Final Amended Consent Decree was entered, establishing the Willits Environmental Remediation Trust (henceforth referred to as the Willits Trust). The "Amended Final Consent Decree" requires Willits Trust to investigate and cleanup the site. Under the "Amended Final Consent Decree", site investigation and cleanup must follow the National Contingency Plan (NCP) rules (see Appendix A—Glossary). The "Amended Final Consent Decree" also includes a provision for medical monitoring.

In addition to clean-up activities that fall under the Consent Decree, Remco is being investigated by the North Coast Regional Water Quality Control Board (RWQCB) for contaminating soil and groundwater. Chromium releases to Baechtel Creek were first reported to the California Department of Fish and Game in 1970. In 1974, the RWQCB found evidence of chromic acid discharges in storm water runoff. In response, the RWQCB adopted a National Pollutant Discharge Elimination System (NPDES) permit that required Remco to eliminate all discharges except discharges from rainfall runoff.

Contamination of the groundwater with diesel fuel was first discovered in 1979. As a result, the RWQCB prohibited Remco from any future discharges to surface water (2). Subsequent investigations revealed hexavalent chromium and VOC contamination in the groundwater (5). In 1993, the RWQCB issued a clean-up and abatement order that required Remco to define the extent of off-site contamination in the groundwater and to implement remedial (clean-up) activities (2). Since that time, a number of investigations have been conducted. In 1998, the Willits Trust initiated remedial activities with the removal of a number of sumps, tanks, pits, and trenches at the site. A remedial investigation report was completed in 2001. In 2003, additional remedial activities to soil and groundwater were initiated at the site. As of this writing, a final remediation plan has not yet been completed.

Land Use

The Remco site occupies approximately 7 acres. The site is located in a mixed residential and commercial area along Main Street (U.S. Highway 101) (Appendix B, Figure 1). The Luna Market and Motel and a residential area bordered the site on the north. Between July 2002 and March 2006, the Willits Trust acquired and demolished the Luna Market, the motel, and 11 residences on the south side of Franklin Avenue. The entire Remco site is fenced, including the properties acquired by the Willits Trust on Franklin Avenue.

A residential area (Walnut Street) and Baechtel Grove Middle School are located south of the facility. The school is located approximately 500 feet from the facility's south facing fence line.

1. A Consent Decree is the legal document, approved and issued by a judge, that formalizes an agreement reached between the plaintiff and the former owners (potentially responsible parties [PRPs]) of a site, where PRPs will conduct the cleanup action; cease or correct actions or processes that are polluting the environment; or otherwise comply with initiated regulatory enforcement actions to resolve site contamination. The Consent Decree describes actions that PRPs are required to perform, that may be subject to a public comment period.

Blosser Lane Elementary School is located approximately $^1/_3$ mile to the south west of the fence line. A vacant lot and commercial and residential areas are located to the west of the facility. To the east of the site is a commercial area and Baechtel Creek (4).

Demographics

Based on 2000 census data, approximately 15,000 people live in the Willits area, with 5,073 people living within the city limits or the incorporated area. The ethnic make-up is roughly 3% American Indian, 14% Hispanic, and 83% white (6). In 1995, 33% of the total population was under age 19 and 13% was over age 65 (7).

CDHS gathered general demographic information on the City of Willits (city limits) and the unincorporated areas of Willits during the years of chrome plating operations at Remco. We gathered information about Baechtel Grove Middle School and Blosser Lane Elementary because of their proximity to the Remco site (8).

The population of the City of Willits was approximately 3,410 in the 1960s, 3,091 in the 1970s, 4,008 the 1980s, 5,006 in the 1990s, and 5,073 in 2000 (A. Falleri, City of Willits, personal communication, May 29, 2002).

The population of the unincorporated areas of the City of Willits was estimated to be 9,935 in the 1980s and 13,155 in the 1990s (5). Population data for the Willits area could not be located for the 1960s and 1970s (A. Falleri, City of Willits, personal communication, June 13, 2002).

Baechtel Grove School opened in 1954, and housed grades five through seven until 1989. Since then, the school has housed grades six through eight (S. Jorgensen, Willits Unified School District, personal communication, September 12, 2002). During the years of Remco operations, the school populations ranged from 520 to 580 students (F. Brant, Principal, Baechtel Grove Middle School, personal communication, May 20, 2002). Blosser Lane Elementary School opened in 1990 and housed grades three through five. The school population remained relatively constant at about 600 students.

Environmental Contamination/Pathway Analysis/Toxicological Evaluation

This section examines the pathways for exposure to contamination from the Remco site. We will examine each of the media (groundwater, sediment, surface water in Baechtel Creek, soil, air, and food chain) to determine whether or not contamination is present and if people in the community are exposed to (or in contact with) the contamination. If people are exposed to contamination in any of the media, we will evaluate whether there is enough exposure to pose a public health hazard. This analysis will systematically evaluate each of the media. Table 1 in Appendix C presents a summary of the exposure pathways identified at this site.

Exposure pathways are means by which people in areas surrounding the sites could have been or could be exposed to contaminants from the site. For target populations to be exposed to environmental contamination, there must be a mechanism by which the contamination comes into direct contact with a human population (9). This is called an exposure pathway. Exposure pathways are classified as either completed, potential, or eliminated.

In order for an exposure pathway to be considered completed, the following five elements must be present: a source of contamination, an environmental medium and transport mechanism, a point of exposure, a route of exposure, and a receptor population. For a population to be exposed to an environmental contaminant, a completed exposure pathway (all five elements) must be present. The following is an example of a completed exposure pathway: a contaminant from a hazardous waste site (source) is released to the air (medium-transport mechanism); the wind blows the contaminant through air into the community (point of exposure) where community members breathe the air (route of exposure and receptor population) (Appendix C, Table 1).

Potential exposure pathways are either 1) not currently complete but could become complete in the future, or 2) indeterminate due to a lack of information. Pathways are eliminated from further assessment if one or more elements are missing and are never likely to exist (9).

Description of Toxicological Implications

For data presented in this document, no current and/or future exposures to Remco-related contaminants (i.e., site-related metals or VOCs) were identified that would indicate a threat to public health. However, two potential current/future exposure pathways could not be evaluated due to a lack of data. CDHS provides recommendations to address these data gaps. Past exposure to Remco-related contaminants were identified and will be evaluated in this section. Before discussing the toxicological evaluation of specific exposure pathway conditions, a description of how we conduct toxicological evaluations is presented.

In a toxicological evaluation, we evaluate the exposures that have occurred to specific contaminants based on the most current studies we can find in the scientific literature. There is not enough available information to completely evaluate exposure to multiple chemicals or possible cancer and noncancer effects of exposure to very low levels of contaminants over long periods of time. Some introductory information follows to help clarify how we evaluate the possible health effects that may occur from exposure to the contaminants identified for follow-up.

When individuals are exposed to a hazardous substance, several factors determine whether harmful effects will occur and the type and severity of those health effects. These factors include the dose (how much), the duration (how long), the route by which they are exposed (breathing, eating, drinking, or skin contact), the other contaminants to which they may be exposed, and their individual characteristics such as age, sex, nutrition, family traits, lifestyle, and state of health. The scientific discipline that evaluates these factors and the potential for a chemical exposure to adversely impact health is called toxicology.

Noncancer Health Effects

To assess the potential noncancer adverse health risks associated with contaminants of concern (COC), we compared contaminant concentrations in “completed” or “potential” exposure pathways to health comparison values. Health comparison values are media specific contaminant concentrations that are used to screen contaminants for further evaluation. Noncancer health comparison values for soil and water are called environmental media evaluation guides (EMEGs) or reference dose media evaluation guides (RMEGS), and are respectively based on ATSDR's minimal risk levels (MRLs) or USEPA's references doses (RfDs), reference concentrations (RfCs), suggested no adverse response level (SNARL) and preliminary remedial goals (PRGs). The California Environmental Protection Agency (CalEPA) Reference Exposure Levels (RELs) and MRLs are used to evaluate exposure from air releases. MRLs, RfDs, RfCs, PRGs, and RELs are estimates of a daily human exposure to a contaminant that is unlikely to cause adverse noncancer health effects. Exceeding a health comparison value does not imply that a contaminant represents a public health threat, but suggests that the contaminant warrants further consideration.

The toxicity studies used to determine the various health comparison values are usually conducted on adult animals or adult humans, mostly worker populations. In an effort to be protective of sensitive populations such as children, an uncertainty factor is included in the derivation of health comparison values.

Cancer Health Effects

Cancer health effects are evaluated in terms of a possible increased cancer risk. Cancer risk is the theoretical chance of getting cancer. In California, 41.5% of women and 45.4% of men will be diagnosed with cancer in their lifetime (about 43% combined) (10). This is referred to as the “background cancer risk.” “Excess cancer risk” to represents the risk above and beyond the background cancer risk. If there is a “one-in-a-million” excess cancer risk from a given exposure to a contaminant, that means one million people are chronically exposed to a carcinogen at a certain level over a lifetime, then one cancer above the background risk may appear in those million persons from that particular exposure. For example, in a million people, it is expected that approximately 430,000 individuals will be diagnosed with cancer from a variety of causes. If the entire population was exposed to the carcinogen at a level associated with a one-in-a-million cancer risk, 430,001 people may get cancer, instead of the expected 430,000.

Cancer risk numbers are a quantitative or numerical way to describe a biological process (development of cancer). This approach uses a mathematical formula to predict an estimated number of additional cancers that could occur due to the exposure modeled. The model is based on the assumption that there are no absolutely safe toxicity values for chemicals that can cause cancer, meaning that the model assumes no matter how low, even for extremely low exposures, there is always the possibility that a true carcinogen could cause a cancer. The models typically use information from higher exposure scenarios and then extend an estimate of risk into lower exposure scenarios using the assumption that lower levels would still be carcinogenic. The calculations take into account the level of exposure, frequency of exposure, length of exposure to a particular carcinogen, and an estimate of the carcinogen’s potency. USEPA and the Office of Environmental Health Hazard Assessment (OEHHA) have developed cancer slope factors and unit risk values for many carcinogens. A slope factor/unit risk is an estimate of a chemical's carcinogenic potency, or potential, for causing cancer. Unit risk values or cancer slope factors are created from studies of persons (workers) or animals to see how much illness developed as a result of exposure. In order to take into account the uncertainties in the science (such as making predictions of health outcomes at lower levels when we only have information about high exposures), the risk numbers used are plausible upper limits of the actual risk, based on conservative assumptions. That is, the theoretical cancer risk estimates are designed to express the highest risk that is plausible for the particular exposure situation, rather than aiming to estimate what is the most likely risk. Given that there is uncertainty to these predictions, it is considered preferable to overestimate, rather than underestimate risk. If adequate information about the level of exposure, frequency of exposure, and length of exposure to a particular carcinogen is available, an estimate of the theoretical increased cancer risk associated with the exposure can be calculated using the cancer slope factor or unit risk for that carcinogen. Specifically, to obtain lifetime risk estimates, the air concentration is multiplied by the unit risk for that carcinogen. To obtain lifetime risk estimates for children, a chronic exposure dose is estimated and then multiplied by the slope factor for that carcinogen.

Cancer risk estimates are a tool to help determine if further action is needed and they should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur. The actual risk is unknown and may be as low as zero (11).

CDHS evaluated nine completed pathways of exposure related to the Remco site (Appendix C, Table 1). Data are presented in tables in Appendix C. In the following pages, we describe our evaluation of these pathways. A brief summary of the toxicological characteristics of the contaminants of concerns identified by CDHS is presented in Appendix D. The toxicological evaluation of the completed exposure pathways involves the use of exposure assumptions. The authors used “high end” estimates and assumptions to ensure potential health hazards from chemicals are recognized.

Discussion of Environmental Contamination

The following conversion chart is included as a reference tool to help differentiate the units of measurement used in the reporting and discussion of sampling data.

Units of Measurement Used in Environmental Sampling and Reporting

Environmental Media	Unit	Equivalent Unit
Water	mg/L (milligrams chemical per liter of water)	ppm (parts per million)
	μg/L (micrograms chemical per liter of water)	ppb (parts per billion)
Soil	mg/kg (milligrams chemical per kilogram soil)	ppm (parts per million)
	μg/kg (micrograms chemical per kilogram soil)	ppb (parts per billion)
Air	mg/m^3 (milligrams chemical per cubic meter of air)	ppmv (parts per million volume) = 24.45/molecular weight of chemical (mg/m^3)
	$\mu g/m^3$ (micrograms chemical per cubic meter of air)	ppbv (parts per billion volume) = 24.45/molecular weight of chemical ($\mu g/m^3$)

On-Site Groundwater and Soil Contamination

Summary: On-site groundwater and soil contamination does not pose a past, current, or future health hazard to the public because people are not coming into contact with these media. The Remco facility is fenced, restricting access to the public and the site is paved for the most part, further reducing the chance for people to come into contact with on-site soils. The City of Willits municipal water supply comes from surface water sources (Eel River) and therefore is not threatened by the on-site groundwater contamination. For these reasons, on-site soil and groundwater exposure pathways have been eliminated, requiring no further evaluation.

On-site groundwater and soil are contaminated but exposure to these media is not occurring. The site is paved eliminating the risk of resuspension and migration of contaminated soils. The site is fenced, prohibiting access to the site by the public. The City of Willits drinking water comes from surface water impoundments, not groundwater wells, and therefore is not threatened by the groundwater contamination at the site (J. Goebel, Regional Water Quality Control Board, personal communication, April 9, 2002). Therefore, these exposure pathways have been eliminated, requiring no further evaluation. On the basis of available information, CDHS concludes that on-site groundwater and soils do not pose a past, current, or future health hazard to the public, under the site's current use. If in the future, land use of the site changes to residential or recreational, then the site will need to be cleaned up to residential standards.

In order to better understand possible off-site exposures, we will briefly describe the contamination present in on-site groundwater and soil.

Groundwater

The groundwater beneath the Remco site contain high levels of VOCs, various metals including hexavalent chromium and total chromium, petroleum hydrocarbons, PAHs (polycyclic aromatic hydrocarbons), and limited detections of PCBs (polychlorinated biphenyls) (4).

Three water bearing zones have been identified under the Remco site. The zones are referred to as the A-zone (about 3-20 feet below ground surface [bgs]), the B-zone (about 20-40 feet bgs), and the C-zone (about 40-60 feet bgs). Groundwater levels at the site fluctuate and during the rainy season (winter and spring), the groundwater levels can rise to the ground surface (4).

> <u>What is a VOC?</u>
> VOCs are substances that easily volatilize (become vapors or gases) to the atmosphere. A significant number of the VOCs are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry cleaning fluids (1).

Generally, the A-Zone groundwater is the most contaminated, containing the highest levels of contaminants. High levels (above 1,000 ppb) of VOCs such as, 1,1,1-trichlorethane (1,1,1-TCA), 1,1-dichloroethylene (1,1-DCE), cis-1,2-DCE, 1,1-dichloroethane (1,1-DCA), tetrachloroethylene (PCE), trichloroethylene (TCE), 2-butanone (MEK), 1,4-dioxane, acetone, and trichlorotrifluoroethane (F reon-113) have been detected. The maximum detected levels are as follows: 4,050 ppb (1,1,1-TCA); 6,070 ppb (1,1-DCE); 5,110 ppb (cis-1,2-DCE); 2,430 ppb (1,1-DCA); 10,300 ppb (PCE); 3,000 ppb (TCE); 20,100 ppb (MEK); 2,200 ppb (1,4-dioxane); 18,000 ppb (acetone); and 3,860 ppb (freon-113) (4).

Other VOCs (1,1,2-TCA, 1,2-dichlorobenzene, 1,2-DCA, 1,2-dichloropropane, 1,2-dichloro-1,2-trifluoroethane, trans-1,2-DCE, arseneous acid, benzene, carbon disulfide chloroethane, chloroform, methylene chloride, methyl tert-butyl ether (MTBE), m,p-xylene, trichlorfluoromethane, toluene, and vinyl chloride) have been detected infrequently and at much lower levels (<75 ppb-300 ppb) (4).

The highest levels of total petroleum hydrocarbons (TPH), consisting of TPH-motor oil, TPH-diesel, and TPH-gasoline, have been detected in A-Zone groundwater. TPH-diesel has been measured at levels up to 2,860 ppm (or 2,860,000 ppb). TPH-motor oil has been measured at levels up to 42 ppm. TPH-gasoline has been detected at levels up to 1 ppm (1,000 ppb) (4).

Polychlorinated biphenyls (PCBs) were detected in two groundwater samples of 21 total samples analyzed. The PCB mixture Arochlor 1016 was detected at a maximum concentration of 6.4 ppb. The PCB contamination is not widespread at the site, and does not appear to have migrated off site (4).

PAHs (anthracene, benzo(a)pyrene, benzo(a)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indenol(1,2,3-c,d)pyrene, napthalene, phenanthrene, and pyrene) have been detected infrequently in groundwater beneath the site, at levels below 25 ppb (4).

<u>What is a TPH?</u>
TPH is a term used to describe a large family of several hundred chemical compounds that originally come from crude oil (1). TPHs are found in fuel products such as gasoline, diesel, and motor oil.

<u>What is a PCB?</u>
PCBs are mixtures of up to 209 individual chlorinated compounds. PCBs are either oily liquids or solids that are colorless to light yellow. PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they do not burn easily and are good insulators. Historically, PCBs have been measured as mixtures called Aroclors (1).

<u>What is a PAH?</u>
PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds (1).

The on-site groundwater is highly contaminated with hexavalent chromium and total chromium. Hexavalent chromium has been measured as high as 900 ppm (900,000 ppb) and total chromium as high as 960 ppm (4). Other metals such as, nickel, lead, copper, zinc, cadmium, manganese, antimony, iron, arsenic, and beryllium, have been detected at much lower levels and much less frequently.

Soil

The soil beneath the Remco site contain high levels of hexavalent chromium and total chromium, various metals, VOCs, petroleum hydrocarbons, PAHs, and limited detections of PCBs (4).

On-site soil has been sampled at the surface down to about 70 feet bgs and analyzed for VOCs, PAHs, PCBs, TPHs, and metals. Most of the contamination is present in the A-Zone soils (0-20 feet); however, chromium contamination has been measured in the C-Zone at a depth of 70 feet (4).

VOC contamination is present in on-site soil across the entire site. The primary VOCs detected in A-Zone soils are 1,1,1-TCA, 1,1-DCA, 1,1-DCE, MEK, acetone, cis-1,2-DCE, methylene chloride, PCE, and TCE. These VOCs have been detected at levels up to 108,000 ppb (1,1,1-TCA), 1,800 ppb (1,1-DCA), 168 ppb (1,1-DCE), 1,960 ppb (cis-1,2-DCE), 3,710 ppb (PCE), 320 ppb (TCE), 940 ppb (MEK), 2,300 ppb (acetone), and 33 ppb (methylene chloride) (4, 12).

TPH-motor oil, TPH-diesel, and TPH-gasoline has been detected in subsurface soil at levels up to 13,000 ppm, 8,560 ppm, and 314 ppm respectively (4, 12).

Aroclor 1242 and Aroclor 1258 (PCBs) have been detected in nine out of 40 soil samples collected, at concentrations up to 142 ppb and 108 ppb, respectively.

PAHs (naphthalene, benzo(a)anthracene, indeno(1,2,2-cd)pyrene, fluoranthene, acenaphthene, fluorene, pyrene, chrysene, benzo(k)fluoranthene, benzo(a)pyrene, acenaphthylene, and phenanthrene) have been measured at levels ranging from 7.1 ppm to 690 ppm (4, 12).

Various metals, including hexavalent and total chromium, have been detected in on-site soil at depths ranging from the surface to about 70 feet. Hexavalent chromium has been measured at levels up to 430 ppm and total chromium at levels up to 8,710 ppm. Levels of aluminum, barium (not site-related but naturally-occurring), nickel, zinc, copper, lead, and manganese have also been measured in subsurface soil as high as 22,000 ppm, 250 ppm, 170 ppm, 930 ppm, 200 ppm, and 1,000 ppm, respectively (4, 12). Other metals (antimony, cadmium, cobalt, arsenic, beryllium, mercury, selenium, silver, and thallium) have been detected at levels below 100 ppm (4, 12).

CDHS has eliminated the exposure pathway to on-site soil because nobody is being exposed or coming into contact with soil on the Remco site. The site is paved, thus eliminating the risk of resuspension and migration of contaminated soils. The site is fenced, prohibiting access to the site by the public. For these reasons, CDHS concludes that on-site soil does not pose a past, current, or future health hazard to the public, under the site's current use. If future land use of the site changes to residential or recreational, then the site will need to be cleaned up to residential standards unless site conditions change. No further evaluation is necessary.

Migration of Contamination Off Site

The groundwater contamination (primarily VOCs) has migrated off site and presents a potential for exposure in five ways: 1) exposure to contaminants (VOCs) in private wells; 2) potential for inhalation of soil gas in buildings located above the VOC-contaminated groundwater; 3) potential uptake of contaminants by plants that are eaten; and 4) groundwater to surface water discharge. Evaluation of these pathways will follow. Hexavalent chromium is the primary site-related metal detected in off-site groundwater. With exception of a few infrequent and low-level detections within the hexavalent chromium plume, other site-related metals have not been detected in off-site monitoring wells. As stated above, the City of Willits drinking water comes from surface water impoundments, not groundwater wells, therefore is not threatened by the off-site groundwater contamination.

The main way for contaminants to have impacted off-site soils is from releases of contaminants (metals, primarily chromium) to the air that deposit onto the soil and from contaminated groundwater that fluctuates during the rainy season, potentially contaminating the subsurface soil. CDHS understands that there are allegations of off-site dumping, which would be another way that soil could become contaminated. Those confirmed off-site dumping locations will be treated as separate sites and will not be addressed further in this PHA.

Evaluation of Private Well Exposure Pathway

Summary: Potential exposures to Remco-related contaminants in private wells did not pose a public health hazard in the past or currently. There is no apparent health risk in the future, provided remedial activities continue. Some VOCs and TPH-diesel have been detected in limited sampling of the nearby private wells. It is unlikely that adverse health effects would have resulted from exposure to Remco-related contamination in private wells, mainly because these wells were used for irrigation purposes, not drinking water and therefore potential exposures would be limited. Even if someone regularly/daily ingested water from the private irrigation well (OW-17) with the highest levels of VOCs measured, we would not expect noncancer health effects to have occurred or be occurring. A low theoretical increased cancer risk was estimated from daily ingestion of the highest levels measured in OW-17. The private irrigation wells that are located in the areas with the highest VOC groundwater contamination (residences along Franklin Street) have either been destroyed or abandoned, thus eliminating any current or future public health hazard. Private wells (also used for irrigation) further down gradient (Highway 20 and East and West Oak Avenue) either do not contain levels of Remco related VOCs or have not been impacted by VOCs at levels above drinking water standards (levels allowable in public drinking water supplies). Remediation of the groundwater plume is necessary to prevent the possibility for potential exposures in the future.

Based on information provided by a representative with City of Willits, it appears that residents on Franklin Avenue, Highway 20 (Flower Street), East and West Oak Avenue have been supplied municipal drinking water as far back as the1930s, and private wells were used for irrigation purposes only (D. Madrigal, City of Willits, personal communication, January 18, 2001). Private well surveys (discussed below) conducted by the RWQCB and ERM-West (environmental consultant for Remco), add further verification that residents did not use private wells for drinking water.

The first indication that site-related contamination had spread off site and impacted private wells was documented by RWQCB in 1981. Diesel contamination was frequently observed in a hand dug well approximately 3-15 feet deep, which was used for irrigation at 75 Franklin Avenue (13). This well was abandoned in the late 1980s (14). In 1982, diesel fuel was observed (no samples analyzed) in a private well identified as OW-19, during an investigation conducted by Alvin Franks (Appendix B, Figure 2) (15). No other site-related contaminants were analyzed.

In March 1991, well surveys were conducted by the RWQCB, due to concerns about groundwater contamination from Remco (14). The purpose of the survey was to identify private wells in the vicinity of the site and to understand the uses of these wells. The RWQCB private well survey indicated that the wells surveyed were either abandoned or used for irrigation purposes, not for drinking water (14). During that same month (March 1991) the County of Mendocino Department of Public Health issued notices to residents warning them of possible groundwater contamination affecting their wells (16).

Later in 1991, during an investigation conducted by ERM-West for Remco, a sample was collected from OW-17 and analyzed for hexavalent and total chromium. Neither hexavalent nor total chromium was detected above the respective laboratory detection limits of 0.01 ppm and 0.02 ppm (17). A private well survey was conducted as part of the ERM-West investigation. According to the survey, the wells were either abandoned or used for washing cars and irrigation purposes, not drinking water (17). Two residents on Highway 20 reported using their well to fill their swimming pools.

More comprehensive sampling of Remco-related contaminants did not occur until 1997. Since then, 24 private wells have been sampled periodically for total chromium, hexavalent chromium, TPH, and VOCs (Appendix B, Figure 2) (4). One well (OW-22) was sampled for 12 additional metals (antimony, arsenic, beryllium, cadmium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc). Copper and zinc were detected at 37.6 ppb and 39.3 ppb, respectively.

CDHS used primary drinking water standards (maximum contaminant levels (MCLs), the allowable level in municipal water supplies) as an initial screen for chemicals/COC (Appendix C, Table 2). In the case of TPH-diesel, the USEPA Suggested No Adverse Response Level (SNARL) was used as a screening value because an MCL has not been set. A contaminant that exceeds drinking water standard or health comparison value is considered a COC and will be evaluated further. None of the private wells sampled contain total chromium at levels above the drinking water standard of 50 ppb. Total chromium was detected in five wells (OW-11, OW-17, OW-21, OW-29, and OW-35) at levels ranging from 1.8 ppb to 13 ppb (4). Hexavalent chromium was not detected in any of the wells above laboratory detection limits, which ranged from 5 ppb to 20 ppb. Since total chromium was not detected above drinking water standards, it is not considered a COC in private wells; hence, no further evaluation is necessary.

Copper and zinc were the only metals detected in OW-22, at 37.6 ppb and 39.3 ppb respectively (4). Primary drinking water standards have not been established for copper or zinc. Copper has a maximum contaminant level goal (MCLG) and “action level” of 1,300 ppb, based primarily on ecological concerns. Zinc is regulated by a secondary drinking water standard (based on taste and odor concerns, not health) of 5,000 ppb. Levels of copper and zinc are well below their respective drinking water standard and are not considered contaminants of concern in OW-22; hence, no further evaluation is necessary.

As discussed above, metal analysis (not including hexavalent and total chromium) in private wells is limited to one sample (OW-22), prohibiting a more complete evaluation. However, samples have been collected and analyzed for 14 metals (antimony, arsenic, beryllium, cadmium, copper, iron, lead, mercury, manganese, nickel, selenium, silver, thallium, and zinc) in off-site groundwater monitoring wells in the general area of these private wells. No site-related metals were detected (4). Therefore, it unlikely that private wells were impacted in the past by site-related metal contamination of the groundwater.

TPH as diesel was detected in three wells (OW-1, OW-5, and OW-23) at levels ranging from 30 ppb to 3,400 ppb, in limited sampling (1-2 samples) (4). The highest concentrations of TPH-diesel was measured in OW-1 (200 ppb) and OW-5 (3,400 ppb), located north of the site in areas where contamination from gasoline service stations is documented and the most likely source of diesel in these wells (J. Goebel, Regional Water Quality Control Board, personal communication April 9, 2002) (Appendix B, Figure 2). Results from limited sampling of OW-1 and OW-5 exceed the SNARL (100 ppb) and therefore TPH-diesel is considered a COC in these private wells (Appendix C, Table 3). The following paragraphs describe CDHS' evaluation of potential exposures to TPH-diesel in private wells.

CDHS evaluated potential noncancer health effects from exposure to diesel in private wells, using a method that considers the hydrocarbon fraction[2] (aliphatic and aromatic fractions) make-up of diesel fuel (18, 19). The toxicity of each fraction is represented by the RfD of a "reference compound" that is considered to have similar effects on the body (18). For example, the toxicity of pyrene was used as the reference compound for the C11-C22 aromatic fraction. CDHS calculated an estimated dose from potential exposure to TPH-diesel in each private well, using the hydrocarbon fraction approach (Appendix C, Table 3). In the following paragraph, CDHS evaluates the worst-case scenario, assuming water from OW-1 and OW-5 was used as the sole source of drinking water, rather than irrigation. CDHS assumed these exposures occurred for 30 years. This scenario was chosen because it is a more straightforward approach and would present an overestimation, rather than an underestimation of the exposure. Exposure from irrigation water would be considerably less than if someone were drinking the water.

The estimated doses from exposure to diesel in OW1 and OW5 do not exceed the RfDs for the reference compounds (Appendix C, Table 3). Thus, potential exposures in the past to diesel in these private wells would not have resulted in noncancer adverse health effects, even if the water were used as a drinking water source instead of irrigation.

Due to a lack of toxicological data, ingestion of diesel is not considered classifiable as a carcinogen, and cannot be evaluated further. Certain constituents of diesel are carcinogenic, but there is no acceptable manner to evaluate the carcinogenicity of TPH measurements.

VOCs have been detected in three private wells above drinking water standards. Sampling results for VOCs indicate that one well (OW-17) has multiple VOCs exceeding drinking water standards (PCE, TCE, 1,1,-DCA, cis-1,2-DCE, and 1,1-DCE) (Appendix C, Table 2) (4). Results from OW-24 show levels of methylene chloride (44 ppb) above drinking water standards (5 ppb) (Appendix C, Table 2). MTBE was detected at levels just above drinking water standards (13 ppb) in OW-7. Most of the remaining private wells do not contain VOCs, or the levels are well below drinking water standards and thus do not require further evaluation.

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2. Composition/fraction of diesel includes C9-C18 aliphatic hydrocarbons (40%) and C11-C22 aromatic hydrocarbons (60%) (17).

In the following paragraphs, CDHS evaluates VOC levels found in three private wells, using the same worst-case scenario/assumptions described for TPH-diesel above (18).

The dose estimates for each of the VOCs detected do not exceed health comparison values (Appendix C, Table 2). Therefore, exposure to methylene chloride in OW-24 and MTBE in OW-7 would not have resulted in noncancer health effects. Similarly, exposure to each of the five VOCs detected in OW-17 would not be expected to cause noncancer adverse health effects. However, since multiple VOCs (PCE, TCE, 1,1-DCA, and 1,1-DCE) were detected in OW-17, CDHS evaluated the additive effects of exposure. This is done by estimating a “hazard index,” which is a calculation used to address exposure to multiple contaminants. If the hazard index is below 1, then no adverse health effects are expected. The estimated hazard index for both children (0.39) and adults (0.39) is below 1, thus no noncancer health effects are expected to have occurred or be occurring from past ingestion of water from OW-17. This means even if OW-17 had been used as a drinking water source instead of irrigation, noncancer health effects would not have occurred. OW-17 was abandoned on March 28, 2000.

CDHS evaluated the theoretical increased cancer risk to residents from exposure to VOCs considered potentially carcinogenic (PCE, TCE, 1,1-DCA, and 1,1-DCE) in OW-17 (Appendix C, Table 2). We assumed OW-17 was used as the sole source of drinking water for 30 years (18 years for a child). We do not have any information regarding the actual amount of time residents lived at the property where OW-17 was located. The 30-year exposure assumption should be viewed as highly conservative and will result in an overestimation of the theoretical increased cancer risk. The total theoretical increased cancer risk was estimated at 3 in 10,000 for an adult, and 2 in 10,000 for a child. This is considered a “low increased risk.” As stated earlier, this exposure scenario probably never occurred because this well was not used for drinking water. Any exposure and resultant risk received during irrigation activities using OW-17 well water would have been much lower. We also evaluated the theoretical increased cancer risk to residents from exposure to methylene chloride in OW-24, using a 30-year exposure assumption (Appendix C, Table 2). The total theoretical increased cancer risk was estimated at 4 in 1,000,000 for adults and 1 in 1,000,000 for children. This is considered “no apparent increased risk.”

In summary, current exposure to Remco-related contaminants in private wells does not pose a public health risk. Potential exposures in the future will be eliminated through remediation of the contaminated groundwater.

CDHS recognizes private wells exist in other areas of Willits where contamination of the groundwater (not related to Remco) may be present. Private wells are not regulated or tested in the State of California, leaving the responsibility of assuring the safety of private well water on the owner of the well. In many cases, private well owners are not aware of potential water quality issues relating to contaminated groundwater. Thus, it seems prudent for Mendocino County Department of Environmental Health to work with the California Regional Water Quality Control Board to provide education to the citizens of Willits, notifying people of areas where contamination sources have been identified.

Evaluation of Soil Vapor/Gas Migration into Buildings

Summary: CDHS examined the potential for indoor air in residences located on Franklin Avenue to be affected by the VOC-contaminated groundwater flowing under their homes. CDHS found: a) concentrations of VOCs in groundwater beneath Franklin Avenue residences are not at levels likely to impact indoor air and b) indoor air sampling conducted in three residences on the south side of Franklin Avenue indicate that the VOCs (low levels) detected in indoor air are at levels commonly found indoors. Based on groundwater data and indoor air sampling data, it does not appear soil gas migration is impacting the indoor air quality in residences on Franklin Avenue at levels discernible from those commonly found indoors. CDHS concludes there is no public health hazard in the past, currently to people from breathing chemicals that have migrated into their homes from contaminated groundwater under Franklin Avenue residences. Remediation of the groundwater is necessary to prevent potential exposures in the future.

The off-site groundwater north of the site is contaminated from a depth of approximately 3 feet to 40 feet. The A-zone (3 to 15 feet bgs) is the most contaminated, predominantly with VOCs, and with hexavalent chromium to a lesser extent. In cases when the groundwater is close to the surface (within 30 feet), volatile chemicals in the groundwater can be pulled into buildings. This is known as soil gas migration/vapor intrusion. Once inside the building, these gases or vapors can be inhaled. While soil gas can be an important source of in-building air contaminants, it is only one of several contributors to the total air contaminants found inside a building (20). Typical indoor air is not considered healthy and contains many chemical constituents, which come from various sources, such as household products, cooking, building materials, and influences from the outdoors.

There has been no sampling of soil gas at the Remco site, adequate to evaluate potential soil gas migration. The levels of VOCs measured in recent groundwater sampling (September 2005), closer to residences, do not indicate that residential indoor air is being impacted by soil gas at levels posing a health threat (21). Given the current understanding of the groundwater plume, concentrations of VOCs under Franklin Avenue residences were likely lower in the past. However, given the complex geology of the area and the high level of community health concerns, CDHS recommended that additional characterization of groundwater and indoor air sampling in residences on the south west side of Franklin Avenue be conducted (22). As a result, the RWQCB requested that the Willits Trust conduct indoor air sampling in the remaining homes on the south side of Franklin Avenue.

In April 2005, indoor air sampling was conducted in the three remaining homes on the south side of Franklin Avenue, two of which are owned by the Willits Trust and were vacant during the sampling. A sample was also taken in the crawl space under the house of the remaining residential property (at that time) on the south side of Franklin Avenue. The Willits Trust purchased this property (67 Franklin Avenue) in September 2005, and the residence was demolished in April 2006.

Low levels of some VOCs were detected in all of the former residences (23) (Appendix C, Table 4). The levels measured are consistent with levels commonly found in indoor air. For purposes of comparison, we have included a range of levels identified in other studies of indoor air in the table (Appendix C, Table 4) (24, 25). At these levels, it is not possible to discern between levels from indoor sources and the contribution (if any) from soil gas. TCE and 1,1,1-TCA (chemicals of concern in groundwater) were not detected in the crawl space sample collected under one of the former residences (Appendix C, Table 4). This suggests that the detections of 1,1,1-TCA and TCE in indoor air are likely from an indoor source, rather than soil gas.

To assess the potential noncancer adverse health risks associated with contaminants in indoor air, we compared the VOC levels to health comparison values (Appendix C, Table 4). None of the VOCs detected exceed health comparison values for noncancer adverse health effects. Thus no noncancer adverse health effects should have occurred or be occurring from exposure to VOCs in indoor air.

Health comparison values for chemicals considered potentially carcinogenic (cancer causing) are set at a level correlating to a “one-in-a-million” theoretical increased cancer risk. Benzene and TCE exceed health comparison values in all of the indoor air samples (Appendix C, Table 4). Cancer health effects are evaluated in terms of a possible increased risk of developing cancer, from which exposure is looked at over a lifetime.

CDHS calculated a theoretical increased cancer risk to former residents who lived on the south side of Franklin, using the highest level of benzene and TCE detected in indoor air. The theoretical lifetime increased cancer risk from exposure to benzene and TCE in indoor air is estimated to be 5 in 100,000. This is considered a very low increased risk. It is important to note that benzene has only been detected in limited samples on site, at low concentrations which would not be expected to impact indoor air (4). Further, benzene is a common contaminant found in outdoor air, from numerous sources (e.g. gasoline, auto exhaust, combustion sources, etc.). In 2005, the California Air Resources Board (CARB) reported the statewide average outdoor (ambient) air level for benzene at 1.5 $\mu g/m^3$. Benzene levels measured indoors are consistent with levels found in outdoor air. Further, benzene has not been detected in the nearest groundwater monitoring wells upgradient from the former residences on Franklin Avenue (J. Goebel, Regional Water Quality Control Board, personal communication, June 8, 2006). TCE was detected in groundwater near this former residence at low concentrations (1.6 µg/L and 3.0 µg/L), which would not be expected to impact indoor air (21). Thus, concentrations of benzene and TCE measured in indoor air are most likely from other sources, and not site related.

In summary, it does not appear that soil gas migration is impacting the indoor air in residences on Franklin Avenue at levels discernable from levels commonly found indoors. On the basis of available data, CDHS concludes there is no apparent public health hazard in the past and currently from exposure to soil gas migration into Franklin Avenue residences. Remediation of VOC-contaminated groundwater is necessary to prevent impacts on indoor air from soil gas in the future.

Evaluation of Possible Food Chain Exposure Pathway

Summary: CDHS reviewed vegetation data (blackberries and plums) collected near the site and the scientific literature regarding plant uptake of hexavalent chromium and VOCs. We evaluated potential exposure from eating blackberries and plums grown near the site. On the basis of our *evaluation, eating blackberries and plums grown near the site and in other areas of Willits does not pose a public health risk from exposure to site-related metals (viz. hexavalent chromium, lead, and zinc). Limited site-related data suggests that VOCs in groundwater do not appear to be taken up in plants along Flower Street (Highway 20), or the uptake is so small that it cannot be measured. Published scientific studies on VOC uptake in plants indicate the majority of VOCs are transpired into the air and would not concentrate in the edible portion of the plant at levels of health concern. CDHS concludes eating blackberries and other fruit grown in areas near Remco and other areas in the community poses no apparent health risk from Remco-related contaminants.*

Residents have expressed concern about the potential for edible plants, such as blackberries or fruit bearing trees, growing above the contaminated groundwater to take up and store contaminants from the contaminated groundwater plume. It is worth noting that most home gardens are grown in the spring and summer when the groundwater is roughly 3 to 6 feet bgs (depending on the location), reducing the likelihood for shallow rooted plants to come into contact with contaminated water. Fruit bearing trees and blackberries have deeper root systems and grow year-round, which represents the greatest concern for potential uptake of contaminated-groundwater. Therefore, the following evaluation focuses on potential uptake of Remco-related contaminants in fruit bearing trees and blackberries. There are no protocols for evaluating this pathway so CDHS conducted a limited literature review looking at uptake of VOCs and hexavalent chromium in edible plants.

CDHS was not able to locate any studies of VOC uptake in edible plants, such as blackberries or fruit trees. There is a great deal of research being conducted on the use of vegetation (trees) for remediation of VOC-contaminated sites. This field of study is known as phytoremediation. In general, the plants take up the chemicals present in water or soil. Then the plants change (degrade), store (sequester), and release (transpire) them, along with water vapor, into the atmosphere. In the limited studies reviewed, VOCs were shown to present at low concentrations in various parts of the plant tissue (root zone, leaves, stems, and trunk cores) (26, 27). Edible plants have been shown to take up both trivalent chromium and hexavalent chromium. Uptake of hexavalent chromium has been observed in the edible portion or fruit (maize/corn) of plants irrigated with water containing hexavalent chromium (28). At low hexavalent chromium concentrations, plants have been shown to effectively reduce hexavalent chromium to trivalent chromium by the plant (29). The amount of uptake is dependant on the concentration of chromium in the water, the pH, and soil type to a certain degree (29). In a published study (not related to Remco) of chromium uptake by corn, low levels of hexavalent chromium were measured in the grain, ranging from 0.004 to 0.5 ppb. Hexavalent chromium levels in irrigation water used for the study ranged from 500 ppb to 25,000 ppb.

In 1998, Henshaw Associates, consultants to the Willits Trust, collected fruit and vegetables (pear, tomatoes, pickles, and garlic clove) grown by a resident on Flower Street and analyzed them for VOCs, total chromium, and hexavalent chromium. No chromium or VOCs were detected in the fruit or vegetables (30). This is not an unexpected result since the chromium-contaminated groundwater plume has not migrated to this area and detections of VOCs have been infrequent and at low levels (less than drinking water standards).

In late 2001, Montgomery Watson Harza (MWH), consultants to the Willits Trust, collected samples of fruit-bearing vegetation (blackberry and plum) from areas on site at the northern boundary, to help determine whether site-related metals, in particular hexavalent chromium (VOCs not analyzed), are being taken up by edible plants/vegetation. The samples were collected from properties that are now owned by the Willits Trust and not accessible to the public. Hexavalent chromium levels in shallow groundwater in areas where blackberry plants and a plum tree grows (northern boundary of the site, former Luna Apartments) are consistent with hexavalent chromium levels (500 ppb to 25,000 ppb) in water that have been shown to be taken up and translocate to the edible portion of plants (29). Blackberries and plums were sampled from these areas and analyzed for metals. Blackberry samples were also collected from the southern end of the site in areas where the groundwater and soil was not impacted by hexavalent chromium contamination. MWH considers these samples “background” (4). Additional samples of fruit purchased from a commercial vendor/grocery store were also analyzed as an added measure of background. These samples were analyzed for a full suite of metals. A summary of the metals detected is presented in Table 5 (Appendix C).

Total chromium, hexavalent chromium, lead, and zinc (primary site-related metals) were detected at consistent levels in all of the samples, including those samples purchased from a grocery store, which were not affected by Remco contaminants. The highest level of hexavalent chromium was measured in the blackberry and plum samples purchased from the grocery store (Appendix C, Table 5). The validity of these results is questionable, as one would not expect the grocery store samples to contain higher levels of site-related contaminants than samples collected from contaminated areas of the site. Further, the laboratory analysis used to quantify hexavalent chromium in the fruit samples was a method developed for soil, which may or may not be appropriate for this type of media (fruit). CDHS recognizes a laboratory method for analyzing hexavalent chromium in produce/vegetation, capable of low-level detection, may not be validated and/or available.

CDHS estimated doses for an individual eating plums and blackberries grown near the site, using health protective assumptions and USEPA guidance (31). We assumed a person ate fruit at the highest value detected in blackberry and plum samples collected near the site, regardless if the sample was characterized as “background,” for 20 years (Appendix C, Table 5). Estimated doses do not exceed health comparison values, thus, noncancer adverse health effects would not be expected.

None of the metals detected in the plum and blackberry samples are considered carcinogenic through the ingestion (eating) route.

A limited review of the literature indicates that some VOCs become sequestered in the plant material; however, the majority of VOCs are transpired into the air. Therefore, it is not expected that VOCs would concentrate at levels of health concern in the edible portions of plants.

In conclusion, on the basis of available data, eating blackberries or plums grown near the site or in other areas of Willits poses no apparent health hazard from exposure to site-related contaminants.

Surface Water/Storm Drain Releases to Baechtel Creek and Possible Exposures

High levels of hexavalent chromium can be absorbed through the skin, resulting in systemic toxicity in addition to irritation and other effects to the exposed skin surface or site of contact. Children and adults report playing in Baechtel Creek and could have been exposed to contaminants emanating from the Remco site through incidental ingestion, and contact with the skin (dermal exposure).

The topography of the site means that surface water would naturally flow in a north easterly direction. The surface water has been collected on site by a storm drain system that flows into the city's storm drain system and then ultimately into Baechtel Creek (Appendix B, Figure 3). In the past (prior to the 1970s), the storm drain system consisted of an unlined ditch along the northern boundary of the facility (32). Between 1970 and 1974, improvements were made to the storm drain system by lining the ditch, installing a subsurface culvert, and adding several catch basins (32). During the mid-1990s to 2000, additional improvements were made to eliminate infiltration of contaminated groundwater into the storm drain through cracks. CDHS recognizes the possibility for rising groundwater to reach the ground surface in areas that are not covered by concrete or pavement and form puddles; however, there is insufficient data to evaluate this scenario. Since most of the site is covered by pavement, surfacing groundwater and subsequent runoff should be limited. Therefore, our evaluation focused on measurements taken in the storm drain system, in Baechtel Creek, and in the south drainage ditch. There have been chemical releases from Remco to the creek. CDHS focused on areas adjacent or downstream of the site since these are the areas that could have been impacted by those releases. CDHS recognizes there are concerns about exposures upstream of the site, but these exposures would not be related to the Remco site on Highway 101.

Historic Releases 1970–1985

Summary: It is difficult to evaluate potential exposures to site-related metals (in particular hexavalent chromium) and VOCs prior to 1991, when monitoring was initiated, because the data is limited. There are a several occasions when releases were reported and hexavalent chromium was measured in Baechtel Creek. Potential exposures to hexavalent chromium on these occasions would not be expected to have resulted in noncancer adverse health effects. However, it is likely other releases of site-related contaminants to Baechtel Creek occurred, possibly at levels of health concern. On the basis of limited data, CDHS concludes that potential exposure to surface water and storm water prior to 1991 posed an indeterminate public health hazard.

CDHS staff reviewed files at the RWQCB in an effort to obtain data and gain a better understanding of historic releases from Remco to the storm drain, which then flows into Baechtel Creek. The data and information reviewed is summarized below and presented in Table 6 (Appendix C) at the end of this document.

In the early 1970s, residential reports of discolored water in Baechtel Creek led to the discovery that Remco operations were responsible for discharging chromium to the storm drain, which empties into Baechtel Creek (Appendix C, Table 6) (33). Over the years, a number of spills or discharges were identified and limited sampling was conducted (5, 6, 32-41). From 1970 to

1985, 13 samples were analyzed for total chromium, and three were analyzed for hexavalent chromium (Appendix C, Table 5). Total chromium was detected at levels ranging from less than 20 ppb (parts per billion) to 310,000 ppb. Hexavalent chromium (a portion of total chromium) was detected at levels ranging from 150 ppb to 42,500 ppb. There was no analysis of other site-related metals (lead, nickel, cadmium, and zinc) or VOCs during this time period. Hexavalent chromium has been identified as a contaminant of concern in Baechtel Creek and will be evaluated further.

It is difficult to accurately estimate historic long-term or chronic exposures from incidental ingestion of Baechtel Creek water because 1) the data are limited to a few samples, 2) the sample analyses do not include all of the potential contaminants released, and 3) Baechtel Creek is a flowing body of water where dilution would occur, thus the samples collected would not be representative of levels in the Baechtel Creek at other locations and on other days. For instance, a citizen reported a concern about a release on September 16, 1974. The health department sampled the creek water on September 19, 1974. If indeed there had been a release of hexavalent chromium, it apparently had dissipated by the time the sampling occurred three days later. CDHS recognizes that during the summer months the creek's flow is minimal and areas of pooled water have been documented (Appendix C, Table 6). Some of the pooled areas were pumped and used for irrigation (5, 40). It is possible that someone could come into contact with water where known levels of chromium have been measured.

On August 10, 1981, a chromium release was identified and water that had pooled in Baechtel Creek was pumped the next day. Total chromium concentrations ranged from 150 ppb to 17,000 ppb and hexavalent chromium ranged from 150 ppb to 7,100 ppb (Appendix B, Table 6). About 2 weeks later (August 26, 1981), total chromium was still detected at 16 ppb and 30 ppb in pooled areas used by a resident for irrigation (Appendix C, Table 6). These levels (16 ppb and 30 ppb) would not pose a health hazard for irrigation purposes. CDHS evaluated the potential 17-day exposure to an adult and child who accidentally drank or came into contact (skin or dermal exposure) with the water from the pooled area while wading, between August 10, 1981, and August 26, 1981, using the highest level of hexavalent chromium that was measured. We calculated both a dermal (skin) dose[3] and an ingestion dose in our evaluation.

Total chromium levels did not exceed the health comparison screening value of 20,000 ppb for children and 50,000 ppb for adults; thus, no further evaluation of total chromium is necessary. There are no health comparison values to evaluate intermediate exposure (14-365 days) to hexavalent chromium in water, so we compared these doses to the USEPA chronic RfD. Chronic RfDs are established for exposures that occur for more than 1 year and are unlikely to result in noncancer adverse health effects. The RfD for hexavalent chromium is derived from the NOAEL

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3 Assumptions used for calculating the dermal dose: Skin surface area (adult) from USEPA Exposure Factors Handbook Tables 6-2 and 6-3 by averaging the 50th percentile for lower legs, feet, and hands of females and males with that of the forearms of males (data not supplied for women) = 5,809 square centimeters (cm^2). Skin surface area for a child: USEPA Exposure Factors Handbook Tables 6-6 and 6-7 average the 50th percentile for total body surface area for males and females ages 8-15 multiplied by the percentage of total surface area that the legs, hands, and feet obtained from Table 6-8 = 5,323 cm^2 (34). Body weight for adults average of the 50th percentile for females and males = 71.8 kilogram (kg) (Table 7-2, USEPA Exposure Factors Handbook). Body weight for child average of the 50th percentile for females and males ages 8-15 = 41.9 kg (Tables 7-6 and 7-7, USEPA Exposure Factors Handbook) (31).

of 2.5 mg/kg/day from a 1-year drinking water study of rats, with a three hundredfold safety factor. The safety factor of 300 represents two tenfold decreases in dose to account for both the expected interhuman and interspecies variability in the toxicity of the chemical in lieu of specific data, and an additional factor of 3 to compensate for the less-than-lifetime exposure duration of the principal study to account for uncertainty (42).

The combined dose an individual would receive from wading and accidentally drinking 0.05 liters of water containing 7,100 ppb (highest level of hexavalent chromium measured during that period) from the pooled areas in Baechtel Creek between August 10, 1981, and August 26, 1981, was estimated at 0.00001 mg/kg/day for an adult and 0.00002 mg/kg/day for a child (8-15 years old). These doses do not exceed the USEPA chronic RfD of 0.003 mg/kg/day. Thus, noncancer adverse health effects should not have occurred from exposure to pooled water in Baechtel Creek in August 10-26, 1981.

On June 14, 1982, a release of chromium was identified when a community member pumped the water for irrigation purposes and noticed discoloration of the water in pooled areas of Baechtel Creek. Total chromium was measured in a pooled area at 310,000 ppb. The pooled areas in the creek were pumped the same day as the release, making it unlikely that a community member would have been exposed to chromium-contaminated water in the pooled areas of the creek. Additionally, there was no indication in RWQCB files describing the event that community members were seen or would have been allowed to swim or play in the contaminated pools in Baechtel Creek, and there do not appear to be any reports of anyone becoming sick from the creek on that day. However, CDHS evaluated the potential one time exposure to a person who accidentally drank or came into contact (skin or dermal exposure) with the water from the pooled area while wading. We assumed that 310,000 ppb of chromium measured was entirely hexavalent chromium. We calculated both a dermal dose and an ingestion dose in our evaluation.

The combined dose an individual would receive from wading and incidentally drinking 0.05 liters of water from the pooled area in Baechtel Creek on June 14, 1982, was estimated to be 0.00003 mg/kg/day for an adult and 0.00005 mg/kg/day for a child (8-15 years old) (43). There are no health comparison values to evaluate short-term exposure to hexavalent chromium in water, so we compared the estimated doses to the USEPA chronic RfD of 0.003 mg/kg/day. Estimated doses do not exceed the RfD for chronic exposure, thus noncancer adverse health effects should not have occurred. As stated earlier, because the release was identified and cleaned up rapidly, it is unlikely that a community member was exposed to the chromium-contaminated pools in Baechtel Creek on June 14, 1982.

Storm Drain Monitoring/Surface Water Samples (1991–2004)

Summary: CDHS determined that potential exposures to children and adults who accidentally ingest (drink) or come into contact with water from Baechtel Creek does not pose a current or future public health hazard from site-related contaminants. The facility is closed, thus eliminating releases to the creek, and improvements to the storm drain system have been implemented to prevent infiltration of contaminated groundwater, which should reduce/eliminate future discharges of contaminated water to Baechtel Creek. Continued monitoring of the storm drain discharges during the rainy season when groundwater levels rise will identify any *unforeseen failure of the system in the future. Surface water and storm water data collected from Baechtel Creek and the south drainage ditch since 1991 do not indicate the presence of site-related contaminants at levels of health concern.*

CDHS reviewed storm drain monitoring data for VOCs, total chromium, hexavalent chromium, and total petroleum hydrocarbons collected between 1991 and 2004 (4). Most of the monitoring data was collected during the months of October through April, when rainfall occurs and storm water runoff is generated. Samples were collected at various locations (SWD1-SWD7) along the storm drain, in Baechtel Creek, and in the south drainage ditch (Appendix B, Figure 3). SWD7 is the last sampling location before storm water leaves the Remco facility and enters the city's storm drain system. In 1994, 1998, and 2000, one sample each year was collected at the outfall location (SWD9), where the storm water enters into Baechtel Creek. In 1997, data was limited, consisting of two surface water samples collected in Baechtel Creek. In addition to the storm water samples, five surface water samples were collected from Baechtel Creek and six samples from the south drainage ditch in 1999.

Volatile Organic Chemicals

Between 1991 and 2004, a number of VOCs (1,1,-TCA, 1,1-DCA, 1,1,-DCE, cis-1,2-DCE, 1,2,4-Trimethylbenzene, acetone, methylene chloride, MTBE, PCE, and TCE) have been detected sporadically in Remco storm water (Appendix C, Tables 7-8) (4, 44-46). We have presented the results in two tables showing samples collected while Remco was still in operation (1991–1995), and samples collected since the facility has closed (1996–2004) (Appendix C, Tables 7-8). As seen in Tables 7 and 8, VOC concentrations in storm water have decreased since Remco operations have ceased and construction improvements have been made to prevent contaminated groundwater from entering the storm drain system. As discussed earlier, these values do not accurately represent the levels in Baechtel Creek where dilution would occur. Decreasing concentrations can be seen between different sampling points on the storm drain and the outfall location. For example, in April 1994, PCE was detected at 13 ppb in a sample collected at SWD4, decreasing to 5.7 ppb at SWD7, and to 3.2 ppb at the outfall location prior to entering Baechtel Creek, where further dilution would occur. No VOCs were detected in the six surface water samples collected from the south drainage ditch.

Between 1991 and 2004, VOC concentrations (individual) in storm water and surface water did not exceed health comparison values (Appendix C, Tables 7-8). Therefore, potential exposures in the past to VOCs in Baechtel Creek and the South Drainage Ditch did not pose a public health hazard. Construction improvements to the storm drain appear to be controlling the infiltration of contaminated groundwater. Continued monitoring of storm water should detect any failures with the storm drain system. For these reasons, future exposures to VOCs in Baechtel Creek from Remco storm water are unlikely.

Hexavalent Chromium and Total Chromium

Between 1991 and 2004, hexavalent chromium and total chromium have been detected in storm water from the Remco site alt levels up to 660 ppb and 992 ppb, respectively (Appendix C, Tables 9-10) (4, 44-46). Hexavalent chromium has been identified as a COC in storm water and will be evaluated further.

CDHS evaluated potential exposure from incidental ingestion and skin contact to hexavalent chromium in Baechtel Creek while wading, with the assumption that people waded in Baechtel Creek for 2.6 hours per day, 50 days per year, for 14 years. We used a public health protective approach to evaluate potential noncancer health effects by estimating an exposure dose to the highest level of hexavalent chromium (660 ppb) detected in storm water (Appendix C, Table 9). This would be considered an overestimation, as actual exposures would have been much less. The combined dose (ingestion and dermal contact—see footnote 4 for assumptions used in calculating dermal dose) was estimated to be 0.000008 mg/kg/day for an adult and 0.0003 mg/kg/day for a child (8-15 years old). The estimated doses are below the USEPA RfD of 0.003 mg/kg/day, and would not be expected to have resulted in noncancer adverse health effects.

Total Petroleum Hydrocarbons (TPH-Diesel)

Between 1998 and 2004, total petroleum hydrocarbons as diesel (TPH-diesel) has been measured in storm water ranging from less than 50 ppb to 617 ppb, at various locations along the storm drain and in Baechtel Creek (Appendix C, Table 11) (4). TPH-diesel was detected at levels ranging from less than 50 ppb to 312 ppb in surface water collected in the south drainage ditch (Appendix B, Figure 3; Appendix C, Table 11). TPH-diesel has been identified as a COC in storm and surface water.

CDHS evaluated potential exposure from incidental ingestion and skin contact to TPH-diesel while wading (18, 19). Estimated doses for children and adults are well below health comparison values (RfDs) (Appendix C, Table 12). Therefore, children and adults who came into contact with storm water at Remco, in Baechtel Creek, and in the south drainage ditch, would not have experienced noncancer adverse health effects from exposures to TPH-diesel while wading.

Due to a lack of toxicological data, dermal contact and ingestion of diesel is not considered classifiable as a carcinogen, and thus cannot be evaluated further.

As discussed above in the “Volatile Organic Chemicals” section, construction improvements to the storm drain appear to be controlling the majority of infiltration of contaminated groundwater. Continued monitoring of storm water should detect any failures with the storm drain system, should they occur. For these reasons, it is unlikely that people will be exposed to site-related contaminants from storm water in Baechtel Creek at levels of health concern.

Evaluation of Sediment Exposure Pathway

Summary: Exposure to children and adults who accidentally ingest or come into contact with sediments in Baechtel Creek does not pose a past (post 1997), current, or future public health hazard. Concentrations of contaminants (hexavalent chromium, total chromium, metals, VOCs, and PAHs) detected in Baechtel Creek sediments are low and would not result in adverse health effects. There is no sampling data available for the pre-1997 time period.

Contaminants from Remco may have been deposited onto sediment in Baechtel Creek through storm drain discharges and surface water runoff. Community members report playing in Baechtel Creek, creating the possibility for people to come into contact with the sediment, exposing them to contaminants through incidental ingestion or dermal contact.

CDHS reviewed sediment data collected in Baechtel Creek between 1997 and 2003. Samples were collected from the surface layer of sediment in Baechtel Creek and analyzed for VOCs, hexavalent chromium, total chromium, other metals, PAHs, and TPH-diesel (Appendix B, Figure 4; Appendix C, Table 13). CDHS is not aware of any sediment data collected prior to 1997. Low levels of Remco-related metals were detected in the majority of Baechtel Creek sediment samples (Appendix C, Table 13). TPH-diesel[4] was detected in almost half of the samples analyzed. VOCs were detected the least, with only one detection of acetone and toluene (Appendix C, Table 12). Fluoranthene, a PAH, was detected in one sample (Appendix C, Table 12).

CDHS compared all of the contaminants detected in Baechtel Creek sediments to health comparison values developed for soil (Appendix C, Table 13). One detection of manganese (4,100 mg/kg) exceeds the health comparison value for a child (3,000 mg/kg) and is considered a COC in sediment. CDHS calculated a dose for a child coming into contact with the highest level of manganese detected in Baechtel Creek sediment (4,100 mg/kg). The estimated dose 0.00054 mg/kg/day is well below the USEPA RfD of 0.14 mg/kg/day. Therefore, children would not be experiencing noncancer adverse health effects from contact with manganese in Baechtel Creek sediment.

No other COCs were identified in Baechtel Creek sediments because levels of contaminants are below health comparison value. Therefore, exposure to Baechtel Creek sediments does not pose a public health hazard in the recent past (post 1997), currently, or in the future. No further evaluation is necessary.

Evaluation of Off-Site Soil Exposure Pathway

Summary: Contact with off-site soil in the Willits community, including Baechtel Grove Intermediate School, Blosser Lane Elementary School, and the future location of the Boys and Girls Club, does not pose a past, current, or future health hazard for children or adults from Remco-related contaminants. Lead has been identified as a contaminant of concern in localized area in off-site soil adjacent to the northern property line of Remco. The property is now owned by the Willits Trust, and the soil has been excavated and removed.

4. Contact with TPH-diesel in sediment was included in dose estimates for potential exposure to storm/surface water in Baechtel Creek (Appendix C, Table 11).

Soil Samples Collected Near the Remco Site

Contaminants from Remco may have been deposited onto soils off site through surface water runoff, aerial deposition, and intentional and/or unintentional dumping of wastes. People can come into contact with these soils and potentially be exposed to contaminants through incidental ingestion or dermal contact.

CDHS reviewed off-site soil data collected by consultants to the Willits Trust between 1998 and 2002, and by the RWQCB in 2001 and 2003 (4, 12, 47). Our review focused on soil samples collected from the surface (0 to 0.2 feet bgs) and near surface (0.5 to 3 feet bgs), because these are the depths—especially 0 to 0.2 feet bgs—at which people are most likely to come into contact with soil. Soil sampling locations and a summary of the results are presented at the end of this document (Appendix B, Figures 5-6; Appendix C, Tables 14-16).

Between 1998 and 2002, the Willits Trust collected 67 surface and near surface samples, collected in off-site areas close to the Remco site (Appendix B, Figure 5) (4, 12, 48). Of those samples, 58 were analyzed (tested) for total chromium and 52 for hexavalent chromium; 35 were tested for other metals; 16 were tested for VOCs and TPH-diesel; two were tested for TPH-gasoline; and four were tested for PAHs (Appendix C, Table 14).

Soil samples collected from a residential yard (SB181) at 27 Franklin Avenue revealed elevated lead in a near surface soil, 0.5 feet bgs at 857 ppm (Appendix B, Figure 4). Lead concentrations at this level are a potential health concern for children and will be evaluated further. Lead levels in soil from this area decrease in concentration with increasing depth, suggesting an aerial source or possibly house paint, not a groundwater source. For example, lead was measured at 857 ppm in a sample collected at 0.5 feet bgs and 28.4 ppm at 1.0 feet bgs (4). This is further supported by the fact that elevated levels of lead (542 ppm) are seen in other surface soil samples collected at the south fence line (SS32) and in a shallow soil sample (1.0 feet bgs) to the west (SB184) of the site, areas where no contamination of lead in the groundwater has been found. It is not unusual for lead contamination to be present in soils around chrome-plating facilities, because it is used as an anode in the electroplating process (discussed earlier in the “Chromium Electroplating” subsection). None of the other metals exceed health comparison values and therefore do not pose a public health hazard. Other than lead, no other metals have been identified as COCs and thus no further evaluation is necessary.

Lead is evaluated relative to an internal dose, not an external dose. Evaluation of lead exposure is done by estimating a blood lead level or the amount of lead present in blood, which is expressed in micrograms of lead per deciliter of blood (µg/dL). Children are considered to be the most sensitive to lead exposure. A blood lead level that exceeds 10 µg/dL is considered elevated (a more detailed discussion of lead toxicity is presented in Appendix D) (49).

CDHS evaluated potential exposure to children from lead in surface soil (0.2 feet bgs) (the depth at which children most frequently come into contact with soil) in the backyard at 27 Franklin Avenue. We estimated an increased blood lead level in children ranging from 2.16 µg/dL to 3.34 µg/dL, may result from exposure to soil containing 168 mg/kg of lead (Appendix C, Table 14). The estimation is based on the assumptions that a child is exposed to the soil through ingestion

(100-200 mg/day), dermal contact, inhalation of dust, and ingestion of homegrown fruits and vegetables. On the basis of our estimation, exposure to surface soil (containing 168 mg/kg lead) alone would not have resulted in elevated blood lead levels in children. Lead was measured at 857 mg/kg at next sampling depth (0.5 feet bgs). We evaluated lead exposure to adults from contact with near surface soil (0.5 feet bgs) during gardening and landscape activities. Exposure to 857 mg/kg of lead in near surface soil may result in an increased blood lead level of 2.89 µg/dL in adults. The estimation is based on the assumptions that an adult is exposed to the soil through dermal contact, ingestion (50 mg/day), inhalation of dust, and ingestion of homegrown fruits and vegetables. Thus, exposure to lead in surface soil at 27 Franklin Avenue does not pose a health hazard for adults or children, based on a review of available data. The lead contamination appears to be localized in two areas close to the Remco fence line; these areas were excavated and the soil removed during the summer of 2003. This property was purchased by the Trust and is no longer an occupied residence.

VOC detections in residential yards along Franklin Avenue were limited to a single detection of acetone (SB-130) and toluene (SB-104), and two detections of 2-butanone (MEK) (SB-129, SB-130) (Appendix B, Figure 4; Appendix C, Table 14). The levels of acetone, toluene, and 2-butanone in soil are below health comparison values and do not pose a public health hazard (Appendix C, Table 14). In 2003, these properties were purchased by the Trust and are no longer occupied residences. Other VOCs were not detected above laboratory detection limits. Thus, no VOCs are considered COCs in off-site soil.

PAHs measured in off-site surface and near surface soil do not exceed health comparison values and therefore are not considered COCs. No further evaluation of these contaminants is necessary.

Health comparison values have not been developed for TPH-diesel in soil. CDHS evaluated potential exposure to TPH-diesel using the hydrocarbon fraction approach (discussed in the “Evaluation of Private Well Exposure Pathway” section) (18, 50). As a worst-case scenario, CDHS assumed a child was exposed to the highest level (892 mg/kg) of TPH-diesel measured in off-site soil (Appendix C, Table 14). This sample was collected along northern fence line of Remco, where there is no public access. The estimated child’s dose[5] for the aliphatic fraction (0.0019 mg/kg/day) does not exceed the reference dose of 0.01 mg/kg/day (50). The estimated child’s dose for the aromatic fraction (0.0029 mg/kg/day) does not exceed the reference dose of 0.03 mg/kg/day (26). The estimated adult dose (0.00048 mg/kg/day) for the aliphatic fraction does not exceed the reference dose of 0.01 mg/kg/day (50). The estimated adult dose for the aromatic fraction (0.00072 mg/kg/day) does not exceed the reference dose of 0.03 mg/kg/day (26). Therefore, exposure to TPH-diesel in off-site soil would not result in noncancer adverse health effects for children or adults.

RWQCB Sampling of Baechtel Grove Middle School, Blosser Lane Elementary, and the Future Location of the Boys and Girls Club

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5. Assumptions used for calculating exposure doses: (max concentration diesel in soil mg/kg/day)(intake rate adult = 100 mg soil/day, intake rate child = 200 mg soil/day)(conversion factor 1E-6)(350 days/year)(exposure duration = 8 years: 1997–2005)/(body weight for adults average of the 50th percentile for females and males = 71.8 kilogram [kg] body weight for child average 1-19 years old = 36 kg)(averaging time: 2,920 days) (37).

In August 2001, the RWQCB conducted groundwater and soil sampling at the Baechtel Grove Middle School, Blosser Lane Elementary, and the future location of the Boys and Girls Club. The sampling was in response to community concerns that contamination from the Remco facility had spread or was dumped in these areas. The RWQCB collected 70 soil samples (surface and near surface), all of which were analyzed for metals; a limited number were analyzed for VOCs, TPHs, and PCBs (Appendix B, Figure 6; Appendix C, Table 15).

There were no VOCs detected in near surface soils. TPH-diesel was detected infrequently in near surface soil at a depth of 3-3.5 feet bgs (Appendix C, Table 15). Ten samples were collected and analyzed for PCBs and none were detected (data summary not included in Table 15). None of the metals, including lead, were elevated above levels attributed to background (51). Metal concentrations, including lead, are low and do not pose a health hazard to adults or children who may come into contact with soil at Baechtel Grove Middle School, Blosser Lane Elementary, and the future location of the Boys and Girls Club. Thus, no further evaluation of these contaminants is warranted. CDHS concludes that there is no health risk to children or adults who may come into contact with soil at Baechtel Grove Middle School, Blosser Lane Elementary School, and the future location of the Boys and Girls Club.

Soil Samples Collected in the Willits Community Further Away from the Site

In January 2002, the Willits Trust collected 28 additional soil samples off site in an effort to establish background (an average or expected amount of a chemical in a specific environment, or the amount found to occur naturally) concentrations for metals (52) (Appendix B, Figure 7; Appendix C, Table 16). These samples were collected in areas further away from the site than other sampling efforts (Appendix B, Figure 7). Concentrations of the metals detected in these soil samples are below health comparison values and do not pose a health hazard to children or adults who may come into contact with these soils (Appendix C, Table 16).

In June 2003, the RWQCB and CDHS staff collected ten surface soil samples in an area not yet tested for site-related metals (Appendix B, Figure 7; Appendix C, Table 16). Concentrations of metals detected are below health comparison values and do not pose a health hazard to children or adults who may come into contact with these soils (Appendix C, Table 16).

In conclusion, on the basis of existing off-site soil data, contact with soil in the Willits community, including Baechtel Grove Intermediate School, Blosser Lane Elementary School, the future location of the Boys and Girls Club does not pose a public health hazard from exposure to Remco-related contaminants.

Evaluation of Historic Air Releases from Chrome-Plating Operations

Summary: On the basis of air modeling data, exposure from breathing historic air releases (1963–1995) of hexavalent chromium from Remco could have resulted in noncancer health effects and some increased risk of cancer (primarily lung) for residents and workers over a large area of Willits. As a result, CDHS classifies the site as posing a public health hazard in the past.

CDHS released a public health assessment that focused on potential exposure to air releases, primarily hexavalent chromium, from chrome-plating operations at Remco (3). Due to the extensiveness of the public health assessment, it will not be replicated in this report, but is available to interested parties and can be obtained online at http://www.ehib.org/cma/project.jsp?mode=Internet&project_key=ABEX01. The following provides a brief summary of the report.

During the years of Remco plating operations, no actual measurements of chemicals in the air around the facility or in the Willits area were required or taken. Chromium electroplating was the primary plating operation at the site. Hexavalent chromium is the primary chemical of concern that was released. To a lesser extent, other chemicals such as VOCs, cadmium, nickel, zinc, and lead were released. In the absence of air measurements/sampling of hexavalent chromium, CDHS used the results of computer air modeling to estimate exposure and evaluate how the health of Willits community members might have been impacted by air releases of hexavalent chromium (there is insufficient data to model releases of other contaminants). Computer air modeling is a mathematical way to estimate how much hexavalent chromium was released from the Remco facility in the past, as well as what the concentrations of hexavalent chromium were in different areas of the Willits community.

CDHS evaluated air model data generated for three different time periods of Remco operations (1963–1975, 1976–1989, and 1990–1995), as well as for the time periods combined (1963–1995). The three time periods evaluated were defined based on the efficiency/level of the air pollution control devices used at the facility. From 1963 to 1975, the chrome-plating tanks operated without pollution/emission controls.

Exposure to hexavalent chromium is currently known to cause both noncancer and cancer health effects. Noncancer health effects include asthma, bloody nose, nasal septum scarring and perforation, runny nose, mild decreased lung function, bronchitis, gastric irritation, and subtle changes in kidney function (affects primarily the proximal tubule). Lung cancer is the primary cancer associated with hexavalent chromium exposure; other cancers (nasal and stomach) have been suggested, but are not well studied. Exposure to hexavalent chromium is not the only cause of these noncancer and cancer health effects.

- 1963−1975: estimated exposure to airborne hexavalent chromium could have resulted in noncancer health effects and some increased risk of cancer for residents and workers (people who worked in Willits) over a large area of Willits.

- 1976−1989: estimated exposure to airborne hexavalent chromium could have resulted in noncancer health effects and some increased risk of cancer for residents and workers over a limited area of Willits.

- 1990–1995: estimated exposure to airborne hexavalent chromium would not be expected to result in noncancer health effects in children or adults in Willits.

- 1963−1995: estimated cumulative exposure to airborne hexavalent chromium could have resulted in noncancer health effects and some theoretical increased risk of cancer for residents and workers over a large area of Willits.

In summary, community members, particularly those exposed prior to the time when emissions controls were implemented (1963–1975), experienced some increase in their risk of developing cancer and could have experienced some noncancer health effects from exposure to hexavalent chromium. CDHS concludes that releases of airborne hexavalent chromium posed a public health hazard in the past (1963–1995).

Evaluation of Airborne Exposure to Volatile Organic Chemicals

Summary: It is probable that residents were exposed to (breathed) VOCs used in facility operations that were released into the air. Limited data suggests that between 1988 and 1991 exposure to airborne VOCs would not have resulted in adverse health effects. However, due to a lack of data, CDHS could not evaluate these exposures and potential health implications for the full extent of Remco operations. Thus, CDHS concludes exposure to air releases of VOCs posed an indeterminate public health hazard in the past (prior to 1988). There is no current public health hazard from releases of airborne VOCs because the facility is closed.

Remco operations involved the use of various solvents (VOCs) that were released to the environment, as evident by soil and groundwater contamination on and off site. Exposure to VOCs in soil and groundwater has been addressed in previous sections in this health assessment. Another way for people to have been exposed to VOCs is from releases to the air through volatilization (chemical in liquid state becomes a vapor or gas). Once the chemical (VOC) has volatilized, it rapidly disperses into the atmosphere where it becomes diluted and eventually degraded. There were no air measurements of VOCs taken during Remco operations that would help provide an understanding of the total extent of exposure in the community. However, limited data from 1988 – 1991 was reported to the USEPA, under the TRI (Toxic Release Inventory program[6])(53). These data were not available during the initial search of the TRI database and subsequent release of the draft PHA.

The majority of emissions/releases reported by Remco was for 1,1,1-TCA. Remco also reported releasing 500 pound (lbs.) of MEK during 1989. The following summarizes the year and total airborne releases/emissions of 1,1,1-TCA, reported by Remco (53):

- 1988: **Total = 77,460 lbs.** (stack = 38,730 lbs., fugitive = 38, 730 lbs.);
- 1989: **Total = 66,000 lbs.** (stack = 33, 000 lbs., fugitive = 33, 000 lbs.);
- 1990: **Total = 142,000 lbs**. (stack = 71,000 lbs., fugitive = 71,000 lbs.);
- 1991: **Total = 39,000 lbs**. (fugitive = 39,000 lbs.).

6 The Emergency Planning and Community Right-to-Know Act (EPCRA) enacted in 1986 requires EPA and the States to annually collect data on releases and transfers of certain toxic chemicals from industrial facilities, and make the data available to the public in the Toxics Release Inventory (TRI).

CDHS requested that ATSDR model the potential airborne concentrations of 1,1,1-TCA for two years, 1988 (earliest data) and 1990 (highest amount of releases reported). ATSDR performed the air modeling using the Industrial Source Complex Short Term (ISCST3) dispersion model (19). The air model was constructed utilizing the same site-specific parameters that were used for estimating airborne concentrations of hexavalent chromium released from Remco (3, 19).

ATSDR estimated the potential maximum airborne concentrations of 1,1,1-TCA at 539 $\mu g/m^3$ in 1988 and 1,206 $\mu g/m^3$ in 1990. The average concentrations of 1,1,1-TCA near homes were estimated to range from 50 $\mu g/m^3$ – 500 $\mu g/m^3$ (19). None of the estimated airborne concentrations of 1,1,1-TCA exceed health comparison values (4,000 $\mu g/m^3$) (54). Thus, between 1988 and 1991 airborne releases of 1,1,1-TCA would not be expected to have resulted in noncancer adverse health effects

Due to a lack of toxicological data, 1,1,1-TCA is not considered classifiable as to human carcinogenicty, and thus cannot be evaluated further.

CDHS concludes exposure to air releases of VOCs posed an indeterminate public health hazard prior to 1988. There is no current public health hazard from airborne VOCs because the site is no longer operating. Future exposures can be mitigated provided the Willits Trust implements adequate safety and control measures during any remedial work involving VOC-contaminated media when there is the possibility for VOCs to be released to the air; these activities should be conducted in conjunction with real-time air monitoring.

Evaluation of Exposure During Remedial Activities at the Site (2000–2004)

Since 1998, several interim remedial actions (IRAs) have been implemented at the site to help improve environmental conditions and address partial cleanup of some areas and/or media (4). Some of these activities have raised health concerns with residents living adjacent to the site, Willits School District staff, and other community members worried about exposure from breathing airborne contaminants generated during the remedial work. Of particular concern were children playing outside at Baechtel Grove School or walking by the facility. As discussed below, CDHS evaluated air monitoring data collected during three remedial activities (in-situ pilot study, removal of PCE-contaminated soils, and vertical chrome tank removal) conducted at the site between 2000 and 2004. On the basis of these data, CDHS concludes the referenced remedial activities did not pose a health risk to the community from exposure to site-related contaminants or byproducts generated during remedial activities.

Evaluation of Hydrogen Sulfide Gas Exposure Pathway from In-Situ Pilot Study (2000)

Summary: A pilot study of the treatment of hexavalent chromium in groundwater did not result in the hydrogen sulfide generation at levels of health concern. During the injection of calcium polysulfide into the groundwater and for 5 weeks after, levels of hydrogen sulfide gas were low and would not have resulted in adverse health effects to nearby residents or the public. Therefore, hydrogen sulfide gas is not considered a COC in the outdoor air during the calcium polysulfide pilot study.

In September 2000, Montgomery Watson Harza, consultants to the Willits Trust, began a pilot study by injecting calcium polysulfide and molasses (reducing agents) into the contaminated groundwater beneath the site. This was done to test whether these chemicals would effectively reduce the hexavalent chromium to trivalent chromium (a less toxic form), and to see whether the reducing conditions would speed up degradation of the VOCs (55). The combination of calcium polysulfide and molasses can result in the formation of hydrogen sulfide gas (H_2S). H_2S has an odor similar to rotten eggs and can be noticed (smelled) at levels as low as 0.0002 ppmv. The formation of H_2S was of greatest concern during the injection process, which began on September 25, 2000, and concluded September 30, 2000. Because of this concern, fixed air monitoring, consisting of six stations in the pilot study area was conducted until May 2001. The fixed station monitors were installed around the pilot study area inside the facility and were designed for continuous operation. The system was tied into the local 911 emergency dispatch that was alerted if concentrations of H_2S reached 1 ppmv (parts per million volume), the designated worker safety level.

Air monitoring of the outside air was performed through a mobile system (Jerome hand-held H_2S meter) at 26 locations (stations) outside the Remco facility and in the surrounding neighborhood (Franklin Avenue). The Jerome meter can detect H_2S as low as 0.001 ppmv. The mobile air monitoring was conducted for about 5 weeks, beginning a week before (September 13, 2000) the injection process in order to establish background or ambient conditions, and continued until November 9, 2000. A level of 0.030 ppmv in the breathing zone (about 5 feet from the ground) outside the Remco facility would result in a shutdown of the injection activities. Representatives from the County of Mendocino Air Quality Management District (CMAQMD) were present during and after the injection process to oversee the air monitoring activities and to collect samples of their own. Our evaluation focused on the results of the mobile air monitoring conducted outdoors, where the community could potentially be exposed.

The mobile air monitoring consisted of 133 monitoring rounds (events) at 26 locations (55). There were two occasions when H_2S was measured above 0.030 ppmv (specified level for outside breathing zone; state ambient air level goal). On September 30, 2000, H_2S was measured at 0.15 ppmv in a mobile sample collected at the northwest side of the Remco facility. Additional monitoring conducted 40 minutes later at the same location showed H_2S at 0.002 ppmv. On October 5, 2000, H_2S was detected at 0.11 ppmv in a sample collected adjacent to Highway 101. Montgomery Watson attributed these detections to instrument drift rather than actual concentrations in the air because reportedly, no odors were noticed at the time of the detections and should have been if H_2S was actually present at the detected level. The levels measured (0.15 ppmv and 0.11 ppmv) are below health comparison values (acute MRL-0.2 ppmv).

Therefore, brief or intermittent exposure to H_2S at these levels would not result in adverse health effects.

CMAQMD staff involved with the air monitoring activities concluded that H_2S was not present in ambient air at levels that would present a health or safety hazard to the public (56). On the basis of our review, CDHS concurs with the findings of the CMAQMD.

Evaluation of Volatile Organic Chemicals, Hexavalent Chromium, and Lead in Air During Soil Removal (2003)

Summary: Limited VOCs (primarily PCE) detected in perimeter air monitoring stations during the removal of VOC-contaminated soil would not result in health effects in children or adults from breathing the air. No hexavalent chromium or lead was detected in dust samples collected from six stations set up around the perimeter of the Remco site. Thus, no COCs were identified in dust generated by the soil removal activities in 2003. CDHS concludes that the removal of VOC and lead source soils conducted in 2003 did not pose a health hazard to the community.

In August 2003, Geomatrix, consultants to the Willits Trust, began removal activities of soils contaminated with "dense non-aqueous phase liquid" (DNAPL), PCE, and lead (57). At high concentrations, solvents heavier than water, like PCE, can accumulate as a separate phase below the water table (DNAPL) and be a long-term source of groundwater contamination. Air monitoring for VOCs, hexavalent chromium, lead, and total dust was conducted daily at six locations along the site perimeter, until the project was completed in October 2003 (Appendix B, Figure 8). VOCs were monitored with both real-time (results available immediately) ambient air monitors (MIRANS) and summa canisters that collect an air sample over the course of a day, which is then sent to a laboratory for analysis.

Hexavalent chromium and lead were not detected in any of the 209 samples analyzed prior (site preparation), during the excavation and off-hauling (disposal) of excavated soil. With the exception of 5 days, the total dust action level (level at which additional dust control measures are implemented) of 50 $\mu g/m^3$ was exceeded; however, these results are generally consistent with background data collected prior to the initiation of site work (57). Thus, it is difficult to determine the contribution from site-related remedial work on the total dust levels measured. Limited VOCs were detected sporadically throughout the preparation, excavation and off-hauling of soils (Appendix C, Table 17). None of the VOCs detected in perimeter air monitoring stations exceed health comparison values, thus potential exposure would not have resulted in health effects to children or adults.

Evaluation of Hexavalent Chromium in Air During Removal of Vertical Chrome-Plating Tanks (2003–2004)

Summary: No hexavalent chromium or lead was detected in dust samples during the removal of the vertical chrome-plating tanks. CDHS concludes the removal of the vertical chrome-plating tanks conducted in December 2003–January 2004, did not pose a health hazard to the community from breathing hexavalent chromium or lead.

In December 2003, Geomatrix initiated activities to remove the underground vertical chrome-plating tanks and associated process tanks (57). Sand-cement slurry was used to backfill the holes. The removal and backfill operation was done inside the Remco building, reducing/eliminating potential exposure to contaminated dust. Air sampling was conducted at five locations along the site perimeter. From November 25, 2003, until January 26, 2004, 115 samples were collected and analyzed for hexavalent chromium and lead. Hexavalent chromium and lead were not detected in any of the samples (57). On the basis of air sampling data, CDHS concludes the removal of the vertical chrome-plating tanks did not pose a health risk to the public.

Quality Assurance and Quality Control

In preparing this PHA, ATSDR and CDHS used information in the referenced documents and assumed that adequate assurance and quality control measures were followed, with regard to chain-of-custody, laboratory procedures, and data reporting. Most of the documents used in the health assessment are prepared for regulatory agencies, which undergo review to ensure that proper quality control measures were followed.

Health Outcome Data

In evaluating a site, ATSDR and CDHS try to understand the potential health impacts on communities near sites containing hazardous chemicals. This involves determining which health effects might be caused by certain amounts of chemicals and determining if people had contact with contaminants (as discussed in the "Environmental Contamination/Pathway Analysis/Toxicological Evaluation" section), and understanding what health problems people in the community are experiencing. In addition to asking community members directly about their health concerns (as reported in the *Community Health Concerns/Health Concerns Evaluation* section), CDHS also tried to get information about the health status of a community from other sources, such as the California Cancer Registry. The CDHS review was conducted and the findings were previously included in the PHA on aerial emissions from the Remco site. The following presentation is for the most part the same, but we included it here as well as this makes each document more complete.

Evaluating whether past releases from the Remco site affected the health of people living in Willits poses challenges. Ideally, to review the health of community members who may have been affected by Remco contaminants, it would be helpful to have thorough records about the symptoms and diseases of persons who lived in Willits during the time they could have been exposed. Information about the diseases and symptoms they had could then be compared to persons who did not live in Willits during that time. However, this type of community health surveillance system is not available because some people go to private physicians, others to health maintenance organizations, and others to county services, etc. In California, there is not a thorough health surveillance system for all diseases. A surveillance system exists for recording cancer cases. Surveillance for birth defects was initiated for a time in the past, but is now very limited. Unfortunately, the lack of a health surveillance system for most illnesses prevents CDHS from obtaining a complete and objective understanding of how much illness Willits residents may have experienced.

The following section describes CDHS review of the cancer surveillance data. Although it is informative to understand the numbers of cancer cases in an area, using cancer surveillance data also is limited in its usefulness in addressing whether contaminants from Remco affected the health of the community. This will be discussed in more detail in the following section.

Cancer Review Data for Willits

Because of concerns about whether potential exposures from Remco (primarily airborne hexavalent chromium) could have caused cancer, CDHS reviewed information on cancer cases in the area. The review attempts to address the question “Are there more cases of cancer occurring in the Willits area than would typically be expected?”

To conduct the review, EHIB requested information on the number of cancer cases in Willits from the Cancer Registry of Northern California (Region 6 of the California Cancer Registry). This registry has been collecting information on all cancer diagnoses in the region since 1988.

Geographic Areas and Time Periods Reviewed

This review examines cancer cases that occurred in the Mendocino County 1990 U.S. census tract 010700, which encompasses the majority of the city of Willits (Appendix B, Figure 9). Census tracts are specific geographical areas defined by the U.S. Bureau of the Census.

This review covered January 1, 1988, through December 31, 2000.Data beyond December 2000 is not yet available through the Census Bureau.

Rationale for Cancer Review and Choice of Cancers

Because there are many different types of cancers, typically, in a review of cancer data, CDHS looked at cancer cases overall (all cancer types combined), and then selected certain cancers that are of interest. Cancers of interest were chosen because they have been noted in previous studies to be associated with exposures of concern. At Remco, the primary exposure is chromium inhalation, so in this case, lung and all respiratory system cancers were chosen because they are the primary cancer types associated with this exposure. Nasal and sinus cavity cancers also were reviewed because they have sometimes occurred more frequently among individuals occupationally exposed to chromium.

The review also included prostate, lymphoma, Hodgkin’s disease, leukemia, bone, stomach, urinary tract, renal, bladder, testicular, and liver cancer (some of these are specific cancers that fall within broader categories). The evidence for an association between chromium and these cancers varies considerably and not all of them have meaningful evidence of an association. However, they are included because they have been identified as cancers that possibly might be related to chromium by a frequently cited researcher, Dr. Max Costa, who reviewed and reported on other people’s studies.

PCE, a primary VOC used at the site, is also a potential carcinogen and may be associated with liver and kidney cancers. There are other VOCs (1,1,1-TCA, acetone, and 2-butanone) that people may have been exposed to in the air; however, there is a lack of data as to their carcinogenicity. As presented in this document, we do not have data regarding how much exposure community members may have had, or if they had exposure. Nevertheless, we have analyzed all cancers together and liver and kidney cancers, as these may be of interest.

Information Provided by the Cancer Review

The cancer review reports two main pieces of information: 1) the number of new cases of cancer that occurred in a particular area within a specific time and 2) an estimate of how many cases would typically be expected for that area, given the number of people who live there. These two figures are compared to see if the number of cancer cases that occurred in a particular area is greater than what would typically be expected.

The first number (the number of new cancer cases) is taken from the cancer records for the specific geographical area studied (in this case, the main census tract for Willits). The second number, the expected number of cancer cases, is estimated on the basis of several other sources of information. Because the number of expected cancer cases depends on the number of people in the area, it is necessary to know the size of the population. Fewer cancers would be expected in a small town than in a large city. The estimate of the expected number also takes into account the age, race, and sex of the population. This is important because different groups of people have different risks of cancer. For example, as cancer cases increase with age, the number of expected cancers would be different in a retirement community when compared with a neighborhood where many young people live.

The cancer registry uses information about how many people are getting cancer in the northern California region generally, in order to estimate how many cancers would be expected to occur in this particular census tract. (Cancer incidence data are from Cancer Registry Region 6; this region covers the 16 northern California counties.) The estimate of the number of people in the census tract, and their age, race, and sex—was based on 1990 census data for the 1988–1995 cases. The 1996–2000 estimates were based on the 2000 census figures. The results are reported for three time periods: 1988–1995, 1996–2000, and a summary of the whole time period, 1988–2000 (Appendix C, Table 16).

Description of Range of Cancers

Another important aspect of assessing whether the observed number of cancers is greater than the expected number is the unpredictability of how many cancers may actually occur. The number of cancers that occur will vary due to the many different factors that are not known, but must be taken into account. To do this, the cancer registry uses statistics to create a range called a confidence interval. If a number (in this case, the number of observed cancers) is greater than the confidence interval, this means it is statistically unlikely that this result occurred by chance.

Analysis of All Cancer Types Combined (1988–2000)

CDHS looked at the number of observed cancers compared to the number of expected cancers for the three time periods together. The number of observed cases (363) was very similar to the number of expected cases (370) (Appendix C, Table 18).

Analysis of Respiratory Cancers (1988–2000)

CDHS looked at the number of respiratory system cancers, finding that observed number (77) was somewhat higher than the expected number (about 66), but still within the expected range (56.1-102.4). A similar finding was observed for lung cancer alone, because lung cancers make up a very large portion of respiratory system cancers. The number of nasal cavity, middle ear, and sinus cancers was too small to report.

Analysis of Other Cancer Types (Liver, Kidney, Lymphomas, Leukemia, Urinary Tract, and Testes)

The number of other cancers was within the expected range (some higher and some lower than the specific expected number).

Summary of Findings

For all individual cancer types reviewed, the number of new cases actually observed during the period of 1988–2000 was within the range of what would be expected, as was the overall number of cancer cases observed. This type of review is not able to determine whether any cases of cancer were caused by chromium exposure or another chemical, but it does not rule out this possibility.

Limitations of the Cancer Rate Review

There are a number of reasons why it is difficult to tell from this type of review whether specific exposures caused cancer in a community. Cancer takes a long time to develop (usually many years), so people may have cancer for a long time before they learn about it. If people moved away, their cancer would not be included. The expected numbers of cancers are based on the census, and if the census is inaccurate, the cancer estimate would be inaccurate too. Finally, there is no information on whether any of the people diagnosed with cancer smoked, and smoking causes lung cancer (85% of lung cancer is caused by cigarette smoking).

Community Health Concerns/Health Concerns Evaluation

Introduction and Purpose

The collection, documentation, and response to community health concerns are critical to the PHA process. The purpose of this section is to 1) list the concerns that have been voiced by Willits community members, 2) provide a response to the concerns with educational information, and 3) specifically address the health and other concerns within the framework and limitations of the PHA.

Process for Gathering Community Health Concerns

CDHS staff first became aware of community health concerns in Willits in April 2000, when contacted by USEPA about the site. In May 2000, CDHS staff members visited the site with representatives from the Willits Trust, the Mendocino County Health Department, USEPA, and the City of Willits, to better understand the layout of the facility and to meet involved agency representatives. CDHS also met with several community members to discuss their concerns and determine how they would like to be involved in the PHA process. Several community members had already documented many concerns and were worried about the health status of the town's residents. One resident had conducted over 100 community interviews and constructed a map that listed the types and location of health concerns. CDHS also met with members of the Willits Environmental Health Center.

After these initial meetings, CDHS spent several months speaking with community members, including small business owners, school district personnel, residents, and medical providers. CDHS also received calls on a regular basis from citizens expressing their concerns. Some community members involved in a lawsuit were instructed by their lawyers not to speak with CDHS staff. CDHS contacted the lawyer for these members to inquire about the best approach for CDHS to document the health concerns of his clients. The lawyer sent CDHS a list of clients/residents that should not be interviewed, resulting in the lack of documentation of health concerns of residents involved in the lawsuit. Some lawsuit participants received an informational flyer describing the PHA process.

At the suggestion of the community, CDHS held an all-day public availability session on November 8, 2000, at the Willits Library. CDHS staff documented the concerns of 15 community members at this session. In addition to these outreach efforts, Whitman Corporation community office staff referred several community members with health concerns to CDHS for interviews.

Willits community members access a variety of medical and other health service options available to them. These private and public providers are located in Willits and in other nearby communities. During the fall of 2000, CDHS spoke with a small group of some of these medical providers at one of their regular meetings in Willits. (Although their comments provided valuable insight, CDHS understands that they do not speak for all medical providers in Willits.) At that time, they were concerned that the actions of community members, such as distributing flyers at a local school that warned parents about the school's drinking water, might be creating hysteria. They were not certain that Remco was causing the health problems of their patients, especially considering that the facility was closed. One medical provider said he knew of only one study that showed increase lung cancer in chromium workers, but it was not proved to be statistically significant. Another provider said he was hearing his colleagues say that chromium did not present a health risk and that it is very toxic in low concentrations if inhaled. He found this information contradictory. A provider felt it would be helpful to know more about the health status of workers and another said that if there is a health problem, the medical providers must keep the best interest of the people in mind.

On October 30, 2000, the federal judge overseeing the Consent Decree held a public forum to listen to community concerns. Over 200 people, including CDHS staff, attended the meeting and 38 people made formal public statements regarding their concerns. Health-related statements made at that meeting are also included in this PHA (i.e., they are incorporated into the summary of health concerns).

Community Involvement and Development of the Site Team

In November 2000, CDHS convened a site team, which is a group of stakeholders interested in the work at the Remco site. The purposes of the site team and public meetings are to conduct health education in order to help the community understand all aspects of the PHA, provide information to the community, bring the community and other agencies involved at the site together, and provide a forum for sharing health concerns. The site team is comprised of a former Remco worker, RWQCB staff, representatives from Mendocino County Health Department, the School District, California Department of Health Services, City of Willits, community members with a variety of health concerns, a local physician, and other local and state agency representatives. Since November 2000, site team meetings were held regularly at the Willits City Hall. Site team meetings have been held on the following dates: November 30, 2000; January 18, 2001; May 24, 2001; September 24, 2001; January 10, 2002; July 25, 2002; September 21, 2002; August 5, 2003, September 30, 2003; November 30, 2003; and November 3, 2004. This PHA will be shared at a meeting for the community.

Between August 2003, and April 2004, CDHS conducted three environmental health education/trainings to local health care providers in Willits and Ukiah about chromium exposure and related health effects. The training included information on potential health effects from exposure to other site-related contaminants (VOCs). In addition, ATSDR provided a training of Mendocino County Mental Health staff on psychological responses to exposure issues related to hazardous waste sites.

Community Concerns

The community described a number of concerns and health effects that have occurred or are occurring. CDHS documented the health concerns of approximately 100 residents and stakeholders. The following section discusses the concerns expressed by community members in greater detail; the table below summarizes these concerns.

Table 19. Health Concerns/Effects Expressed to CDHS

Noncancer Health Effects/Concerns	Cancer Health Effects/Concerns

• Reproductive concerns
  ➢ irregular and painful menstrual cycle
  ➢ tumors
  ➢ spontaneous abortion
  ➢ endometriosis
  ➢ polycystic ovary syndrome
• Nose bleeds
• Asthma
• Allergies
• Developmental disabilities
• Kidney Disease
• Birth defects
• Headaches/migraines
• Diabetes
• Chronic fatigue
• Fatty tumors
• Sarcoidosis
	• Breast cancer
	• Testicular cancer
	• Lung cancer
	• Leukemia
	• Cervical cancer
	• Colon cancer
	• Brain tumor/cancer

In evaluating the community concerns, CDHS considered whether contaminants evaluated for completed exposure pathways were at levels associated with the health concerns expressed by the community. For the pathways where there is a lack or limited data and potential exposures could not be estimated, in particular breathing/inhalation of VOCs, a summary of potential health effects associated with those chemicals likely to be present in that pathway is provided.

Health Effects Evaluation

Completed Exposure Pathways and Chemicals Evaluated

Inhalation of hexavalent chromium has been linked to health conditions other than cancer, including nasal septum perforation, nasal ulcerations, scarring, bronchitis, asthma exacerbation (aggravation), hematological and gastrointestinal effects, subtle kidney effects, and reproductive effects in men. These health effects could have occurred in some areas of Willits in the past (1963–1995) as a result of air releases of hexavalent chromium from Remco (3).

Both national and international agencies[7] that classify chemicals according to their ability to cause cancer have designated certain hexavalent chromium compounds to be known human carcinogens when inhaled. Studies of both humans and animals have demonstrated that inhalation of hexavalent chromium can cause lung cancer. Inhalation of hexavalent chromium

7 U.S. Department of Health and Human Services, International Agency for Research on Cancer, and U.S. Environmental Protection Agency.

has also been associated with nasal and stomach cancer; however, these cancer effects have not been well studied.

As stated earlier, a PHA with a focus on inhalation exposure to air releases from Remco containing detailed information about health effects associated with hexavalent chromium exposure and additional information on causes/known risk factors of the health concerns shown in the above table, is available from CDHS and can be obtained online at http://www.ehib.org/cma/project.jsp?mode=Internet&project_key=ABEX01 (3).

Exposure to other site-related chemicals in the other completed exposure pathways evaluated in this PHA would not be expected to result in adverse noncancer or cancer health effects.

Pathways/Chemicals Not Evaluated Due to a Lack of Data

Exposure and potential health effects from breathing VOCs could not be evaluated due to a lack of data. Community members have expressed a concern over health problems they believe related or caused by exposure to VOCs during Remco operations. The following provides a brief summary of health effects associated with the primary VOCs used at Remco that community members could have breathed (products containing VOCs used at Remco and/or breakdown products were not included).

- 1,1,1-Trichloroethane (TCA) (primary solvent used at Remco): Exposure to 1,1,1-TCA can cause unconsciousness and other effects if inhaled at high concentrations (> 10,000 ppmv or 54,000,000 μg/m^3) , but usually the effects will disappear after exposure ends. In animal studies, high (> 5,000,000 μg/m^3) levels of 1,1,1-TCA has been shown to damage the breathing passages, affect the nervous system, and causes mild effects on the liver. In studies of pregnant rats and rabbits, high levels (> 32,000,000 μg/m^3) of 1,1,1-TCA has been shown to cause reproductive effects, such as delayed development and changes in the setting of the bone structure. It is not known whether 1,1,1-TCA causes reproductive or developmental effects in humans (54). There is no available information to show 1,1,1-TCA causes cancer (54).

- 2-Butanone (methyl ethyl ketone or MEK): Breathing 2-butanone has been shown to cause irritation of the nose, throat, skin, and eyes at concentrations around 100 ppmv (294,478 μg/m^3). No one (human) has died from breathing 2-butanone alone. If 2-butanone is breathed along with other chemicals that damage health, it can increase the amount of damage that occurs (synergism). Serious health effects in animals have been seen only at very high levels (~3,000 – 10,000 ppmv). When breathed, these effects included birth defects, loss of consciousness, and death. There are no long-term inhalation studies of animals (58). Limited studies of workers exposed to 2-butanone did not find an increase in cancer (58).

- Acetone: Breathing moderate-to-high levels, greater than 100 ppmv or 237,546 μg/m^3, of acetone for short periods of time can cause nose, throat, lung, and eye irritation; headaches; light-headedness; confusion; increased pulse rate; effects on blood; nausea; vomiting; and shortening of the menstrual cycle in women. Usually, people will smell and experience respiratory irritation or burning eyes, which serves as a warning helping one to avoid breathing damaging levels of acetone. Acetone at levels greater than 21,000 ppmv

(50,000,000 µg/m3) may cause loss of consciousness and possibly coma (59). Animal studies have shown long-term exposures to cause kidney, liver, and nerve damage; increased birth defects; and lowered ability to reproduce (males only). It is not known if people would have these effects (59). It is not known if breathing or swallowing acetone for long periods will cause cancer. Studies of workers exposed to acetone found no significant risk of death from cancer (59).

- Tetrachlorethylene (PCE): High concentrations ranging from ~200 ppmv or 1,357,873 µg/m^3 (less serious effects) to >5,000 ppmv or 33,946,830 µg/m^3 of PCE—particularly in closed, poorly ventilated areas—can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Limited studies of women working in the dry-cleaning business have indicated the occurrence of more menstrual problems and spontaneous abortions than women who are not exposed. However, it is not known if PCE was responsible for these problems because other possible causes were not considered. Animal studies indicate exposure to PCE levels exceeding 100 ppmv can damage the kidney, liver and cause reproductive effects (60). PCE may reasonably be anticipated to be a carcinogen. PCE has been shown to cause liver and kidney tumors in animals (60). It is important to note the toxicological information provided for the VOCs discussed above is from worker and animal studies, where exposures levels were much higher than levels one would expect to find in ambient air around the Remco facility because of the dilution that would occur.

General Community Concerns

Several general community concerns were provided in addition to the health specific concerns. Those concerns are listed below with a response.

Air

Residents who live/lived near Remco reported there were times when they could see a yellow mist in the air, which made it hard to breathe. One resident reported that this mist damaged the paint on their car. According to the resident, Remco repainted their car.

Stress

Stress is defined as the state of physical or psychological strain or tension. Several community members reported that they felt a great deal of stress regarding the Remco site. They were concerned about the impact of the contamination on their health. They were also worried that "unknown" problems at Remco might affect their health. Also, community residents reported a high level of distrust and concern that decisions relating to the cleanup of the Remco site will not be protective of health for the future.

In September 1995, ATSDR, Emory University, and the Connecticut Department of Health co-sponsored an expert panel workshop on the psychological responses to hazardous substances (61). The purpose of this workshop was to thoroughly explore and examine all that is known about how communities and individuals respond socially and psychologically to hazardous substances and the possible effects of those responses on their health. The workshop pointed out that the first scientific studies on the health effects of stress were related to the Three Mile Island accident (61). Baum and colleagues found levels of psycho-physiological effects from stress such as psychological distress, sub-clinical anxiety disorders, and depression were elevated compared to controls. This comparison also revealed increased blood pressure and higher than normal levels of urinary cortisol and norephrine metabolites. These findings were similar to those found by Baum and colleagues in chronic stress response in a community located near a leaking hazardous waste site (61).

Given the possible health impacts from stress that may already be occurring in the Willits community about perceived exposure to site-related contaminants and exposures identified relating to inhalation of hexavalent chromium, CDHS believes stress support and counseling services should be available to the community, as needed.

In August 2003, CDHS coordinated a training between ATSDR and Mendocino County Mental Health staff on community/individual psychological responses to exposure issues from hazardous substances. The purpose of the training was to better equip local mental health workers in addressing stress-related issues resulting from an awareness of potential exposure concerns from Remco.

Children's Health Considerations

CDHS and ATSDR recognize that, in communities with contaminated water, soil, air, or food (or all of these combined, depending on the substance and the exposure situation), infants and children can be more sensitive than adults to chemical exposures. This sensitivity results from several factors: 1) children might have higher exposures to environmental toxins than adults because, pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults; 2) children play outdoors close to the ground, which increases their exposure to toxins in dust, soil, surface water, and ambient air; 3) children have a tendency to put their hands in their mouths, thus potentially ingesting contaminated soil particles at higher rates than adults; some children even exhibit an abnormal behavior trait known as "pica," which causes them to ingest non-food items, such as soil; 4) children are shorter than adults, which means they can breathe dust, soil, and vapors close to the ground; 5) children's bodies are rapidly growing and developing, thus they can sustain permanent damage if toxic exposures occur during critical growth stages; and 6) children and teenagers more readily than adults can disregard no trespassing signs and wander onto restricted property. CDHS considered children for each of the pathways evaluated in this PHA.

Conclusions

CDHS evaluated nine completed exposure pathways (past, current, and future) using environmental data collected at and around the Remco site. The completed exposure pathway related to historic air releases of hexavalent chromium was the focus of an earlier health assessment and was not replicated in this document (3).

Because of the high level of exposure identified from historic air releases of hexavalent chromium, we have restated the recommendations presented in that PHA (3). On the basis of available data, CDHS concludes that the following pathways pose no apparent public health hazard:

- private well usage for consumption and irrigation purposes (past, current);
- breathing VOCs in indoor air from soil vapor intrusion (past, current);
- swimming or wading in Baechtel Creek (current and future);
- contact with sediment in Baechtel Creek (past, current, and future);
- contact with off-site soil, including Baechtel Grove School, Blosser Lane Elementary School, and the future Boys and Girls Club (past, current, and future);
- eating blackberries or fruits from trees grown near the Remco site and in other areas of the community (past, current, and future);
- contact with soil in the Willits community (past, current, and future); and
- breathing contaminants during interim remedial activities completed at the Remco site (2000–2003);
- breathing VOCs released during Remco operations between 1988 and 1991.

Four time frames within an exposure pathway could not be evaluated due to insufficient data or a potential exposure pathway exists in the future. As a result, CDHS concludes that the following activities pose an indeterminate public health hazard:

- breathing VOCs released during Remco operations (past, prior to 1988);
- swimming or wading in Baechtel Creek (past);
- private well usage for consumption and irrigation purposes (future) and;
- breathing VOCs in indoor air from soil vapor intrusion (future).

One exposure pathway, air releases of hexavalent chromium, was the focus of an earlier health assessment and is summarized in this PHA (3). CDHS used air modeling data to evaluate exposure airborne hexavalent chromium (released during chromium plating) because there were no actual samples taken during the time period Remco conducted chrome plating (1963–1995). Exposure to hexavalent chromium is currently known to cause both noncancer and cancer health effects. Noncancer health effects include, asthma, bloody nose, nasal septum scarring and perforation, runny nose, mild decreased lung function, bronchitis, gastric irritation, and subtle changes in kidney function (affects primarily the proximal tubule). Lung cancer is the primary cancer associated with hexavalent chromium exposure; other cancers (nasal and stomach) have been suggested, but are not well studied. (Exposure to hexavalent chromium is not the only cause of these noncancer and cancer health effects.) On the basis of air modeling data, CDHS concludes that residents and workers could have experienced noncancer health effects and some increased risk of cancer (primarily lung) from breathing hexavalent chromium over a large area of Willits (3). As a result, CDHS classifies the site as posing a public health hazard in the past (1963–1995), from exposure to airborne hexavalent chromium.

CDHS reviewed the numbers of lung and other cancers that actually occurred in the Willits area between 1988 and 2000. The review showed that the number of cases of cancer in Willits during those years was not higher than expected for that population. The number of lung cancer cases was somewhat higher, although not statistically greater, than expected. However, the cancer review is not an effective tool for studying and characterizing how exposure to hexavalent chromium may have increased the risk of cancer in the Willits community. Thus, CDHS concludes that community members, especially those exposed prior to the time when emissions controls were implemented, experienced some increase in their risk of cancer.

CDHS has conducted a number of community outreach activities in an effort to collect and understand health concerns that community members believe are related to operations and/or contamination from the Remco facility. CDHS responds to these concerns by indicating whether the contaminant(s) in the exposures pathways/activities evaluated is/are associated with the health concern expressed and is present at levels where health effects have been seen in scientific studies.

Recommendations

1. CDHS/ATSDR recommend remedial actions to be taken to prevent future impacts to private irrigation wells and prevent exposure from breathing VOCs in indoor air from soil gas migration/vapor intrusion.

2. CDHS/ATSDR recommend Mendocino County Department of Environmental Health work with the California Regional Water Quality Control Board to provide education to the citizens of Willits, notifying people of areas where contamination sources have been identified.

3. CDHS/ATSDR recommend that the feasibility of medical monitoring/clinical evaluations be considered for Willits residents and people who worked in Willits, who may have been exposed to air releases of hexavalent chromium from Remco between 1963 and 1995. If medical monitoring is undertaken, CDHS recommends that an expert work group with community representation be established to develop a protocol for medical monitoring/clinical services, including criteria for participation and an overall implementation plan.

4. CDHS/ATSDR recommend counseling and stress support services be considered for impacted residents and workers, as needed. These activities could fall under the medical monitoring provision of the Consent Decree.

5. CDHS/ATSDR recommend that the Willits Trust implement adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the site. This should be conducted in conjunction with air monitoring, using detection limits adequate to protect public health.

Public Health Action Plan

The Public Health Action Plan (PHAP) for this site contains a description of actions taken, to be taken, or under consideration by ATSDR and CDHS or others at and near the site. The purpose of the PHAP is to ensure that this PHA not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The first section of the PHAP contains a description of actions completed. The second section is a list of additional public health actions that are planned for the future.

Actions Completed

1. CDHS/ATSDR formed and convened a site team to guide the PHA process, communicate with the larger public, and bring the stakeholders together for increased information sharing with the public. Between November 2000 and November 2004, 11 site team/public meetings have been held.

2. CDHS/ATSDR gathered community concerns through meeting with community members and by conducting two public availability sessions for the community.

3. CDHS/ATSDR have provided health education to the community by convening several community meetings. Topics included an overview of the PHA process and air modeling, an introduction to toxicology and chromium health effects, the health effects of VOCs, information about groundwater hydrogeology and the movement of Remco-related contaminants, biological monitoring, case study of chromium impacts in another community, and health study options and limitations.

4. At the request of CDHS, the RWQCB conducted additional off-site surface soil sampling for hexavalent chromium in areas that were subject to the highest estimated air levels of hexavalent chromium. The sampling was conducted to further address potential soil impacts from aerial deposition. (June 2003)
5. CDHS reviewed additional off-site surface soil sampling conducted by the RWQCB in June 2003. (July 2003)

6. CDHS/ATSDR released a PHA evaluating exposures to historic air releases from the Remco facility. The public comment draft was released in July 2003 and the final report was released in August 2004.

7. CDHS/ATSDR developed and distributed a fact sheet that summarized the findings of the public health assessment evaluating exposure to historic air releases from the Remco facility. (August 2003, updated in August 2004)

8. CDHS reviewed the work plan for removal of VOC-contaminated soils and recommended the Willits Trust implement additional air monitoring. (September 2003)

9. CDHS/ATSDR conducted a needs assessment with local health care providers to determine future training needs relative to hexavalent chromium exposure and resulting health effects. (December 2003)

10. CDHS provided environmental health education/training to local health care providers about chromium exposure and related health effects. (August 2003, March 2004, and April 2004)

11. CDHS wrote two letters to the City of Willits requesting that the recommendation for medical monitoring be forwarded to the judge overseeing the site for funding consideration under the Consent Decree. (October 21, 2003, March 7, 2005)

12. CDHS/ATSDR funded a workshop of clinicians with expertise in environmental and occupational medicine to discuss medical monitoring options for the Willits community. (March 29, 2006)

Ongoing Actions

1. CDHS/ATSDR will continue to provide health outreach and education to the community and recommend that health education activities be tailored to meet the community's needs. CDHS will initiate discussion with the community to allow for input in the development of that education approach.

2. CDHS/ATSDR is constructing a health consultation discussing the scientific merit of various health study options.

Actions Planned

1. CDHS will summarize in a fact sheet the findings of the final PHA evaluating exposure to historic air releases of hexavalent chromium from the Remco facility.

2. CDHS will disseminate information summarizing the findings of this comprehensive PHA.

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Certification

This Public Health Assessment (PHA), Evaluation of Exposure to Contaminants from the Abex/Remco Hydraulics Facility, Willits, California, was prepared by the California Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the PHA was begun. Editorial review was completed by the Cooperative Agreement Partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this PHA and concurs with the findings.

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Appendix A—Glossary

Absorption
How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure
Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Adverse Health Effect
A change in body function or the structures of cells that can lead to disease or health problems.

ATSDR
The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and ten regional offices in the U.S. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (USEPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

Background Level
An average or expected amount of a chemical in a specific environment or, amounts of chemicals that occur naturally in a specific environment.

Cancer Risk
The potential for exposure to a contaminant to cause cancer in an individual or population is evaluated by estimating the probability of an individual developing cancer over a lifetime as the result of the exposure. This approach is based on the assumption that there are no absolutely "safe" toxicity values for carcinogens. USEPA and the California EPA have developed cancer slope factors and inhalation unity risk factors for many carcinogens. A slope factor is an estimate of a chemical's carcinogenic potency, or potential, for causing cancer.

If adequate information about the level of exposure, frequency of exposure, and length of exposure to a particular carcinogen is available, an estimate of excess cancer risk associated with the exposure can be calculated using the slope factor for that carcinogen. Specifically, to obtain risk estimates, the estimated, chronic exposure dose (which is averaged over a lifetime or 70 years) is multiplied by the slope factor for that carcinogen.

Cancer risk is the theoretical chance of getting cancer. In California, 41.5% of women and 45.4% of men (about 43% combined) will be diagnosed with cancer in their lifetimes (36). This is referred to as the "background cancer risk." The term "excess cancer risk" represents the risk above and beyond the "background cancer risk." A "one-in-a-million" excess cancer risk from a given exposure to a contaminant means that if one million people are chronically exposed to a carcinogen at a certain level, over a lifetime, then one cancer above the background risk may appear in those million persons from that particular exposure. For example, in a million people, it is expected that approximately 430,000 individuals will be diagnosed with cancer from a variety of causes. If the entire population was exposed to the carcinogen at a level associated with a one-in-a-million cancer risk, 430,001 people may get cancer, instead of the expected 430,000. Cancer risk numbers are a quantitative or numerical way to describe a biological process (development of cancer). In order to take into account the uncertainties in the science, the risk numbers used are plausible upper limits of the actual risk, based on conservative assumptions.

Chronic Exposure
A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than 1 year to be chronic.

Completed Exposure Pathway
See Exposure Pathway.

Concern
A belief or worry that chemicals in the environment might cause harm to people.

Consent Decree
A legal document, approved and issued by a judge, that formalizes an agreement reached between the City of Willits and the former owners (PRPs), where PRPs will conduct the clean-up action at the Remco site; cease or correct actions or processes that are polluting the environment; or otherwise comply with initiated regulatory enforcement actions to resolve site contamination. The Consent Decree describes actions that PRPs are required to perform and may be subject to a public comment period.

Concentration
How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant
See Environmental Contaminant.

Dermal Contact
A chemical getting onto your skin. (See Route of Exposure.)

Dose
The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day.”

Dose/Response
The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration
The amount of time (days, months, and years) that a person is exposed to a chemical.

Environmental Contaminant
A substance (chemical) that gets into a system (person, animal, or environment) in amounts higher than that found in Background Level, or what would be expected.

Environmental Media
Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an Exposure Pathway.

Exposure
Coming into contact with a chemical substance (for the three ways people can come in contact with substances, see Route of Exposure).

Exposure Assessment
The process of finding the ways people come in contact with chemicals, how often, and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway
A description of the way that a chemical moves from its source (where it began), to where, and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having five parts: 1) a source of contamination, 2) an environmental media and transport mechanism, 3) a point of exposure, 4) a route of exposure, and 5) a receptor population. When all five parts of an exposure pathway are present, it is called a Completed Exposure Pathway.

Frequency
How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.

Hazardous Waste
Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Comparison Value
Media specific concentrations that are used to screen contaminants for further evaluation.

Health Effect
ATSDR deals only with Adverse Health Effects (see definition in this glossary).

Indeterminate Public Health Hazard
The category is used in public health assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.
Ingestion

Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (see Route of Exposure).

Inhalation
Breathing. It is a way a chemical can enter your body (see Route of Exposure).

LOAEL
Lowest Observed Adverse Effect Level. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

National Contingency Plan (NCP)
The National Oil and Hazardous Substances Pollution Contingency Plan promulgated by the USEPA contains stringent federal guidelines for so-called “Superfund” cleanups conducted by or under the supervision of the federal government.

Noncancer Evaluation, ATSDR’s Minimal Risk Level (MRL), USEPA’s Reference Dose (RfD) and Reference Concentration (RfC), and California EPA’s Reference Exposure Level (REL)
The MRL, RfD, RfC, and REL are estimates of daily exposure to the human population (including sensitive subgroups), below which noncancer adverse health effects are unlikely to occur. The MRL, RfD, RfC, and REL only consider noncancer effects. Because they are based only on information currently available, some uncertainty is always associated with the MRL, RfD, RfC, and REL. “Safety” factors are used to account for the uncertainty in our knowledge about their danger. The greater the uncertainty, the greater the “safety” factor and the lower the MRL, RfD, RfC or REL.

When there is adequate information from animal or human studies, MRLs and RfDs are developed for the ingestion exposure pathway, whereas RELs and RfCs are developed for the inhalation exposure pathway.

Separate noncancer toxicity values are also developed for different durations of exposure. ATSDR develops MRLs for acute exposures (less than 14 days), intermediate exposures (from 15 to 364 days), and for chronic exposures (greater than 1 year). The California EPA develops RELs for acute (less than 14 days) and chronic exposure (greater than 1 year). USEPA develops RfDs and RfCs for acute exposures (less than 14 days), subchronic exposures (from 2 weeks to 7 years), and chronic exposures (greater than 7 years). Both the MRL and RfD for ingestion are expressed in units of milligrams of contaminant per kilograms body weight per day (mg/kg/day). The REL and RfC for inhalation are expressed in units of milligrams per cubic meter (mg/m^3).

NOAEL
No Observed Adverse Effect Level. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard
The category is used in ATSDR’s public health assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring, but the exposures are

not at levels expected to cause adverse health effects.

No Public Health Hazard
The category is used in ATSDR's public health assessment documents for sites where there is no evidence of exposure to site-related chemicals.

PHA
Public Health Assessment. A report or document that looks at chemicals at a hazardous waste site and determines if people could be harmed from coming into contact with those chemicals. The PHA also recommends possible further public health actions if needed.

Plume
A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney, contaminated underground water sources, or contaminated surface water (such as lakes, ponds, and streams).

Point of Exposure
The place where someone can come into contact with a contaminated environmental medium (air, water, food, or soil). For example, the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population
A group of people living in a certain area or the number of people in a certain area.

PRP
Potentially Responsible Party. A company, government, or person that is responsible for causing the pollution at a hazardous waste site. PRPs are expected to help pay for the cleanup of a site.

Public Health Hazard
The category is used in public health assessments for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria
Public health assessment categories given to a site, which tell whether people could be harmed by conditions present at the site. The categories are: 1) urgent public health hazard, 2) public health hazard, 3) indeterminate public health hazard, 4) no apparent public health hazard, and 5) no public health hazard.

Qualitative Description of Estimated Increased Cancer Risks
The qualitative interpretation for estimated increased cancer risks are as follow:

Quantitative Risk Estimate	Qualitative Interpretation
Less than 1 in 100,000	No apparent increased risk
1 in 100,000 to 9 in 100,000	Very low increased risk

1 in 10,000 to 9 in 10,000	Low increased risk
1 in 1,000 to 9 in 1,000	Moderate increased risk
Greater than 9 in 1,000	High increased risk

Receptor Population
People who live or work in the path of one or more chemicals, and who could come into contact with them (see Exposure Pathway).

Route of Exposure
The way a chemical can get into a person's body. There are three exposure routes: 1) breathing (also called inhalation), 2) eating or drinking (also called ingestion), and 3) getting something on the skin (also called dermal contact).

Safety Factor
Also called Uncertainty Factor. When scientists do not have enough information to decide if an exposure will cause harm to people, they use uncertainty factors and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.

Source (of Contamination)
The place where a chemical comes from, such as a smokestack, landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first point of an exposure pathway.

Sensitive Populations
People who may be more sensitive to chemical exposures because of certain factors such as age, sex, occupation, a disease they already have, or certain behaviors (cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Toxic
Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology
The study of harmful effects of chemicals on humans or animals.

Volatile Organic Chemical (VOC)
Substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen. These substances easily volatilize (become vapors or gases) into the atmosphere. A significant number of VOCs are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry-cleaning fluids).

Appendix B—Figures

Figure 1. Location of Abex/Remco Site, Willits, California

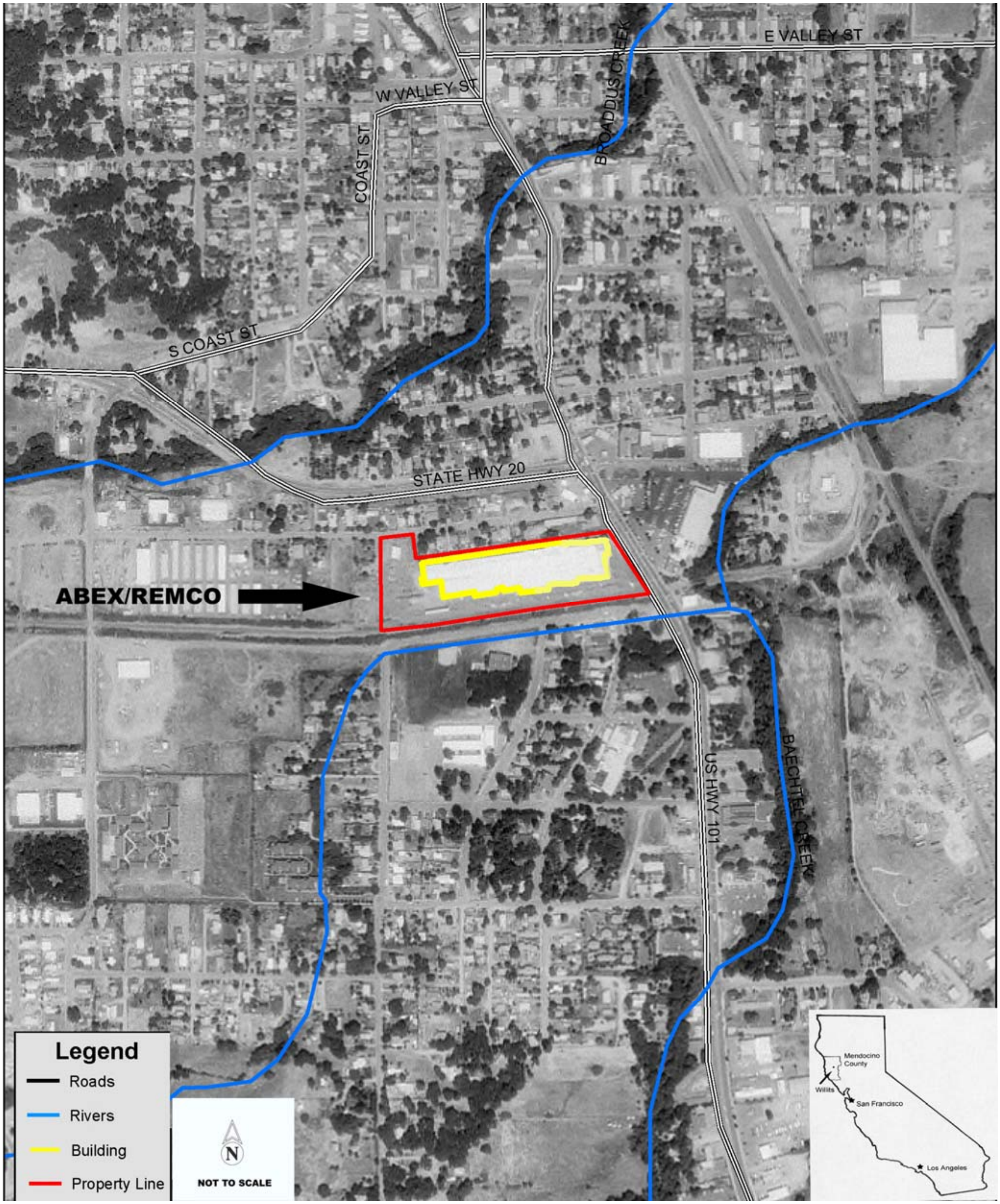


Figure 2. Approximate Location of Private Wells Near the Remco Facility, Willits, California (4)

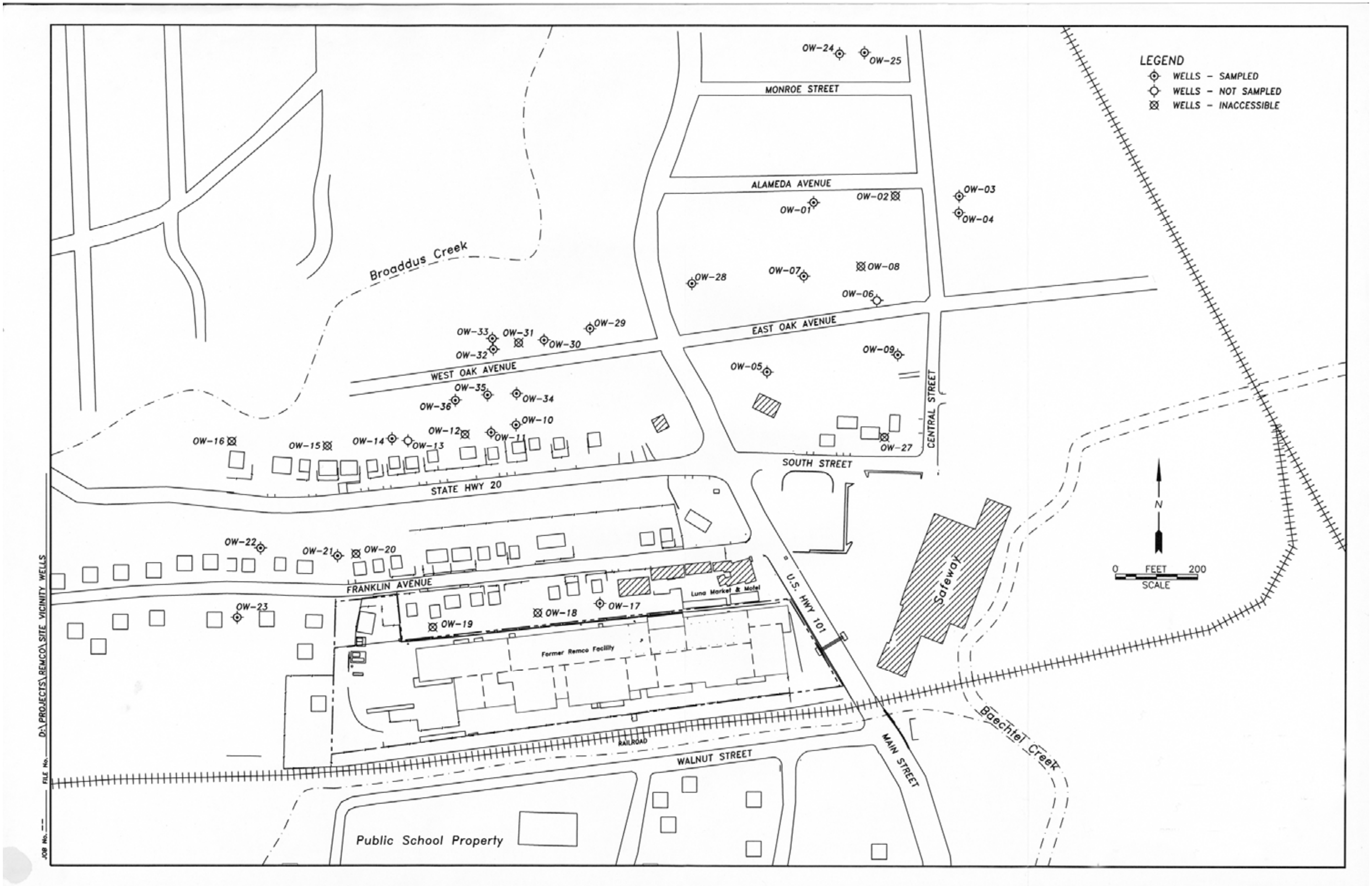


Figure 3. Approximate Location of Storm Drain and Surface Water Samples, Remco Site, Willits, California (4)

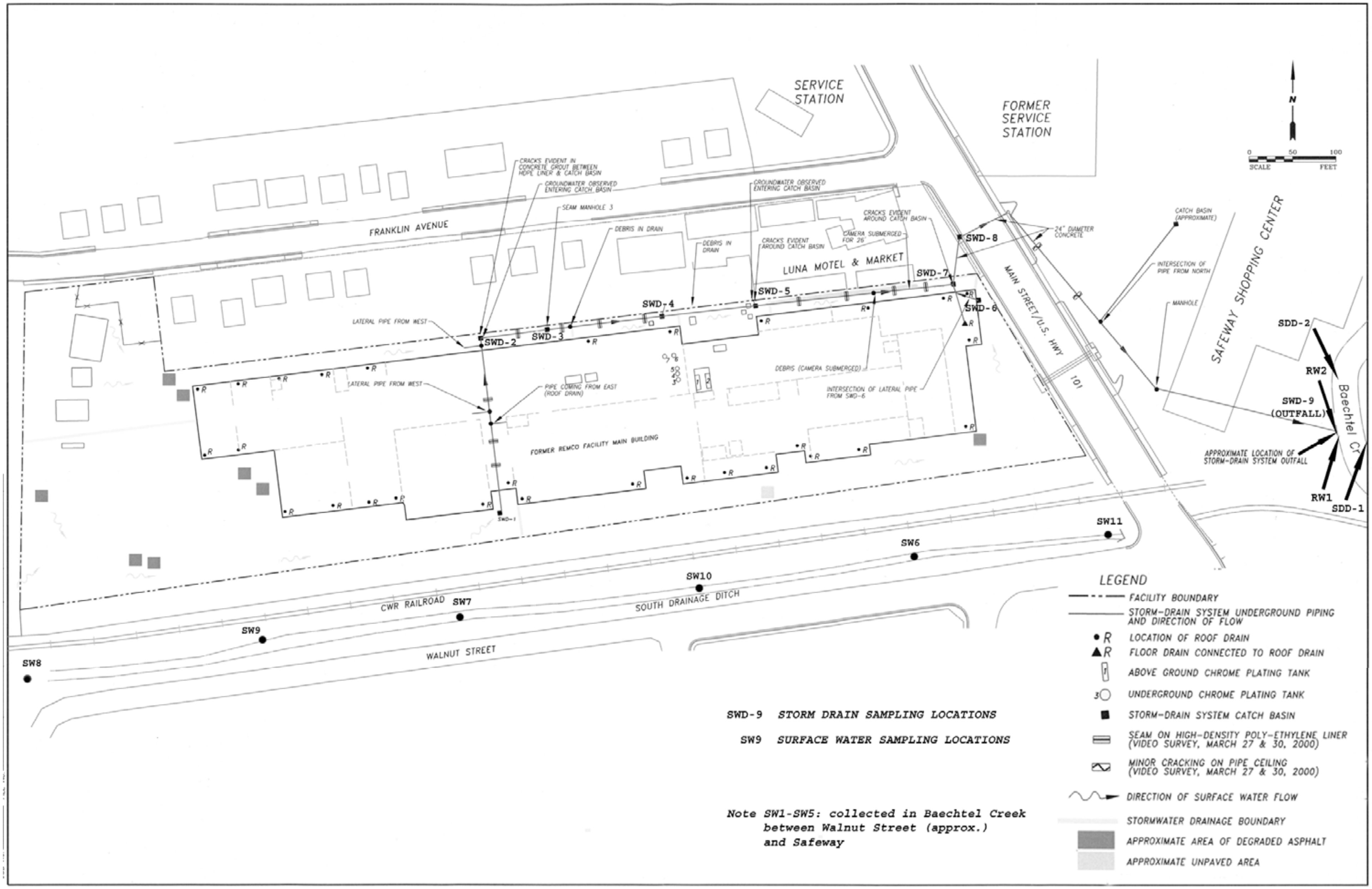


Figure 4. Approximate Location of Sediment Samples, Remco Site, Willits, California (4)

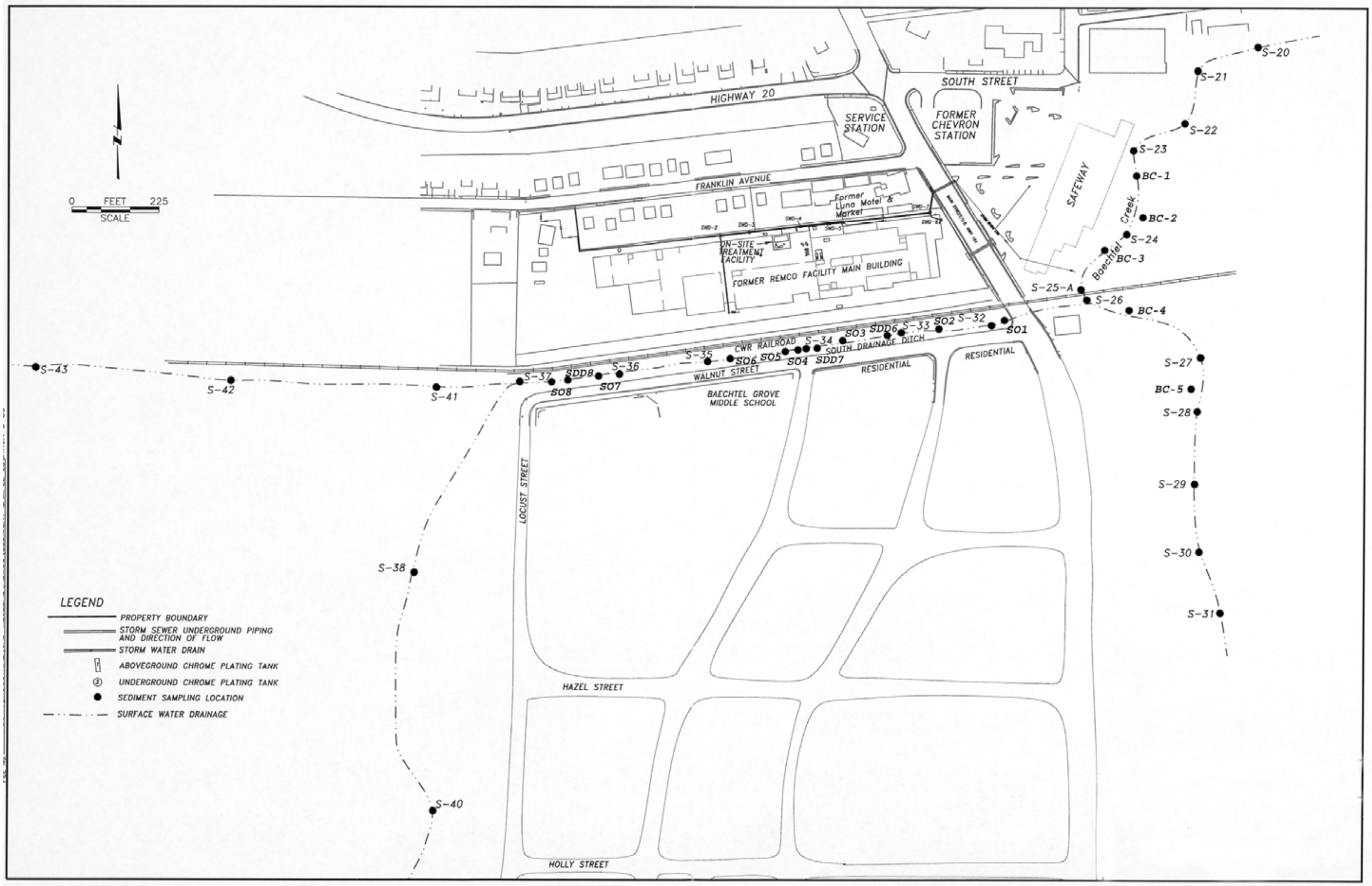


Figure 5. Approximate Location of Surface and Shallow Soil Samples, Remco Site, Willits, California (4)

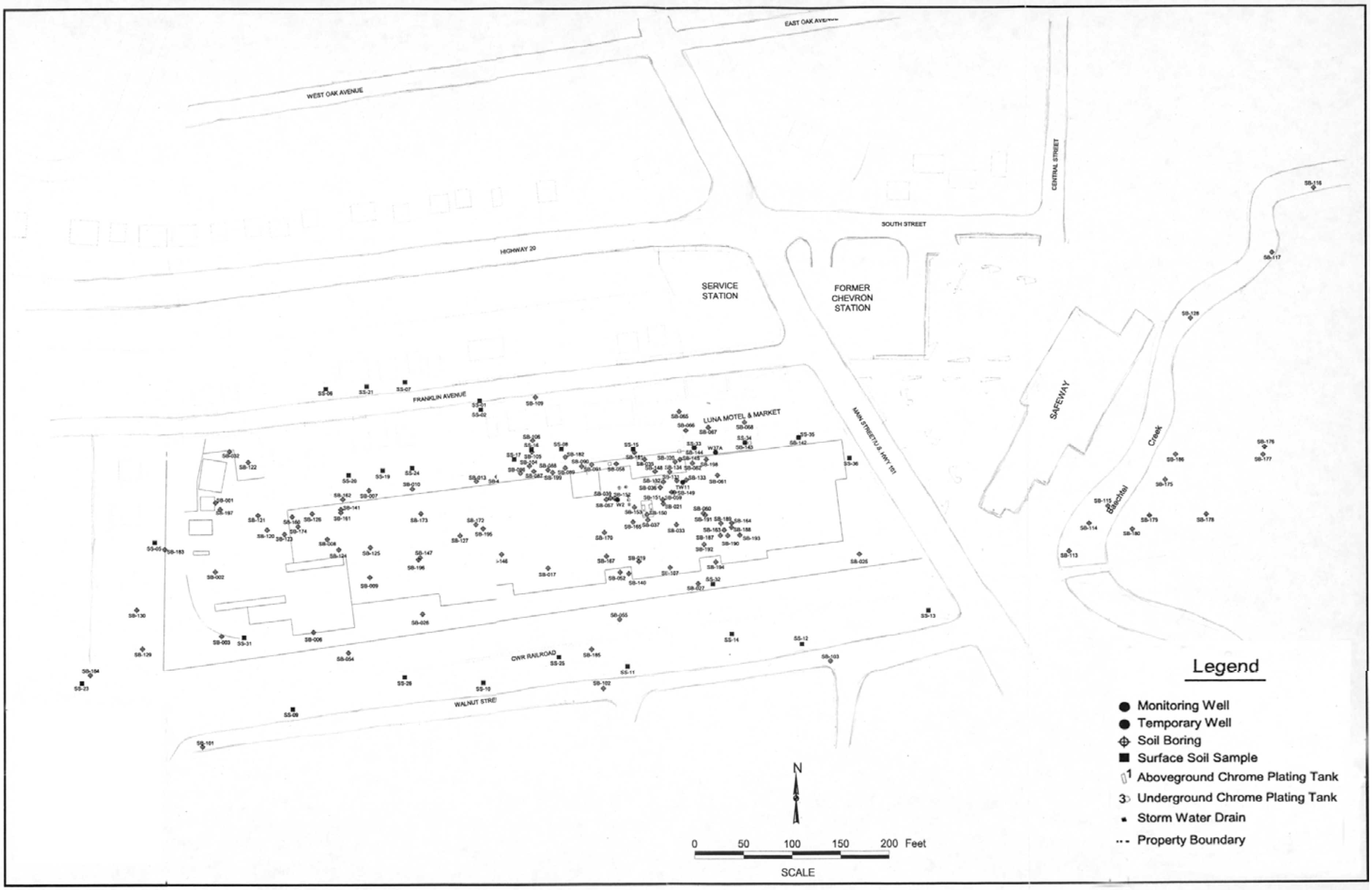
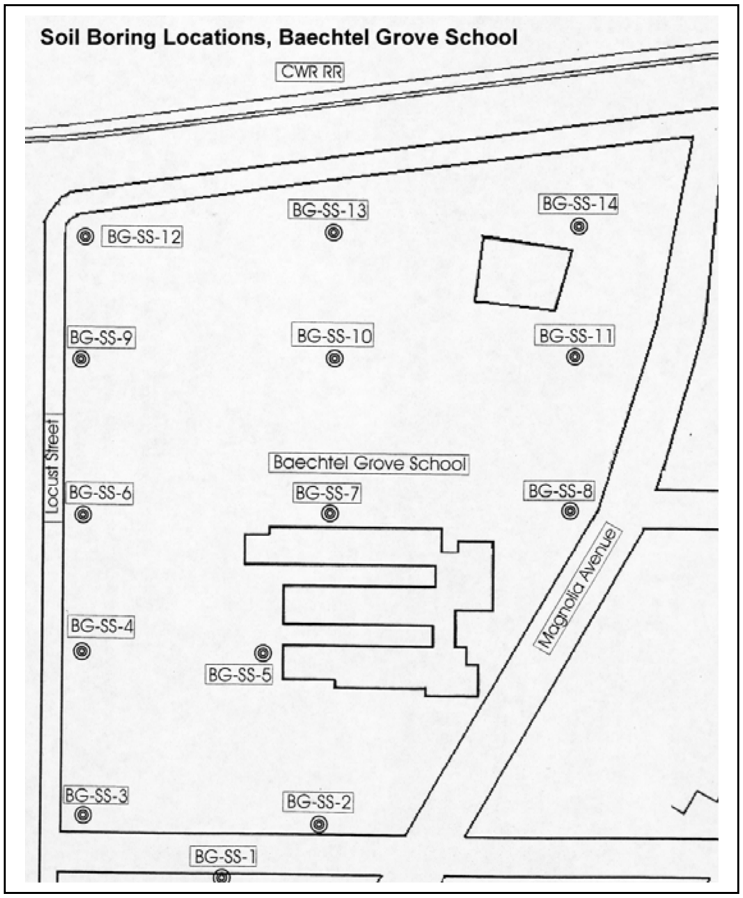
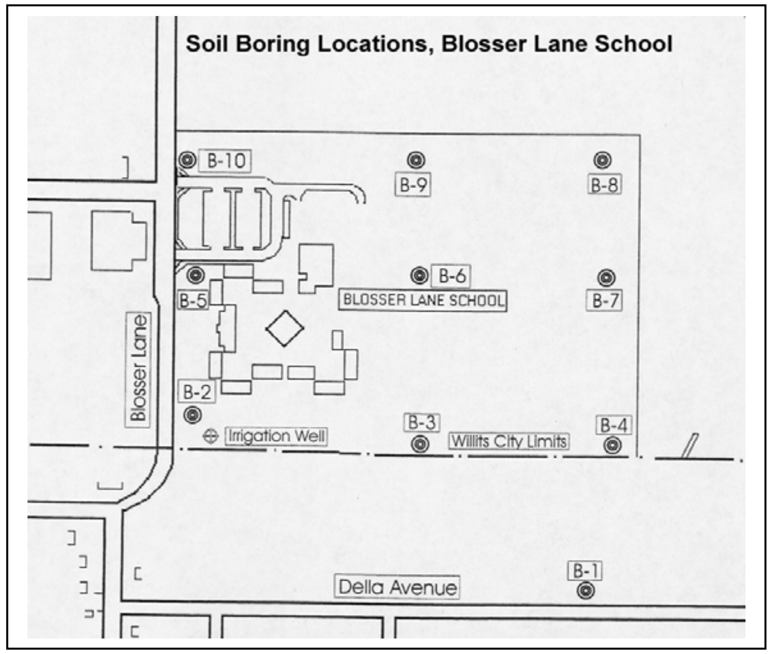


Figure 6. Approximate Location of the Regional Water Quality Control Board (RWQCB) Soil Samples Collected at Baechtel Grove Middle School, Blosser Lane Elementary School, and the Future Boys and Girls Club, Remco Site, Willits, California (62)





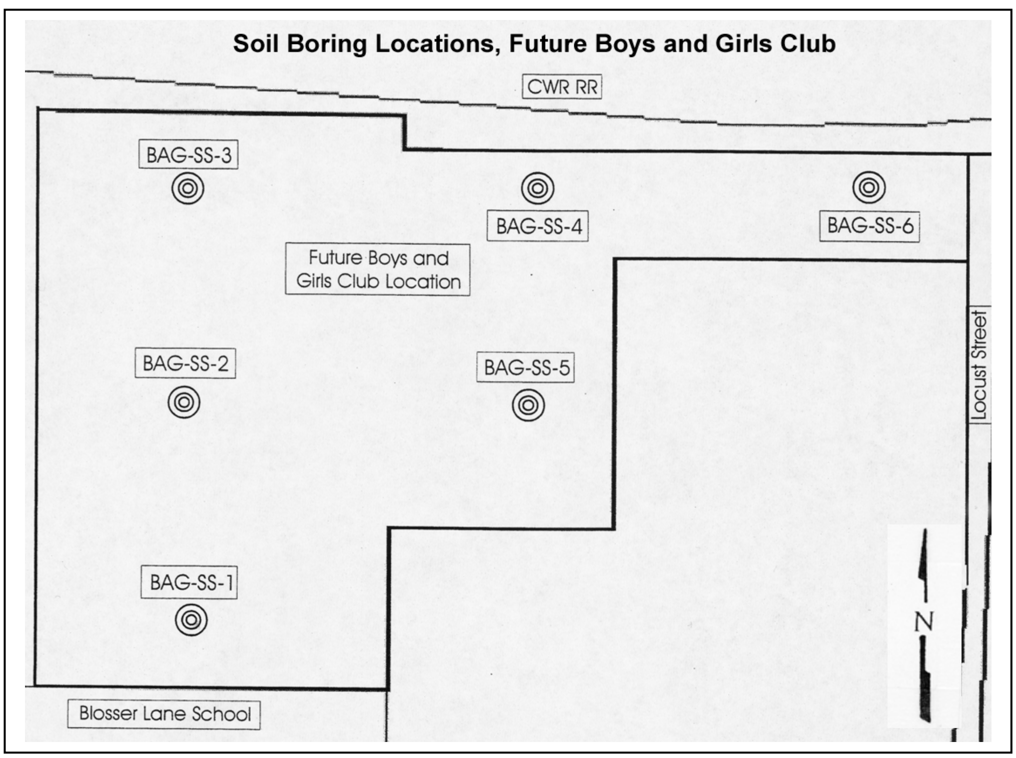


Figure 7. Approximate Location of Soil Samples Collected in the Willits Community, Remco Site Willits, California (4)

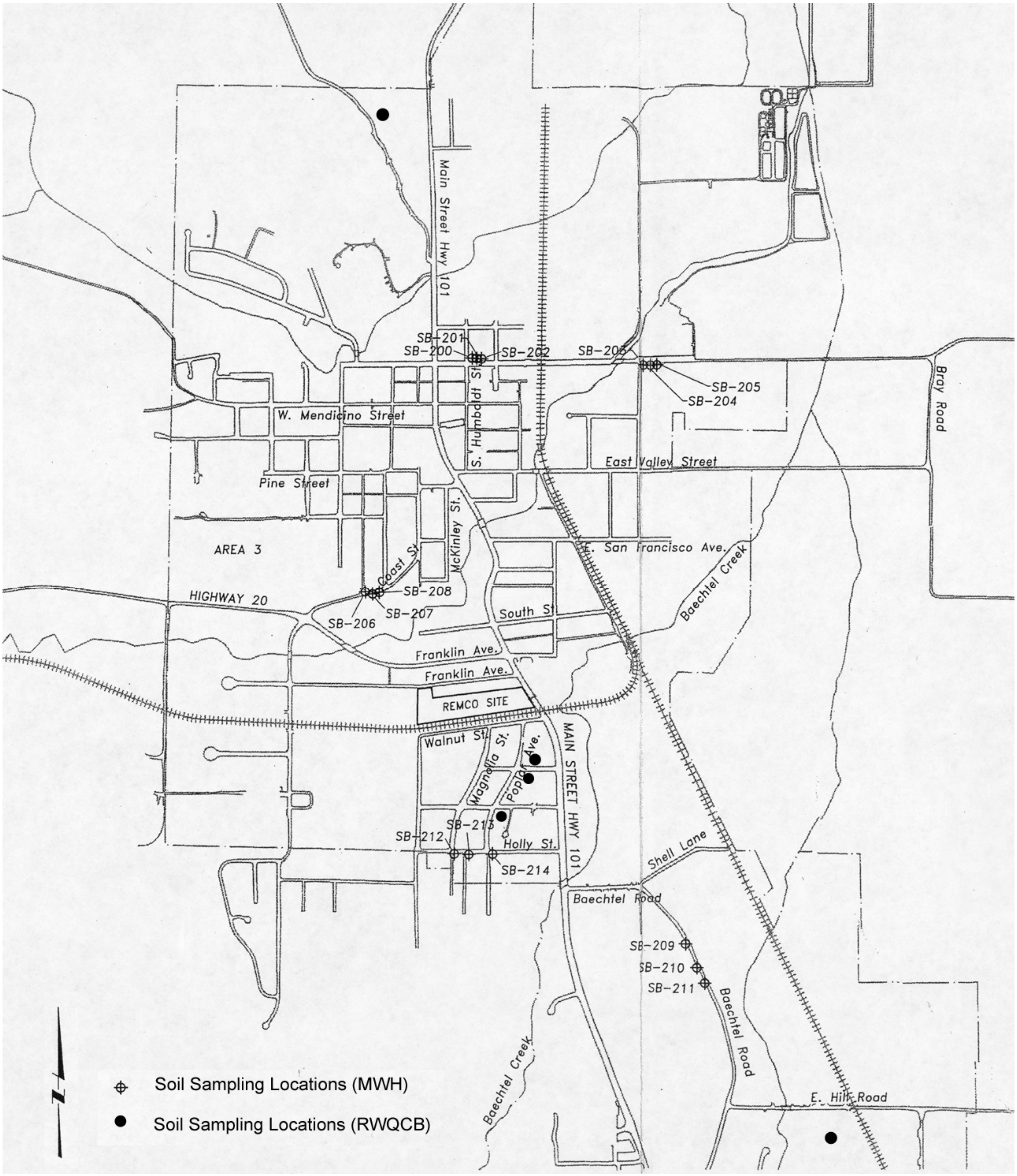


Figure 8. Location of Perimeter Air Monitoring Stations and Soil Excavation Areas for the Interim Remedial Action—Removal of Source Soils (2003), Remco Site, Willits, California (63)

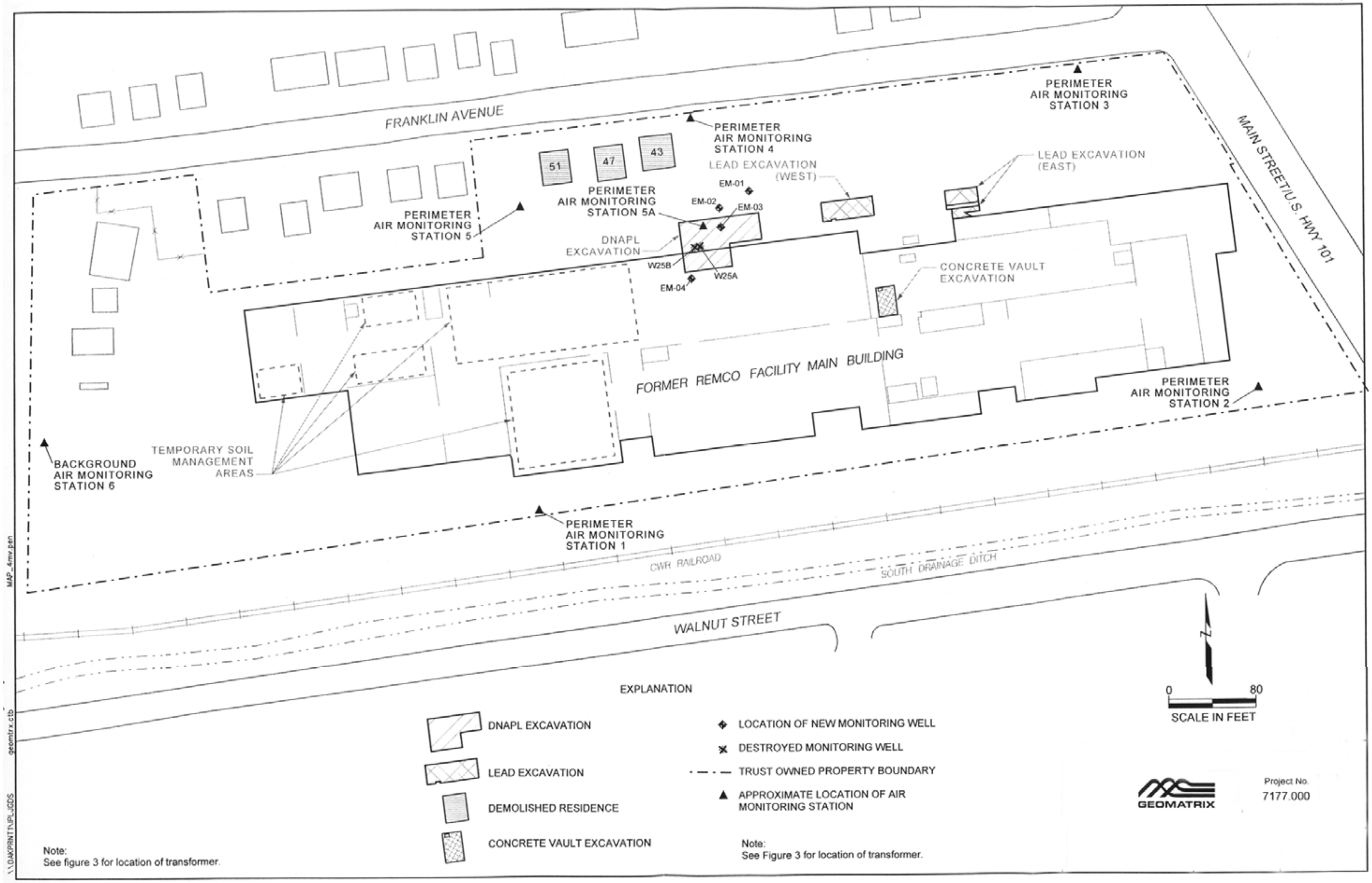
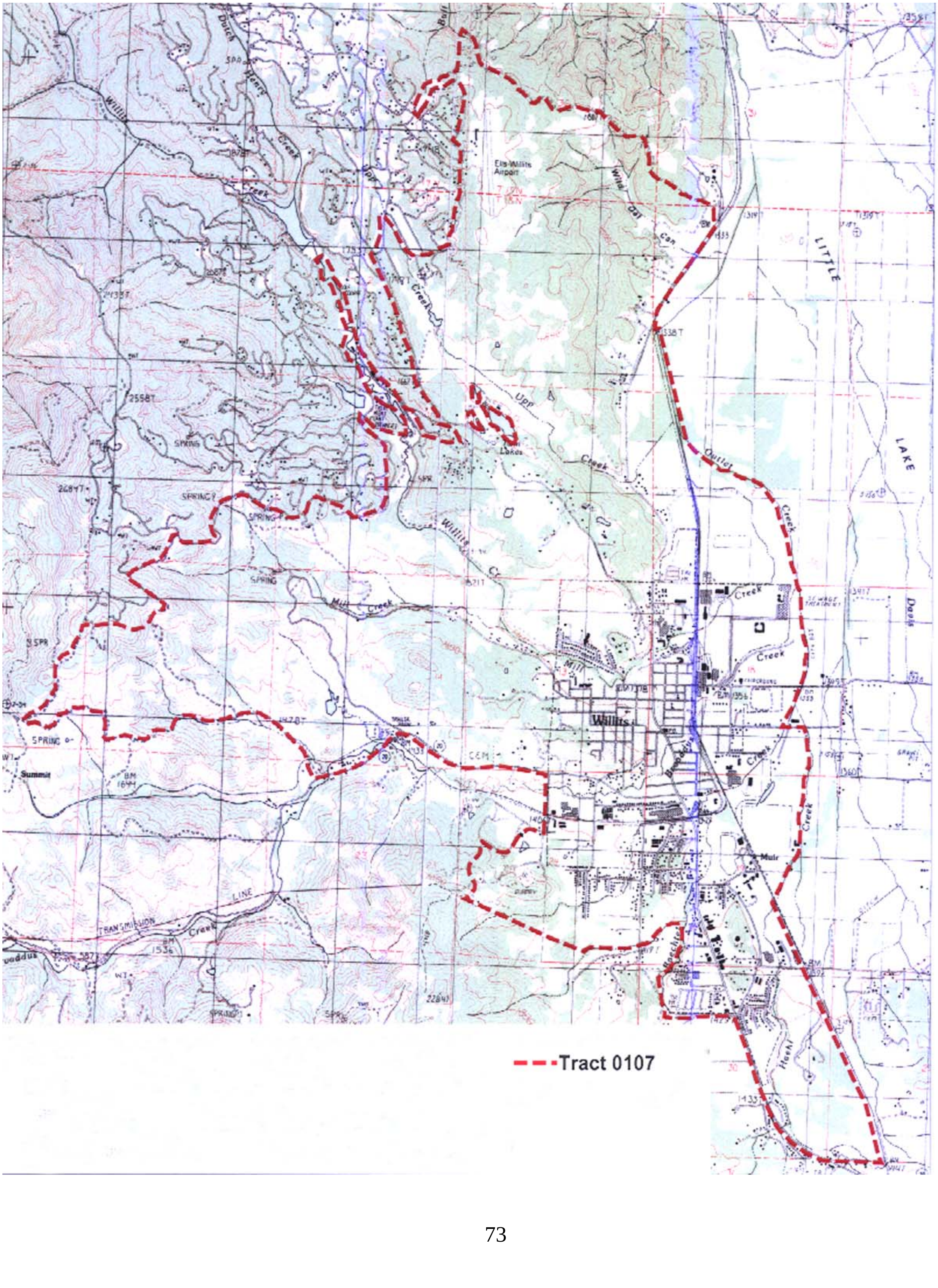


Figure 9. Location of 2000 U.S. Census Tract 0107, Remco Site, Willits, California (7)



Appendix C—Tables

Table 1. Completed Exposure Pathways (Situations), Remco Site, Willits, California

Pathway Name	Contaminants of Concern	Pathway Elements						Conclusions/Recommendations
		Source	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Time	
Private well owners near the Remco site	VOCs, TPH-diesel	Remco	Water	House tap	Ingestion (drinking)	Adults and children who live or visit a house with a private well	Past, current, future	No apparent public health hazard currently from Remco contaminants in private wells. Potential exposures in the future will be eliminated through cleanup of the contaminated groundwater. Potential exposures in the past would not be expected to cause noncancer health effects.
Indoor air	VOCs	Remco	Soil gas	Indoor air	Inhalation (breathing)	Residents living above VOC-contaminated groundwater	Past, current, future	No apparent public health hazard in the past or currently. Future impacts to indoor from soil gas migration will be eliminated through remediation of the groundwater.
Food chain	Metals, VOCs	Remco	Plants	Blackberries, fruit-bearing trees	Ingestion	Residents living above VOC-contaminated groundwater	Past, current, future	No apparent health hazard from eating blackberries or plums grown in areas near the site from Remco-related contaminants.
Baechtel Creek water	Hexavalent chromium, TPH-diesel, VOCs	Remco storm drain discharges	Water	Baechtel Creek	Ingestion, dermal (skin) contact	General public who swim or wade in Baechtel Creek	Past, current, future	Indeterminate public health hazard in the past due to a lack of data. No current or future public health hazard.
Baechtel Creek sediment	Manganese, TPH-diesel	Remco storm drain discharges	Sediment	Baechtel Creek	Ingestion, dermal (skin) contact	General public who come into contact with Baechtel Creek sediment	Past, current, future	No apparent public health hazard from sediment in Baechtel Creek: site-related contaminants were not detected at levels that would be of health concern.
Off-site soil in the Willits Community	Site-related metals (in particular lead)	Remco	Soil	Off-site soil	Ingestion	General public	Past, current, future	No apparent public health hazard: contaminants were not found at levels of health concern in areas sampled in the community, including Baechtel Grove Middle School, Blosser Lane Elementary School and the future location of the Boys and Girls Club.
Air	Hexavalent chromium	Remco	Air	Air	Inhalation (breathing)	General public (residents, and people who work or visit Willits)	Past	Past public health hazard. Public health assessment evaluating historic air releases of hexavalent chromium available upon request (48).

Table 1. Completed Exposure Pathways (Situations), Remco Site, Willits, California

Pathway Name	Contaminants of Concern	Pathway Elements						Conclusions/Recommendations
		Source	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Time	
Air	VOCs	Remco	Air	Air	Inhalation	General public	Past	Indeterminate public health hazard in the past (prior to 1988): insufficient data to evaluate potential exposure in the past from VOCs released to the air during Remco operations. No current or future public health risk because Remco is no longer operating.
Air	H_2S gas, hexavalent chromium, lead, VOCs	Remco remedial activities	Air	Air	Inhalation	General public	Past, current, future	No apparent public health hazard from in-situ pilot study (2000): H_2S was not detected at levels that would result in health effects. No future public health hazard to H_2S because pilot study has concluded. No health risk from exposure to DNAPL and lead during soil removal (2003) since hexavalent chromium and lead were not detected and sporadic detections of VOCs were not at levels that would result in health effects. Hexavalent chromium and lead were not detected during vertical chrome tank removal (2003–2004). Potential exposure in the future can be mitigated, provided the Trust continues to implement adequate control measures and monitoring during remedial activities at the site.

VOC—volatile organic chemical
TPH—total petroleum hydrocarbons
H_2S—hydrogen sulfide
DNAPL—dense non-aqueous phase liquid

Table 2. Contaminants Detected Above Drinking Water Standards (MCLs) in Private Wells and Noncancer/Cancer Health Effects Evaluation, Remco Site, Willits, California

Private Well OW-17							
Contaminant and MCL	**Date(s) of Detection**	**Levels Detected (ppb)**	**Health Comparison Value (ppb)**	**Reference Dose (RfD) (mg/kg/day)**	**Dose Estimate**	**Hazard Quotient (Noncancer)**	**Theoretical Increased Cancer Risk**
1,1-Dichloroethane (DCA) MCL = 5 ppb	12/17/97 5/28/98	56 53	NA	NA	0.0015 $_{child}$ 0.0015 $_{adult}$	Cannot estimate without RfD	2 in 1,000,000 $_{child}$ 4 in 1,000,000 $_{adult}$
1,1-Dichloroethylene (DCE) MCL = 6 ppb	12/17/97 5/28/98	31 30	90 EMEG $_{child}$ 300 EMEG $_{adult}$	0.009	0.0008 $_{child}$ 0.0008 $_{adult}$	0.09 $_{child}$ 0.09 $_{adult}$	1 in 10,000 $_{child}$ 2 in 10,000 $_{adult}$
cis-1,2-Dichloroethylene (DCE) MCL = 6 ppb	12/17/97 5/8/98	47 67	3000 EMEG $_{child}$ 10,000 EMEG $_{adult}$	0.03	0.0018 $_{child}$ 0.0018 $_{adult}$	0.06 $_{child}$ 0.06 $_{adult}$	Slope factor under review/cannot estimate increased risk
Tetrachloroethylene (PCE) MCL = 5 ppb	12/17/97 5/8/98	80 89	100 RMEG $_{child}$ 400 EMEG $_{adult}$	0.01	0.0024 $_{child}$ 0.0024 $_{adult}$	0.24 $_{child}$ 0.24 $_{adult}$	3 in 100,000 $_{child}$ 5 in 100,000 $_{adult}$
Trichloroethylene (TCE) MCL = 5 ppb	12/17/97 5/28/98	68 65	NA	NA	0.0018 $_{child}$ 0.0018 $_{adult}$	Cannot estimate without RfD	7 in 1,000,000 $_{child}$ 1 in 100,000 $_{adult}$
Hazard Index (Sum of hazard quotient values) **= 0.39** $_{child}$ and **0.39** $_{adult}$ **Total Theoretical Increased Cancer Risk = 2 in 10,000** $_{child}$ and **3 in 10,000** $_{adult}$							

Table 2. Contaminants Detected in Private Wells Above Drinking Water Standards (MCLs) and Noncancer/Cancer Health Effects Evaluation, Remco Site, Willits, California

Private Well OW-7						
Contaminant and MCL	**Date(s) of Detection**	**Level Detected (ppb)**	**Health Comparison Value (ppb)**	**MRL (mg/kg/day)**	**Dose Estimate (mg/kg/day)**	**Theoretical Increased Cancer Risk**
Methyl tert-butyl ether (MTBE) MCL = 13 ppb	12/18/97	14	3000 EMEG $_{child}$ 10,000 EMEG $_{adult}$	0.3*	0.0004 $_{child}$ 0.0004 $_{adult}$	Slope factor unavailable/cannot estimate increased risk
Private Well OW-24						
Contaminant and MCL	**Date(s) of Detection**	**Level Detected (ppb)**	**Health Comparison Value (ppb)**	**MRL (mg/kg/day)**	**Dose (mg/kg/day)**	**Theoretical Increased Cancer Risk**
Methylene Chloride (not site-associated) MCL = 5 ppb	12/18/97	44	NA	0.06	0.0012 $_{child}$ 0.0012 $_{adult}$	2 in 1,000,000 $_{child}$ 4 in 1,000,000 $_{adult}$

Data source (4)
ppb—parts per billion
mg/kg/day—milligram per kilogram per day
NA—not available
MCL—maximum contaminant or allowable level in municipal water supplies (drinking water standard).
EMEG—environmental media evaluation guideline for noncancer health effects (based on the Agency for Toxic Substances and Disease Registry's minimal risk level).
RMEG—reference dose environmental media evaluation guideline for noncancer health effects (based on the U.S. Environmental Protection Agency's reference dose).
MRL—Agency for Toxic Substances and Disease Registry's minimal risk level: estimates of a daily human exposure to a contaminant that is unlikely to cause adverse noncancer health effects.
* Intermediate (7-365 days) exposure duration (no chronic health comparison values are available).
Typically, if a contaminant does not exceed a health comparison value, no further evaluation is warranted because health effects are not likely to occur, and dose estimates are not calculated. However, since OW-17 has multiple contaminants, doses estimates and the hazard index were calculated to account for multiple chemical exposures. If the hazard index is below 1, then noncancer health effects would not be expected.
OW-7: The level of MTBE is below health comparison values and the MRL and should not result in noncancer adverse health effects in children or adults.
OW-24: The dose estimated dose for methylene chloride is below the MRL and should not result in noncancer or cancer adverse health effects in children or adults.
Oral cancer slope factors (mg/kg/day) used to estimate theoretical increased cancer risk: 1,1-DCA = 0.0057; 1,1-DCE = 0.60; methylene chloride = 0.0075; PCE = 0.051; and TCE = 0.015 (64).
Dose calculation: [(contaminant concentration milligram per liter - maximum detection used)(intake rate = 1 liter/day child, 2 liters/day adult)(exposure frequency = 350 days/year)(exposure duration = 30 years adult, 18 years child)/(body weight = 36 kg child, 71.9 kg adult)(averaging time = exposure duration x 365 days)] (31, 43). Child's body weight average of 6 months–19 years of age (31). Adult body weight average of the 50th percentile for females and males (31).

Table 3. Detections of Total Petroleum Hydrocarbons as Diesel in Private Wells and Noncancer Health Effects Evaluation Using Hydrocarbon Fraction Approach, Remco Site, Willits, California

Private Well Name	Date(s) of Detection	Level Detected (ppb)	C9-C18 Aliphatic Fraction Dose Estimate (mg/kg/day)	C11-C22 Aromatic Fraction Dose Estimate (mg/kg/day)
Private Well OW-1	1/17/98	3400	0.04_{child} 0.04_{adult}	0.05_{child} 0.05_{adult}
Private Well OW-5	12/18/97	200	0.002_{child} 0.002_{adult}	0.003_{child} 0.003_{adult}
Reference Dose (RfD)			0.1	0.03

Data source (4)
ppb—parts per billion
mg/kg/day—milligram per kilogram per day
Reference dose (RfD) for C9-C18 aliphatic hydrocarbons derived by Massachusetts Department of Environmental Protection (18).
RfD for C11-C22 aromatic hydrocarbons represented by RfD for pyrene (18, 19).
Dose calculated based on hydrocarbon fraction (C9-C18 = 40%) (C11-C22 = 60%) [(highest level detected)(fraction (%))(intake rate= 1 liter/day child, 2 liters/day adult)(exposure frequency = 350 days/year)(exposure duration = 30 years of exposure adult, 18 years child)/(body weight = 36 kg child, 71.9 kg adult)(averaging time = exposure duration x 365 days)] (31, 43). Child's body weight average of 6 months-19 years of age (31). Adult body weight average of the 50^{th} percentile for females and males (31).

Table 4. Volatile Organic Chemicals (VOCs) Detected in Indoor Air in Residences on the South Side of Franklin Avenue and Health Comparison Values, Remco Site, Willits California

Chemical/VOC	Sample Location and Level Detected ($\mu g/m^3$)			Health Comparison Values ($\mu g/m^3$)	Range of VOCs Detected in Other Indoor Air Studies (24) ($\mu g/m^3$)
	Willits Trust Property (67 Franklin Avenue)	Willits Trust Property (61 Franklin Avenue)	Willits Trust Property (71 Franklin Avenue)		
Benzene	1.3 (living room) 1.7 (bedroom) 0.48 (crawl space)	0.54 (central hallway)	2.2 (living room)	60 (REL) 0.10 (CREG) 159 (MRL)	2 - 29
Ethyl benzene	0.66 (living room) 0.67 (bedroom) 0.16 (crawl space)	0.19 (central hallway)	1.1 (living room)	1.7 (PRG*) 2,000 (REL) 4,335 (MRL)	2.2 - 35
Trichloroethylene (TCE)	0.037 (living room) 0.096 (bedroom) <0.026 (crawl space)	0.12 (central hallway)	0.049 (living room)	538 (MRL) 600 (REL) 0.017 (PRG*)	1 - 20
1,1,1-Trichloroethane (TCA)	0.42 (living room) 0.38 (bedroom) <0.18 (crawl space)	<0.19 (central hallway)	<0.19 (living room)	1,000 (PRG)	2 - 20
Toluene	1.3 (living room) 1.7 (bedroom) 0.48 (crawl space)	0.89 (central hallway)	6.4 (living room)	300 (REL) 400 (PRG)	2 - 150
m/p Xylenes	1.9 (living room) 1.9 (bedroom) 0.53 (crawl space)	0.56 (central hallway)	2.1 (living room)	700 (REL) – based on total xylenes	2.6 - 94 (total xylenes)
o-Xylenes	0.60 (living room) 0.74 (bedroom) 0.22 (crawl space)	0.20 (central hallway)	0.80 (living room)	700 (REL) – based on total xylenes	2.6 - 94 (total xylenes)

Data source (23)

REL—Office of Environmental Health Hazard Assessment's reference exposure level (estimates of a daily human exposure to a contaminant that is unlikely to cause adverse noncancer health effects)

MRL—Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (estimates of a daily human exposure to a contaminant that is unlikely to cause adverse noncancer health effects)

PRG* —U.S. Environmental Protection Agency's preliminary remedial goal level (based on 1 in 1,000, 000 increased cancer risk). The PRG for TCE is based on a cancer potency factor that has been withdrawn by the USEPA.

CREG— ATSDR's cancer risk evaluation guide (based on 1 in 1,000,000 increased cancer risk)

Table 5. Summary of Metals Detected in Blackberry and Plum Samples and Health Effects Evaluation, Remco Site, Willits, California

Chemical	Range of Levels Detected in Blackberries Collected at Northern Boundary of Remco (mg/kg)	Range of Levels Detected in Blackberries Collected Near the South Drainage Ditch* (mg/kg)	Range of Levels Detected in Blackberries Purchased at a Grocery Store* (mg/kg)	Range of Levels Detected in Plums Collected at Northern Boundary of Remco (mg/kg)	Range of Levels Detected in Plums Purchased at a Grocery Store* (mg/kg)	Adult Dose Estimates for Blackberries (mg/kg/day)	Adult Dose Estimates for Plums (mg/kg/day)	Health Comparison Value (Source) (mg/kg/day)
Aluminum	<8-15	<16-48	<16-23	5.9-16	ND	0.00001	0.00001	NA
Barium	5.6-7.4	8-23	9.9-19	1.6-7.0	2.6-3.2	0.000005	0.000006	0.07 (RfD)
Hexavalent chromium	0.34-0.62	<0.04-0.67	0.32-0.75	0.20-0.62	0.31-0.80	0.0000001	0.0000005	0.003 (RfD)
Total chromium	0.23-0.35	0.23- 0.98	0.30-0.60	0.14-0.21	0.25-0.69	0.0000002	0.0000002	1.5 (RfD)
Copper	4.8-5.2	4.8-<45	4.9-6.9	2.5-5.8	<5.1-6.5	0.000001	0.000005	0.03 (Int. MRL)
Lead†	0.15-0.19	0.03-0.22	0.11-0.27	0.01-0.09	0.03-0.16	____	____	NA
Manganese	14-15	14-87	21-80	3.1-6.0	<0.07-18	0.00002	0.00005	0.14 (RfD)
Molybdenum	0.11-0.16	0.06-0.35	0.06-0.54	0.01	ND	0.00000007	0.000000008	0.005 (RfD)
Silver	ND	0.02-0.18	0.01-0.02	<0.004-0.01	0.02-0.23	0.00000004	0.000000009	0.005 (RfD)
Zinc	11-13	8.5-27	13-27	5.7-9.3	11-21	0.000006	0.000007	0.3 (MRL)

Data source (4)
mg/kg/day—milligram per kilogram per day
ND—not detected
NA—not available
Samples characterized as "background." Samples collected near the south drainage ditch are considered up gradient and unaffected by the chromium contaminated groundwater plume. Dose estimates calculated for highest value in blackberries and plums collected on or adjacent to the site; results from samples obtained from the grocery store were not included in dose estimates.
MRL—Agency for Toxic Substances and Disease Registry's minimal risk level
RfD—U.S. Environmental Protection Agency's reference dose
Int. MRL—intermediate (15-365 days exposure) MRL
Trivalent chromium RfD used to evaluate total chromium.
†Lead is evaluated relative to an internal dose, not an external dose. Evaluation of lead exposure is done by estimating a blood lead level or the amount of lead present in blood, which is expressed in micrograms of lead per deciliter of blood (μg/dL). Children are considered to be the most sensitive to lead exposure. A blood lead level that exceeds 10 μg/dL is considered elevated. Ingestion of blackberries and plums near the site is consistent with background concentrations present in/on food and would not result in elevated blood lead levels in children. Exposure assumptions used in dose estimates based on USEPA guidance (assumes an adult eats 6.4 mg blackberries/kg body weight/day and 24.8 mg plums/kg-body weight/day; assumes 100% absorption (31).

Table 6. Historic Storm Drain Releases of Chromium from Remco to Baechtel Creek, Remco Site, Willits, California

Date Discharge Identified	Sample Date	Sample Location	Total Chromium (ppb or μg/L)	Hexavalent Chromium (ppb or μg/L)	Method for Identification/Discovery of Discharge
9/30/70		No data located			DFG investigator obtained statement from resident (citizen complaint).
8/4/71		No data located			Mendocino County Health Department staff inspected the creek near Remco and stated that it was yellow.
5/24/73		No data located			Mendocino County Health Department staff interviewed drillers who stated chromic acid spilled into drilled holes.
	8/7/73	Baechtel Creek below outfall	21	NA	RWQCB monitoring sample.
		Remco outfall	<20	NA	
	12/20/73	Cooling water discharge	42,500	42,500	RWQCB monitoring sample.
	1/21/74	Cooling water discharge	NA	9,600	RWQCB monitoring sample.
9/19/74		No data located			Mendocino County Health Department received citizen complaint on 9/16/74.
	5/6/77	Storm water discharge	190	NA	RWQCB monitoring sample.
8/10/81	8/10/81	Four areas of pooled water below culvert and behind Safeway	150-17,000	150-7,100	Remco reported the spill to the DFG Warden in Willits, who then contacted the RWQCB. Baechtel Creek had no stream flow, but there were areas of shallow pooled water approximately 1.5 feet deep. Pooled areas were pumped on 8/11/81.

Table 6. Historic Storm Drain Releases of Chromium from Remco to Baechtel Creek, Remco Site, Willits, California

Date Discharge Identified	Sample Date	Sample Location	Total Chromium (ppb or µg/L)	Hexavalent Chromium (ppb or µg/L)	Method for Identification/Discovery of Discharge
8/10/81	8/14/81	Resample pooled areas	<50-5,500	NA	
8/10/81	8/26/81	Pooled area (Railroad Avenue)	16	NA	RWQCB received letter from Remco on 8/20/81 reporting spill (8/10/81). Resident living on Railroad Avenue called the RWQCB on 8/24/81 regarding spill. The resident used pooled water in Baechtel Creek for irrigation and requested that it be sampled.
			30		
6/14/82	6/14/82	Pooled area adjacent to Baechtel Creek	210,000	NA	Railroad Avenue resident notified the RWQCB of the spill (discolored water in creek). The pooled areas in the creek were pumped on the same day the spill was identified (6/14/82).
		Baechtel Creek above discharge	100	NA	
		Baechtel Creek 200 feet below discharge	600	NA	
		Baechtel Creek discharge (exact location not specified)	310,000	NA	
10/24/85	10/7/85	Baechtel Creek	280	NA	September monitoring report submitted to the RWQCB by Remco. The RWQCB sent letter to Remco stating chromium levels were in violation of effluent discharge limits.

Data source (5, 6, 32-41)
µg/L—microgram per liter
DFG—California Department of Fish and Game
NA—not analyzed
RWQCB—Regional Water Quality Control Board

Table 7. Volatile Organic Chemicals (VOCs) Detected in Storm Water Samples During Remco Operations (1991–1995) and Health Comparison Values, Remco Site, Willits, California

Chemical	Results from Sampling Locations Along the Storm Drain (SWR*, SWD1-SWD6, C1, C2) (ppb or μg/L)	Results from Sampling at the Remco Discharge Location (SWD7) (ppb or μg/L)	Results from Sampling at the Baechtel Creek Outfall Location	Health Comparison Values (Source) (ppb or μg/L)
1,1,1-Trichloroethane (TCA)	120*, 27*, 3.2*, 65*, 46*, 5.3, 3.5, 10, 1.2 (Average = 13.5)	4, 21, 67, 31, 20, 8.6, 1.4, 5, 19, 54, 58, 2.2, 19, 1.5, 50, 4.3, 120, 2.8, 34, 46, 2.2, 1, 2.5, 16, 7 (Average = 20.0)	0.9	200 (MCL)
1,1-Dichloroethane (DCA)	**12***, 2.6, **24***, **40***, 3.4, 1.8, 3.7, 0.4 (Average = 4.5)	0.7, **9.7**, **5**, 3.1, 1.3, 3.8, **13**, **14**, **5.4**, **12**, 1.1, 22, 1.2, **12**, **32**, 0.9, 2.4, 1.2, 2.9, **15**, 3.9 **(Average = 5.5)**	0.8	5 (MCL)
1,1-Dichloroethylene (DCE)	20*, 30*, 35*,5* (Average = 4.7)	8.9, 4.8, 2.8, 0.8, 10, 14, 2.3, 8.7, 0.6, 14, 10, 20, 0.9, 8.1, 1.7 (Average = 3.7)	<0.4	90 $EMEG_{child}$ 300 $EMEG_{adult}$
cis-1,2-Dichloroethylene (DCE)	25*, 49*,5*, 0.6*, 50* (Average = 6.7)	23, 12, 6, 3.6, 0.5, 3.5, 20, 33, 7.1, 19, 1.3, 31, 19, (Average = 6.1)	NA	3,000 $EMEG_{child}$ 10,00 $EMEG_{adult}$
Tetrachloroethylene (PCE)	48*, 1*, 34*, 0.6*, 1.2, 13, 3.6 (Average = 5.2)	0.6, 9.6, 38, 12, 7.6, 5.2, 1.1, 3.5, 31, 44, 9, 38, 3, 89, 5.7, 30, 85, 2, 3.9, 2, 3.9, 22, 5.9 (Average = 15.1)	3.2	100 $RMEG_{child}$ 400 $RMEG_{adult}$
Trichloroethylene (TCE)	**19***, **7.5***, **10***, **23***, 0.4 (Average = 3.2)	2.2, **9.7**, 3.5, 2.8, 2.2, 2.1, **12**, **14**, **5.2**, **14**, 1.6, **7.6**, 2.7 (Average = 2.8)	<0.4	5 (MCL)

Data (4)
See Figure 3 for sampling locations.
ppb—parts per billion; μg/L—microgram per liter
SWR—storm water runoff (no sampling location identified). *Results correspond to sampling locations C1and C2. There are no historical maps showing the actual sample location; assumption that samples collected along storm drain system corresponding to SWD1 and SWD2 (T. James, Montgomery Watson personal communication March 5, 2002). Only detected values are reported in table. We used ½ the detection limit for results reported under the detection limit in deriving the average.
MCL—maximum contaminant level allowed in drinking water; EMEG—environmental media evaluation guideline for noncancer health effects (based on the Agency for Toxic Substances and Disease Registry minimal risk level); RMEG—reference dose media evaluation guide for noncancer health effects (based on the U.S. Environmental Protection Agency's reference dose)
Bold values indicate level exceeds health comparison value. Exposure not likely at locations along the storm drain (SWR, SWD1-SWD6, C1, C2), because these locations are on site and not accessible to the public.
NA—not analyzed

Table 8. Volatile Organic Chemicals (VOCs) Detected in Surface Water and Storm Water Samples (1996–2004) Collected After Remco Closed and Health Comparison Values, Remco Site, Willits, California

Chemical	Results from Sampling Locations Along the Storm Drain (SWR*, SWD1-SWD6, SW-8) (ppb or µg/L)	Results from Sampling at the Remco Discharge Location and in Baechtel Creek (SW01-SW05, SDD2, SWD7, SWD9, RW1, RW2) (ppb or µg/L)	Health Comparison Values (Source) (ppb or µg/L)
1,1,1-Trichloroethane (TCA)	34, 5.7, 2.7, 16.9, 33, 5.3, 15.9, 0.5, 1.8, 1.3, 1.1, 1.1 (Average = 9.9)	2.2, 1, 2.5, 2.5, 1.4, 18, 4.1, 6.7, 9.4, 1.1, 1.5, 0.5, 0.5, 0.5 (Average = 3.5)	200 (MCL)
1,1-Dichloroethane (DCA)	0.6, 0.6, 5, 1.5, 2.5, 5, 1.5, 2.4, 0.8, 0.8, 0.6, 0.6, 0.7, 1.4, 1.0, 0.9, 0.8 (Average = 1.6)	0.9, 2.4, 1.2, 0.5, 3, 13, 0.5, 1.4, 0.7, 0.5, 0.6 (Average = 2.4)	5 (MCL)
1,1-Dichloroethylene (DCE)	3, 0.8, 1.1, 3, 0.8, 1 (Average = 0.6)	1, 0.5, 0.6, (Average = 0.3)	90 EMEG $_{child}$ 300 EMEG $_{adult}$
cis-1,2-Dichloroethylene (DCE)	0.8, 0.9, 5, 2.8, 0.8, 4.3, 5, 3, 4, 0.8, 0.6, 0.6, 0.6, 0.8, 0.6, 0.6, 0.6 (Average = 1.8)	3, 3, 1.1, 2.3, 0.9, 0.6, 1.0, 0.8 (Average = 1.6)	3,000 EMEG $_{child}$ 10,00 EMEG $_{adult}$
1,2,4-Trimethylbenzene	0.7, 1.3, 0.8, 0.7 (Average = 0.3)	0.8, 0.6, (Average = 0.3)	12 (PRG)
Acetone	11.6, 10.9, 11.7, 30.5, 10.4 (Average = 32)	18.4, 10.9, 11.3 (Average = 6.6)	9,000 RMEG $_{child}$ 30,000 RMEG $_{adult}$
Methylene chloride	0.6 (Average = 0.3)	ND above MDL	600 EMEG $_{child}$ 2,000 EMEG $_{adult}$
Methyl-T-Butyl Ether (MTBE)	ND above MDL	0.8, 0.6, 2.7, 0.6, 0.6 (Average = 1.0)	3,000 EMEG $_{child}$ 10,000 EMEG $_{adult}$ 13 (MCL)
Tetrachloroethylene (PCE)	8*, 4.4, 1.7, 1.9, 1.6, 0.8, 1.8, 31, 28.6, 4.8, 26.7, 1.6, 30, 26.3, 25.2, 0.6, 1.3, 0.6, 0.5, 0.5, 0.8 (Average = 9.5)	2, 3.9, 2, 0.8, 0.8, 0.6, 0.7, 1.0, 0.6 (Average = 1.4)	100 RMEG $_{child}$ 400 RMEG $_{adult}$
Trichloroethylene (TCE)	5, 2.4, 0.6, 3.1, 5, 2.3, 3 (Average = 0.9)	3, 2.1, 0.7, 1.6, 0.6 (Average = 0.6)	5 (MCL)

Data source (4, 44-46). See Figure 3 for sampling locations.
ppb—parts per billion; µg/L—microgram per liter
SWR—storm water runoff (no sampling location identified). *Results correspond to sampling locations SWD1-SWD6. There are no historical maps showing the actual sample location; assumption that samples collected along storm drain system (T. James, Montgomery Watson personal communication March 5, 2002). Table indicates total number of samples collected between 1996 and 2001 at the locations identified in the table. Only detected values are reported. We used ½ the detection limit for results reported under the minimum detection limit (MDL) in deriving the average. The average was estimated only for volatile organic chemicals positively detected in at least one sample).
MCL—maximum contaminant level allowed in drinking water; EMEG—environmental media evaluation guideline for noncancer health effects (based on the Agency for Toxic Substances and Disease Registry's minimal risk level); RMEG—reference dose media evaluation guide for noncancer health effects (based on the U.S. Environmental Protection Agency's reference dose); PRG—U.S. Environmental Protection Agency's preliminary remedial goal; ND—not detected
Bold values indicate level exceeds health comparison value for children or MCL. Exposures not likely at locations along the storm drain (SWR, SWD, SWD1-SWD6), because locations are on site and not accessible to the public.

Table 9. Total and Hexavalent Chromium Detected in Storm Water Samples Collected During Remco Operations (1991–1995) and Health Comparison Values, Remco, Willits, California

Chemical	**Detections from Sampling Locations Along the Storm Drain (SWR*, SWD1-SWD6,) (ppb or µg/L)**	**Detections from Sampling at the Remco Discharge Location (SWD7) (ppb or µg/L)**	**Detections from Sampling at the Outfall to Baechtel Creek (SWD9) (ppb or µg/L)**	**Health Comparison Values (Source) (ppb or µg/L)**
Hexavalent chromium	60, 11 (Average = 8.0)	**40**, **90**, **270**, **40**, **280, 660**, **420, 190**, 10, 20, 6, **310, 128**, 17.9, 26, 25.1, **55.8**, **177**, **228**, 22 **(Average = 102)**	13	30 (RMEG $_{child}$) 100 (RMEG $_{adult}$)
Total chromium	10 (Average = 8.6)	70, 20, 80, 22, 220, 88, 110, 100, 10, 40, 270, 660, 490, 170, 20, 190, 340, 100, 37.7, 23.9, 57.8, 190, 137, 58 (Average = 136)	Not analyzed	20,000 (RMEG $_{child}$) 50,000 (RMEG $_{adult}$)

Data source (4)

See Figure 3 for sampling locations.

ppb—parts per billion; µg/L—microgram per liter

SWR—storm water runoff (no sampling location identified). *There are no historical maps showing the actual sample location; assumption that samples were collected along storm drain system corresponding to SWD1 and SWD2 (T. James, Montgomery Watson personal communication March 5, 2002). We used ½ the detection limit for results reported under the minimum detection limit (MDL) in deriving the average for contaminants positively detected.

RMEG—reference dose media evaluation guide (based on the U.S. Environmental Protection Agency's reference dose). No other metals were analyzed.

Bold values indicate level exceeds health comparison value for children or the maximum contaminant level allowed in drinking water. Exposures not likely at locations along the storm drain (SWR, SWD1-SWD6), because locations are on site and not accessible to the public.

Table 10. Metals Detected in Surface Water and Storm Water Samples (1996–2004) Collected After Remco Closed and Health Comparison Values, Remco Site, Willits, California

Chemical	Detections and Number of Samples Analyzed from Sampling Locations Along the Storm Drain (SWR*, SWD1-SWD6) (ppb or μg/L)	Detections from Sampling at the Remco Discharge Location (SWD7) (ppb or μg/L)	Detections from Sampling in Baechtel Creek (SW01-SW05, SWD9, SDD1, SDD2, S-09, S-10) (ppb or μg/L)	Detections from Sampling in South Drainage Ditch (SW6-SW11) (ppb or μg/L)	Health Comparison Values (Source) (ppb or μg/L)
Hexavalent chromium	9.5, 10.3, 6.1, 22.2, 9.3, 1.4, 2.8 (Average = 3.9)	16.1, 95, 9, 7.9, 8.8, 7.5, 15, 18 (Average = 11.4)	ND above MDL 10 ppb	NA	30 RMEG $_{child}$ 100 RMEG $_{adult}$
Total chromium	520, 22.3, 6.4, 17.7, 18.8, 23.2, 67, 10.2, 141, 11, 10, 922, 5.9, 9.8, 6.9, 8.1, 6.6, 11.8 (Average = 55.6)	22.8, 104, 6.1, 15.8, 21.4, 11.3, 14, 10, 10, 7.8, 5.6 (Average = 11.4)	9, 4.3, 1.7, 29, 27, 53 (Average = 10.2)	ND above MDL (10ppb)	20,000 RMEG $_{child}$ 50,000 RMEG $_{adult}$
Copper	NA	NA	18.7, 23.0, 25.9, 53.3, 14.8 (Average = 27.1)	20.6, 17.7, 21.3, 19.1, 24.2, 17.3 (Average = 20.0)	300 EMEG $_{child}$ 1,000 EMEG $_{adult}$
Total iron	806, 1690, 617 (Average = 1,037)	1,340	NA	NA	300 (NSDWR)
Lead	NA	NA	10.3	4.8	15 (CA action level)
Total manganese	15.4, 12.6, 17.1 (Average = 15.0)	57.3	NA	NA	500 RMEG $_{child}$ 2,000 RMEG $_{adult}$
Zinc	NA	NA	37.6, 171, 203, 61.3, 113 (Average = 117)	25.5, 37.6, 26.3, 34, 45.1, 51.1 (Average = 28.1)	3,000 EMEG $_{child}$ 10,000 EMEG $_{adult}$

Data source (4, 44-46)
See Figure 3 for sampling locations.
SWR—storm water runoff (no sampling location identified). *There are no historical maps showing the actual sample location; assumption that samples were collected along storm drain system corresponding to SWD1 and SWD2 (T. James, Montgomery Watson personal communication March 5, 2002). We used ½ the detection limit for results reported under the minimum detection limit (MDL) in deriving the average for contaminants positively detected; average excluded if higher than the maximum detected concentration (43).
ppb—parts per billion; μg/L—microgram per liter
ND—not detected; NA—not analyzed.
RMEG—reference dose media evaluation guide (based on the U.S. Environmental Protection Agency's reference dose); EMEG—environmental media evaluation guide (based on the Agency for Toxic Substances and Disease Registry's minimal risk level); NSDWR—national secondary drinking water regulations (based on taste and odor, not health). California action level which triggers water systems into taking treatment steps.
Exposures not likely at locations along the storm drain (SWR, SWD1-SWD6), because locations are on site and not accessible to the public.

Table 11. Total Petroleum Hydrocarbons (TPH) Detected in Storm and Surface Water (1998–2004) After Remco Closed and Health Comparison Values, Remco Site, Willits, California

Chemical	**Detections from Sampling Locations Along the Storm Drain (SWR*, SWD1-SWD6) (ppb or μg/L)**	**Detections from Sampling at the Remco Discharge Location (SWD7) (ppb or μg/L)**	**Detections from Sampling in Baechtel Creek (SW01-SW05, SWD9, SDD1, SDD2, S-09, S-10) (ppb or μg/L)**	**Detections from Sampling in South Drainage Ditch (SW6-SW11) (ppb or μg/L)**	**Health Comparison Values (Source) (ppb or μg/L)**
TPH-diesel	**617, 495, 56.6, 485, 195, 136, 254, 80.9, 115, 240, 215, 217, 166, 92.6, 194, 129, 248, 214, 196 (Average = 228)**	**1760, 311, 208**, 82.9 **126**, 14, 94, **170 (Average = 147)**	**140, 176, 159, 114, 124, 117 (Average = 110)**	99.6, **312, 114**, 64.8 (Average = 98.4)	100 (SNARL)

Data source (4, 44-46)
See Figure 3 for sampling locations.
SWR—storm water runoff (no sampling location identified). *There are no historical maps showing the actual sample location; assumption that samples were collected along storm drain system corresponding to SWD1 and SWD2 (T. James, Montgomery Watson personal communication March 5, 2002). We used ½ the detection limit for results reported below the minimum detection limit (MDL) in deriving the average for contaminants positively detected; average excluded if higher than the maximum detected concentration (43). Bolded values exceed the SNARL.
ppb—parts per billion; μg/L—microgram per liter.
SNARL—USEPA suggested no-adverse response level.

Table 12. Evaluation of Potential Ingestion and Dermal Exposure to TPH-Diesel Detected in Storm/Surface Water and Sediment (1998–2004) Using the Hydrocarbon Fraction Approach, Remco Site, Willits, California

Hydrocarbon Fraction of Diesel	Sampling Locations Along the Storm Drain (SWR*, SWD1-SWD6)	Remco Discharge Location (SWD7)	Sampling Locations in Baechtel Creek (SW01-SW05, SWD9, SDD1, SDD2, S-09, S-10)	Sampling Locations in the South Drainage Ditch (SW6-SW11)	Health Comparison Values (Source) (mg/kg/day)
	Dose Estimates (mg/kg/day)	Dose Estimates (mg/kg/day)	Dose Estimates§ (mg/kg/day)	Dose Estimates (mg/kg/day)	
C9-C18 (40%) Aliphatic hydrocarbons	0.000010 child 0.000006 adult	0.000006 child 0.000004 adult	0.000008 child 0.000005 adult	0.000004 child 0.000003 adult	0.1 (RfD)
C11-C22 (60%) Aromatic hydrocarbons	0.000012 child 0.000008 adult	0.000009 child 0.000006 adult	0.000012 child 0.000008 adult	0.000006 child 0.000004 adult	0.03 (USEPA's RfD for pyrene)

Data source (4, 44-46)
TPH—total petroleum hydrocarbons
SWR—storm water runoff (no sampling location identified). *There are no historical maps showing the actual sample location; assumption that samples were collected along storm drain system corresponding to SWD1 and SWD2 (T. James, Montgomery Watson personal communication March 5, 2002). We used ½ the detection limit for results reported below the minimum detection limit (MDL) in deriving the average for contaminants positively detected; average excluded if higher than the maximum detected concentration (43). CDHS assumed exposure to the average concentration through ingestion and dermal contact with TPH-diesel at each location shown in the table above. Exposures not likely at locations along the storm drain (SWR, SWD1-SWD6), because locations are on site and not accessible to the public.
mg/kg/day—milligram per kilogram per day
RfD—U.S. Environmental Protection Agency (USEPA) reference dose
§Dose estimates for sampling locations in Baechtel Creek include exposure to TPH-diesel in sediment (65.8 mg/kg).
Sediment dermal dose calculation: [(concentration in sediment)(adherence factor = 0.07mg/cm^2 event)(skin surface area = see below)(exposure time = 2.6 hours per/event)(exposure frequency =50 events/year) (exposure duration = 8 years of exposure)(body weight = 41.9 kg child, 71.9 kg adult)(averaging time = exposure duration x 365days = 2,920 days)] (19).
Assumptions used for dermal dose calculation: skin surface area (adult) from USEPA's Exposure Factors Handbook Tables 6-2 and 6-3 by averaging the 50th percentile for lower legs, feet, and hands of females and males with that of the forearms of males (data not supplied for women) = 5,809 cubed centimeters (cm^2). Skin surface area for a child: USEPA's Exposure Factors Handbook Tables 6-6 and 6-7 averaging the 50th percentile for total body surface area for males and females ages 8-15 multiplied by the percentage of total surface area that the legs, hands, and feet obtained from Table 6-8 = 5,323 cm^2 (31). Body weight for adults averaging the 50th percentile for females and males = 71.8 kilograms (kg) (Table 7-2, USEPA's Exposure Factors Handbook). Body weight for child averaging the 50th percentile for females and males ages 8-15 (ages most likely to play in creek) = 41.9 kg (Tables 7-6 and 7-7, USEPA's Exposure Factors Handbook) (31).
Ingestion dose calculation: [(average level detected)(intake rate = 0.05 liter/event)(exposure time = 2.6 hours/event)(exposure frequency = 350 days/year)(exposure duration = 8 years of exposure)(body weight = 41.9 kg child, 71.9 kg adult)(averaging time = exposure duration x 365days = 2,920 days)].
Surface water dermal dose calculation: [(average level detected)(permeability coefficient (Kp) = 1.2 cm^2)(skin surface area = see above)(exposure time = 2.6 hours per/event)(frequency = 50 events/year)(duration = 8 years)(conversion factor = 0.001)/(body weight)(averaging time-exposure duration x 365 days = 2,920 days)].
Note: In the absence of Kp value for diesel or hydrocarbon fractions, CDHS used the predicted Kp value for naphthalene—component of diesel (19).

Table 13. Contaminants Detected in Baechtel Creek Sediments (1997–2003) and Health Comparison Values, Remco Site, Willits, California

Contaminant	Class/Type of Contaminant	Range of Concentrations (mg/kg or ppm)	Number of Detections	Number of Samples Collected	Values (Source) (mg/kg or ppm)
Aluminum	metal	8,010-28,600	23	23	100,000 ($EMEG_{child}$) 1,000,000 ($EMEG_{adult}$)
Arsenic	metal	1.02-10.3	33	39	20 ($EMEG_{child}$) 200 ($EMEG_{adult}$)
Barium	metal	66.6-396	23	23	4,000 ($RMEG_{child}$) 50,000 ($RMEG_{adult}$)
Beryllium	metal	0.33-0.53	16	39	50 ($EMEG_{child}$) 700 ($EMEG_{adult}$)
Cadmium	metal	0.06-0.12	7	39	10 ($EMEG_{child}$) 100 ($EMEG_{adult}$)
Hexavalent chromium	metal	5.90*	1	60	200 ($RMEG_{child}$) 2,000 ($RMEG_{adult}$)
Total chromium	metal	25-110	29	52	80,000 ($RMEG_{child}$)§ 1,000,000 ($RMEG_{adult}$)§
Cobalt	metal	6.3-42.3	23	23	500 ($EMEG_{child}$) 7,000 ($EMEG_{adult}$)
Copper	metal	15.5-70.8	39	39	2,900 (Residential PRG)
Lead	metal	3.90-84.0	36	39	150 (CA Residential PRG)
Manganese	metal	384-4,100	23	23	3,000 ($RMEG_{child}$) 40,000 ($RMEG_{adult}$)
Mercury	metal	0.019-0.195	12	39	2.3 (Residential PRG)
Molybdenum	metal	0.10-0.53	16	23	300 ($RMEG_{child}$) 4,000 ($RMEG_{adult}$)
Nickel	metal	35.1-88.6	39	39	1,000 ($RMEG_{child}$) 10,000 ($RMEG_{adult}$)
Selenium	metal	0.505-0.764	10	39	300 ($EMEG_{child}$) 4,000 ($EMEG_{adult}$)
Vanadium	metal	22.1-84.3	23	23	200 ($EMEG_{child}$) 2,000 ($EMEG_{adult}$)
Zinc	metal	32.8-206	39	39	20,000 ($EMEG_{child}$) 200,000 ($EMEG_{adult}$)
Anthracene	PAH	0.011-0.014	2	23	20,000 ($RMEG_{child}$) 200,000 ($RMEG_{adult}$)

Table 13. Contaminants Detected in Baechtel Creek Sediments (1997–2003) and Health Comparison Values, Remco Site, Willits, California

Contaminant	Class/Type of Contaminant	Range of Concentrations (mg/kg or ppm)	Number of Detections	Number of Samples Collected	Health Comparison Values (Source) (mg/kg or ppm)
Fluoranthene	PAH	0.01-0.17	10	31	2,000 (RMEG $_{child}$) 30,000 (RMEG $_{adult}$)
Naphthalene	PAH	0.01-0.20	9	23	1,000 (RMEG $_{child}$) 10,000 (RMEG $_{adult}$)
Phenanthrene	PAH	0.010-0.087	13	23	20,000 (RMEG $_{child}$) 200,000 (RMEG $_{adult}$)
TPH-diesel	TPH	2.6-65.8	13	29	Not available
Acetone	VOC	0.048	1	23	20,000 (RMEG $_{child}$) 1,000,000 (EMEG $_{adult}$)
Toluene	VOC	0.021	1	23	1,000 (EMEG $_{child}$) 10,000 (EMEG $_{adult}$)

Data source (7, 65)
mg/kg—milligram per kilogram; ppm—parts per million
EMEG—environmental media evaluation guideline for noncancer health effects (based on the Agency for Toxic Substances and Disease Registry's minimal risk level)
RMEG—reference dose media evaluation guide for noncancer health effects (based on U.S Environmental Protection Agency's reference dose)
PRG—U.S. Environmental Protection Agency's preliminary remedial goal
* Data quality is questionable since results could not be replicated in additional sampling efforts.
§ Health comparison value for trivalent chromium; none available for total chromium (total chromium comprised predominantly of trivalent chromium).
PAH—polycyclic aromatic hydrocarbon; TPH—total petroleum hydrocarbon; VOC—volatile organic chemical
NA—not available

Table 14. Summary of Off-Site Surface and Near Surface Soil Data Collected Near the Remco Site (1998–2002), Willits, California

Sample Location and Depth (bgs)	SB175-SB184, SS5-SS17, SS19-SS23, SS25, SS26, SB 239, SB 240, SB 242, SB 246, SB 247 0-0.5 ft	SB113-SB117, SB129, SB130, SB181-SB184, SB 239, SB 240, SB 242, SB 246, SB 247, SBB1, SBB2 1 ft	SB54, SB55, SB65-SB68, SB101-SB106, SB109, SBB1 SBB2, W37A 2.5-3 ft	Health Comparison Value (Source)
Contaminant	**Range of Levels (Average) (mg/kg or ppm)**	**Range of Levels (Average) (mg/kg or ppm)**	**Range of Levels (Average) (mg/kg or ppm)**	**Range of Background (Bkgd) Metal Concentrations (Average) (mg/kg or ppm)**
Aluminum	11,000-16,000 (12,600)	12,000-14,000 (14,028)	16,200-18,300 (17,250)	100,000 (EMEG $_{child}$) Bkgd = 10,000-300,000 (71,000)
Antimony	0.51-1.27 (0.81)	Not detected above MDL	Not detected above MDL	20 (EMEG $_{child}$) Bkgd = 0.15-1.95 (0.60)
Arsenic	<1-44 (6.46)	3.0-6.2 (4.4)	3.28-6.67 (4.67)	20 (EMEG $_{child}$), 0.5 (CREG) Bkgd = 0.6-11 (3.5)
Barium	110-240 (154)	130-208 (156)	151-238 (194)	4,000 (RMEG $_{child}$) Bkgd = 133-1,400 (509)
Beryllium	0.26-0.48 (0.39)	0.32-0.60 (0.44)	0.36-0.70 (0.45)	50 (EMEG $_{child}$) Bkgd = 0.25-2.7 (1.3)
Cadmium	<0.09-1.92 (0.43)	<0.08-0.70 (0.24)	<0.05-0.90 (0.27)	10 (EMEG $_{child}$) Bkgd = 0.05-1.7 (0.36)
Cobalt	10.0-17.0 (12.4)	10.0-14.0 (12.0)	11.0-13.0 (13.0)	500 (EMEG $_{child}$) Bkgd = 2.7-46 (14.9)
Hexavalent chromium	<0.03-0.15 (0.04)	<0.03-0.41 (0.06)	<0.01-1.10 (0.21)	200 (RMEG $_{child}$) Bkgd = NA
Total chromium	13.9-132 (52.9)	38.6-80.0 (61.1)	35.7-101 (62.5)	80,000 (RMEG $_{child}$) Bkgd = 23-1,579 (122)
Copper	18.5-170 (38.2)	18.2-31.0 (22.7)	10.9-32.4 (22.0)	2,900 (Residential PRG) Bkgd = 9.1-96.4 (28.7)
Mercury	0.02-0.18 (0.07)	<0.02-0.06 (0.04)	<0.05-0.054 (0.034)	2.3 (Residential PRG) Bkgd = 0.10-0.90 (0.26)
Manganese	320-580 (441)	430-596 (476)	455-510 (482)	3,000 (RMEG $_{child}$) Bkgd = 253-1,687 (646)
Nickel	12.9-81.0 (50.7)	35.7-65.0 (58.6)	28.6-119 (65.8)	1,000 (RMEG $_{child}$) Bkgd = 9-509 (57)
Lead	4.40-857 (86.2)	3.20-93.2 (21.8)	4.61-11.6 (7.71)	150 (Residential PRG) Bkgd = 12.4-97.1 (23.9)
Selenium	0.54-0.79 (0.66)	0.54-0.77 (0.70)	ND above MDL	300 (EMEG $_{child}$) Bkgd = 0.02-0.43 (0.06)
Vanadium	32-42 (37)	35.0-48.5 (40.7)	49.8-52.7 (51.5)	200 (EMEG $_{child}$) Bkgd = 39-288 (112)
Zinc	61.0-810 (159)	47.0-94.7 (66.2)	26.8-57.6 (44.5)	20,000 (EMEG $_{child}$) Bkgd = 88-236 (149)

Table 14. Summary of Off-Site Surface and Near Surface Soil Data Collected Near the Remco Site (1998–2002), Willits, California

Sample Location and Depth (bgs)	**SB113-SB117, SB129, SB130, (SS34, SS35, SB142 Fence Line) 0-2 ft**	**SB25, SB54, SB55, SB66, SB104-SB106, SB109, SB129, (SB142, W37A Fence Line) 2-3 ft**	**Health Comparison Value (Source) (mg/kg or ppm)**
VOCs	**Range of Levels (Average) (mg/kg or ppm)**	**Range of Levels (Average) (mg/kg or ppm)**	
All VOCs	<0.005-<0.02 (except for the ones indicated below)	<0.005-<0.02 (except for the ones indicated below)	——
2-Butanone (MEK)	0.01-0.02 (0.009)	<0.005-<0.02	30,000 ($RMEG_{child}$)
Acetone	0.10 (0.02)	<0.005-<0.02	20,000 ($RMEG_{child}$)
Toluene	<0.005-<0.02	0.01 (0.005)	1,000 ($EMEG_{child}$)
TPHs			
TPH-diesel	<5-117 (43.2)	<5-892* (22.0)	Not available
TPH-gasoline (limited sampling)	Not analyzed	<1-314*	Not available
PAHs			
All PAHs	Not analyzed	Not detected above MDL (<0.017-<0.660)	acenaphthene-3,000 ($RMEG_{child}$)

Data source (4, 12, 48, 66)
bgs—below ground surface; ft—feet; mg/kg—milligram per kilogram; ppm—parts per million; ppb—parts per billion
EMEG—Environmental Media Evaluation Guide (based on the Agency for Toxic Substances and Disease Registry's minimal risk level); CREG—Cancer Risk Evaluation Guide; RMEG—Reference Dose Evaluation Guide (based on the U.S. Environmental Protection Agency's reference dose); PRG—U.S. Environmental Protection Agency's Preliminary Remediation Guide
VOC—volatile organic chemical; TPH-total petroleum hydrocarbons; PAH-polycyclic aromatic hydrocarbons

Sampling data and background presented as ranges followed by the average in parentheses (mg/kg or ppm). All samples were analyzed for hexavalent chromium and total chromium (SB113-117 hexavalent chromium analysis only), and a limited number of analyses were performed for other metals (number of samples indicated in the table). We used ½ the detection limit for detections reported below the minimum detection limit (MDL).

* Samples located on site at fence line were not used in calculating average for off-site soil. High MDL (660 ppb) for acenaphthylene, other PAHs MDL <34 ppb.

Table 15. Summary of Soil Samples Collected at Baechtel Grove Middle School, Blosser Lane Elementary School, and the Future Boys and Girls Club (2001), Remco Site, Willits, California

Sample Location and Depth (bgs)	**RWQCB Samples B1-B4, BGSS1-BGSS14, BAGSS1-BAGSS6 0-0.5 ft**	**RWQCB Samples B1-B4, BGSS1-BGSS14, BAGSS1-BAGSS6 0.5-1 ft**	**Health Comparison Value (Source) Background (Bkgd) Metal Concentrations (mg/kg or ppm)**
Metals	**Range of Levels (Average) (mg/kg or ppm)**	**Range of Levels (Average) (mg/kg or ppm**	
Arsenic	Not detected above MDL	Not detected above MDL	20 (EMEG $_{child}$) 0.5 (CREG) Bkgd = 0.6-11 (3.5)
Cadmium	Not detected above MDL	Not detected above MDL	10 (EMEG $_{child}$) Bkgd = 0.05-1.7 (0.36)
Copper	13-50 (31)	14-38 (24)	2,900 (Residential PRG) Bkgd = 9.1-96.4 (28.7)
Mercury	<0.019-0.35 (0.050)	<0.021-0.18 (0.048)	2.3 (Residential PRG) Bkgd = 0.10-0.90 (0.26)
Lead	<6.8-47 (11)	<7.0-17 (9.6)	150 (Residential PRG) Bkgd = 12.4-97.1 (23.9)
Nickel	28-73 (48)	28-67 (48)	1,000 (REMEG $_{child}$) Bkgd = 9-509 (57)
Zinc	43-160 (66)	39-110 (58)	20,000 (EMEG $_{child}$) Bkgd = 88-236 (149)
Hexavalent chromium	Not detected above MDL	Not detected above MDL	200 (RMEG $_{child}$) Bkgd = Not available
Total chromium	31-87 (44)	31-64 (46)	80,000 (RMEG $_{child}$) Bkgd = 23-1,579 (122)

Sample Location and Depth (bgs)	**RWQCB Samples B6 3-3.5 ft**	**RWQCB Samples B1, B2, B4/B3, B6-B8, B10, B110 -1ft/>3ft**	**Health Comparison Value (Source) (mg/kg or ppm)**
VOCs and TPH	**Range of Levels (Average) (mg/kg or ppm**	**Range of Levels (Average) (mg/kg or ppm**	
All VOCs	<0.005		_____
2-Butanone (MEK)	<0.005		30,000 (RMEG $_{child}$)
Acetone	<0.005		20,000 (RMEG $_{child}$)
Toluene	<0.005		1,000 (EMEG $_{child}$)
TPH-diesel		<5-12/<5-74 (6.2)/(17)	Not available
TPH-gasoline (limited sampling)		<1.3/<1.2	Not available

Data source (51)
bgs—below ground surface; ft—feet; mg/kg—milligram per kilogram; ppm—parts per million
EMEG—Environmental Media Evaluation Guide (based on the Agency for Toxic Substances and Disease Registry's minimal risk level); CREG—Cancer Risk Evaluation Guide; RMEG—Reference Dose Evaluation Guide (based on U.S. Environmental Protection Agency's reference dose); PRG—U.S. Environmental Protection Agency's Preliminary Remediation Guide; VOC—volatile organic chemical; TPH-total petroleum hydrocarbons
Sampling data and background presented as ranges followed by the average in parentheses (mg/kg or ppm). All samples were analyzed for hexavalent chromium and total chromium, and a limited number of analyses were performed for other metals (number of samples indicated in the table). We used ½ the detection limit for detections reported below the minimum detection limit (MDL).

Table 16. Summary of Off-Site Surface and Near Surface Soil Collected in the Willits Community, Remco Site, Willits, California

Sample Location and Depth (bgs)	1 ft	0-3 inches	3-6 inches	Background (Bkgd) Metal Concentrations (mg/kg or ppm)
Chemical	**Range of Levels (mg/kg or ppm)**	**Range of Levels (mg/kg or ppm)**	**Range of Levels (mg/kg or ppm)**	
Aluminum	6,500-27,000 (13,526)	Not analyzed	Not analyzed	100,000 (EMEG $_{child}$) Bkgd = 10,000-300,000 (71,000)
Antimony	0.11-0.22 (0.17)	Not analyzed	Not analyzed	20 (EMEG $_{child}$) Bkgd = 0.15-1.95 (0.60)
Arsenic	2.8-12 (6.6)	Not detected above MDL (<10)	<8.6-12 (6.0)	20 (EMEG $_{child}$), 0.5 (CREG) Bkgd = 0.6-11 (3.5)
Barium	50-190 (112)	Not analyzed	Not analyzed	4,000 (RMEG $_{child}$) Bkgd =
Beryllium	0.22-0.42 (0.35)	Not analyzed	Not analyzed	50 (EMEG $_{child}$) Bkgd = 0.25-2.7 (1.3)
Cadmium	Not detected above MDL (<0.05)	Not detected above MDL (<0.90)	Not detected above MDL (<0.90)	10 (EMEG $_{child}$) Bkgd = 0.05-1.7 (0.36)
Cobalt	8.1-16 (12)	Not analyzed	Not analyzed	500 (EMEG $_{child}$) Bkgd = 2.7-46 (14.9)
Hexavalent chromium	Not detected above MDL (<0.10)	Not detected above MDL (<0.05)	Not detected above MDL (<0.05)	200 (RMEG $_{child}$) Bkgd = Not available
Total chromium	30-73 (49)	32-53 (48)	32 – 55 (47)	80,000 (RMEG $_{child}$) Bkgd = 23-1,579 (122)
Copper	11-44 (22)	26-40 (32)	21 – 36 (28)	2,900 (Residential PRG) Bkgd = 9.1-96.4 (28.7)
Mercury	0.03-0.52 (0.12)	Not analyzed	Not analyzed	2.3 (Residential PRG) Bkgd = 0.10-0.90 (0.26)
Manganese	260-1,000 (525.3)	Not analyzed	Not analyzed	3,000 (RMEG $_{child}$) Bkgd = 253-1,687 (646)
Molybdenum	<0.55-1.2 (0.57)	Not analyzed	Not analyzed	300 (RMEG $_{child}$) Bkgd = 0.1-9.6 (1.3)
Nickel	35-130 (64)	26-71 (48)	28-74 (51)	1,000 (RMEG $_{child}$) Bkgd = 9-509 (57)
Lead	5-45 (13)	10-60 (28)	7.7-58 (24)	150 (Residential PRG) Bkgd = 12.4-97.1 (23.9)
Vanadium	25-59 (40)	Not analyzed	Not analyzed	200 (EMEG $_{child}$) Bkgd = 39-288 (112)
Zinc	28-74 (50)	47-120 (74.8)	44-90 (67)	20,000 (EMEG $_{child}$) Bkgd = 88-236 (149)

Data source (52, 67)

bgs—below ground surface; ft—feet; mg/kg—milligram per kilogram; ppm—parts per million; EMEG—Environmental Media Evaluation Guide (based on the Agency for Toxic Substances and Disease Registry's minimal risk level); CREG—Cancer Risk Evaluation Guide; RMEG—Reference Dose Evaluation Guide (based on U.S. Environmental Protection Agency's reference dose); PRG—U.S. Environmental Protection Agency's Preliminary Remediation Guide. Sampling data and background presented as ranges followed by the average in parentheses (mg/kg or ppm). We used ½ the detection limit for results reported below the minimum detection limit (MDL). Background soil data (51).

Table 17. Volatile Organic Chemicals (VOCs) Detected During the Removal of On-Site PCE (DNAPL) Soils (2003), Remco Site, Willits, California

VOC	VOCs Detected in Perimeter Air Monitoring Stations During Site Prep (9/8/03–9/12/03) (µg/m^3)	VOCs Detected in Perimeter Air Monitoring Stations During Soil Excavation (9/13/03–9/30/03) (µg/m^3)	Monitoring Stations During Demobilization, Soil Off-Hauling, and Paving (10/01/03–10/31/03) (µg/m^3)	Health Comparison Value (Source) (µg/m^3)
Benzene	Station 5: 4.2	Not detected	Station 3: 3.6, 5.3 Station 4: 3.2 Station 5: 3.9	159 (Acute MRL)
2- Butanone	Not detected	Not detected	Station 1: 17 Station 4: 19 Station 5: 30, 70 Station 6: 210	5,000 (RfC)
PCE	Not detected	Station 2: 16 Station 3: 9.7 Station 5: 9.9	Station 5: 6.2	1,357 (Acute MRL)

Data source (57)
PCE—Tetrachloroethylene
DNAPL—dense non-aqueous phase liquid
µg/m^3—micrograms per cubic meter
Acute exposure: 1-14 days
MRL—Agency for Toxic Substances and Disease Registry's minimal risk level
RfC—U.S. Environmental Protection Agency's reference concentration (noncancer)

Table 18. Mendocino County Census Tract 0107000—Observed vs. Expected Cancer Incidence (Invasive Only) at Selected Sites, Both Sexes and All Races Combined, 1988–2000, Remco Site, Willits, California

Cancer Site	Time Period	Observed Cases	99% Confidence Range (around the observed)	Expected Cases
All Cancer Sites Combined				
	1988–1995	230	192.6-271.8	213.3
	1996–2000	133	105.0-165.5	156.6
	1988–2000	363	315.6-414.8	369.8
I. All respiratory cancers (including lung, nasal cavity, middle ear, accessory sinus, larynx, pleura, trachea, mediastinum, and other respiratory)				
	1988–1995	49	32.6-69.9	39.5
	1996–2000	28	16.0-44.5	26.1
	1988–2000	77	56.1-102.4	65.6
a. Lung				
	1988–1995	47	31.0-67.5	36.5
	1996–2000	26	14.5-42.0	24.3
	1988–2000	73	52.7-97.8	60.8
b. Nasal cavity/Middle ear/accessory sinus				
	1988–1995	0	-	<5
	1996–2000	0	-	<5
	1988–2000	0	-	<5
II. Prostate				
	1988–1995	20	10.1-34.5	26.7
	1996–2000	15	6.7-28.0	21.4
	1988–2000	35	21.4-53.1	48.1
III. Lymphomas (Hodgkin's Disease and non-Hodgkin's lymphomas)				
	1988–1995	15	6.7-28.0	9.3
	1996–2000	7	1.8-16.9	6.8
	1988–2000	22	11.6-37.0	16.1
a. Hodgkin's Disease				
	1988–1995	<5	-	<5
	1996–2000	<5	-	<5
	1988–2000	<5	-	<5
IV. Leukemia (all subtypes)				
	1988–1995	7	1.8-16.9	5.2
	1996–2000	0	-	<5
	1988–2000	7	1.8-16.9	9.1
V. Bone				
	1988–1995	0	-	<5

Table 18. Mendocino County Census Tract 0107000—Observed vs. Expected Cancer Incidence (Invasive Only) at Selected Sites, Both Sexes and All Races Combined, 1988–2000, Remco Site, Willits, California

Cancer Site	Time Period	Observed Cases	99% Confidence Range (around the observed)	Expected Cases
	1996–2000	0	-	<5
	1988–2000	0	-	<5
VI. Stomach				
	1988–1995	<5	-	<5
	1996–2000	<5	-	<5
	1988–2000	5	0.9-14.0	5.84
VII. All Urinary Tract (includes urinary bladder, kidney, ureter, and other urinary)				
	1988–1995	19	9.4-33.2	11.8
	1996–2000	6	1.4-15.5	8.3
	1988–2000	25	13.8-40.8	20.1
a. Urinary bladder				
	1988–1995	14	6.0-26.6	7.1
	1996–2000	5	0.9-14.0	4.6
	1988–2000	19	9.4-33.2	11.7
b. Kidney				
	1988–1995	5	-	<5
	1996–2000	<5	-	<5
	1988–2000	6	1.4-15.5	7.8
VIII. Testes				
	1988–1995	0	-	<5
	1996–2000	<5	-	<5
	1988–2000	<5	-	<5
IX. Liver				
	1988–1995	<5	-	<5
	1996–2000	<5	-	<5
	1988–2000	<5	-	<5
VIII. Brain and nervous system				
	1988–1995	<5	-	<5
	1996–2000	<5	-	<5
	1988–2000	<5	-	5.97

Appendix D—Brief Summaries of Chemicals of Concern (COCs)

This appendix provides background information from toxicological profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR), information developed by the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA), and the U.S. Environmental Protection Agency (USEPA). It highlights the toxicological effects of chemicals of concern (chemicals exceeding health comparison or screening values) detected in air, soil, surface water, or groundwater in and around the Remco site.

Volatile Organic Chemicals

1,1-Dichloroethane (1,1-DCA) (64, 68)

- Synthetic chemical.
- Used as a solvent, degreaser, and to produce other chemicals.
- Evaporates easily, from soil and water.
- Breaks down slowly in air, relatively quickly in water.
- Can enter body through inhalation, ingestion, and dermal absorption.
- Adverse health effects in animals due to long-term inhalation exposures at high concentrations include kidney damage and delayed growth of their offspring, liver damage, eye and skin irritation, central nervous system depression, drowsiness, and unconsciousness.
- Inhalation unit risk = 1.6×10^{-6} $(\mu g/m^3)^{-1}$.
- Carcinogenicity: USEPA—possible human carcinogen (causes glandular cancers in rats and mice).

1,1-Dichloroethylene (1,1-DCE) (69)

- Synthetic chemical, most commonly used to make other products.
- Evaporates very quickly from soil and water.
- Breaks down quickly in the air, slowly in water.
- Can enter body through inhalation, ingestion, or possibly dermal contact, most commonly from products containing this chemical.
- Adverse health effects due to chronic inhalation include neurological effects, and possible kidney and liver damage.
- An animal study indicated that mice breathing 1,1-dichloroethene for 1 year developed kidney cancer.
- Intermediate inhalation MRL = 5 ppm (19,800 $\mu g/m^3$) (liver effects in guinea pigs).
- Chronic oral MRL = 0.009 mg/kg/day (liver effects in rats).
- Oral reference dose = 0.009 mg/kg/day (liver effects in rats).
- Oral slope factor = 0.6 $(mg/kg/day)^{-1}$.
- Inhalation unit risk = 5×10^{-5} $(\mu g/m^3)^{-1}$.
- Carcinogenicity: USEPA—possible human carcinogen.

cis-1,2-Dichloroethylene (cis-1,2-DCE) (70)

- Synthetic chemical, most commonly used to make solvents and other products.
- Highly flammable liquid; breaks down quickly in the air.

- Can enter body through inhalation, ingestion, or possibly dermal contact, most commonly from products containing this chemical.
- Adverse health effects include possible kidney, liver damage, and reduction of red blood cells.
- Intermediate oral MRL = 0.3 mg/kg/day (kidney effects in rats).
- Carcinogenicity: USEPA—not classified.

Tetrachloroethylene (PCE) (60)

- Synthetic chemical used as a dry-cleaning fluid, a degreaser, and as a starting material for other products.
- Evaporates quickly; breaks down very slowly.
- Can travel easily through soils to reach groundwater.
- Most common way to enter body is inhalation, also ingestion if drinking water is contaminated.
- Adverse health effects due to chronic inhalation exposure possibly include reproductive effects in women.
- Liver and kidney cancer has been shown in animal studies.
- Chronic inhalation MRL = 40 ppb (270 $\mu g/m^3$) (neurological effects in humans).
- RfD = 0.01 mg/kg/day (liver effects in mice).
- High levels of exposure in animals may cause liver, kidney damage.
- OEHHA oral slope factor = 0.54 $(mg/kg/day)^{-1}$.
- OEHHA inhalation slope factor = 0.021 $(mg/kg/day)^{-1}$.
- OEHHA inhalation unit risk = 5.9×10^{-6} $(\mu g/m^3)^{-1}$.
- Carcinogenicity: USEPA—carcinogenicity currently under review; Department of Health and Human Services (DHHS)—may reasonably be anticipated to be a human carcinogen; International Agency for Research on Cancer (IARC)—probable human carcinogen (limited human, sufficient animal evidence).

1,1,1-Trichloroethane (TCA) (54)

- Synthetic chemical with many industrial and commercial uses; found in many household products.
- Most of the 1,1,1-trichloroethane released into the environment enters the air, where it lasts in the atmosphere for about 6 year.
- Most common way to enter body is inhalation, also ingestion if drinking water is contaminated.
- Studies in animals show that breathing air that contains very high levels of 1,1,1-TCA (higher than 1,000,000 $\mu g/m^3$) damages the breathing passages and causes mild effects in the liver, in addition to affecting the nervous system.
- Unknown whether breathing air containing 1,1,1-trichloroethane affects reproduction or development in people.
- Intermediate inhalation MRL = 700 ppb (4,000 $\mu g/m^3$) (neurological effects in gerbils).
- Carcinogenicity: USEPA and IARC—not classifiable as to human carcinogenicity.

Trichloroethylene (TCE) (71)

- Synthetic chemical, liquid at room temperature; most commonly used as a degreaser, also used in some household products.
- Evaporates readily from surface soil, water; breaks down in air to form phosgene, a lung irritant; breaks down more slowly from deep soils, groundwater.
- Can enter body through inhalation, ingestion, or dermal absorption.
- Adverse health effects due to chronic exposure possibly include liver, kidney, non-Hodgkins lymphoma, childhood leukemia, heart defects, and other birth defects.
- Acute inhalation MRL = 2,000 ppb (10,700 $\mu g/m^3$) (neurological effects in humans).
- Intermediate inhalation MRL = 100 ppb (540 $\mu g/m^3$) (neurological effects in rats).
- Chronic inhalation REL= 600 $\mu g/m^3$ (effects on the nervous system and eyes).
- Acute oral MRL = 0.2 mg/kg/day (developmental effects in mice).
- OEHHA oral slope factor = 0.013 $(mg/kg/day)^{-1}$.
- OEHHA inhalation slope factor = 0.007 $(mg/kg/day)^{-1}$.
- OEHHA inhalation unit risk = 2×10^{-6} $(\mu g/m^3)^{-1}$.
- Carcinogenicity: USEPA—probable human carcinogen (inadequate human, sufficient animal evidence); U.S. Department of Health and Human Services (DHHS)—may reasonably be anticipated to be a human carcinogen; International Agency for Research on Cancer (IARC)—probable human carcinogen (limited human, sufficient animal evidence).

Methyl tert-butyl ether (MTBE) (72)

- Synthetic flammable liquid made from combinations of isobutylene and methanol.
- Fuel additive for oxygenating gasoline for cleaner burning.
- Evaporates from open containers.
- Water soluble and widespread groundwater contaminant.
- Can enter the body through inhalation and ingestion; car exhaust primary source of exposure.
- Drinking or breathing MTBE may cause nausea, nose and throat irritation, and nervous system effects.
- Intermediate oral MRL = 0.3 mg/kg/day (liver effects in rats).
- Carcinogenicity: USEPA—not classified.

Methylene chloride (73)

- Synthetic chemical, widely used in solvents, paint strippers, and other products.
- Evaporates easily, but does not easily dissolve in water.
- Enters the body most commonly through inhalation, but also through ingestion and dermal absorption.
- Breathing large amounts of methylene chloride can cause nausea, dizziness, and a tingling or numbness in fingers and toes.
- Animal studies of rats and mice exposed to high levels (inhalation) of methylene chloride showed increased lung and liver cancers.
- Chronic oral MRL = 0.06 mg/kg/day (liver effects in rats).
- Oral reference dose = 0.06 mg/kg/day (liver effects in rats).
- Chronic inhalation MRL = 300 ppb; intermediate inhalation MRL = 300 ppb; acute inhalation MRL = 600 ppb.

- Inhalation reference concentration=3,000 $\mu g/m^3$ (adverse health effects in rats).
- Oral slope factor = 0.0075 $(mg/kg/day)^{-1}$.
- Inhalation unit risk = 4 x 10^{-7} $(\mu g/m^3)^{-1}$.
- Carcinogenicity: USEPA—probable human carcinogen (inadequate human, sufficient animal studies); U.S. Department of Health and Human Services (DHHS)—reasonably anticipated to be a carcinogen; International Agency for Research on Cancer (IARC)—possibly carcinogenic to humans (limited evidence, less than sufficient evidence in animals).

Metals

Chromium (42, 74)

- Naturally-occurring element found in soil and in volcanic dust and gases.
- Different forms (valence states) of chromium. Most common: trivalent chromium and hexavalent chromium.
- Hexavalent chromium is generally produced by industrial sources.
- Ingestion of hexavalent chromium poses a relatively low health concern because it is rapidly transformed into trivalent chromium in the gastrointestinal tract.
- Adverse health effects from breathing hexavalent chromium include asthma, bloody nose, nasal septum scarring and perforation, runny nose, mild decreased lung function, bronchitis, gastric irritation, and subtle changes in kidney function (affects primarily the proximal tubule).
- In worker studies inhalation of hexavalent chromium has been shown to cause lung cancer; other cancers (nasal and stomach) have been suggested, but are not well studied.
- Chronic (>365 days) oral RfD for hexavalent chromium = 0.003 mg/kg/day (reduced body weight in rats).
- Chronic (>365 days) oral RfD for trivalent chromium = 1.5 mg/kg/day (reduced liver weight in rats).
- Inhalation unit risk = 0.15 $(\mu g/m^3)^{-1}$.
- Carcinogenicity for hexavalent chromium: USEPA—human carcinogen; U.S. Department of Health and Human Services (DHHS)—known human carcinogen; International Agency for Research on Cancer (IARC)—carcinogenic to humans.
- Carcinogenicity for trivalent and total chromium: USEPA—not classifiable; U.S. Department of Health and Human Services (DHHS)—not classified; International Agency for Research on Cancer (IARC)—not classifiable.

Lead (49)

- Naturally-occurring metal found in small amounts in the earth=s crust, most of the high levels of lead found in the environment are from human activities.
- People may be exposed to lead by eating foods or drinking water that contains lead, spending time in areas where leaded paints have been used or are deteriorating, lead pipes, drinking from leaded-crystal glassware.
- People who live near hazardous waste sites may be exposed to lead and chemicals containing lead by breathing the air, swallowing dust and dirt containing lead, or drinking lead-contaminated water.

- Lead affects the nervous system, the blood system, the kidneys and the reproductive system.
- Low blood levels (30 μg/dL) may contribute to behavioral disorders; lead levels in young children have been consistently associated with deficits in reaction time and with reaction behavior. These effects on attention occur at blood lead levels extending below 30 μg/dL, and possibly as low as 15-20 μg/dL.
- Health effects associated with lead are not based on an external dose, but on internal dose that takes into account total exposure.
- Federal agencies and advisory groups have redefined childhood lead poisoning as a blood lead level of 10 μg/dL.
- OSHA requires workers with a blood lead level >50 μg/dL be removed from the workroom where lead exposure is occurring.
- Carcinogenicity: USEPA—probable human carcinogen.

Total Petroleum Hydrocarbons (TPH) (18)

- Term used to describe a family of several hundred chemicals derived from crude oil.
- Most products that contain petroleum hydrocarbons will burn.
- Everyone is exposed to TPH from nay sources, including fumes from gas pumps, oil spilled on the ground, household products, etc.
- The compounds in different TPH fractions affect the body in different ways;
- Carcinogenicity: USEPA—not classifiable (based on no human data and inadequate data from animal bioassays).

TPH-Diesel (18, 50)

Aliphatic fraction (C9-C11)

- Adverse health effects seen in animal studies include liver and kidney effects.
- Ocular effects have been seen in humans exposed to naphthalene (constituent of fraction).
- Chronic reference dose = 0.1 mg/kg/day

Aromatic Fraction (C11-C22)

- Health effects seen in animals include kidney effects (renal tubular pathology and decreased kidney weights).
- RfD = 0.03 (represented by RfD for pyrene).
- Carcinogenicity: USEPA—not classifiable (based on no human data and inadequate data from animal bioassays).

Appendix E—Public Comments and Responses from the California Department of Health Services (CDHS)

On January 23, 2006, this Public Health Assessment (PHA) for the Remco site was released in draft for public comment. The comment period was open for 6 weeks, ending on March 6, 2006.

As part of the release, the PHA was placed in several libraries in the area for public review and comment. The PHA was mailed to more than 200 addresses from the CDHS mailing list for the Remco site. This list contains residents and former residents of the nearby neighborhood, other community stakeholders, civic and political interested parties, and government agencies. The PHA is available on the CDHS web site at www.ehib.org.

CDHS received comments from the following individuals and/or groups: three private citizens; North Coast Regional Water Quality Control Board (RWQCB), Erler & Kalinowski, Inc. (EKI) (representing the City of Willits) and, the Willits Environmental Remediation Trust (WERT). The comments are provided in the following pages. Comments about typographical errors are excluded. When appropriate, a response from CDHS is provided in *italics*.

Comments from Private Citizens (CDHS Received Comments from Three Individuals)

Citizen #1

A report released last month by Cal Dept. of Health Services concludes a public health hazard persisted in Willits, California (1963-1995) from daily exposure to both, Chromium 6 (Cr6), and volitile acids, eminating from the now abandoned REMCO plating industry. (Whitman/Pepsico).

"In summary, community members, particularly those exposed prior to emission controls ('63-'75), experience some increase in risk of developing cancer, and could have experienced some non-cancer health effects from exposure to (Cr6)." Non cancer health effects include asthma, ulcers, nose bleed, skin condition.

In addition, the study concludes: "It is probable residents could have been exposed (also) to Volitile Organic Compounds (used to etch metal) that posed an indeterminate public health hazard", concurrently.

Although clearly implicating REMCO, the report has been criticized for overly polite condolence to Willits reluctance to relocate an elementary school adjacent to the toxic site, and plans to open a Boys & Girls Club nearby. An omission of one fact endangering public health is serious enough concern to bring a whole study into question.

CDHS Response: CDHS evaluated all potential ways (exposure pathways) students attending Baechtel Grove Middle School and Blosser Lane Elementary School, could be or may have been exposed to Remco related contaminants in air, soil, and groundwater. There is no completed exposure pathway to Remco contaminants for students/children attending these schools. There is no health hazard to students or staff attending Baechtel Grove Middle School and Blosser Lane Elementary School from Remco-related contamination.

In speaking of Remedial Action taken at the site, out of concern for the children of Baechtel Grove schoolyard, and walking by the site, the Dept of Health fails to mention a chain link fence did little to keep the dust from continuing to contaminate these school kids, and was primarily installed to keep people off the property, not contain toxic runoff. Similarly the report puts the children adjacent to the site out of danger during an overlapping period in which the entire City had increased accumulative risk of both cancer and non cancer adverse health effects.

CDHS Response: Air monitoring (dust, metals, VOCs) was conducted during the remedial activities conducted between 2000 and 2004. No Remco-related contaminants were detected in dust measured at the perimeter of the site. Please refer to Evaluation of Exposure During Remedial Activities at the Site (2000 – 2004) section in the PHA.

In refering to 1995 as the year releases from the plant ceased to pose a risk the report does overlook some well known facts: not a bucket of dirt was removed till 1998, and a number of off-site illegal dumps connected to the facility had been since located, including one down the street, and a child who died in 1997 had Cr6 in his vomit, after sipping Baechtel Creek water.

CDHS Response: The Department of Toxic Substances Control in coordination with the RWQCB have investigated a number of the alleged claims regarding 'illegal dumping". As of this writing, none of the "illegal dumps" have been located.

CDHS is not aware of any data from 1997, showing hexavalent chromium (Cr6) in the vomit of the child who died.

Finally, 32 years of heavy metals and solvants in a confined watershed, doesn't blow away, but settles down. No attempt was made to determine pathways for these contaminants in later years.

CDHS Response: CDHS' evaluation includes past, current and future exposure pathways. As a result, we recommended that remediation of groundwater is necessary to ensure the protection of public health in the future.

[Letter signed by a private citizen]

Citizen #2

I have been involved as an observer who is interested in the toxic contamination problem in Willits, Mendocino County, California for about ten years. I worked for Project Censored at Sonoma State University and was co-producer in a project producing one-hour radio documentaries for National Public Radio. One of our subjects for a documentary was how the chemical using industries effected the towns and the people who lived in the towns that they were built near.

As it happened, I have a friend who was born in Willits and who suffers from the exposures of chemicals that she had while living and going to school there. After an editorial board meeting, I was sent to Willits to interview "victims" of the Remco toxic mess. After completing my interviews I was invited to return in a couple of weeks to attend a meeting at city hall. I returned and have been returning ever since, video-taping meetings, scenarios and circumstances.

My interest in Willits comes from another perspective, besides being an investigative reporter for

Project Censored (you can learn about Project Censored on the Internet by using the search words "Project" "Censored"). Project Censored has been publishing an annual book on the year's 25 most censored news stories for more than a quarter century.

Also, I am the acting chairman of a 501 (c)(3) non-profit organization called Compensation Alert, which was formed in the early 1990's to help injured workers with their on-the-job injury claims filed under the State of California's Department of Workers Compensation.

Workers Compensation was started nation-wide in 1912 and has been actively in existence ever since. The Workers Comp story, state-by-state is a very complicated and perverse story that I will not get into now.

I worked for more than 15 years in oil refineries as a maintenance and as a construction electrician, foreman and superintendent. I am very aware of the hazardous chemicals reported in this study, including the ill effects caused by exposure to them. During my years of working in oil refineries I was exposed to a variety of chemicals including some of those discussed for the Willits exposures. I do have some problems caused by my exposure to PCB's and VOC's during my oil refinery employment.

I have been riding or driving through Willits since the 1950's.

When I began attending the various meetings at Willits and heard the war stories of the injured workers from the Remco Factory, I raised the question about the records that should have been held by the Workers Compensation office in Eureka. Strangely, none of the authorities seemed to put much importance on the information that should have been documented by the Workers Compensation office. If there were no records kept or no claims filed with Workers Compensation, then I believe there is a serious legal liability to address.

In view of the illnesses to the workers at the Remco factory(s) I would expect that claims were filed with Workers Compensation. If not, why not?

<u>CDHS Response</u>: *CDHS and ATSDR recognize that Remco workers were likely exposed to higher levels of work place chemicals, compared to those seen in the community. ATSDR does not include worker compensation issues as part of its federal public health activities. Exposure to toxic chemicals in the workplace is governed by the Occupational Safety and Health Administration (OSHA) and the National Institute of Occupational Safety and Health (NIOSH), and is outside the scope of this evaluation.*

I have found it very perplexing to not read very much of what is going on in Willits. Only an occasional news story. Or, as an example, remote incidents that have directly to do with the chemical mess in Willits.

As it happens, *(personal identifier deleted)* MA CCC-A, the person who is treating me for a hearing loss problem has a son who worked for a laboratory in Petaluma, Sonoma County who had to test water samples from Willits. The water samples were so "hot" that they had to be drastically diluted in order for the testing equipment to handle the samples. *(personal identifier deleted)* son is in the Peace Corp and is stationed in Africa and I did communicate with him. He said the samples were so hot they (at the lab) were even afraid to get a drop on their shoes. *(Personal identifier and phone number deleted)*

<u>CDHS Response:</u> *As discussed in the PHA, on-site groundwater is highly contaminated, with hexavalent chromium, VOCs, and other constituents (pleaser refer to the Onsite Groundwater and Soil section of the PHA). Currently, there is no completed exposure pathway to the contaminated groundwater (nobody is coming into contact with the contaminated groundwater). CDHS has recommended that the groundwater be remediated (cleaned-up) to prevent potential exposure in the future.*

I think the Workers Compensation aspect of the Willits toxic mess is extremely important.

[Letter signed by a private citizen]

<u>Citizen #3</u>

"The Tragedy of Remco" was published in the Willits News on January 9th, 2004. The essay told the story of how Remco, an innovative, locally owned company that started here in Willits. It paid top wages, made high quality hydraulic cylinders, sawmill machinery and supported innovative research and was forced to close.

It is a law of Physics and Chemistry that matter can neither be created nor destroyed. Matter can be transformed, transported, or sequestered (stored). I have a Masters Degree in Forestry from UC Berkeley with 23 US Patents. The Patents are in Forest and Wastewater related Industry, some of which are in use worldwide. My business is located on the North side of Franklin Avenue, not far from the Remco site.

I first thought that my Biogest System could extract and treat the contaminated ground water. It worked but could not economically deal with the large amounts associated with Remco.

I then explored, tested and built the Solar Powered Artificial Wetland (SPAW) that has treated and evapotranspired wastewater for over 15 years. There is no need for a discharge. Any inorganic chemicals (i.e.: chromium, lead etc.) and organic chemicals polyaromatic hydrocarbons (PAH) are absorbed by the redwood roots. Only pure water is transpired from the leaves. The chemicals are absorbed and become part of the plant tissue (sequestered). This can be stored for over a thousand years for redwoods. My studies indicate that Chrome 6 is reduced to Chrome 3 by bioremediation as it is absorbed and assimilated by the redwoods.

I have presented my SPAW Plan numerous times in person and by letter, yet only Jan Gobel of the Regional Water Quality Control Board has visited the SPAW. The SPAW continues to operate at my home at 23881 Sherwood Road, which is a bit over a half mile north of Willits.

I hope you and your staff will plan for an hours visit to our Spaw. The rapid growth (over 4" in diameter and 36' high) redwood that is only a bit over six years old should impress you. The

SPAW system at Remco would raise Redwood seedlings in pots until they are about four-feet high when they would be planted in a Redwood Grove, like the one you can visit.

<u>CDHS Response</u>: CDHS staff (Tracy Barreau) accompanied Jan Goebel during the visit and demonstration of the SPAW. On that same day CDHS also toured the Willits reclamation plant, where redwood seedlings were being grown in treated wastewater. Staff found the SPAW very interesting and hopes that pilot testing is successful in showing the SPAW to be an effective remedial tool.

CDHS does not have any regulatory authority at the Remco site or in the decisions regarding the selection of remedial measures. The Regional Water Quality Control Board is the regulatory agency overseeing the cleanup at Remco site and will be evaluating options for remediation.

[Letter signed by a private citizen]

Comments Submitted by the California Regional Water Quality Control Board, North Coast Region

Former AbexlRemco Hydraulics Facility, 934 South Main Street, Willits, California
Regional Water Board staff received the *Public Health Assessment Report for Evaluation of Exposures to Contaminants From the Former Abex/Remco Hydraulics Facility, Willits, Mendocino County.* The report was prepared by the Department of Health Services (CDHS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). Thank you for the opportunity to review and comment on the report.

As you know, the Regional Water Board is overseeing the investigation and cleanup of the former AbexlRemco Hydraulics Facility. In preparation of the report, CDHS reviewed the file record of the Regional Water Board. Regional Water Board staff finds that the data and information contained in the Public Health Assessment Report is accurate.

CDHS recommends the following actions:

1. Medical monitoring/clinical evaluations be considered for Willits residents and people who worked in Willits, who may have been exposed to air releases of hexavalent chromium from Remco between 1963 and 1995. If medical monitoring is undertaken, CDHS recommends that an expert work group with community representation be established to develop a protocol for medical monitoring/clinical services, including criteria for participation and an overall implementation plan.

2. Counseling and stress support services be considered for impacted residents and workers as needed.

3. The Willits Trust implement adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities. Mitigation measures should include air monitoring using detection limits adequate to protect public health.

Regional Water Board staff fully supports CDHS's recommendations contained in the Public Health Assessment Report, and look forward to our continued joint participation in community outreach associated with the investigation and cleanup of the former Remco Hydraulics site.

If you have any questions, please contact Dave Evans or Janice Goebel of my staff at (707) 576-2676.

[Letter signed by the Executive Officer of the California Regional Water Quality Control Board, North Coast Region]

Comments Submitted by the Willits Environmental Remediation Trust

The Willits Environmental Remediation Trust ("Willits Trust") has reviewed the Public Health Assessment for Evaluation of Exposures to Contaminants from the Former AbexlRemco Hydraulics Facility, Willits, Mendocino County, California ("Public Health Assessment" or "PHA") prepared by the California Department of Health Services ("CDHS"), as submitted for public comment on January 23, 2006.

As you are aware, the Willits Trust has been charged by the United States District Court for the Northern District of California, as its instrumentality, with responsibility for the investigation and remediation ("Work") of the former Remco Hydraulics, Inc. Facility in Willits, California ("Site"), which Site is also the subject of the PHA. The Willits Trust is required to conduct such Work in a manner consistent with the federal National Contingency Plan. The Willits Trust was charged with, amongst other things, identifying and prospectively addressing, any threats to human health or the environment posed by the Site. The focus of CDHS's PHA is primarily historical and current. Given the different focus of the Willits Trust, our comments are limited primarily to the portions of the PHA regarding current and/or future potential health risks.

p. 3, last bullet: Based on the findings of the PHA, CDHS recommended that "The Willits Trust should implement adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during the remedial activities at the site. This should be in conjunction with air monitoring, using detection limits adequate to protect public health."

The Willits Trust *consistently* has implemented numerous and conservative mitigation measures in all its activities at the Site, more than sufficient to protect human health, and intends to continue conducting similar measures in all future Work at the Site.

<u>*CDHS Response:*</u> *Comment noted.*

p. 5, paragraph 4: The Willits Trust did acquire the former Luna Market and Motel and two adjacent residential properties (27 & 37 Franklin Avenue) in July 2002. Later, the Willits Trust acquired nine additional residential properties on Franklin Avenue (43, 47, 51, 57, 61, 64, 67, 71, 75 and 83 Franklin Avenue). However, these properties were not acquired in July 2002 as indicated in this paragraph. Following is a summary of the dates of purchase and demolition of structures on the properties that the Willits Trust has purchased:

Address	Acquired.	Structures Demolished
(Luna)	July 2002	September/October 2002
27 Franklin	July 2002	August 2003
37 Franklin	July 2002	September/October 2002
43 Franklin	December 2003	September/October 2003
47 Franklin	September 2003	September/October 2003
51 Franklin	August 2003	September/October 2003
57 Franklin	August 2003	No Structures on Property
61 Franklin	August 2004	June 2005
67 Franklin	September 2005	Not yet Demolished
71 Franklin	March 2005	June 2005
75 Franklin	March 2005	June 2005
83 Franklin	March 2005	June 2005

CDHS Response: The text has been modified to reflect the comment.

p. 5, paragraph 5: The first sentence of this paragraph refers to a "site fence line". The Willits Trust would like to clarify that there are two fence lines on property owned by the Willits Trust. One fence is located at the boundary of the former Remco Facility, enclosing the original facility boundary. A second perimeter fence encloses all property owned by the Willits Trust, including the more recently acquired Franklin Avenue properties.

CDHS Response: The text has been modified to reflect the comment.

p. 5, Footnote 2: Footnote 2 states that the Consent Decree requires that the "PRPs [Potentially Responsible Parties] will conduct all or part of a cleanup action . . ." Actually, the Amended Final Consent Decree, Final Order and Final Judgement; and Order Establishing the Willits Environmental Remediation Trust ("Amended Final Consent Decree"), as entered on December 22, 2000, requires that the Willits Trust, ***not the PRPs***, conduct the investigation and cleanup at the Remco Site.

CDHS Response: The text has been modified to reflect the comment.

p. 11, paragraph 4: The Willits Trust has collected numerous groundwater samples and analyzed the samples for metals, including cadmium, lead, nickel, copper and zinc using EPA Method 6010B. As stated in the method, chromium is not a potential interferent with these five metals. This data is being evaluated in the Baseline Risk Assessment currently being conducted by the Willits Trust, which will assess all current and potential future risks at the Site.

CDHS Response: The statement in the draft PHA was based on conversations with Terry James, formerly with Montgomery Watson Harza, consultant to the Willits Trust. The statement has been deleted from the final PHA, based on the comment.

p. 16, paragraph 2: The private well identified as OW-17 was abandoned March 28, 2000.

<u>CDHS Response:</u> Comment noted. This information has been added to the PHA.

p. 17, paragraph 2: The PHA states that "Levels of VOCs in groundwater are not consistent throughout the area and have not been adequately characterized." This statement is made relative to the evaluation of the vapor intrusion into the residences on Franklin Avenue. The Willits Trust has conducted extensive groundwater sampling at the Remco Facility as well as on residential properties to the north of the Remco Facility along Franklin Avenue, and contrary to this statement in the PHA, the Willits Trust believes that the VOCs in groundwater have been adequately characterized.

<u>CDHS Response:</u> CDHS agrees with the comment and has modified the text to add clarity.

p. 17, paragraph 3: CDHS states that no sampling of soil gas has been conducted at the Remco Site. Actually, a limited number of soil gas samples *were* collected prior to the Willits Trust's involvement at the Site, as documented in the Remedial Investigation Report (MWH, April 2002). However, the high groundwater table and relatively fine vadose zone soils result in the vadose zone being highly saturated. Under these conditions, soil gas samples are not good indicators of the potential migration of VOCs in the soil gas and, therefore, these samples have not been collected by the Willits Trust at the Site.

<u>CDHS Response:</u> Comment noted.

p. 17-18 CDHS evaluated the potential intrusion of VOC vapors into residential structures on Franklin Avenue using two different methods:

1. a screening level analysis based on concentrations of VOCs in groundwater, and indoor air sampling conducted in three residential structures on the south side of Franklin Avenue.

The first screening-level analysis involved reportedly applying a dilution factor as defined in the DTSC February 2005 Guidance document. The DTSC February 2005 Guidance (p.14) states that the default screening level analysis is applicable for sites with certain conditions present, one of which is that groundwater is *greater* than 10 feet below surface grade. The groundwater underlying the Franklin Avenue residences is typically *less* than 10 feet and therefore, as indicated in the DTSC guidance, this screening-level analysis is not appropriate for the Remco Site.

In addition to the fact that the method of screening analysis utilized is not Site-appropriate, CDHS did not apply the screening level attenuation (dilution) factor correctly in conducting its analysis resulting in prediction errors regarding the potential indoor air concentration of c-1,2-DCE. However, it is important to note that the location where the highest c-1,2-DCE was detected has never underlain *any* residence. Based on the distribution of VOCs in groundwater, *significantly* lower concentrations of VOCs would have been expected under the former residences on Franklin Avenue. Lastly, currently the only residential structure remaining on the south side of Franklin Avenue is the structure at 67 Franklin Avenue, which is scheduled to be demolished this month.

<u>CDHS Response:</u> CDHS recognizes that a screening analysis is not appropriate for the Remco site because of shallow groundwater, which is the reason we had previously requested indoor air sampling, rather than using the Johnson and Ettinger model. The discussion in the text regarding attenuation was meant to provide the lay reader with a general understanding that VOC concentrations measured in groundwater would not result in the same concentration in indoor air, due to soil gas migration. We utilized 1,2-DCE as an example of what the concentration in indoor air would be using an attenuation factor of 1000; it was not meant to be used as a prediction or screening level for 1,2-DCE. We recognize that this may be confusing and have removed the statement from the PHA.

Consistent with the DTSC guidance, after conducting the screening level analysis, CDHS evaluated the indoor-air data collected by the Willits Trust from residential properties on Franklin Avenue. The Willits Trust concurs with CDHS's conclusion that the detection of TCA and TCE in indoor air are likely from an indoor source. However, the Willits Trust believes that CDHS's conclusion that the concentrations of " . . . benzene measure in indoor air are *most likely* from other sources, and not site related" (emphasis added) should be more conclusive. Concentrations of benzene measured in indoor air are entirely consistent with concentrations of benzene in ambient air (outdoor). Based on this data, it is our opinion that the benzene detected in indoor air is clearly not from Remco, but from other (non-Remco) source(s), such as the adjacent Highway 101.

<u>CDHS Response:</u> Comment noted.

[Letter signed by the Trustee of the Willits Environmental Remediation Trust]

Comments Submitted by Erler & Kalinowski, Inc., (EKI) on behalf of the City of Willits

Erler & Kalinowski, Inc. ("EKl") reviewed and prepared comments regarding the ***Public Health Assessment, Evaluation of Exposures to Contaminants from the ABEX/Remco Hydraulics Facility ("Remco Site''), Willits, Mendicino County, California*** dated 23 January 2006 (the "Comprehensive PHA"). The Comprehensive PHA was prepared by the California Department of Health Services ("CDHS") under a cooperative agreement with the Agency for Toxic Substances and Disease Registry ("ATSDR"). Previously, EKI reviewed and prepared comments on the Final PHA for historic airborne hexavalent chromium exposures prepared by CDHS and dated 30 July 2004 and transmitted them to you in a letter dated 14 January 2005. The results of the Final PHA for historic hexavalent chromium exposures are incorporated into the Comprehensive PHA. It should be noted that the Willits Trust is preparing a separate human health risk assessment under the jurisdiction of the North Coast Regional Water Quality Control Board ("RWQCB") that is a more in depth evaluation of potential risks than that provided in the Comprehensive PHA.

OVERVIEW

The Comprehensive PHA presents assessments of historic, current, and future potential human exposures to chemicals of concern ("COCs") from the Remco Site and the resulting estimated non-cancer and cancer risks to populations within the Willits community. The primary COCs at the Remco Site are hexavalent chromium and volatile organic compounds ("VOCs"). The assessments are based on soil, air, and groundwater data collected during various investigations and remedial activities conducted since the 1970's around the former Remco facility.

The CDHS evaluated eleven pathways or activities that could allow exposure to COCs from the Remco Site to cause human health problems:

- Private well usage for irrigation purposes (past, current, and future)
- Exposure from breathing VOCs in indoor air from the offsite groundwater contamination that underlies residences (past, current, and future)
- Swimming or wading in Baechtel Creek (current and future)
- Contact with sediment in Baechtel Creek (past, current, and future)
- Playing or coming into contact with offsite soil (except on Franklin Avenue), including Baechtel Grove School, Blosser Elementary School and the future Boys and Girls Club (past, current, and future)
- Eating blackberries and fruit from trees near the Remco Site and other areas in the community (past, current, and future)
- Breathing contaminants from interim remedial activities completed at the Remco Site (2000-2003)
- Soil contact in the Willits community (past, current, and future)
- Breathing VOCs released during Remco operations (past)
- Swimming or wading in Baechtel Creek (past)
- Air releases of hexavalent chromium released during Remco operations (past)

On the basis of the review and analysis summarized in the Comprehensive PHA, the CDHS concluded that eight of the eleven pathways/activities "pose no apparent public health hazard", that two pathways (breathing VOCs released during Remco operations in the past and swimming or wading in Baechtel Creek in the past) could not be evaluated due to insufficient data, and that one pathway (historic air releases of hexavalent chromium from Remco operations) posed a public health hazard in the past.

On the basis of the findings regarding the potential historic air releases of hexavalent chromium, the CDHS recommends that:

- The feasibility of medical monitoring/clinical evaluations should be considered for residents and people who worked in Willits between 1963 and 1995 and an expert workgroup should be established to develop a protocol for such services.

- Counseling and stress support services should be considered for impacted residents and workers, as needed.

- The Willits Trust should implement adequate measures to mitigate re-suspension of hexavalent chromium-containing dust or soils that could be generated during remedial activities at the site. This should be conducted in conjunction with air monitoring, using detection limits adequate to protect public health.

Based on EKI's review of the Comprehensive PHA we find that:

1) The Comprehensive PHA is a "screening level" evaluation of potential human health risks associated with the Remco Site. It is not intended and should not be viewed as an alternative or replacement for the comprehensive evaluation and remediation process being conducted by the RWQCB;

2) The Comprehensive PHA does not adequately evaluate the potential for exposures to COCs in groundwater;

3) The Comprehensive PHA does not adequately evaluate the potential for exposures to COCs in the indoor air of residences in the areas of documented offsite contamination; and,

4) The Comprehensive PHA does not correctly evaluate the potential human exposures to hexavalent chromium in air due to past Remco operations, as previously discussed in the EKI letter dated 14 January 2005.

Each of these findings is discussed in more detail below.

DISCUSSION

EKI Issue 1: The CDHS has conducted a "screening level" evaluation of potential human health risks associated with the Remco Site that should not supersede the RWQCB process.

The CDHS Comprehensive PHA is a "screening level" evaluation that is intended to provide "an initial look at the site to help determine what follow-up activities are needed: additional site characterization, health education, health study, or specific measures to reduce or eliminate exposures". Given the limited purpose of the Comprehensive PHA, no final conclusions regarding potential human health risks related to the contamination at the Remco Site should be made by the City of Willits based on the findings presented in the document. A more comprehensive analysis of the risks presented by the Remco Site and their implications for future remediation and site reuse will be presented in the human health risk assessment being prepared by the Willits Trust for submission to the RWQCB.

<u>CDHS Response:</u> The PHA is not intended to replace the Human Health Risk Assessment that is required by law under the regulatory framework. The Human Health Risk Assessment is a tool used to inform remedial options for the site. In contrast, the PHA documents and evaluates community concerns and past exposure scenarios to evaluate the need for interventions, to reduce or eliminate exposure or to identify appropriate public health activities such as health studies, health education, etc.

EKI Issue 2: The CDHS does not adequately evaluate the potential for exposures to COCs in groundwater.

The Comprehensive PHA provides only a cursory evaluation of the potential for exposures to COCs in offsite groundwater and ignores the fact that the groundwater is a drinking water resource in Willits that has been degraded as a result of the past and ongoing releases of COCs from the Remco Site. We understand that deed restrictions prohibit consumption of groundwater from wells on the Remco Site, however, active wells remain on offsite residential properties in areas affected by Remco groundwater contamination. Although the City of Willits supplies drinking water to residents, there is nothing to prevent offsite residents from utilizing groundwater as drinking water. Such use would be a potential pathway for exposure to COCs. This issue should be analyzed and addressed in the human health risk assessment and the development of a final remedial plan for the Remco Site being conducted under the jurisdiction of the RWQCB.

<u>CDHS Response:</u> CDHS did not "ignore" the fact that groundwater in Willits could be used as a drinking water source (through private wells) as indicated by the comment. We evaluated potential exposure to contamination in private wells that have been impacted by contamination from the Remco site. Our evaluation included a worst-case scenario, so that any current health risk would be identified (please refer the Evaluation of Private Well Exposure Pathway section in the PHA). With exception of one private (irrigation) well owner on Highway 20, it is our understanding that all private wells in the impacted area have either been abandoned or destroyed. The private well owner on Highway 20 has been notified that 1,1,1-TCA was detected in her/his irrigation well at levels <u>below</u> drinking water standards and advised not to drink the water. With respect to exposure in the future, already stated in the PHA, "potential exposures in the future will be eliminated through remediation of the contaminated groundwater". While remedial measures are already underway at the site, a recommendation has been added to the PHA to add emphasis on the need for remediation of the groundwater.

CDHS recognizes that private wells exist in other areas of Willits where groundwater contamination may exist, from sources other than Remco. Private wells are not regulated, leaving the responsibility of ensuring water quality to the private well owner. Unfortunately, many private well owners are not aware of groundwater contamination issues that may be *impacting their well. CDHS shares the concern expressed by EKI, that private well owners who are supplied water by the City of Willits may still drink from their private well. Thus, it seems prudent for Mendocino County Department of Environmental Health to provide private well education to the citizens of Willits and notify them of areas where contamination has been documented. We have added this recommendation to the final PHA.*

EKI Issue 3: The Comprehensive PHA does not adequately evaluate the potential for exposures to COCs in indoor air in residences in the areas of offsite contamination.

The CDHS uses incorrect screening values and limited indoor air sampling data to conclude that there is no harmful exposure to VOCs in indoor air in residences above the offsite groundwater contamination.

<u>CDHS Response</u>: *CDHS did not use screening values in evaluating potential exposure to VOCs in indoor air from soil gas migration (vapor intrusion) as indicated by the comment. USEPA and DTSC guidance clearly state that screening analysis is not appropriate at sites with shallow groundwater (<10 feet), such as the case with Remco and adjacent residential areas on Franklin Avenue. Thus, CDHS recommended indoor air sampling be conducted, which was carried out by the Willits Trust (please see Evaluation of Soil Vapor/Gas Migration into Buildings section in PHA). CDHS' evaluation and conclusions were based on actual indoor air data collected from residences on Franklin Avenue, not screening values or estimates*.

The CDHS concludes on the basis of their review of groundwater data that the maximum concentrations of VOCs do not present a risk to human health through the indoor air pathway. They base this analysis on a "1,000-fold dilution factor" for the migration of VOCs in groundwater to indoor air and a review of limited indoor air sampling conducted by the Willits Trust.

<u>CDHS Response</u>: *As stated above and shown in the PHA, the conclusions were based on actual indoor air sampling, not screening values or estimated concentrations from groundwater data.*

The "1,000-fold dilution factor" proposed by CDHS was selected from the dilution factors cited by the Department of Toxic Substances Control (DTSC) in the *Interim Final Guidance for Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air* dated 15 December 2004 and revised 7 February 2005 ("DTSC Indoor Air Guidance"). In fact, in the DTSC document includes a range of dilution factors from 10 to 10,000. The DTSC default attenuation factor for existing residences with a slab on grade construction or crawl spaces is 200 and the default attenuation factor for residence with basements is 10 (see Table 2 - Attenuation Factors). Thus, the Comprehensive PHA should have considered a range of attenuation factors. Even using the non-conservative attenuation factor assumed by the CDHS, the concentrations of VOCs in groundwater would result in theoretical increased cancer risks that may be deemed significant for residents over the plume. Of particular concern is the presence of vinyl chloride, the most toxic of the VOCs present in groundwater. At the maximum concentration in groundwater cited by the CDHS (39 µg/L), vinyl chloride exceeds the San Francisco Bay Regional Water Quality Control Board Environmental Screening Level for residential uses by an order of magnitude (3.9 µg/L). As described below, even using the CDHS assumed attenuation factor of 1000 and the measured concentration of 3.9 μg/L vinyl chloride in groundwater, the calculated indoor air concentration is almost 500 times higher than the 1 in1,000,000 cancer risk concentration.

<u>CDHS Response:</u> CDHS appropriately evaluated the indoor air pathway using actual indoor air data. In the absence of soil gas data, groundwater data alone is not adequate for estimating risks from vapor intrusion (DTSC Indoor Air Guidance, 2005). DTSC guidance clearly states that the converting groundwater data (using partitioning equations, as done by EKI) to a gas phase is too uncertain for evaluating risk from vapor intrusion. Further, the groundwater data used by EKI in their equation were "grab" samples, which should not be used for evaluating vapor intrusion.

In addition, the CDHS incorrectly calculates the indoor air concentration of cis-l ,2-DCE based on the measured groundwater concentration of 940 μg/L 1,2- DCE (page 17). Considering the groundwater concentration of 940 μg/L, a dimensionless Henry's constant of 0.167, **a soil gas to indoor air attenuation factor of 1,000**, the indoor air concentration of 1,2-DCE would be 157 $\mu g/m^3$, not 3.6 $\mu g/m^3$ as described by CDHS. For comparison, the Region IX PRG for 1,2-DCE in ambient air is 37 $\mu g/m^3$.

<u>CDHS Response:</u> CDHS did not state that there is a "<u>soil gas</u> to indoor air attenuation factor of 1,000", as suggested by the comment. The PHA states, "studies on soil gas migration have shown generally, that a 1,000-fold dilution factor can be assumed between the levels of <u>VOCs</u> in <u>groundwater</u> and the levels of VOCs that could be in indoor air as a result of soil gas migration". The discussion in the PHA regarding attenuation/dilution was meant to provide a community member with a general understanding that VOC concentrations measured in <u>groundwater</u> would not result in the same concentration in indoor air, due to soil gas migration. We utilized a <u>groundwater concentration</u> for 1,2-DCE as an example of what the concentration in indoor air would be, assuming a dilution factor of 1,000; it was not a prediction or screening level for 1,2-DCE. We recognize that presenting this example was confusing and have removed the example from the PHA.

In addition to the incorrect interpretation and use of the attenuation factor, EKI provides "theoretical" concentrations for vinyl chloride and 1,2-DCE in indoor air, but fails to mention the fact that neither vinyl chloride nor 1,2-DCE were detected in any of the actual indoor air or crawl space samples collected. It is unclear why EKI provides an increased cancer risk using estimated data, when actual indoor air sampling does not indicate the presence of vinyl chloride (at the reporting limit of 0.026 – 0.045 μg/m3).

The EKI statements and theoretical estimations are misleading to the public and may create unnecessary alarm.

EKI's calculation used the following equations from the DTSC Indoor Air Guidance:
C indoor air = attenuation factor * C soil gas
C soil gas = C groundwater * Hc * Conversion factor
attenuation factor = ratio of indoor air to soil gas (assumed to be 1,000 by CDHS)
C soil gas = Soil gas concentration ($\mu g/m^3$)
C groundwater = Groundwater concentration (μg/L)
Hc = Dimensionless Henry's constant

Conversion factor = 1000 (L/m^3)

Similarly, the calculated indoor air concentration for vinyl chloride would be 43 µg/m^3 assuming a groundwater concentration of 39 µg/L, a Henry's constant of 1.11, and the assumed non-conservative attenuation factor of 1000. For comparison, the Region IX PRG for vinyl chloride in ambient air is 0.11 µg/m^3 and the ATSDR CREG for vinyl chloride is 0.1 µg/m^3.

<u>CDHS Response</u>: EKI's calculation is incorrect, based on the above premise that an "attenuation factor = ratio of indoor air to <u>soil gas</u> (assumed to be 1,000 by CDHS)". CDHS never stated that there is a soil gas to indoor air attenuation factor of 1,000, as suggested above (in bold). EKI has incorrectly interpreted the sentence in the PHA which states, "studies on soil gas migration have shown generally, that a 1,000-fold dilution factor can be assumed between the levels of <u>VOCs</u> in <u>groundwater</u> and the levels of VOCs that could be in indoor air as a result of soil gas migration".

EKI's comparison to the PRG and ATSDR CREG is inappropriate for two reason: 1) the calculation is based on a false premise and: 2) vinyl chloride was not detected in any of the indoor air or crawl space samples collected.

The Comprehensive PHA then relies upon limited indoor air sampling conducted by the Willits Trust to conclude that no exposures above those commonly found in homes is currently occurring. In fact, the science of indoor air sampling is not well established. At a minimum, given the changes in groundwater elevation that occur over the course of a year (which can "pump" VOCs from groundwater and soil gas into overlying structures) and the changes in temperature and heating and cooling (which affect how VOCs might be drawn into a residence), sampling should be conducted over the course of a year to examine potential variations. This has not been done for residents overlying the groundwater plume off of the Remco Site.

<u>CDHS Response</u>: CDHS agrees that seasonal variations can affect migration of soil gas. The Willits Trust has purchased and demolished all the houses on the south side of Franklin Avenue that overlie the groundwater plume, making additional indoor air sampling impossible.

Further, the Comprehensive PHA compares the limited indoor air sampling data with limited and apparently subjectively selected "health comparison values." Table 4 in the Comprehensive PHA includes some (but not all available) Region IX preliminary remediation goals ("PRGs"), Office of Environmental Health Hazard Assessment reference exposure levels ("RELs"), Agency for Toxic Substances and Disease Registry ("ATSDR") minimal risk levels ("MRLs"), and ATSDR cancer risk evaluation guides ("CREGs"). There are instances, however, where the selected health comparison values are not conservative values and the basis for the CDHS selected value is not discussed or justified. For example, the MRL given for TCE (538 µg/m^3) in Table 4 is for an intermediate exposure (1 to 364 days) for noncancer health effects. The PRG value of 0.017 µg/m^3 for 1 in 1,000,000 increased cancer risk is neither selected or included on Table 4 for comparison.

<u>CDHS Response:</u> CDHS used the most conservative (health protective) noncancer health comparison value available for TCE, which is the ATSDR intermediate MRL. We have revised the table to include additional reference values. It is worth noting that the PRG value for TCE is

based on a cancer potency factor that has been withdrawn by the USEPA; thus it should not be assumed that exceeding the PRG results in a 1 in 1,000,000 (one million) increased cancer risk. CDHS calculated the increased cancer risk from exposure to TCE at a level of 0.96 µg/m^3 (the highest level measured in indoor air in a former residence on Franklin Avenue), using the OEHHA unit risk factor for TCE (0.000002 µg/m^3)$^{-1}$. The estimated increased cancer risk for a residential exposure scenario is 2 in 10,000,000 (ten million), which is considered "no apparent increased risk".

The Comprehensive PHA apparently uses studies from 1986 and 1990 to compare the limited indoor air sampling VOC concentrations with other studies of background indoor air quality. However, recent literature suggests the cited data may not be representative of current conditions. For example, the Comprehensive PHA cites the range of 1 to 20 µg/m^3 for TCE in indoor air whereas a comprehensive study in the Denver area yielded a median TCE concentration of 0.13 µg/m^3 (Krutz and Folkes, 2002). If background indoor air quality concentrations are to be compared with the limited indoor air data available for the Remco Site, a literature review with more recent citations should be conducted.

<u>CDHS Response:</u> *CDHS reviewed the indoor air study referenced by EKI in the comment. In the study, residents were advised to "avoid cleaning prior to sampling, to avoid hobbies that utilize VOCs, and to remove VOC-containing materials from their basements and garages." As a result the authors caution that the background indoor air results may not represent "typical" indoor air. Additionally, the maximum level of TCE measured in the study was 27 µg/m^3, which is higher than the upper end value cited in the PHA.*

The main focus of the PHA is to evaluate potential health impact from soil gas migration, based on site-related data. Providing additional literature citations will not change the conclusions reached by CDHS.

EKI concludes that the indoor air exposure pathway is likely an open exposure route for offsite residents in homes overlying the Remco contamination. Additional evaluation of the potential for exposure and actions necessary to protect human health should be defined in the human health risk assessment and remedial plan developed under the jurisdiction of the RWQCB.

<u>CDHS Response:</u> *There are no off-site residences overlying the VOC groundwater plume and thus, indoor air is not an "open exposure route" as indicated by the comment. To some extent the past is an "open exposure route" because of a lack of data prior to the early 2000s.*

As stated in the PHA, remediation of the groundwater is necessary to prevent potential exposure in the future. As specified by law, the human health risk assessment will provide information that will guide the remedial decisions for the Remco site.

EKI Issue 4: The CDHS does not correctly evaluate potential historic exposures to hexavalent chromium in air due to past Remco operations.

As noted in the 14 January 2005 letter prepared by EKI, it is apparent that some level of hexavalent chromium was released from the Remco facility into the air during historic operations. Data indicate that chromium may be currently present at the former Remco Site in dust, soil, and groundwater. However, there are no known actual measurements of chemicals in the ambient air that were taken on the property or off-site during facility operations. The estimates of historic airborne hexavalent chromium concentrations and resulting estimated cancer risks presented in the Final PHA (referenced and repeated in the Comprehensive PHA) are based on air dispersion modeling. Although some site-specific data are available, the site-specific data as acknowledged in the Final PHA to be "sparse" and "conflicting". In addition there can be substantial disagreement regarding adaptation of the site-specific data for model input parameters[1]. In the absence of site-specific data for certain input parameters, there is still more likelihood disagreement regarding assumptions required for model simulations. Consequently, there is no way to know what levels of chromium were present in ambient air in the Willits community in the past. Therefore, the potential for human health effects related to historic discharges of hexavalent chromium are also not known. However, the available data referenced by CDHS itself do not suggest a measurable increase in cancer cases in Willits that might be relate to the Remco discharges.

CDHS Response: The above comments have already been expressed by EKI and addressed in detail by CDHS in the Final Public Health Assessment, Evaluation of Exposure to Historic Air Releases from the Abex/Remco Hydraulics Facility, July 20, 2004.

EKI has taken certain words ("sparse" and "conflicting") from the document out of context, to make implications about the modeling. EKI elected not to conduct an independent review of the air modeling, but instead to rely solely on the opinions expressed by Latham and Watkins, lawyers for the responsible party (Pepsi Americas). The issues expressed by Latham and Watkins, if valid, would not have changed the conclusion presented in the PHA; high levels of airborne hexavalent chromium were released into the community from the Remco facility. The air modeling and PHA conducted for the Remco site underwent a rigorous review process, which included external scientific review similar to what published journal articles undergo before publication.

In the concluding sentence above ("available data referenced by CDHS itself do not suggest a measurable increase in cancer cases in Willits that might be relate to the Remco discharges. ") EKI makes reference the Cancer Registry data reviewed by CDHS; these data do show more lung cancer cases than expected, though not statistically significant. Limitations with Cancer Registry data restrict the ability to determine whether there was or could be a measurable increase in cancer cases in Willits related to Remco releases. Please refer to the Health Outcome section of the PHA for a more detailed discussion on the limitations of Cancer Registry data.

EKI CONCLUSIONS

The CDHS comprehensive PHA is a "screening level" evaluation that is intended to provide "an initial look at the site to help determine what follow-up activities are needed: additional site characterization, health education, health study, or specific measures to reduce or eliminate exposures". Given the fact that the Comprehensive PHA is only a screening level evaluation, no final conclusions regarding potential human health risks related to the contamination at the

1. The CDHS acknowledges this complexity in its response to comments on the draft PHA submitted by Latham and Watkins on behalf of Whitman.

Remco Site should be made by the City of Willits based on the findings presented in the document. A more comprehensive analysis will be presented in the human health risk assessment being prepared by the Willits Trust for submission to the RWQCB.

EKI agrees with the recommendation that measures should be undertaken to mitigate future potential exposure to chromium remaining at the former Remco facility. EKI believes that these measures will be defined as part of the remedial investigation/remedial action plan process currently being conducted with oversight from the RWQCB.

As indicated above and in our 14 January 2005 letter, the CDHS analysis of potential exposures due to past releases of hexavalent chromium to the atmosphere is flawed. EKI recommends that the City of Willits consult with the appropriate qualified professionals regarding this issue and the CDHS recommendations regarding the provision of counseling and stress support services for impacted residents and medical monitoring/clinical evaluation for Willits residents and people who worked in Willits who may have been exposed to chromium when the Remco facility was operational.

CDHS Response: *On January 26, 2005, EKI provided a summary of the PHA to the Willits City Council, at which time Earl James of EKI stated that the final PHA was scientifically sound. It is unclear why EKI appears to be giving inconsistent guidance to the City of Willits.*

On March 29, 2006, CDHS in collaboration with Robert Harrison, M.D., professor of Occupational and Environmental Medicine at the University California of San Francisco (UCSF) Medical Center convened a workshop of clinicians, with expertise in occupational and environmental medicine to discuss medical monitoring for Willits residents. The workshop included a consultant (Robert Blink) hired by the City of Willits. There was consensus by the group of experts that outreach and some form of medical evaluation program is appropriate for the Willits community. A summary of the workshop proceedings and recommendation of the expert work group will be provided in a report scheduled to be released summer 2006.

[Letter signed by Earl James, Remco project manager and Vice President of Erler & Kalinowski, Inc.]