FINAL

FOCUSED RISK ASSESSMENT FOR THE PERSON GENERATING STATION PUBLIC SERVICE COMPANY OF NEW MEXICO

Prepared For

PUBLIC SERVICE COMPANY OF NEW MEXICO

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EXECUTIVE SUMMARY

The objective of this report is to quantitatively characterize under both current and unlikely, but potential future exposure scenarios the probable carcinogenic and noncarcinogenic risks posed to human health from volatile organic compound (VOC) contamination in soil and shallow ground water at the Public Service Company of New Mexico's Person Generating Station site, Albuquerque, New Mexico. This report evaluates and documents potential threats that would be posed by existing site contamination if no remediation were completed at the site. This report also investigates whether the planned remedial action project is expected to restore the site to a state that is adequately protective of human health. Additionally, this report provides information that can be used to determine concentrations of chemicals that can remain onsite and still be protective of human health.

Previous environmental characterizations at the Person Generating Station site have detected several VOC contaminants, including 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE), and tetrachloroethene (PCE), in both soil and shallow ground water. The source of this contamination was a below-grade waste oil tank, which was removed from service in October 1983. The tank was used to store a variety of liquid waste streams, including steam cleaning residues containing chlorinated solvents.

The Public Service Company of New Mexico prepared a shallow ground water remedial action plan for the site as directed in Phase II, Item 1.B, of the Corrective Action Directive (CAD). The remedial action proposed for the site consists of a two-phased approach to soil and shallow ground water treatment (i.e., initial phase of pilot testing and a second phase of full-scale remediation). Based on the physical site conditions and the nature and extent of contamination, soil vapor extraction and ground water pumping and treatment were identified as the appropriate remedial technologies to implement at this site. Past experience and site-specific, preliminary quantitative analysis of the expected performance of these technologies demonstrate that these technologies should be effective at both removing source contamination and minimizing the potential migration of contaminants. The New Mexico Environment Department has approved this remedial action plan, and initial technology tests are scheduled to begin in late August of 1994.

Quantitative risk information was developed in support of the remedial action plan for the site. Four general types of receptors were considered to evaluate both current and hypothetical future risks posed by exposure to current levels of contamination and by exposure to residual contamination left onsite following completion of the planned remedial project. All risk calculations incorporate potential cumulative risks due to exposure to 1,1,1-TCA, 1,1-DCE, and PCE in all affected environmental media. Existing site characterization data and fate and transport calculations were used to conservatively estimate the risk assessment concentration levels by media for each of the three VOCs. Toxicity information for the three VOCs was obtained from technical literature.

Exposure equations using U.S. Environmental Protection Agency (EPA) risk assessment methods were developed for several different types of receptors: onsite and offsite current and hypothetical future light industrial/commercial workers, onsite current remediation/construction workers, onsite and offsite hypothetical future residents, and offsite current recreators. Although the physical characteristics and location of the site will likely prohibit unrestricted future residential development, conservative risk estimates based on hypothetical future residential land use were developed for comparison purposes. Risks to hypothetical current residents were also calculated. These risks assume no remediation (i.e., baseline conditions). They were included at the request of New Mexico Environment Department for comparison purposes. Specific risks posed to considered receptors were evaluated by factoring appropriate exposure pathways into the receptor-specific exposure equations. Exposure routes that could be included were dermal contact with contaminated soil, incidental ingestion of contaminated surficial soil, inhalation of VOCs in the outdoor breathing zone due to upward diffusion through soil into the atmosphere, inhalation of VOCs in buildings, dermal contact with contaminated ground water, inhalation of contaminants during domestic use of contaminated ground water, ingestion of contaminated ground water during domestic use, dermal contact with ground water routed into surface water used for recreation, and incidental ingestion of contaminated ground water routed into surface water used for recreation. Total risks posed to each receptor were evaluated by summing the possible risks posed by exposure to each contaminant for all exposure pathways.

Quantitative estimates of total risk for current exposure scenarios for onsite and offsite light industrial/commercial workers and onsite remediation/construction workers demonstrate that exposure to existing site contamination at the site is below the EPA target risk range of one individual in one million (10^{-6}) to one individual in ten thousand (10^{-4}) developing cancer over a lifetime and is not expected to cause any noncarcinogenic effects. In other words, existing levels of contamination at the site do not present a significant threat, as defined by EPA risk assessment policy and guidance, to individuals that may be reasonably expected to be exposed under current site conditions (which also included the planned remedial action).

It is important to note, however, that because of more conservative exposure pathways, existing site contamination may pose an unacceptable risk to both onsite and nearby offsite hypothetical residents if the site were to remain unremediated, and to surface water recreators if extracted ground water is not treated before discharge to surface water bodies. Quantitative calculations of total risk for potential future residential exposure scenarios, which are based on conservative estimates of the expected level of residual contamination remaining onsite following completion of the planned remedial action, suggest that the planned remedial action should result in a level of cleanup that will be adequately protective of human health (i.e., resulting in a cumulative individual carcinogenic risk level within the target risk range of 10^{-4} to 10^{-6} and no noncarcinogenic hazards), even for hypothetical future onsite and offsite residents. Similar calculations of total risk for potential future surface water recreators indicate that treatment of extracted shallow ground water via air stripping and carbon adsorption prior to discharge to receiving surface water, which is currently part of the remedial action plan for the site, will achieve concentration levels that are adequately protective of human health.

The second objective of this report was to develop an estimation of the level of contamination that could remain onsite and still be adequately protective of human health. Risk-based preliminary remediation goals (PRGs) for soil and shallow ground water were developed for each of the VOCs using a cumulative carcinogenic target risk level of 1×10^{-5} and a cumulative noncarcinogenic level of 1.0. The three receptors used to characterize existing and expected residual risk following implementation of the planned remedial project were also used to develop these risk-based PRGs. Existing concentrations of soil contamination are less than the most stringent risk-based PRGs, suggesting that planned soil remediation is necessary only to remove source contamination and prevent potential additional ground water degradation. Using the most conservative land use assumption (unrestricted residential development), target risk-based PRGs for shallow ground water are 3,000 parts per billion (ppb), 0.1 ppb, and 4.8 ppb for 1,1,1-TCA, 1,1-DCE, and PCE, respectively. The risk-based target cleanup level for 1,1,1-TCA is greater than the Maximum Contaminant Levels (MCLs); however, the risk-based PRGs for shallow ground water for PCE and 1,1-DCE are less than their MCLs, due to the chemicals' carcinogenicity. This information should be very useful during future discussions about realistic cleanup goals for the Person Generating Station site.

SECTION 1

INTRODUCTION

Engineering-Science, Inc. (ES) was contracted by the Public Service Company of New Mexico (PNM) to perform several critical tasks involved in selecting, designing, and implementing an appropriate remedial action at the Person Generating Station site near Albuquerque, New Mexico. This report supplements the *Corrective Measures Proposal* (CMP) prepared in accordance with Phase II, Item 1.B, of the Corrective Action Directive (CAD) (Engineering-Science, 1994). The CMP evaluated and recommended the most appropriate remedial technologies for the site, and provided a conceptual design of the recommended remedial approach. Although a preliminary exposure assessment was included in the CMP, the New Mexico Environment Department (NMED) determined that additional quantitative risk information was necessary to assess the continuing need for and effectiveness of the remedial action described in the CMP.

It is appropriate at this point to define some of the key terms used in this focused risk assessment. A *risk assessment* is the scientific estimation of a hazard. A *baseline risk assessment* describes the hazards that might exist if no remediation or institutional controls were applied at a site. The term *focused risk assessment* describes a more specialized risk assessment that incorporates the objectives of different types of risk assessments as described in the U.S. Environmental Protection Agency's (EPA's) Risk Assessment Guidance for Superfund (RAGS) manuals (EPA, 1989, 1991a, 1991b). *Exposure assessment* involves estimating the type and magnitude of exposures to contaminants of concern (COCs) that are present at or migrating from a site. A *risk assessment concentration level* or *exposure point concentration* is the highest concentration a potential receptor would reasonably be expected to contact. A *toxicity assessment* defines the dose at which adverse effects caused by exposure to a COC may occur. And finally, a *risk-based preliminary remediation goal* (PRG) is a long-term target concentration based on toxicity information rather than on promulgated cleanup standards, and which can be used to analyze, select, and design an appropriate remedial action.

1.1 PURPOSE AND OBJECTIVE

The purpose of this report is to quantitatively characterize under both current and hypothetical future exposure scenarios the potential carcinogenic and noncarcinogenic risks posed to human health from volatile organic compound (VOC) contamination in soil and shallow ground water at the Person Generating Station site. The source of this contamination was a below-grade waste oil tank, which was removed from service in

October 1983. The tank was used to store a variety of liquid waste streams, including steam cleaning residues containing chlorinated solvents. There are three separate objectives of this focused risk assessment. First, this report evaluates and documents potential threats posed by existing site contamination if no action were taken. Second, this report investigates whether the remedial action already planned for the site will pose health risks during implementation and whether such action is expected to restore the site to be adequately protective of human health (commonly termed the risk evaluation of a remedial alternative). This evaluation focuses on the potential risks associated with the remedial action recommended in the CMP, plus potential risks associated with any residual contamination. Third, this report provides information which can be used to determine the levels of contamination that can remain onsite and still be protective of human health, both now and in the future.

1.2 RISK ASSESSMENT APPROACH

A focused risk assessment strategy was implemented to best support the remedial action project planning for the Person Generating Station site. A baseline risk assessment was determined to be inappropriate at this time since PNM and the NMED have already agreed to begin remediation at the site. The focused risk assessment strategy couples elements of the traditional baseline risk assessment and elements of an evaluation of the short- and long-term risks associated with implementing a remedial action at a site. Risks were quantitatively evaluated using a site-specific approach based on the risk assessment principles and procedures outlined in the EPA RAGS (EPA 1989, 1991a, 1991b) manuals.

This focused risk assessment quantitatively evaluated risks posed to human receptors due to exposure to VOC contamination in soil and shallow ground water at the Person Generating Station site. Risks to ecological receptors were not addressed as part of this effort because the site is currently developed for industrial use only, it does not support rare or economically valuable ecological resources, and significant concentrations of VOCs are not likely to be accessible to potential ecological receptors, either now or following remediation.

Existing site characterization data and fate and transport calculations were used to conservatively estimate the concentration levels by media for each of the three VOCs of concern at the site [1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE), and tetrachloroethene (PCE)]. Representative, media-specific concentration levels were developed using the methods specified for calculating exposure point concentrations appropriate for use in risk assessments per EPA (EPA, 1992a) guidance. Existing soil gas data were used in soil diffusion and outdoor/indoor air dispersion models recommended by the EPA to determine conservative exposure concentrations of VOCs under both outdoor and indoor conditions. This approach is conservative when evaluating potential residual site risks because the positive effects of vapor extraction (source removal) are not factored into the residual risk analysis. Existing surficial and vadose zone soil measurements taken from within the former waste tank area in 1984 were used to characterize soil contamination at the site. This approach is extremely conservative because the source area is currently covered by a 25 feet x 35 feet closure cap which minimizes downward infiltration and effectively eliminates the upward soil exposure pathway. However, in the absence of soil data more representative of onsite and offsite conditions, risk estimates assumed that these most contaminated soils are readily accessible and characteristic of all onsite and offsite soil. In effect, these concentrations represent a "worst case" concentration estimate.

Existing shallow ground water data were used to evaluate current site risks. Existing and modeled shallow ground water data were used to evaluate current and future and expected residual risks, respectively, due to exposure to contaminated ground water. Existing shallow ground water data were also used to evaluate the risks posed to hypothetical receptors under the most conservative exposure scenarios if no action were taken at the site.

Existing ground water data was also used to simulate possible surface water concentrations due to pumping and discharge activities in the absence of treatment. No dilution was considered. This data was used to evaluate potential risks to receptors if treatment of extracted ground water was not implemented during remediation activities. To determine whether the planned treatment of extracted ground water would be sufficient to protect potential receptors, concentrations expected in treated ground water to be discharged to surface water were based both on expected performance estimates and conservatively on surface water standards. The proposed treatment system is expected to reduce VOCs in the extracted shallow ground water to concentrations that meet existing surface water standards prior to discharge.

The CMP for the Person Generating Station site included a preliminary investigation of the effectiveness of coupling natural physical and chemical processes with more aggressive pump-and-treat actions to reduce contaminant concentrations in the shallow ground water. Simulated ground water data were used to assess the risks associated with expected residual shallow ground water contamination following implementation of the planned remedial project as described in the CMP. More detailed information on the data used in the focused risk assessment is presented in Section 3 of this report.

Assumptions about land use are at the heart of identifying potential receptors, potential exposure pathways, and reasonable exposure scenarios. The EPA advises that the land use associated with the highest (most conservative) potential level of exposure and risk that can reasonably be expected to occur should be addressed in a risk assessment (EPA, 1991c). Although the exposure scenarios based on hypothetical future residential land use provide the most conservative risk estimates and are important considerations in deciding whether to take an action at a site, EPA risk assessment guidance materials state that this conservative approach may not be justifiable if the site is surrounded by operating industrial facilities and can reasonably be assumed to remain as industrialized areas. In these cases, the EPA recommends using other exposure scenarios, such as agricultural or light commercial/industrial, including a qualitative assessment of the likelihood that the assumed reasonable future land use will occur (55 Federal Register 710). Because the physical characteristics and locale of the Person Generating Station site may prohibit future unrestricted residential development, this most conservative future land use assumption may not be reasonable and representative of the potential future exposure potential for the site. However, NMED requested that conservative risk estimates based on a hypothetical future residential land use be developed for the site, for comparison purposes.

The focused risk assessment includes seven different exposure scenarios:

- Scenario 1: Current risks to both onsite and nearby offsite light industrial/ commercial workers;
- Scenario 2: Current risks to onsite construction/remediation workers;
- Scenario 3: Current risks to potential offsite recreators during remediation activites;
- Scenario 4: Future risks to both onsite and nearby offsite light industrial/ commercial workers;
- Scenario 5: Future risks to onsite construction/remediation workers following remediation;
- Scenario 6: Future risks to both onsite and nearby offsite residents following remediation; and
- Scenario 7: Future risks to both onsite and nearby offsite residents if no action were taken at the site (for comparison purposes).

Risks to light industrial/commercial workers and construction/remediation workers incorporated carcinogenic and noncarcinogenic effects due to exposure to soil and soil gas contamination. No ground water component was included in these exposure scenarios because ground water is located approximately 110 feet below ground surface (bgs) and the planned remedial action consists of a fully enclosed extraction, treatment, and discharge system. It is highly unlikely that these receptors could reasonably be exposed to the ground water medium. VOC concentrations in shallow ground water affected by past activities at the Person Generating Station site were used to assess hypothetical potential residential exposures only (including surface water recreators). Routes of exposure to light industrial/commercial workers were assumed to be incidental ingestion and dermal contact with contaminated surficial soils and inhalation of VOCs within the outdoor breathing zone due to upward diffusion through the contaminated soils into the atmosphere. Routes of exposure to construction/ remediation workers were assumed to be incidental ingestion of and dermal contact with contaminated vadose zone soils currently covered by the protective closure cap and inhalation of VOCs within the outdoor breathing zone due to upward diffusion through the contaminated soils into the atmosphere.

Risks to potential offsite recreators incorporated carcinogenic and noncarcinogenic effects due to exposure to extracted ground water discharged to surface water during remediation. Although the primary recreation receptor is likely to be a golfer using the facilities near the surface water body receiving effluent discharge during remediation activities, a surface water recreator in direct contact with the affected medium during recreational events was assumed (i.e., swimmer). Routes of exposure were assumed to be incidental ingestion of and dermal contact with both contaminated and treated ground water during recreation. No inhalation component was considered. Routes of exposure involving secondary receptors (i.e., fish) were not considered reasonable even under the most conservative assumptions. The surface water body that may receive treated effluent from remedial activities does not and could not support commercial or sport fish populations.

Risks to hypothetical future residents reflected both the carcinogenic and noncarcinogenic effects due to exposure to soil gas, soil, and shallow ground water. Risks from domestic use of contaminated ground water were factored into the total risk calculation under the residential exposure scenario. Routes of exposure to this receptor included inhalation from showering with, dermal contact with, and ingestion of ground water; dermal contact with contaminated surficial soil; and inhalation of VOCs inside houses. More detailed information on the types of exposure considered for each receptor and how exposure equations were developed for this focused risk assessment is presented in Section 4 of this report.

Toxicity information used to characterize potential site risks under different exposure scenarios was obtained from the technical literature. Information on toxic endpoints (i.e., critical effects on target organs) was factored into the risk calculations. More detailed information on specific toxicity values and sources is presented in Section 5 of this report.

Cumulative total risk estimates were developed for each different exposure scenario considered in this report. Both carcinogenic and noncarcinogenic risks for each receptor were evaluated for all exposure pathways completed under conservative assumptions. These risks were summed for all chemicals and exposure pathways to define the total risk to a specific receptor. Section 6 presents these risk calculations and qualitatively discusses the meaning of these values.

1.3 RELATIONSHIP TO OTHER PLANNING DOCUMENTS

This focused risk assessment was prepared to support the remedial action described, evaluated, and recommended for implementation at the Person Generating Station site (Engineering-Science, 1994). Quantitative risk estimates can be useful in determining the level of remediation required at a site to protect current and potential future human receptors from harmful exposure to site contamination. This focused risk assessment makes use of all available site characterization data to develop medium-specific concentration estimates that are representative of potential exposures at the site. This focused risk assessment also conservatively evaluates the anticipated effectiveness of the planned remedial project in reducing the risk posed by site contamination to acceptable levels. Such data supplements existing technology performance evaluations to ensure that an appropriate response action is planned for the site. Finally, this focused risk assessment contributes to the overall design of the planned remedial action for the Person Generating Station site by specifying whether treatment of extracted ground water is necessary and identifying the level of residual contamination that can remain onsite and still be adequately protective of human health. These risk-based target cleanup goals provide benchmark values that can be used to guide final decisions on the required level of remediation at the site.

SECTION 2

SITE DESCRIPTION

The following sections briefly describe the physical characteristics and operational history of the Person Generating Station site. Summary information on the nature and extent of contamination from site activities is also presented.

2.1 PHYSICAL CHARACTERISTICS

The Person Generating Station site, which was operated and is maintained by the PNM, is located in the Albuquerque Basin, a physiographic drainage basin in the middle portion of the long Rio Grande Valley which runs north to south throughout New Mexico (Kelley, 1977). The Person Generating Station site is surrounded by operational industrial facilities and commercial businesses. The AT 8 SF Railroad runs through the right-of-way on the site's western boundary. Interstate 25 (and its right-of-way property) is located approximately 1,000 feet to the east of the site. The New Mexico Championship Golf Course is located to the northeast and downgradient of the Person Generating Station site, across Interstate 25. No residential developments currently exist within the immediate environs of the Person Generating Station site (see Figure 2.1).

The regional topography of the Rio Grande Basin is defined by the Rio Grande River, which flows perennially north to south, approximately bisecting the alluvial valley and creating an alluvial floodplain to the east and west. Tijeras Arroyo, which has eroded through the land surface southeast of the Person Generating Station site, opens south onto the Rio Grande floodplain and flows to the southwest. The land surface in the vicinity of the Person Generating Station site slopes from 5 to 40 percent to the west. Local landforms include dissected terraces and alluvial fans. The Person Generating Station site itself is characterized by physical topographical features and hardy, weedy vegetation common in semiarid, front range, industrial areas.

The ground water table is approximately 110 feet below ground surface (bgs) at the Person Generating Station site. Ground water generally flows southward within the Rio Grande Basin. However, in the immediate vicinity of the Person Generating Station site, the upper 25 to 35 feet of ground water flows about 82° east of south at a gradient of 0.43 percent, flattening east of Interstate 25 (Metric, 1993). Potentiometric measurements suggest the presence of a lower flow zone in which ground water flows 83° east of south at a gradient of 0.48 percent. Further details on site hydrogeology can be found in the *Corrective Action Directive Assessment Summary Report, Person Generating Station* (Metric, 1993) and the CMP (Engineering-Science, 1994).

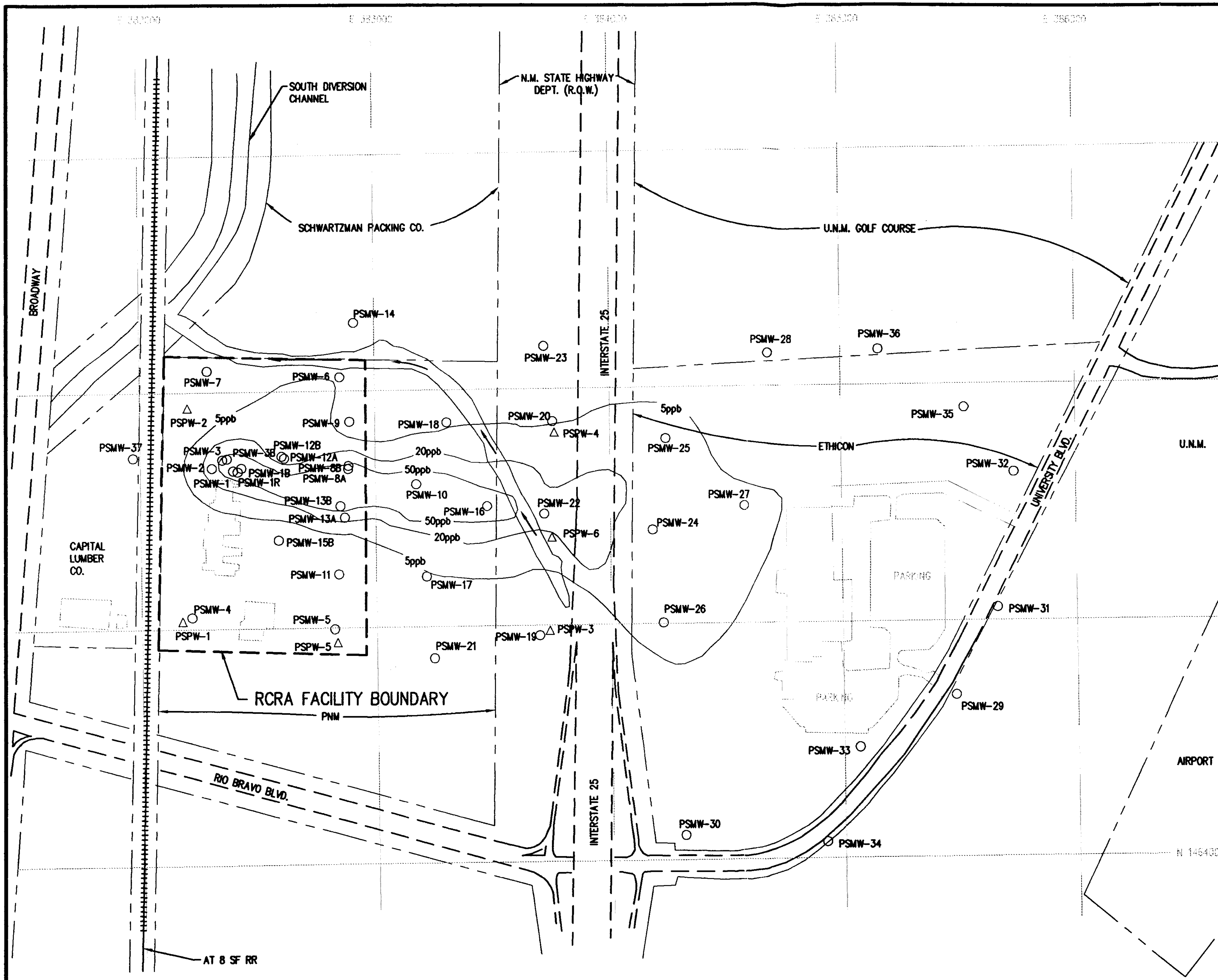


FIGURE 2.2

PUBLIC SERVICE COMPANY OF NEW MEXICO EXISTING CONCENTRATION (ppb) OF PCE IN GROUNDWATER

PERSON STATION
BERNALILLO COUNTY, NM

ENGINEERING-SCIENCE, INC.
Denver, Colorado

93DN1223, 03/15/94 at 10:39

2.2 OPERATIONAL HISTORY

The north side of the Person Generating Station site included a maintenance area, which supported, among other activities, equipment cleaning efforts. The wash area included a sump and a below-grade, vertically-placed 3.5 feet x 10 feet cylindrical waste oil storage tank to collect wastes generated during equipment cleaning.

Liquid wastes collected in the sump were piped approximately 9 feet to the waste oil tank. Historical records and interviews with retired personnel indicate that waste oils and greases, kerosene, a water-trisodium phosphate mixture used in steam cleaning, Stoddard Solvent, Dowclene EC, and other solvent mixtures generated during maintenance activities were piped into the tank (Metric, 1993). Dowclene EC is a generic solvent with two primary ingredients: 1,1,1-trichloroethane (1,1,1-TCA) and tetrachloroethene (PCE). Records suggest that major use of Dowclene EC began in 1979. Equipment repainting activities conducted in 1980 generated another type of liquid effluent, including waste paint, paint thinners, and turpentine, that also was collected in the waste oil tank. Maintenance personnel noted when the tank appeared to be full and arranged for various waste oil reclaimers to remove the contents and recycle the material at other locations.

The tank was apparently in use from about July 1976 until October 13, 1983, when it was discovered that the tank bottom was constructed of permeable soil. Immediately upon this discovery, PNM emptied the tank and removed it from service. PNM notified the EPA, the NMED, and the National Response Center of the discovery, and arranged for the most highly contaminated source material to be removed from the bottom of the tank and placed in 55-gallon steel drums. This drummed material was ultimately transported offsite in 1987 for disposal as hazardous waste.

Following removal of the tank from service, PNM installed a closure cap on the 25 feet x 35 feet source area to minimize infiltration of precipitation. The cap is composed of a minimum 6 inch thick concrete cap over a minimum 6 inch layer of compacted soil over two layers of 80-mil High Density Polyethylene (HDPE) plastic sheeting. The excavated material from the tank area was replaced with gravel overlain by compacted soil.

To assess the potential environmental contamination stemming from this waste oil tank, PNM conducted several assessment projects. Details of these projects are summarized in the CMP for the site. Briefly, PNM completed a series of environmental sampling programs to characterize the nature and extent of contamination in soil and shallow ground water, including source soil sampling, soil gas analysis, and extensive ground water monitoring. Results of these analyses were considered when developing an appropriate response action for the site. Results of these efforts are factored into this focused risk assessment to provide quantitative risk information in support of the planned remedial project described in the CMP for the site.

The Person Generating Station is no longer operational. Access to the site is restricted by a series of security fences and locked gates. Ongoing activities at the site are limited to environmental characterization and remediation.

2.3 NATURE AND EXTENT OF CONTAMINATION

As discussed previously, PNM has documented the presence of several VOCs in the subsurface. The principal contaminants identified during monitoring activities are 1,1,1-TCA, PCE, and 1,1-dichloroethene (1,1-DCE). It appears that storage of rinse waters containing Dowclene EC, which contained significant concentrations of two of these constituents (1,1,1-TCA and PCE), in the below-grade waste oil tank was the primary source of these contaminants. The presence of 1,1-DCE, which is not known to be a component of any of the liquid wastes introduced into the source waste oil tank, is likely attributable to the transformation of 1,1,1-TCA via hydrolysis. The transformation reactions probably initiated in the source waste tank and continued during downward migration into and within the shallow ground water. Decreasing levels of 1,1,1-TCA and increasing levels of 1,1-DCE in the shallow ground water plume support this conclusion.

2.3.1 Soil Contamination

Detailed information on the extent of soil contamination at the Person Generating Station site in the vicinity of the source waste oil tank was reported in the *Final Soil Contamination Assessment Report* for the site (Geoscience Consultants, 1984). This assessment documented high concentrations of VOCs in the upper 65 feet of the 110-feet-thick vadose zone between the previous location of the tank bottom and the ground water table. Laboratory analysis of soil borehole samples taken from the former waste oil tank area focused on PCE. Soil sample results showed that the bulk of contaminated soil extends downward approximately 70 feet, is approximately 30 feet in diameter, and includes about 60,000 cubic feet of soil. Concentrations of contaminants measured in the surficial soil (i.e., the top 3 inches) at the site are significantly less than concentrations found in deeper soils. This characteristic profile of increasing contamination with depth is expected because of the volatile nature of the chemicals and because of the presence of waste oil tank water, which once provided a mechanism for downward transport through the vadose zone. However, because this mechanism has not existed since 1983, soil contamination is not likely to still be migrating appreciably downward toward the ground water. This hypothesis is further supported by data which show very low concentrations of VOCs in soil from 70 feet bgs down to the ground water table, even in the most contaminated soil.

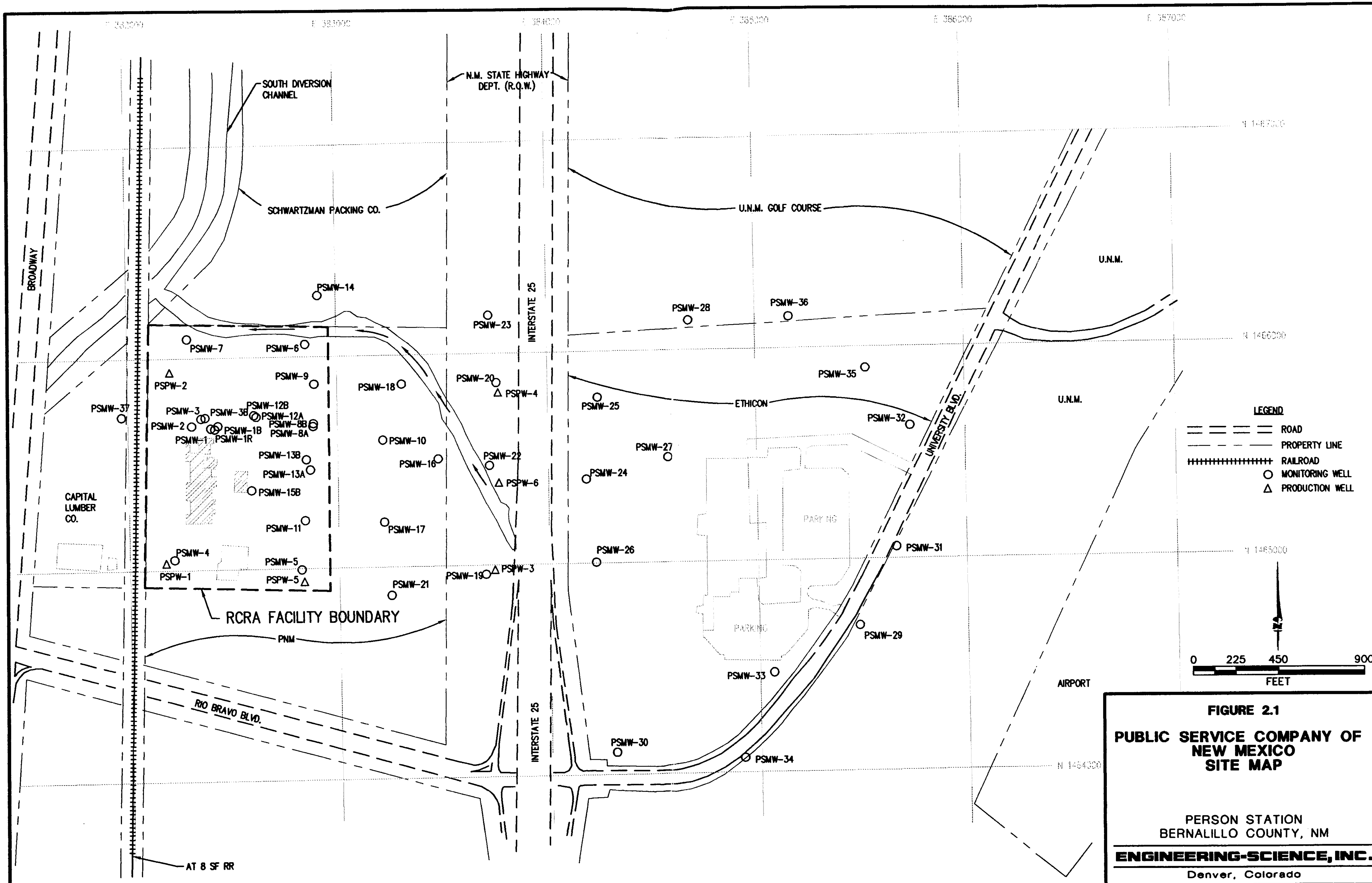
2.3.2 Shallow Ground Water Contamination

Several completed and ongoing assessments at the Person Generating Station site focus on determining the horizontal and vertical extent and rate of movement of the VOC plume in the shallow ground water (Geoscience Consultants, 1984; Tracer Research Corporation, 1990; Metric, 1993; Engineering-Science, 1994). Ground water monitoring data and indicator soil and soil gas data all demonstrate that the total estimated areal extent of the dissolved VOC plume is approximately 36 acres (Metric, 1993). PCE and 1,1-DCE plumes extend downgradient to the east about 2,400 feet from the former waste oil tank area. The 1,1,1-TCA plume extends about 1,200 feet downgradient from the former waste oil tank area. The smaller horizontal extent of the 1,1,1-TCA plume may be attributable to a less-concentrated source and/or more effective *in situ* removal mechanisms in comparison to the other two VOCs.

Figure 2.2 illustrates the areal extent of the existing PCE plume, which is representative of the entire area affected by all three measured VOCs (adapted from Metric, 1993).

The vertical extent of shallow ground water contamination under the Person Generating Station site is about 20 feet below the ground water table. There is no evidence of dense nonaqueous phase liquids (DNAPLs) in the shallow ground water underlying the site. PNM is also currently investigating the nature and extent of contamination in the deeper aquifer. This focused risk assessment is intended to evaluate risks posed by exposure to contamination in soils and shallow ground water.

Monitoring well data from the last five years suggest the plume may have reached its maximum areal extent and may actually be shrinking (Metric, 1993). It is conceivable that the horizontal extent of the shallow VOC ground water plume may be largely attenuated by natural processes, including a general lowering of the ground water table (at a rate of 1 foot/year) in the area. VOCs that have been adsorbed or absorbed onto immobile soil and organic material in the aquifer may have been left stranded above the ground water table and unavailable to mass transport mechanisms (e.g., advective ground water flow). It has been suggested that a portion of these VOCs may ultimately be transported upward through the vadose zone by diffusion in the soil gas and slowly discharged into the atmosphere (Metric, 1993). Other subsurface characteristics (e.g., low local gradients, heterogeneous permeabilities) may also be limiting the movement of the VOCs over large distances. Fate and transport model simulations completed in support of the CMP for the Person Generating Station site suggest that the shallow VOC plume will not significantly increase in areal extent even if no action other than source removal were taken at the site.


SOUTH DIVERSION CHANNEL
N.M. STATE HIGHWAY DEPT. (R.O.W.)
SCHWARTZMAN PACKING CO.
U.N.M. GOLF COURSE
U.N.M.
BROADWAY
INTERSTATE 25
PSMW-14
PSMW-23
PSMW-28
PSMW-36
PSMW-7
PSMW-6
PSPW-2
PSMW-9
PSMW-18
PSMW-20
PSPW-4
PSMW-25
ETHICON
PSMW-35
PSMW-32
UNIVERSITY BLVD.
PSMW-37
PSMW-3
PSMW-3B
PSMW-12B
PSMW-12A
PSMW-8B
PSMW-8A
PSMW-2
PSMW-1B
PSMW-1
PSMW-1R
PSMW-10
PSMW-13B
PSMW-13A
PSMW-15B
PSMW-16
PSMW-22
PSPW-6
PSMW-24
PSMW-27
CAPITAL LUMBER CO.
PSMW-11
PSMW-17
PARKING
PSMW-26
PSMW-31
PSMW-4
PSPW-1
PSMW-5
PSPW-5
PSMW-19
PSPW-3
PSMW-21
RCRA FACILITY BOUNDARY
PNM
PARKING
PSMW-29
PSMW-33
AIRPORT
RIO BRAVO BLVD.
PSMW-30
PSMW-34
AT & SF RR
LEGEND
ROAD
PROPERTY LINE
RAILROAD
MONITORING WELL
PRODUCTION WELL
0 225 450 900
FEET
FIGURE 2.1
PUBLIC SERVICE COMPANY OF NEW MEXICO SITE MAP
PERSON STATION
BERNALILLO COUNTY, NM
ENGINEERING-SCIENCE, INC.
Denver, Colorado

SECTION 3

DATA EVALUATION

Existing soil, soil gas, and ground water data collected at the Person Generating Station site were used to evaluate current and future site risks if no remedial action were taken at the site. Existing ground water data and technology performance estimates were used to evaluate potential site risks associated with extraction and discharge of shallow ground water during remediation. Existing soil and soil gas data and modeled ground water data were also used to conservatively evaluate the anticipated effectiveness of the planned remedial action in minimizing the risks due to hypothetical future exposure to residual site contamination. The following sections describe what data and analysis methods were used to derive exposure point concentrations used in risk calculations for the site.

3.1 CONTAMINANTS OF CONCERN

Three COCs were used to evaluate potential site risks: 1,1,1-TCA, 1,1-DCE, and PCE. Although several other VOCs have been occasionally reported in samples above detection limits [i.e., chloroform, 1,1-dichloroethane (1,1-DCA), 1,2-DCA, trichloroethene, and bromochloromethane], they have only been detected in less than 5 percent of the sampled media. In accordance with EPA risk assessment methods, contaminants with a frequency of detection of less than 5 percent can be omitted from the risk assessment process. Therefore, risk calculations included in this focused risk assessment are limited to 1,1,1-TCA, 1,1-DCE, and PCE.

3.2 TYPES OF AVAILABLE DATA

The following sections summarize the data used to develop representative exposure point concentrations for each COC by media.

3.2.1 Existing Soil Gas Data

A shallow soil gas investigation was recently completed at the Person Generating Station site (Tracer Research Corporation, 1990). Data were collected from 40 onsite and 12 offsite sample locations. Rather than develop soil gas concentration estimates based on a simple gas diffusion model and soil contamination data, actual measured soil gas data were used to investigate potential carcinogenic and noncarcinogenic effects due to inhalation of volatilizing COCs under both outdoor and indoor conditions. These data were used to assess both current and future risks if no remediation were completed at the site and potential future risks posed by exposure to site contamination following planned remediation. No attempt was made to adjust soil concentrations to reflect representative soil gas concentrations anticipated following remediation. Initial engineering estimates suggest that the planned soil vapor extraction activities at the site should effectively reduce soil contamination and soil gas contamination by at least 90 percent. Using unremediated soil contamination values will provide a conservative estimate of potential risks due to this exposure pathway.

3.2.2 Existing Soil Data

Data on the nature and extent of soil contamination at the Person Generating Station site in 1984 are readily available (Geoscience Consultants, Ltd., 1984), However, surficial and vadose zone soil data were only collected within the former waste oil tank area prior to installation of the closure cap. Exposure concentration levels based on these 19 samples are extremely conservative for two important reasons. First, these data are representative of only the most contaminated soil material at the site. Use of this data to characterize potential representative soil concentrations to which potential human receptors may be reasonably exposed will overestimate the amount of soil contamination at the site. For example, even if these soil concentrations were representative of onsite conditions, it is highly unlikely that these concentrations reflect existing or potential offsite conditions. As discussed, data indicate that soil contamination is limited to the soil column which extends approximately 70 feet bgs and approximately 30 feet in diameter directly beneath the former waste oil tank area. No vertical transport mechanism has existed since 1983 (when PNM ceased to use the waste oil tank to store liquid wastes) to facilitate the downward advection of soil contamination. No significant lateral transport mechanism exists to allow soil contamination to migrate beyond this source area.

Second, the presence of the 25 feet x 35 feet closure cap over the former waste oil tank area effectively makes these soils inaccessible to human receptors under most reasonable exposure assumptions. The only way that a current or hypothetical future receptor could come into contact with these soils would be to dig beneath the closure cap. This is not a reasonable exposure assumption. However, in the absence of soil data more representative of actual exposure conditions at the site, these data were used to provide a "worst case" or bounding estimate of potential risks due to exposure to site soil contamination.

Surficial soil (0 - 3 inches) and vadose zone soil (3 inches - 10 feet bgs) measurements were considered to be different media with different and distinct exposure potentials per EPA risk assessment guidance. Exposure scenarios considered in this focused risk assessment assumed completed exposure pathways to those soils likely to be encountered during normal activities of light industrial/commercial workers, construction/remediation workers, and residents. It is not likely that any receptor would come into contact with deeper soils under reasonable exposure assumptions.

3.2.3 Existing Measured and Modeled Ground Water Data

Significant ground water quality data exist for the Person Generating Station site and have been incorporated into the remedial action design and performance assessment described in the CMP. Ground water data from 1993 sampling efforts at 21 onsite and 19 offsite sample locations were used to determine representative exposure concentrations to address potential future risks to hypothetical future residents should the site remain unremediated. However, since PNM has committed to a remediation program for the site, comprehensive fate and transport estimates developed as part of the CMP to investigate the potential effectiveness of the recommended ground water pump-and-treat network were also used to quantitatively estimate potential risks subsequent to remediation. These fate and transport simulations have been reviewed by NMED as part of the CMP planning process. Details on these model simulations are presented in the CMP (Engineering-Science, 1994).

3.2.4 Simulated Surface Water Data

The planned remedial action for shallow ground water at the site involves extraction, treatment, and discharge of ground water to a receiving surface water body. To determine whether such action would be protective of possible receptors under conservative exposure assumptions, potential offsite surface water recreators were considered. Surface water data, assuming no treatment of extracted ground water, was assumed to be similar to existing ground water quality data. Concentrations of COCs in existing ground water data were conservatively assumed to represent concentrations in the receiving surface water bodies following discharge of extracted, untreated ground water. No dilution was considered. Concentrations of COCs assumed to be present in the receiving surface water bodies following discharge of ground water treated via coupled air stripping and carbon adsorption were based both on expected performance efficiencies and current surface water standards. Thus, quantitative risk information was developed to investigate whether effluent concentrations likely to be achieved by the planned remedial action would be protective of human health under conservative exposure assumptions.

3.3 RISK ASSESSMENT CONCENTRATION LEVELS

After sources of environmental characterization data for the Person Generating Station site were identified, representative exposure concentrations or risk assessment concentration levels were determined in accordance with guidance from the EPA. The representative exposure point concentration or the risk assessment concentration level for each COC for each medium was defined as the concentration that represents the highest exposure that could reasonably be expected to occur for a given exposure pathway. This value is intended to account for both the uncertainty in environmental data and the variability in exposure parameters (EPA, 1992). Simple statistics and recommended air dispersion models were employed to compute the risk assessment levels for each of the COCs for each exposure pathway considered in this focused risk assessment for the Person Generating Station site. The following sections describe the methods and assumptions used in these calculations.

3.3.1 Statistical Evaluation

Available data for each COC by medium (i.e., onsite and offsite surficial soil data, onsite and offsite vadose zone soil data, onsite and offsite soil gas data, and onsite and offsite current and modeled shallow ground water data) were compiled (see Tables 3.1 through 3.5). Because simulated surface water data used in this focused risk assessment was based either on existing, onsite ground water data or single-point

TABLE 3.1
CALCULATION OF ONSITE SHALLOW SOIL GAS RISK ASSESSMENT CONCENTRATION LEVELS
PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

Sample	Measured Concentration			Exposure Concentration Calculation		
	1,1,1-TCA[a] (ppbv)[d]	1,1-DCE[b] (ppbv)	PCE[c] (ppbv)	1,1,1-TCA (ppbv)	1,1-DCE (ppbv)	PCE (ppbv)
SG-01	<0.00008	<0.0005	8.00E-03	4.00E-05	2.50E-04	8.00E-03
SG-03	1.00E-02	<0.02	5.00E-02	1.00E-02	1.00E-02	5.00E-02
SG-04	7.00E-02	<0.02	1.00E-01	7.00E-02	1.00E-02	1.00E-01
SG-08	<0.00008	<0.005	4.00E-03	4.00E-05	2.50E-03	4.00E-03
SG-09	<0.00008	<0.005	<0.00004	4.00E-05	2.50E-03	2.00E-05
SG-10	<0.00008	<0.0005	2.00E-03	4.00E-05	2.50E-04	2.00E-03
SG-11	<0.0004	<0.02	9.00E-03	2.00E-04	1.00E-02	9.00E-03
SG-12	4.00E-03	<0.005	6.00E-02	4.00E-03	2.50E-03	6.00E-02
SG-13	1.00E-02	<0.03	2.00E-01	1.00E-02	1.50E-02	2.00E-01
SG-14	3.00E-02	<0.05	4.00E-01	3.00E-02	2.50E-02	4.00E-01
SG-15	5.00E-02	2.00E-01	5.00E-01	5.00E-02	2.00E-01	5.00E-01
SG-16	1.00E-01	4.00E-01	2.00E+00	1.00E-01	4.00E-01	2.00E+00
SG-17	8.00E-02	<0.05	5.00E-01	8.00E-02	2.50E-02	5.00E-01
SG-18	2.00E-02	<0.005	2.00E-01	2.00E-02	2.50E-03	2.00E-01
SG-23	2.00E-03	<0.005	2.00E-02	2.00E-03	2.50E-03	2.00E-02
SG-24	1.00E-03	<0.002	4.00E-03	1.00E-03	1.00E-03	4.00E-03
SG-25	9.00E-04	<0.002	3.00E-03	9.00E-04	1.00E-03	3.00E-03
SG-27	<0.0001	<0.005	<0.00004	5.00E-05	2.50E-03	2.00E-05
SG-33	6.00E-02	<0.05	5.00E-01	6.00E-02	2.50E-02	5.00E-01
SG-35	9.00E-02	<0.05	7.00E-01	9.00E-02	2.50E-02	7.00E-01
SG-36	4.00E-02	<0.01	3.00E-01	4.00E-02	5.00E-03	3.00E-01
SG-37	2.00E-02	<0.01	4.00E-02	2.00E-02	5.00E-03	4.00E-02
SG-38	1.00E-02	<0.01	4.00E-03	1.00E-02	5.00E-03	4.00E-03
SG-49	2.00E-02	<0.01	2.00E-01	2.00E-02	5.00E-03	2.00E-01
SG-56	2.00E-02	<0.02	2.00E-01	2.00E-02	1.00E-02	2.00E-01
SG-57	4.00E-03	<0.005	4.00E-02	4.00E-03	2.50E-03	4.00E-02
SG-66	1.00E+00	2.00E+00	6.00E-01	1.00E+00	2.00E+00	6.00E-01
SG-67	8.00E-04	<0.008	2.00E-03	8.00E-04	4.00E-03	2.00E-03
SG-68	<0.001	<0.04	5.00E-02	5.00E-04	2.00E-02	5.00E-02
SG-69	6.00E-02	2.00E+00	5.00E-02	6.00E-02	2.00E+00	5.00E-02
SG-70	5.00E-01	2.00E+00	5.00E-01	5.00E-01	2.00E+00	5.00E-01
SG-71	1.40E+01	8.00E+00	6.00E+00	1.40E+01	8.00E+00	6.00E+00
SG-78	2.00E-01	2.00E+00	2.00E+00	2.00E-01	2.00E+00	2.00E+00
SG-83	4.00E-01	2.00E-01	2.00E-01	4.00E-01	2.00E-01	2.00E-01
SG-84	4.00E+00	8.00E+00	4.00E+00	4.00E+00	8.00E+00	4.00E+00
SG-85	6.00E+00	7.00E+00	5.00E+00	6.00E+00	7.00E+00	5.00E+00
SG-86	2.00E+00	4.00E+00	2.00E+00	2.00E+00	4.00E+00	2.00E+00
SG-87	2.00E-01	6.00E-01	2.00E-01	2.00E-01	6.00E-01	2.00E-01
SG-88	5.00E-03	<0.005	1.00E-04	5.00E-03	2.50E-03	1.00E-04
SG-90	4.40E+01	2.30E+01	6.50E+01	4.40E+01	2.30E+01	6.50E+01
Frequency	32/40	13/40	38/40			
Maximum				44.00	23.00	65.00
95% UCL[e]				1.40	1.51	1.05

a/ 1,1,1-TCA=1,1,1-trichloroethane.

b/ 1,1-DCE=1,1-dichloroethene.

c/ PCE=tetrachloroethene.

d/ ppbv=part per billion, volume per volume.

e/ 95% UCL=95 percent upper confidence limit on the arithmetic mean assuming normality.

TABLE 3.2
CALCULATION OF OFFSITE SHALLOW SOIL GAS RISK ASSESSMENT CONCENTRATION LEVELS PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

Sample	Measured Concentration			Exposure Concentration Calculation		
	1,1,1-TCA[a] (ppbv)[d/]	1,1-DCE[b/] (ppbv)	PCE[c/] (ppbv)	1,1,1-TCA (ppbv)	1,1-DCE (ppbv)	PCE (ppbv)
SG-18	2.00E-02	<0.005	2.00E-01	2.00E-02	ND[e/]	2.00E-01
SG-19	4.00E-03	<0.01	2.00E-02	4.00E-03	ND	2.00E-02
SG-20	1.00E-03	<0.005	5.00E-05	1.00E-03	ND	5.00E-05
SG-22	1.00E-03	<0.005	1.00E-03	1.00E-03	ND	1.00E-03
SG-43	1.00E-03	<0.002	<0.00002	1.00E-03	ND	1.00E-05
SG-44	1.00E-04	<0.002	<0.00002	1.00E-04	ND	1.00E-05
SG-49	2.00E-02	<0.01	3.00E-01	2.00E-02	ND	3.00E-01
SG-50	3.00E-02	<0.005	1.00E-02	3.00E-02	ND	1.00E-02
SG-51	8.00E-04	<0.005	<0.00004	8.00E-04	ND	2.00E-05
SG-52	1.00E-02	<0.005	<0.00004	1.00E-02	ND	2.00E-05
SG-53	3.00E-03	<0.01	6.00E-02	3.00E-03	ND	6.00E-02
SG-54	2.00E-03	<0.01	5.00E-03	2.00E-03	ND	5.00E-03
Frequency	12/12	0/12	8/12			
Maximum				0.03	--[g/]	0.30
95% UCL[f/]				0.012	--	0.204

a/ 1,1,1-TCA=1,1,1-trichloroethane.
b/ 1,1-DCE=1,1-dichloroethene.
c/ PCE=tetrachloroethene.
d/ ppbv=part per billion, volume per volume.
e/ ND=not detected.
f/ 95% UCL=95 percent upper confidence limit on the arithmetic mean assuming normality.
g/ No calculated value

022/722445/9.WK1

TABLE 3.3

CALCULATION OF SURFICIAL SOIL AND VADOSE ZONE SOIL RISK ASSESSMENT CONCENTRATION LEVELS

PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

Sample	Surficial Soil (0 – 3" bgs[a/]) Exposure Concentration Calculation[c/]			Vadose Zone Soil (3" – 10' bgs [b/]) Exposure Concentration Calculation[c/]		
	1,1,1-TCA[d/] (ug/g soil)[g/]	1,1-DCE[e/] (ug/g soil)	PCE[f/] (ug/g soil)	1,1,1-TCA (ug/g soil)	1,1-DCE (ug/g soil)	PCE (ug/g soil)
PS-1	--[h/]	--	0.062	--	--	0.030
PS-2	--	--	0.030	--	--	0.006
PS-3	--	--	0.015	--	--	0.005
PS-4	--	--	0.017	--	--	371.5
PS-5	--	--	--	462.2	--	--
PS-6	--	--	0.052	--	--	0.028
PS-7	--	--	0.156	--	--	0.012
PS-8	0.152	--	0.575	0.002	--	0.011
PS-9	1.388	--	20.9	--	--	0.030
PS-10	0.280	--	0.320	0.146	--	0.017
PS-11	--	--	--	--	--	0.121
PS-12	--	--	0.169	0.002	--	0.004
PS-13	--	--	0.100	0.173	--	23.3
PS-14	0.051	--	0.032	0.099	--	0.029
PS-15	--	--	0.030	--	--	0.447
PS-16	0.002	--	0.137	--	--	0.001
PS-17	--	--	0.029	--	--	0.005
PS-18	0.040	--	0.129	0.001	--	0.007
PS-19	--	--	22.5		--	0.020
Frequency	6/19	--	17/19	7/19	--	18/19
Maximum	1.388	--	22.5	462.2	--	371.5
95% UCL[i/]	0.614	--	5.522	147.15	--	55.86

a/ 0-3" bgs=0-3 inches below ground surface.
b/ 3"-10' bgs = 3 inches to 10 feet below ground surface.
c/ Values based on 1984 sampling event.
d/ 1,1,1-TCA=1,1,1-trichloroethane.
e/ 1,1-DCE=1,1-dichloroethene.
f/ PCE=tetrachloroethene.
g/ ug/g soil=micrograms per gram of soil.
h/ -- No data reported.
i/ 95% UCL-95 percent upper confidence level on the arithmetic mean assuming normality.

TABLE 3.4
CALCULATION OF ONSITE GROUND WATER RISK ASSESSMENT CONCENTRATION LEVELS
PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

Sample	1993 Concentrations (averaged)[a/]			Residual Concentrations (averaged)[b/]		
	1,1,1-TCA[c] (ppb)	1,1-DCE[d/] (ppb)	PCE[e/] (ppb)	1,1,1-TCA (ppb)	1,1-DCE (ppb)	PCE (ppb)
PSMW-01	99	78.5	615	--[g/]	--	--
PSMW-01R	36.5	56.5	185	--	2	2
PSMW-01B	0.2	0.1	0.1	--	--	--
PSMW-03B	0.3	0.3	0.3	--	2	2
PSMW-05	0.3	0.3	0.35	--	0.05	0.05
PSMW-06	0.4	0.85	4.4	--	--	--
PSMW-07	0.3	0.3	0.3	--	--	--
PSMW-08A	17	73.17	106	--	3	3
PSMW-08B	0.23	0.23	0.23	--	3	3
PSMW-09	0.1	0.5	0.9	--	1	1
PSMW-10	13	93.5	170	--	3	3
PSMW-11	0.1	0.7	0.1	--	1	1
PSMW-12A	2.1	6.2	8	--	2	2
PSMW-12B	0.1	0.1	0.1	--	2	2
PSMW-13A	4.1	44	38	--	3	3
PSMW-13B	0.1	0.1	0.1	--	3	3
PSMW-15B	0.1	0.1	0.1	--	1	1
PSMW-16	6.7	58	96.5	--	2	2
PSMW-17	0.5	9	4.2	--	1	1
PSMW-18	0.7	1.7	3.9	--	2	2
PSMW-21	0.1	0.1	0.2	--	0.05	0.05
Frequency	15/21	15/21	15/21			
Maximum	99	93.5	615	--	3	3
95% UCL[h/]	16.7	31.6	109.0	--	2.2	2.2

a/ Average of all reported values obtained during 1993 sampling events.

b/ Modeled concentration based on 6 years of pumping using 4 wells and 14 years of attenuation (i.e., 20 years after initiating planned remediation at the site).

c/ 1,1,1-TCA = 1,1,1-trichloroethane

d/ 1,1-DCE = 1,1-dichloroethene

e/ PCE = tetrachloroethene

f/ ppb=parts per billion.

g/ -- no data available.

h/ 95% UCL = 95 percent upper confidence limit on the arithmetic mean assuming normality.

TABLE 3.5
CALCULATION OF OFFSITE GROUND WATER RISK ASSESSMENT CONCENTRATION LEVELS
PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

Sample	1993 Concentrations (averaged)[a]			Residual Concentration[b]		
	1,1,1-TCA[c] (ppb)[f]	1,1-DCE[d] (ppb)	PCE[e] (ppb)	1,1,1-TCA (ppb)	1,1-DCE (ppb)	PCE (ppb)
PSMW-14	0.1	0.1	0.1	--[g]	0.05	0.05
PSMW-19	0.1	0.5	0.5	--	--	--
PSMW-20	0.2	3.1	4.5	--	1	1
PSMW-22	2.65	27.5	31.5	--	1	1
PSMW-23	0.1	0.1	0.1	--	1	1
PSMW-24	0.4	15	15	--	0.05	0.05
PSMW-25	0.4	17	15	--	0.05	0.05
PSMW-26	0.5	24	13	--	0.05	0.05
PSMW-27	0.1	7.9	9.85	--	0.05	0.05
PSMW-28	0.1	0.1	0.1	--	0.05	0.05
PSMW-29	0.1	0.1	0.1	--	2	2
PSMW-30	0.9	0.1	0.1	--	0.05	0.05
PSMW-31	0.5	0.1	0.1	--	2	2
PSMW-32	0.1	0.1	0.1	--	2	2
PSMW-33	0.1	0.1	0.1	--	0.05	0.05
PSMW-34	0.1	0.1	0.1	--	0.05	0.05
PSMW-35	0.1	0.1	0.1	--	1	1
PSMW-36	0.1	0.1	0.1	--	0.05	0.05
PSMW-37	0.1	0.1	0.1	--	--	--
Frequency	7/19	7/19	7/19			
Maximum	2.65	27.5	31.5	--	2	2
95% UCL[h]	0.58	8.43	7.97	--	0.93	0.93

a/ Average of all reported values obtained during 1993 sampling events.

b/ Modeled concentration based on 6 years of pumping using 4 wells and 14 years of attenuation (i.e., 20 years after initiating planned remediation at the site).

c/ 1,1,1-TCA = 1,1,1-trichloroethane

d/ 1,1-DCE = 1,1-dichloroethene

e/ PCE = tetrachloroethene

f/ ppb=parts per billion.

g/ -- no data available.

h/ 95% UCL = 95 percent upper confidence limit on the arithmetic mean assuming normality.

performance estimates and detection limits, no additional statistical evaluation was necessary.

The EPA has provided recommendations and guidance on what would result in an estimate of the exposure concentration appropriate for use in reasonable maximum exposure (RME) risk estimates. The EPA has defined the concentration term as the 95 percent upper confidence limit (UCL) of the arithmetic mean for data sets that are not small. If data for a site is limited (i.e., less than 5 values), it may be more appropriate to use the maximum value as the concentration term in risk calculations. The data sets for the Person Generating Station site were sufficient in number to compute the concentration term. The EPA finds that the 95 percent UCL provides reasonable confidence that the true site average will not be underestimated and increases the consistency and comparability of risk assessments.

The 95 percent UCL of a mean is defined as a value, that when calculated repeatedly for randomly drawn subsets of site concentration data, equals or exceeds the true mean 95 percent of the time. Although the 95 percent UCL of the mean provides a conservative estimate of the average, it should not be confused with a 95th percentile of site concentration data. The 95 percent UCL was selected as the value to use as the average concentration in risk calculations to account for both the uncertainty in the contaminant concentration and variability in the exposure parameters used to estimate risk. Statistical confidence limits are the classical tool for addressing uncertainties of a distribution average. The 95 percent UCL is used as the average of the site concentration data because it is not possible to know the true mean.

The 95 percent UCL is calculated differently for data that can be described as normal and for data that can be described as lognormal. ES used two types of statistical tests to identify the best distributional assumption for the data sets by environmental medium. The first test used was the Chi-Square goodness-of-fit test. This test allows the user to compare observed to expected frequencies to determine whether the data can be described by a theoretically interesting distribution such as the normal or lognormal distribution. A significance level of 0.95 was employed in this test. It is prudent to conduct at least two types of statistical tests to determine data distribution to reduce the uncertainty associated with interpreting statistical results. ES elected to use the Kolmogorov-Smirnov one-sample test to evaluate the overall goodness-of-fit between site concentration data and a specified theoretical distribution. The Kolmogorov-Smirnov test is generally more efficient than the Chi-Square test. This test computes the maximum distance between the cumulative distribution functions of the sample and the theoretical distribution. If this distance is large enough, the hypothesis that the theoretical distribution (i.e., normal or lognormal) fits the data set is rejected. A significance level of 0.95 was also employed in this test.

Measured site concentration data was tested using both of these statistical tests for normality and lognormality. Both detected and nondetected values were included at this step. Ground water data from 1993 sampling events were averaged for each well to provide a representative, single-point value. Results from this step indicated that data from onsite and offsite soil gas could be best described by a lognormal distribution, whereas all other site concentration data (soil and ground water) could be described by either a normal or lognormal probability density (i.e., the statistical tests indicated a relatively good fit to both theoretical approximations). Although most elements and data from many Superfund sites appear to be lognormally distributed, it is possible that the lognormal characteristic of the data sets for the Person Generating Station site is attributable to the presence of a few relatively high concentration values, which effectively skew the right tail of the distribution (i.e., positive skewness). Most of the data by environmental medium generally clustered around the detection limit or at low levels. The presence of a few high values in the data sets is the result of the expected heterogeneity of site contamination. The data sets reflect differences between samples taken from within or near the source area (i.e., the 25 feet x 35 feet former waste tank area) and samples taken from environmental media that is significantly less contaminated (if contaminated at all). This analysis was deemed necessary to ensure that the computed exposure concentration values reflected the most conservative estimate of the site mean.

Following distribution testing, all nondetect values were replaced with one-half the reported detection limit per EPA (1989). Each of the data sets was characterized by a large scale on which measurements had been made, which complicated statistical approximations. For example, the reporting scale for 1,1,1-TCA in onsite soil gas was extremely large as the values ranged from below 0.00008 ppbv to 44 ppbv, thus spanning approximately 5.5 orders of magnitude. Once this data was transformed using the natural logarithm function to achieve a more normal distribution, the standard deviation was still large because of the extreme variability of the data. Transforming the data as recommended by the EPA did not result in complete normalization; the data were still skewed. If these transformed data and subsequent summary statistics were used to calculate the 95 percent UCL, the concentration value would be orders of magnitude greater than the maximum measured value. In these cases, the EPA recommends using the maximum measured value unless the use of another value that is a better, yet conservative, approximation of the site mean can be justified (EPA, 1989 and 1992).

The goal of the 95 percent UCL is to provide a conservative estimate of the site mean. The possibility of using the robust normal approximation on the data sets to derive a better conservative estimate of the site mean was explored. This approach was considered reasonable as the distribution tests also supported the use of the normal approximation. Further, the normal approximation is the most appropriate statistical tool for data sets with these types of characteristics because the normal approximation is relatively insensitive to the presence of a few "outliers" in a data set that is otherwise generally normal without scaling. The calculated mean assuming normality was larger than that calculated for the data set assuming lognormality because of the scale on which measurements had been made. Yet the calculated 95 percent UCL assuming normality was within the range suggested by the data sets. In fact, assuming normality of the data set resulted in a 95 percent UCL that approached the maximum value. The normal approximation was robust enough to account for the presence of a few high measurements in a data set dominated by low to relatively low values. The normal approximation resulted in a reasonable yet conservative estimate of the site mean even given the differences in observations caused by contaminant distribution patterns at the site. The lognormal approximation was too sensitive to these data differentials, resulting in inaccurate statistical approximations of the 95 percent UCL. Use of the maximum value as a conservative estimate of the site mean was deemed inappropriate and indefensible given that these values came from samples taken from within or adjacent to the source area, which is currently covered by the closure cap. The maximum value in this case is not representative of the concentration to which a receptor could reasonably be exposed.

It is important to note that the data sets for the Person Generating Station site were sufficient to qualitatively verify that this "alternate" value provided high coverage of the true population mean (EPA, 1992). Data sets with at least 10 to 20 samples provide good estimates of the mean, although data sets with more than 20 samples generally provide better and consistent estimates of the mean. At least 12 and up to 40 individual observations per environmental medium were used to compute the exposure concentration for the Person Generating Station site. The number of available samples is sufficient to identify the dominant statistical characteristics of the population in question. The computed 95 percent UCL fits well within the range of data for the site, and approaches the maximum concentration even in the presence of many lower values.

The use of transformed data would inappropriately overestimate the actual site mean as indicated by the data sets for the site. Because the statistical tests suggested that the normal distribution was also a good approximation for most site data, the robust normal approximation was used in the exposure concentration calculations. Use of the normal approximation resulted in reasonable 95 percent UCL values that equal or exceed an extremely conservative estimate of the mean for the site. This means that the derived exposure concentration value is a conservative estimate of the true mean for the site, which is the intended goal of EPA's guidance. Use of the lognormal approximation would yield an invalid estimate of the standard deviation (i.e., the data were not normalized upon transformation, which invalidates one of the assumptions on which the calculation is based) (Anderson, 1987; Gilbert, 1987). Thus, the lognormal approximation of the 95 percent UCL is not statistically defensible due to limitations of the normalizing techniques for these data sets. Therefore, 95 percent UCLs assuming normality were computed for each COC by medium to develop a risk assessment concentration level that reflects reasonable potential exposures for the Person Generating Station site (EPA, 1992a). This approach is consistent with the intent of EPA risk assessment guidance. Tables 3.1 through 3.5 present these data and the computed 95 percent UCLs for each COC for each medium.

3.3.2 Summary of Air Dispersion Calculations

Soil gas risk assessment concentration levels should not be directly used to evaluate potential risks due to inhalation of VOCs diffusing upward through the vadose zone into the atmosphere or accumulating in buildings. Because this exposure pathway may represent a source of risk for the exposure scenarios considered in this focused risk assessment, several diffusion and dispersion models recommended by the EPA (EPA, 1992) were employed to determine risk assessment concentration levels for volatilizing COCs in the atmosphere and accumulating in buildings. Two simple flux models were coupled with a distance-related attenuation/dispersion equation to estimate the concentration in the air a receptor may reasonably be expected to inhale.

The first calculation required estimating the outdoor concentration of each COC for which there were soil data at a specified distance from a constant emission (i.e., slow, molecular diffusion through contaminated soils). Emission rates were calculated based on soil contaminant levels, diffusion coefficients, depth of soil cover, and soil porosity. The risk assessment concentration level for vadose zone soils was used as the source term in these computations. Conservative estimates of diffusion rates through air were assumed for each of the COCs. The effective depth of soil cover is based on thickness of the closure cap, but no adjustments were made to account for the different effects of the various materials used in the cap to minimize upward diffusion. This simplification should provide a conservative estimate of the upward flux rate of the chemical via simple diffusion through the closure cap.

This flux rate was then incorporated into a simple virtual upwind point source dispersion equation recommended by the EPA to characterize air quality impacts (EPA, 1981; EPA, 1992b). A mean wind speed of 4.64 meters/second was reasonably assumed given the characteristics and Front Range location of the Person Generating Station site. Two separate outdoor concentration levels were developed: one for an onsite receptor and one for a receptor standing at the downwind property line of the site. Table 3.6 summarizes these input parameters and resulting flux and concentration estimates. These diffusion values were used to assess potential risks to current and hypothetical future light industrial/commercial workers due to inhalation of COCs volatilizing from contaminated soils into the atmosphere.

The second calculation involved estimating the outdoor concentration using a more conservative model appropriate for potentially acute exposure scenarios, such as onsite construction/remediation workers. This model, also recommended by the EPA (1992b), is driven by pressure changes that can increase the concentration of VOCs "forced" from the soils (i.e., soil gas expressed because of pressure difference). Because the proposed vapor extraction system will be connected to activated carbon canisters designed to remove over 99 percent of vapor contamination before the treated effluent is discharged to the atmosphere (Engineering-Science, 1994), workers would not be exposed to this acute contamination source. However, these receptors may be working in close proximity to the former waste oil tank area. The pressure-driven flux model provides a method to conservatively estimate the concentration of soil gas to which construction/remediation workers could potentially be exposed.

The pressure-driven model was originally developed to estimate the rate of flux from soil pores through a building foundation (Nazaroff and Sextro, 1989). This model has been modified to estimate the flux of VOCs from the former waste oil tank area assuming a defective or cracked closure cover. Using this modified pressure driver, the model provides for an increased flux from the soils beyond that predicted using only simple diffusion. A soil permeability typical of sandy soils was assumed. A temperature-driven pressure differential of 0.2 pascals was assumed, which is reasonable for a relatively temperate environment (Michelson et al., 1993). As before, the calculated flux was used in a simple virtual upwind model to take into account the effects of atmospheric dispersion. Table 3.6 also presents these input parameters and resulting exposure point concentration estimates.

TABLE 3.6
MODEL PARAMETERS USED IN PREDICTIVE BASELINE EMISSIONS CALCULATIONS
PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

Estimating Outdoor Concentration at Distance Due to Constant Emission

(1) Q = 6*D*C*A*P ^ (4/3)*[(1/L)*(W1/W)]

	1,1,1-TCA	1,1-DCE	PCE
D (diffusion coefficient, cm2/s)	0.1	0.1	0.1
C (saturated vapor concentration, g/cm3)	7.19E-04	3.09E-03	1.79E-04
A (exposed area, cm2)	8139	8139	8139
P (soil porosity, %)	30	30	30
L (effective depth of soil cover, cm)	30.48	30.48	30.48
W1/W (weight fraction of chemical in soil, g/g)	1.47E-04	--	5.59E-05
Q (emission rate of chemical, g/s)	1.58E-03	--	1.49E-04

(2) C = 16*2Q/[(15.74)*(Lv)*(sz)*(w)]

	1,1,1-TCA	1,1-DCE	PCE
Lv (distance along centerline to receptor, m)			
Onsite	323.9	323.9	323.9
Offsite	1628.4	1628.4	1628.4
sz (conc. at receptor height, m)	1.6	1.6	1.6
w (assumed mean wind speed, m/s)	4.64	4.64	4.64
C (virtual concentration at receptor, g/m3)			
Onsite	1.33E-06	--	1.26E-07
Offsite	2.65E-07	--	2.51E-08

Estimating Outdoor Concentration Due to Pressure-Driven Flux

(1) F = [(6.283)*(L)*(P)*(k)]/[(u)*(ln 2h/r)]

	1,1,1-TCA	1,1-DCE	PCE
L (foundation perimeter, m)	36	36	36
P (pressure difference, Pa)	0.20	0.20	0.20
k (permeability of soil to air, m2)	2.00E-04	2.00E-04	2.00E-04
u (dynamic viscosity of air, Pa-s)	1.80E-04	1.80E-04	1.80E-04
h (depth of measured contaminant, m)	2	2	2
r (one-half soil gap, m)	7.50E-04	7.50E-04	7.50E-04
F (flux into atmosphere, m3/s)	5.86	5.86	5.86

(2) C = (3.2E7*F*Csg)/[(15.74)*(Lv)*(sz)*(w)]

	1,1,1-TCA	1,1-DCE	PCE
Csg (soil gas concentration, g/cm3)	1.40E-09	1.51E-09	1.05E-09
Lv (distance along centerline to receptor, m)			
Onsite	323.9	323.9	323.9
Offsite	1628.4	1628.4	1628.4
sz (conc. at receptor height, m)	1.6	1.6	1.6
w (assumed mean wind speed, m/s)	4.64	4.64	4.64
C (virtual concentration at receptor, g/m3)			
Onsite	6.93E-06	--	5.20E-06
Offsite	1.38E-06	--	1.03E-06

Estimating Concentration in Building Using Diffusion-Driven Flux Model

F = [(D)*(P2) ^ 2.33*(A)]/[(P1) ^ 2*(X)]

	1,1,1-TCA	1,1-DCE	PCE
D (diffusion coefficient, m2/s)	1.00E-05	1.00E-05	1.00E-05
P2(air-filled soil, unitless)	0.29	0.29	0.29
P1 (total soil porosity, unitless)	0.30	0.30	0.30
A (intrusion area, m2)	1.20	1.20	1.20
X (depth to source, m)	1	1	1
F (flux into building, m3/s)	7.45E-06	7.45E-06	7.45E-06

(2) C = [(F)*(Csg)]/(ACS)*(V)*(MF)]

	1,1,1-TCA	1,1-DCE	PCE
Csg (concentration in soil gas, mg/m3)			
Onsite	1.40	1.51	1.05
Offsite	0.012	--	0.204
ACS (air changes per second, 1/s)	5.55E-04	5.55E-04	5.55E-04
V (building volume, m3)	1950.60	1950.60	1950.60
MF (mixing factor, unitless)	0.75	0.75	0.75
C (concentration in building, mg/m3)			
Onsite	1.29E-05	1.39E-05	9.64E-06
Offsite	1.10E-07	--	1.87E-06

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The third air dispersion calculation completed in support of the focused risk assessment for the Person Generating Station site used a simple diffusion/intrusion flux model and an indoor VOC concentration model. The diffusion flux model is analogous to the pressure-driven flux model used previously since the flux is calculated using the foundation cracks of a hypothetical structure. The indoor concentration model was developed to estimate the average annual VOC concentration accumulating in a residence located at the source of contaminant flux. This value will be different for buildings located onsite versus offsite because of difference in soil gas concentrations (Michelson et al., 1993). This model minimizes the effects of dispersion under atmospheric conditions by containing the flux within a structure. These coupled models were used to conservatively estimate the concentration of soil gas to which potential residents could be exposed.

Conservative input parameters were assumed for these coupled models. The available area of the hypothetical building's foundation available for upward diffusion was assumed to be 1.2 square meters (m^2), which is not unreasonable for a typical single-family residence (Michelson et al., 1993). The concentration of soil gas volatilizing from soils was based on the onsite and offsite soil gas sampling results presented earlier. A single story building was assumed, thus decreasing the number of air changes per second and increasing the final mixed concentration within the building. A mixing factor of 0.75 was used to address mixing within the structure (Murphy et al., 1986). Table 3.6 summarizes these input parameters and corresponding results.

3.3.3 Results by Media

Table 3.7 summarizes the risk assessment concentration levels determined from available site characterization and fate and transport calculations for each of the COCs and media considered in the focused risk assessment for the Person Generating Station site. Data are presented for calculation of potential risks due to a particular exposure pathway for each receptor considered in this analysis.

TABLE 3.7
SUMMARY OF RISK ASSESSMENT CONCENTRATION LEVELS
PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

Contaminant	Soil Gas in Breathing Zone Outside Onsite		Soil Gas in Breathing Zone Outside Offsite		Soil Gas Accumulating in Structure	
	Diffusion Current/Future[a/] (mg/m3)	Pressure-Driven Current Only (mg/m3)	Diffusion Current/Future[a/] (mg/m3)	Pressure-Driven Current Only (mg/m3)	Onsite Current/Future[a/] (mg/m3)	Offsite Current/Future[a/] (mg/m3)
1,1,1-TCA[c/]	1.33E-06	6.93E-06	2.65E-07	1.38E-06	1.29E-05	1.10E-07
1,1-DCE[d/]	--[e/]	--	--	--	1.39E-05	--
PCE[f/]	1.26E-07	5.20E-06	2.51E-08	1.03E-06	9.64E-06	1.87E-06

Contaminant	Surficial Soil (0 - 3") bgs[g/]	Deeper Soils (3" - 10') bgs[h/]	Groundwater			
	Onsite/Offsite	Onsite/Offsite	Onsite		Offsite	
	Current/Future[a/] (ug/g soil)	Current/Future[a/] (ug/g soil)	Current (ug/L)	Future[i/] (ug/L)	Current (ug/L)	Future[i/] (ug/L)
1,1,1-TCA	0.614	147.15	16.7	--	0.58	--
1,1-DCE	--	--	31.6	2.20	8.43	0.93
PCE	5.52	55.86	109.0	2.20	7.97	0.93

a/ Future concentrations for soil and soil gases do not account for the significant removal which will take place during soil vapor extraction.
b/ mg/m3=milligrams per cubic meter.
c/ 1,1,1-TCA = 1,1,1-trichloroethane
d/ 1,1-DCE = 1,1-dichloroethene
e/ -- = no data available.
f/ PCE = tetrachloroethene
g/ 0 to 3 inches below ground surface.
h/ 3 inches to 10 feet below ground surface.
i/ Future ground water concentrations are based on predicted reductions that will occur as a result of planned remediation and natural attenuation.

SECTION 4

EXPOSURE ASSESSMENT

In the exposure assessment for the focused risk assessment for the Person Generating Station site, potential receptors that could come into contact with site-related contamination and the pathways through which these receptors might be exposed were identified. In this section, both current and hypothetical future receptors are described and the amount of contamination to which they might be exposed is evaluated.

4.1 EXPOSURE PATHWAY ANALYSIS

To have a completed pathway of exposure, there must be a source of contamination, a receptor, and a route through which the contamination can reach the receptor. This circuit of exposure, called an exposure pathway, is evaluated briefly in the CMP and shown graphically in Figure 4.1. If a pathway is not considered to be completed, there is no risk.

4.1.1 Existing and Potential Future Sources and Release Mechanisms

As described in Sections 2 and 3 of this report, several conservative assumptions about source terms for site contamination were necessary to determine risk assessment concentration levels for each of the COCs by media. For example, soil data from the former waste oil tank area were used to characterize the soil contamination for the entire site and offsite locations. This approach will obviously overestimate the amount of contamination that a potential receptor may reasonably contact given that site characterization data show that the extent of soil contamination is limited to a 30-foot-diameter column directly beneath the closure cap. However, to address the potential sources of site-related contamination described in the CMP, conservative assumptions about the nature and extent of contamination were necessary. The sources of site-related contamination addressed in this focused risk assessment are soil gas, surficial soils, vadose zone soils, shallow ground water, and surface water that receives extracted ground water during remediation activities. A detailed description of the risk assessment concentration levels for each COC for each of these potential sources is presented in Section 3 of this report.

4.1.2 Existing and Potential Future Receptors

After potential sources of site-related contamination were identified, assumptions about current and future land uses for the Person Generating Station site were considered. As discussed previously, land use is at the heart of identifying potential

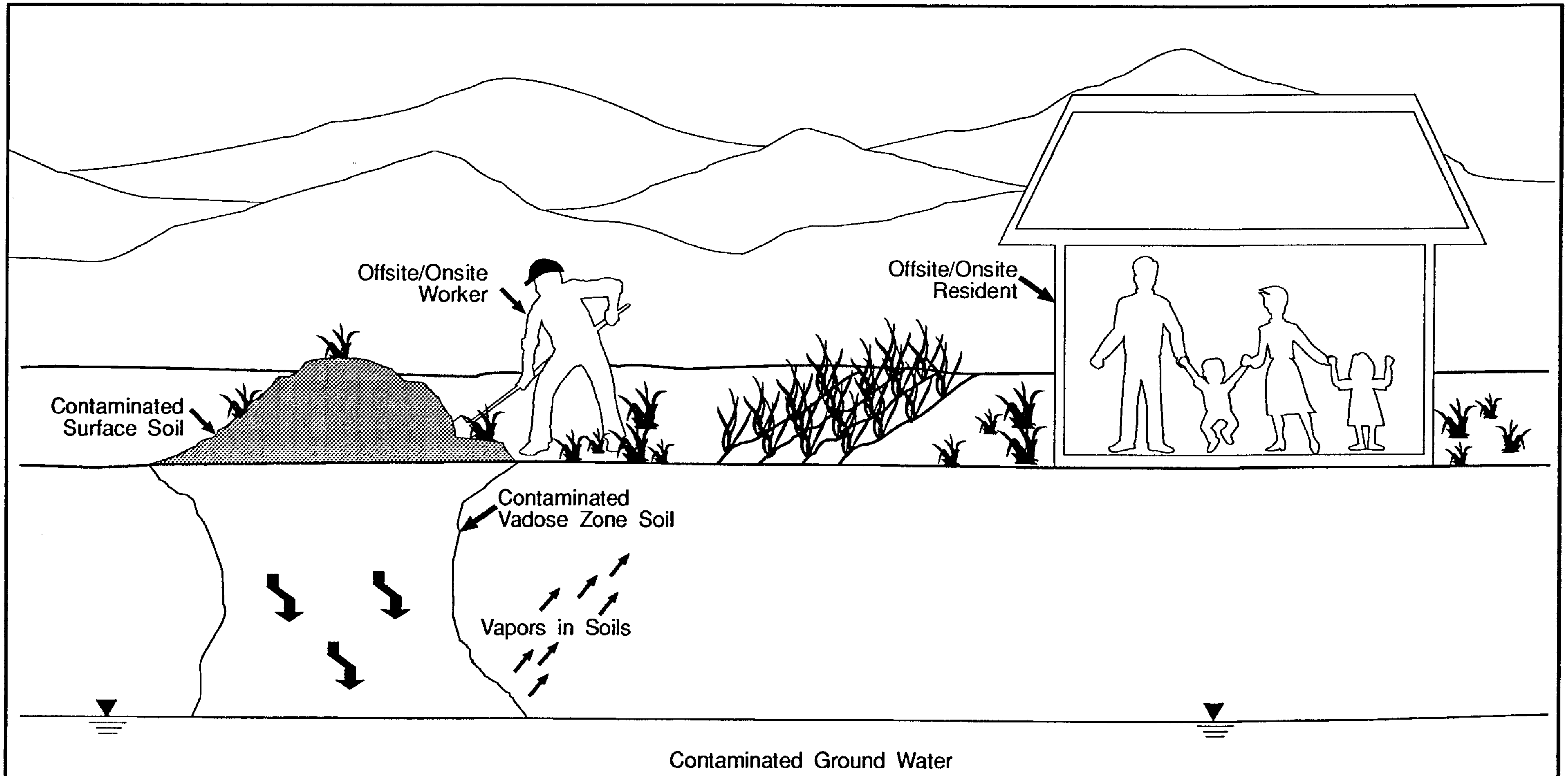

FIGURE 4.1

CONCEPTUAL EXPOSURE ASSESSMENT MODEL

Person Generating Station
Public Service Company of New Mexico

ENGINEERING-SCIENCE, INC.

Denver, Colorado

722445

receptors, potential exposure pathways, and reasonable exposure scenarios. The Person Generating Station site is currently surrounded by operational industrial and commercial facilities. No residential developments currently exist within the immediate environs of the site. Further, the Person Generating Station site is no longer operational and access is restricted by a series of locked gates and a security fence. Thus, current land use may conservatively be defined as light industrial/commercial.

Assumptions about hypothetical future land uses must be made to ensure that the highest level of exposure and risk that can reasonably be expected to occur are addressed. Exposure scenarios based on the hypothetical future residential land use assumption result in the most conservative risk estimates and can be important considerations in deciding whether or not to take an action at the site. However, the EPA cautions that this conservative approach may not be justifiable if a site may reasonably be assumed to remain within and surrounded by an industrialized area. In these cases, the EPA recommends using another exposure scenario, such as agricultural or light commercial/industrial, including a qualitative assessment of the likelihood that the assumed reasonable future land use will occur (55 Federal Register 710). In actuality, the objective of assumptions about future land uses is to develop risk calculations to determine whether or not a response action is warranted by the site. These hypothetical future land use assumptions are designed solely to evaluate the need for action at a site. However, since PNM has already committed to implementing a two-phase remediation project at the site, estimates about the potential future risks associated with site contamination are only relevant in terms of justifying a decision already made and providing a basis for evaluating the risks that may be associated with residual contamination following remediation of the site.

Under reasonable current land use assumptions, the Person Generating Station site can be described as an industrial facility. Thus, potential current receptors include worker populations. The worker population used in this focused risk assessment was further subdivided into onsite and nearby offsite light industrial/commercial workers and onsite construction/remediation workers. Onsite and nearby offsite light industrial/commercial workers were assumed to be exposed to contaminated surficial soil and soil gases volatilizing into the atmosphere from contaminated soil. Onsite construction/remediation workers were assumed to be exposed to both vadose zone soils and soil gases volatilizing into the atmosphere from contaminated soils. Exposure to shallow ground water was not considered reasonable given the depth to the water table (i.e., 110 feet bgs) and plans for a fully enclosed extraction, treatment, and discharge treatment system.

Another current receptor was included in this evaluation to investigate the need for and effectiveness of the proposed treatment train for ground water extracted during remediation activities at the site. The remedial action plan calls for discharge of extracted ground water to a nearby surface water body. Although this surface water body is not currently or likely to be used for recreation, this type of exposure was assumed to ensure that the proposed remedial action would be sufficient to protect human health even under conservative reasonable maximum exposure (RME) conditions. Thus, the current receptors were expanded to include potential offsite recreators. Although the primary recreation receptor under realistic conditions is likely to be a golfer using the facilities near the surface water body receiving effluent discharge, a surface water recreator in direct contact with the affected medium during recreational events (i.e., a swimmer) was assumed. This approach results in conservative risk estimates for this type of exposure. Both adult and children recreators were included in this exposure scenario. These receptors were assumed to be exposed to ground water that had been discharged into the receiving surface water during recreation activities.

Concentrations of contaminants to which current receptors could be exposed were estimated using measured concentrations and conservative assumptions. The only fate and transport modeling completed was simple diffusion/air dispersion calculations to estimate the current risk assessment exposure point concentrations in air breathed by workers. Assumptions used in these models were conservative and overestimated exposure point concentrations. Simple soil flux measurements will be taken at the Person Generating Station site during Phase I of the shallow ground water remedial project to verify the estimates used in these risk calculations. Section 3 defines the models used to estimate the amount of soil gas present in the air breathed by current onsite and offsite workers.

The Person Generating Site will likely not ever be available for unrestricted residential development. However, in accordance with technical direction from NMED and in the interest of developing the most conservative risk estimates, both future industrial and residential land uses were assumed. Hypothetical current and future receptors considered in this analysis therefore included both worker populations and residential populations. Since there are no residential developments at the site, risks to onsite current residents are hypothetical. Two types of future residential exposure scenarios are included in this evaluation: (1) hypothetical onsite and offsite residents exposed to site-related contamination that has not been remediated nor benefited from the effects of natural attenuation processes such as dispersion, adsorption, and degradation, and (2) hypothetical onsite and offsite residents exposed to the residual contamination following planned remediation. The only difference between these two types of hypothetical future residents is the risk assessment concentration level. The first type of resident is exposed to current concentrations, whereas the second type is exposed to concentrations that include some of the beneficial effects of planned remediation and natural attenuation.

The future worker populations were subdivided in the same way as under current conditions (i.e., light industrial/commercial and construction/remediation) and they were exposed to the same contaminated media. The risk assessment concentration levels used for these receptors were based on current conditions. No fate and transport modeling has been completed to account for the anticipated beneficial effects in soil of planned remediation and natural attenuation. Use of these unadjusted risk assessment concentration levels will overestimate the risk due to exposure to soil contamination in the future since remediation is already planned. In essence, these risk estimates will describe the risk to these hypothetical future receptors should the site remain unremediated.

The hypothetical future residents were assumed to have built their houses on and adjacent to the Person Generating site and were assumed to be using the contaminated shallow ground water for domestic purposes. This is an extremely conservative exposure pathway because the shallow ground water contamination is limited to the 20 feet immediately below the ground water table. It is highly unlikely that the hypothetical future residents would install a potable water well to this depth. A recent survey of ground water wells in the vicinity of the site (Metric, 1992) demonstrated that most wells were screened at intervals hundreds of feet below the ground water table. If risk assessment concentration levels were calculated for wells screened over a longer interval, the concentrations would decrease as a result of increased dilution. Further, it would also not be advisable to screen a well for potable applications at such a shallow depth given the current rate of lowering of the ground water table in the area (1 foot/year). Nevertheless, the hypothetical future residents were assumed to be exposed to contaminants in shallow ground water by ingestion, dermal contact, and inhalation of vapors while showering. Incidental ingestion and dermal contact with surficial soils were also assumed to occur. Inhalation of soil gases accumulated in single-family, single-story buildings was also factored into the risk estimates for these receptors.

As with the hypothetical future workers, no fate and transport calculations were performed on soil contamination which hypothetical future residents may contact. Simple diffusion/dispersion calculations used to estimate concentrations of VOCs accumulating in both onsite and offsite structures were based on current soil and soil gas data. No adjustment was made to account for the effects of planned remediation and natural attenuation.

However, both existing and modeled concentrations of the COCs in shallow ground water were used in this focused risk assessment. Concentrations measured in 1993 were used to evaluate risks posed to hypothetical future residents exposed to current conditions. As discussed previously, these hypothetical future receptors and risk assessment concentration levels are provided to evaluate the needed intensity of the planned remedial action and as a basis for comparison. Concentrations modeled as part of the performance assessment completed to support the CMP were used to assess the potential risks associated with residual contamination. These modeled concentrations were based on source removal and use of a pump-and-treat network for 6 years and natural attenuation for 20 years. Thus, these modeled concentrations simulate the anticipated nature and extent of contamination in the shallow ground water 20 years from initiation of planned remedial actions at the site. The modeled concentrations were used to assess risks to hypothetical future residents exposed to future conditions.

4.2 QUANTIFICATION OF EXPOSURE: CHEMICAL INTAKES

Intake estimates are normally expressed as the amount of chemical at the exchange boundary in milligrams per kilogram of body weight per day (mg/kg-day), which represents an intake normalized for body weight over time. The total exposure is then divided by the time period of interest to obtain an average exposure over time. The time used to average exposure is a function of the toxic endpoint: for noncarcinogenic effects it is the exposure time, and for carcinogenic effects it is a lifetime. A generic equation for calculating chemical intakes is shown in Table 4.1.

TABLE 4.1
GENERIC EQUATION FOR CALCULATING INTAKE FACTORS
PERSON GENERATING STATION PUBLIC SERVICE COMPANY OF NEW MEXICO

$$I = C \times \frac{CR \times EFD}{BW} \times \frac{1}{AT}$$

Where:

I	=	Intake; the amount of chemical at the exchange boundary (mg/kg body weight-day)

<u>Chemical-related variable</u>

C	=	Chemical concentration; the average concentration contacted over the exposure period (e.g., mg/liter of water)

<u>Variables that describe the exposed population</u>

CR	=	Contact rate; the amount of contaminated medium contacted per unit time or event (e.g., liters/day)
EFD	=	Exposure frequency and duration; describes how long and how often exposure occurs. Often calculated using two terms (EF and ED);
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight; the average body weight over the exposure period (kg)

<u>Assessment-determined variable</u>

AT	=	Averaging time; period over which exposure is averaged (days)

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The emphasis in risk assessment conducted under EPA Superfund guidance is on chronic exposures unless specific conditions warrant a short-term or acute assessment. In this evaluation, long-term and short-term exposures to relatively low chemical concentrations are of greatest concern. Acute exposures were therefore not evaluated.

Exposure/intake variables were used to estimate intakes that approximate a reasonable maximum exposure (RME). For chemical exposure, a combination of the 95 percent UCL, average values, and best professional judgment (BPJ) were used in the intake calculations to best estimate the overall RME (EPA, 1989). For worker pathways involving air and subsurface soils, only adult receptors were used. It was assumed that adults would be at greatest risk through these pathways (EPA, 1991a). For pathways involving surficial soil (e.g., residents), a combined adult/child receptor was used. For pathways involving surface water (e.g., recreators), adult and child recreators were addressed separately. All of these assumptions serve to provide the best estimate of the RME. Detailed intake calculations by media and exposure routes are presented in the following subsections. Intake variables for each receptor are shown in Table 4.2.

4.2.1 Current Exposure Scenarios

Worker populations and potential offsite surface water recreators were considered under reasonable current exposure scenarios. Industrial/commercial workers are currently exposed only to surficial soil contamination and soil gas volatilizing from soils into the atmosphere. Current construction/remediation workers are exposed to both subsurface soils and soil gas volatilizing into the atmosphere. Offsite surface water recreators may be exposed to extracted ground water that has been discharged to surface water during remediation.

4.2.1.1 Onsite and Nearby Offsite Light Industrial/Commercial Workers

Standard default intake variables as defined by the EPA (1991d) were used exclusively in quantifying exposure of the light industrial/commercial workers to inhalation of contaminants from the atmosphere. The standard default exposure variables described in the Supplemental Guidance (EPA, 1991d) were also used exclusively in quantifying exposure of the light industrial/commercial workers due to incidental ingestion of surface soil.

Light industrial/commercial workers were also assumed to dermally contact the surface soil. The intake variables for dermal contact with contaminants in surface soil are the same as those for incidental ingestion with the following exceptions. For dermal contact, it was assumed that only the hands and arms of the light industrial/commercial worker would contact the soil, resulting in a skin surface area of 5,000 square centimeters (cm^2). In addition, an absorption fraction of 25 percent was assumed for contaminants in the soil because of the volatile nature of the contaminants based on studies done on absorption from soil (Ryan et al., 1983). The intake variables, resulting exposure factors, and the formulas used to calculate intake for light industrial/commercial workers are shown in Table 4.2.

TABLE 4.2
INTAKE VARIABLES FOR PUBLIC SERVICE OF NEW MEXICO PERSON GENERATING SITE
ADULT AND ADULT/CHILD WEIGHTED INTAKE FACTORS

ADULT

RECEPTOR	MEDIA	PATH	RISK TYPE	CF (kg/mg)	ATC (days)	ATN (days)	BW (kg)	ED (years)	EF (days or events/yr)	ET (hours/event)	IR[a/]	AF (mg/cm^2)	SA (cm^2)	IF[b/]
Residential														
resident	groundwater	inhalation	noncarcinogenic	–	25550	10950	70	30	350	0.2	0.6	–	–	1.64E–03
resident	groundwater	inhalation	carcinogenic	–	25550	10950	70	30	350	0.2	0.6	–	–	7.05E–04
resident	groundwater	ingest	noncarcinogenic	–	25550	10950	70	30	350	–	2	–	–	2.74E–02
resident	groundwater	ingest	carcinogenic	–	25550	10950	70	30	350	–	2	–	–	1.17E–02
resident	groundwater	dermal	noncarcinogenic	1.00E–03	25550	10950	70	30	350	0.2	–	–	23000	6.30E–02
resident	groundwater	dermal	carcinogenic	1.00E–03	25550	10950	70	30	350	0.2	–	–	23000	2.70E–02
resident	surface soil	ingest	noncarcinogenic	USE WEIGHTED VALUE										
resident	surface soil	ingest	carcinogenic	USE WEIGHTED VALUE										
resident	surface soil	dermal	noncarcinogenic	USE WEIGHTED VALUE										
resident	surface soil	dermal	carcinogenic	USE WEIGHTED VALUE										
resident	soil gas	inhalation	noncarcinogenic	–	25550	10950	70	30	350	24	0.83	–	–	2.74E–01
resident	soil gas	inhalation	carcinogenic	–	25550	10950	70	30	350	24	0.83	–	–	1.17E–01
Comm./Ind.														
worker	air	inhalation	noncarcinogenic	–	25550	9125	70	25	250	8	0.83	–	–	6.52E–02
worker	air	inhalation	carcinogenic	–	25550	9125	70	25	250	8	0.83	–	–	2.33E–02
worker	surface soil	ingest	noncarcinogenic	1.00E–06	25550	9125	70	25	250	–	50	–	–	4.89E–07
worker	surface soil	ingest	carcinogenic	1.00E–06	25550	9125	70	25	250	–	50	–	–	1.75E–07
worker	surface soil	dermal	carcinogenic	1.00E–06	25550	9125	70	25	250	–	–	1	5800	2.03E–05
worker	surface soil	dermal	noncarcinogenic	1.00E–06	25550	9125	70	25	250	–	–	1	5800	5.68E–05
Constr./Rem.														
worker	subsoil	ingest	noncarcinogenic	1.00E–06	25550	730	70	2	250	–	50	–	–	4.89E–07
worker	subsoil	ingest	carcinogenic	1.00E–06	25550	730	70	2	250	–	50	–	–	1.40E–08
worker	subsoil	dermal	carcinogenic	1.00E–06	25550	730	70	2	250	–	–	1	5800	1.62E–06
worker	subsoil	dermal	noncarcinogenic	1.00E–06	25550	730	70	2	250	–	–	1	5800	5.68E–05
worker	air	inhalation	noncarcinogenic	–	25550	730	70	2	250	8	0.83	–	–	6.52E–02
worker	air	inhalation	carcinogenic	–	25550	730	70	2	250	8	0.83	–	–	1.86E–03
Recreational														
adult recreator	surface water	ingestion	noncarcinogenic	1	25550	8760	70	24	32	2	0.05	–	–	1.25E–04
adult recreator	surface water	ingestion	carcinogenic	1	25550	8760	70	24	32	2	0.05	–	–	4.29E–05
adult recreator	surface water	dermal	noncarcinogenic	1.00E–03	25550	8760	70	24	32	2	–	1	23000	5.76E–02
adult recreator	surface water	dermal	carcinogenic	1.00E–03	25550	8760	70	24	32	2	–	1	23000	1.98E–02
child recreator	surface water	ingestion	noncarcinogenic	1	25550	2190	15	6	32	2	0.05	–	–	5.84E–04
child recreator	surface water	ingestion	carcinogenic	1	25550	2190	15	6	32	2	0.05	–	–	5.01E–05
child recreator	surface water	dermal	noncarcinogenic	1.00E–03	25550	2190	15	6	32	2	–	1	7280	8.51E–02
child recreator	surface water	dermal	carcinogenic	1.00E–03	25550	2190	15	6	32	2	–	1	7280	7.29E–03

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TABLE 4.2
INTAKE VARIABLES FOR PUBLIC SERVICE OF NEW MEXICO PERSON GENERATING SITE
ADULT AND ADULT/CHILD WEIGHTED INTAKE FACTORS

WEIGHTED[c/]

RECEPTOR	MEDIA	PATH	RISK TYPE	CF (kg/mg)	ATC (days)	ATN (days)	BW (kg)	ED (years)	EF (days or events/yr)	IR[a/]	AF (mg/cm^2)	SA (m^2/event)	IF[b/]
residents	soil	ingestion	carcinogenic	1.00E-06	25550	10950	NA	30	350	114	–	–	4.68E-05
residents	soil	ingestion	noncarcinogenic	1.00E-06	25550	10950	NA	30	350	114	–	–	1.09E-04
residents	soil	dermal	carcinogenic	1.00E-06	25550	10950	59	30	350	–	1	4360	3.04E-05
residents	soil	dermal	noncarcinogenic	1.00E-06	25550	10950	59	30	350	–	1	4360	7.09E-05

NOTE:
CF = Conversion Factor
ATC = Averaging Time – Carcinogenic
ATN = Averaging Time – Noncarcinogenic
BW = Body Weight
ED = Exposure Duration
EF = Exposure Frequency
ET = Exposure Time
IR = Ingestion Rate
AF = Adherence Factor
SA = Surface Area
IF = Intake Factor
a/ = Oral ingestion rates are in mg/L for water and mg/kg for soil. Inhalation rates are in m^3/hour.
b/ = Units of the IF change based upon units of the inputs. When combined with concentration terms, shwon on Tables 6.1 to 6.6, the units will be mg/kg–day.
c/ Weighted values were based on RAGS, Part B (EPA, 1991), which takes into account the difference in daily soil ingestion rates (and dermal contact rates), body weights, and exposure durations for two exposure groups – children of one to six years and others of seven to 31 years.

4.2.1.2 Onsite Construction/Remediation Workers

Intake variables defining onsite construction/remediation workers' exposure to soil gas were identical to those used for the light commercial/industrial worker except that the construction/remediation worker will remain at the job for an equivalent of only 2 years (instead of the 25 years assumed for the light commercial/industrial worker). This assumption is based on best professional judgment as most construction-related/remediation activities at the site would likely not last more than the equivalent of 2 years of continuous exposure. For example, planned remediation activities at the site will not require workers to be constantly present after initial installation activities are complete.

Onsite construction/remediation workers are also assumed to be exposed to subsurface soils. The routes of exposure include both incidental ingestion and dermal contact with contaminants in the subsurface soils. The intake variables used in calculating the exposure factors for routes of exposure to subsurface soil are shown in Table 4.2. The intake variables are all standard default exposure variables, as defined by the EPA, with the following exceptions. As described earlier, the amount of time the construction/remediation workers are expected to remain at their jobs is equivalent to 2 years. It was assumed that only the hands and arms of the construction/remediation workers would dermally contact subsurface soil because the rest of their skin would be covered with clothing. The skin area exposed was estimated to be 5,800 cm^2. As described earlier, an absorption fraction of 25 percent was assumed based on studies on absorption from soil (Ryan et al., 1983).

4.2.1.3 Offsite Surface Water Recreators

Surface water exposure has been addressed for adult and child receptors separately. As noted previously, offsite surface water recreators have been conservatively assumed to be individuals in direct contact with the affected medium during exposure events (i.e., a swimmer). This scenario was adopted to provide a best estimate of the RME. However, the most realistic recreational receptor is a golfer using the facilities near the surface water body. The golfer receptor would not be in direct contact with the surface water as part of normal activities. Use of the surface water recreator scenario ensures that the planned remedial activities are protective of human health under the most reasonably conservative exposure assumptions.

The routes of exposure for both adult and child include incidental ingestion of and dermal contact with surface water while swimming. Inhalation of VOCs from surface water was not addressed because this exposure route was considered to pose an insignificant risk to recreators. VOCs are likely to volatilize during transport and discharge into the surface water. The skin area assumed to be exposed to the surface water during swimming was 23,000 cm^2 for an adult, which represents the total adult body skin area as calculated for the 90th percentile of the American adult male and described in RAGS (EPA, 1989), and 7,280 cm^2 for a child. Each recreator was assumed to be participating in surface water recreation in 2 hour events 32 times per year. The intake variables used in calculating the exposure factors for both adult and child recreators is shown on Table 4.2.

4.2.2 Hypothetical Future Exposure Scenarios

Future exposed populations include both workers and residents. Intake variables and resultant exposure factors for future worker populations were identical to those described in the previous section and thus are not repeated here. This section will only describe the intake variables and exposure factors for the hypothetical future resident.

Hypothetical future residents were assumed to be exposed to contaminants in shallow ground water, surface soil, and soil gases accumulated in structures. The routes of exposure to ground water were assumed to be ingestion, dermal contact, and inhalation of vapors while showering. The routes of exposure to surface soils are assumed to be incidental ingestion and dermal contact. The route of exposure to soil gases is assumed to be only inhalation.

Intake variables for ingestion of shallow ground water were the standard default exposure variables defined by EPA (1991d) and are shown in Table 4.2. The exposure factor for dermal contact with contaminants in shallow ground water used a combination of standard default exposure variables and best professional judgment if the EPA had not defined standard default variables. The skin area exposed was assumed to be 23,000 cm^2 which represents the total adult body skin area as calculated for the 90th percentile of the American adult male and described in RAGS (EPA, 1989). A chemical-specific permeability constant (Kp) value was determined to calculate dermal intakes. All Kp values were taken from the *Dermal Exposure Assessment: Principles and Applications* (EPA, 1992c). All other intake variables are standard default values.

Inhalation of vapors while showering was calculated using a model developed by Andelman (1984, 1985a, and 1985b) and published in *Management of Manufactured Gas Plant Sites* (Atlantic Environmental Services, Inc., 1988). In the model, the air concentration is determined by a balance between the rate of release from the shower water and the rate of air exchange between the shower and the rest of the house. The constants used in the model were set to match the observed efficiency of volatilization of trichloroethene (TCE) in model showers, and to fit the observed shower air concentration of TCE in several homes with contaminated water where measurements have been made. Scaling to other contaminants was accomplished by assuming that the rate of volatilization between shower water and the air is proportional to the VOC's Henry's Law Constant. The average concentration of a volatile compound in the shower air over a period of t_s minutes is:

$$C_s = C_{inf} \, [1 + (1/(kt_s)) \, (e^{(kts-1)}] \text{ for } t_s > 0$$

Where:

C_s = Average concentration of a VOC in the shower air over a duration of t_s minutes in milligrams per cubic meter (mg/m^3);

C_{inf} = Asymptotic concentration in air if the shower ran for a long time (much longer than 5 minutes), calculated below (mg/m^3);

t_s = Time in shower [typical value for an adult is 12 minutes (min) or 0.2 hours (hrs)];

k = Rate constant for exponential function, defined below (1/min);

C_{inf} = $[(E)(F_w)\ (C_t/1{,}000)]/F_a$;

k = F_a/V_b;

Where:

E = Efficiency of release of compounds from water to air, defined below (unitless);

F_w = Flow rate of water in shower, typical value is 8 liters per minute (L/min);

C_t = Concentration in shower water, determined case by case; C_t is the concentration of contaminant in ground water where domestic water is provided by a well in micrograms per liter (μg/L) or ppb; upper limit of 95th-percentile confidence interval of measured values or maximum detected values were used;

F_a = Flow rate of air in shower [typical value is 2.4 cubic meters per minute (m^3/min)];

V_b = Volume of bathroom [typical value is 12 m^3];

E = $(E_{TCE})(H)/(H_{TCE})$;

Where:

E = Efficiency of release of compounds from water to air [$0 \leq E \leq 1$; if E has a calculated value greater than 1, then E must be set equal to 1 (unitless)];

E_{TCE} = Efficiency of release of TCE from water to air [E_{TCE}=0.6 is typical (unitless)];

H = Henry's Law Constant for an organic compound (m^3-atm/mole); and

H_{TCE} = Henry's Law Constant for TCE [typical value is H_{TCE}=9.10E-03 (m^3-atm/mole)].

Chemical-specific intakes for inhalation of volatilized chemicals while showering were determined based on EPA (1989, 1991d) guidance, and were calculated only for the adult receptor.

These variables and the resultant exposure factor are shown in Table 4.2. It is important to note that the concentration of contaminants inhaled during domestic use of contaminated ground water is a modeled, rather than measured concentration. The assumptions used in the model were conservative and may tend to overestimate risks.

In calculating exposure variables for incidental ingestion and dermal contact with surface soil, standard default exposure variables, as defined by the EPA (1991d), were used. As specified in EPA guidance, a combined adult/child receptor was used to estimate intake variables for incidental ingestion of soil. Estimates of intakes from dermal contact were made using standard default exposure variables, with the exception of the skin surface area involved. The skin surface area was estimated assuming that the adult and child receptors would contact the skin with only their hands and arms and the absorption fraction would be 25 percent. A combined adult/child receptor exposure factor was used to calculate risks through the dermal route of exposure to residential receptors. The intake variables and resulting exposure factors are shown in Table 4.2.

Hypothetical future residents were also assumed to inhale vapors in their homes that have accumulated from soil gases, in addition to inhaling vapors in the shower. The intake variables used to calculate the exposure factor were all standard default exposure variables, as defined by the EPA. These variables are shown in Table 4.2.

SECTION 5

TOXICITY ASSESSMENT

The objective of the toxicity assessment is to weigh available evidence regarding the potential for particular contaminants to cause adverse effects to potentially exposed individuals, and to provide, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects. The types of toxicity information considered in this focused risk assessment included the reference dose (RfD) and reference concentration (RfC) used to evaluate noncarcinogenic effects, and the slope factor (SF) and unit risk to evaluate carcinogenic potential.

All toxicity values were obtained from the Integrated Risk Information System (IRIS) (Micromedix, Inc., 1994). If toxicity values for the three chemicals were not available on IRIS, the Health Effects Assessment Summary Tables (HEAST) (EPA, 1993) were consulted. For PCE, the SF has been withdrawn, but is retained in this analysis to provide a quantification of the risks posed by PCE. Use of this withdrawn toxicity value may overestimate or underestimate potential carcinogenic risks due to exposure to PCE. Using a withdrawn toxicity value is recommended for the focused risk assessment for this site since PCE is the COC for which the most site characterization data are available. RfCs and unit risks, given as concentrations, were converted to doses for use in risk tables following guidance in HEAST.

Toxicity values for dermal exposures were also calculated for both RfDs and SFs. Because there is no reference for dermal toxicity values or accepted guidance on how these values should be calculated, the most applicable values from the literature were used. This approach and its inherent uncertainties are described in more detail in Section 5.3.

5.1 NONCARCINOGENIC EFFECTS

For chemicals that exhibit noncarcinogenic (i.e., systemic) effects, authorities consider organisms to have repair and detoxification capabilities that must be exceeded by some critical concentration (threshold) before the detrimental health effect is manifested. For example, an organ can have a large number of cells performing the same or similar functions significantly depleted before the effect on the organ is seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism within an appreciable risk of adverse effects.

Health criteria for chemicals exhibiting noncarcinogenic effects for use in risk assessments were generally developed using EPA RfDs and RfCs developed by the

RfD/RfC Work Group and included in IRIS (Micromedix, Inc., 1994). In general, the RfD/RfC is "an estimate of an average daily exposure to an individual (including sensitive individuals) below which there will not be an appreciable risk of adverse health effects" (Micromedix, Inc., 1994). The RfD/RfC was derived using uncertainty factors (e.g., to adjust from animals to humans and to protect sensitive subpopulations) to ensure that it is unlikely to underestimate the potential for adverse noncarcinogenic effects. The purpose of the RfD/RfC is to provide a benchmark against which the sum of other doses (i.e., those projected from human exposure to various environmental conditions) might be compared. Doses that are significantly higher than the RfD/RfC may indicate that an inadequate margin of safety could exist for exposure to that substance and that an adverse health effect could occur.

Oral RfDs were found for 1,1-DCE and PCE. These values are shown in the risk calculations presented in Tables 6.1 through 6.6 in Section 6. 1,1-DCE causes noncarcinogenic effects to the liver. PCE causes hypertoxicity and weight gain. No information on the noncarcinogenic effects of 1,1,1-TCA was found. A more detailed description of the existing toxicity information for the three chemicals can be found in the chemical toxicity profiles in Appendix A.

5.2 CARCINOGENIC EFFECTS

For chemicals that exhibit carcinogenic effects, most authorities recognize that one or more molecular events can evoke changes in a single cell or in a small number of cells that can lead to tumor formation. This is the non-threshold theory of carcinogenesis which purports that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. Generally, regulatory agencies assume the non-threshold hypothesis for carcinogens in the absence of information concerning the mechanisms of action for the chemical.

EPA's Carcinogen Risk Assessment Verification Endeavor (CRAVE) has developed slope factors and unit risks (i.e., dose-response values) to estimate excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. Risks estimated using slope factors are considered unlikely to underestimate actual risks, but they may overestimate actual risks. Excess lifetime cancer risks are generally expressed in scientific notation and are probabilities. An excess lifetime cancer risk of $1x10^{-6}$ (one in one million), for example, represents the probability that one individual in a population of one million will develop cancer as a result of exposure to a carcinogenic chemical over a 70-year lifetime under specific exposure conditions. The EPA has suggested developing remedial alternatives for cleanup of Superfund sites using total excess lifetime cancer risks ranging from 10^{-4} (one in ten thousand) to 10^{-6} (e.g., EPA, 1991c).

In practice, slope factors are derived from the results of human epidemiology studies or chronic animal bioassays. The data from animal studies are fitted to the linearized, multistage model and a dose-response curve is obtained. The upper limit of the 95th-percentile confidence interval slope of the dose-response curve is subjected to various adjustments, and an interspecies scaling factor is applied to conservatively derive the slope factor for humans. Thus, the actual risks associated with exposure to a potential carcinogen quantitatively evaluated based on animal data are not likely to exceed the risks estimated using these slope factors, but they may be much lower. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad-hoc basis. These models provide rough but plausible estimates of the upper limits on lifetime risk. Slope factors based on human epidemiological data are also derived using very conservative assumptions and, as such, they too are considered unlikely to underestimate risks. In summary, while the actual risks associated with exposures to potential carcinogens are unlikely to be higher than the risks calculated using a slope factor, they could be considerably lower. It should be emphasized that the linearized multistage procedure leads to a plausible upper limit of the risk that is consistent with some proposed mechanisms of carcinogenesis.

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. The EPA system involves characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data (EPA, 1986). The weight-of-evidence classification is an attempt to determine the likelihood that the agent is a human carcinogen, and thus qualitatively affects the estimation of potential health risks. Three major factors are considered in characterizing the overall weight of evidence for carcinogenicity: (1) the quality of evidence from human studies and (2) the quality of evidence from animal studies, which are combined into a characterization of the overall weight of evidence for human carcinogenicity; and (3) other supportive information which is assessed to determine whether the overall weight of evidence should be modified. No uncertainty values are associated with carcinogenic toxicity values because the uncertainty is reflected by the category to which the chemical is assigned. The EPA's final classification of the overall weight of evidence includes the following five categories:

Group A - Human Carcinogen - This category indicates that there is sufficient evidence from epidemiological studies to support a causal association between an agent and cancer.

Group B - Probable Human Carcinogen - This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) that, in the absence of adequate data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C - Possible Human Carcinogen - This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D - Not Classified - This category indicates that the evidence for carcinogenicity in animals is inadequate.

Group E - No Evidence of Carcinogenicity to Humans - This category indicates that there is no evidence for carcinogenicity in at least two adequate animal tests in different species, or in both epidemiological and animal studies.

Slope factors and unit risks are developed by the EPA based on epidemiological or animal bioassay data for a specific route of exposure, either oral or inhalation. For some chemicals, sufficient data are available to develop route-specific slope factors for inhalation and ingestion. For chemicals with only one route-specific slope factor but for which carcinogenic effects may also occur via another route, the available value may be used (per the EPA) to evaluate risks associated with other potential routes of exposure (EPA, 1989).

Oral and inhalation slope factors were found for 1,1- DCE and PCE. A dermal slope factor was also calculated from the oral slope factor as described in Section 5.3. 1,1-DCE is assumed to cause kidney cancer and is classified as an Group C carcinogen. The carcinogenicity of PCE is currently not classified, and 1,1,1-TCA is a Group D carcinogen.

5.3 DERMAL TOXICITY

Only oral and inhalation values have been derived by the EPA and are listed in IRIS or HEAST. The EPA has not developed toxicity values for dermal exposure due to the lack of scientific studies to quantify dermal toxicity and carcinogenic potential for the vast majority of priority pollutants. In the absence of dermal reference toxicity values, the EPA has suggested that in some cases it is appropriate to modify an oral RfD so it can be used to estimate the hazard incurred by dermal exposure (EPA, 1989). This requires that the observed toxic endpoints are the same for both oral and dermal exposures and that a quantitative estimate exists for both dermal and oral absorption of the chemical. This information is generally not available for most priority pollutants. Oral toxicity values are often used to quantify risk associated with dermal exposure. As a consequence, any valuation of the contribution of dermal exposure to the overall hazard should be viewed as highly tentative at best. Oral absorption factors for the COCs were taken from appropriate Agency for Toxic Substance and Disease Registry (ATSDR) Profiles as a conservative estimate of oral absorption. When ATSDR Profiles were not available, or when information on the extent of absorption was not located, a default value of 0.90 was used by adopting absorption factors from similar chemicals.

SECTION 6

RISK CHARACTERIZATION

Toxicity data and exposure information were finally coupled to quantitatively and qualitatively characterize the potential risks to human receptors exposed to site-related contamination. This step of the focused risk assessment process is called risk characterization.

Noncarcinogenic risks were evaluated by comparing projected site-specific chemical intake values, which incorporate the risk assessment concentration level for the media of interest, for each specific COC and for each exposure route considered in this focused risk assessment (see Section 4.2) to the appropriate RfD/RfC or threshold concentration (see Section 5.1). This ratio is called the hazard quotient (HQ). HQs were developed for each COC and each exposure pathway for which there may be noncarcinogenic effects. These HQs were then summed across each exposure pathway and each COC to estimate the total noncarcinogenic risk posed to each type of receptor considered in this focused risk assessment. If the ratio between the projected site-specific intake value and the threshold concentration is less than unity, then there is no appreciable noncarcinogenic threat to the specific receptor group that may be reasonably exposed to contamination at the site. No appreciable noncarcinogenic threat (i.e., cumulative HQ < 1) suggests that action at a site may not be warranted. Conversely, if the cumulative HQ exceeds unity, then exposure to site-related contamination may result in adverse, noncarcinogenic effects, and remedial action is usually warranted.

Carcinogenic effects were evaluated to assess the probability that any one group of receptors considered in this focused risk assessment would develop cancer as a result of exposure to contamination at or related to the Person Generating Station site. These probability estimates are based on assumptions about the characteristics of exposure (see Section 4.2) and toxicity information (see Section 5.2). An excess lifetime cancer risk of $1x10^{-6}$ (one in one million), for example, represents the probability that one individual in one million will develop cancer as a result of exposure to that carcinogenic chemical under the specific exposure conditions used in the chemical intake calculations. Risk assessment guidance and policy developed by the EPA states that action may not be warranted at a site where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure (RME) for both current and future land uses is less than 10^{-4}. The upper boundary of the risk range is not an absolute line at $1x10^{-4}$, however, but should be used when making risk management decisions. In any event, if MCLs are exceeded at a site, action is generally warranted (EPA, 1991c).

Major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties embodied in this focused risk assessment are also discussed.

6.1 SUMMARY OF RISK ESTIMATES

Tables 6.1 through 6.7 present the risk calculations for each of the seven exposure scenarios considered for the Person Generating Station site. Table 6.8 summarizes the conservative risk estimates for each of the major receptor groups considered in this analysis. Briefly, risk calculations indicate that there are no adverse noncarcinogenic effects and the calculated carcinogenic risks were below the target EPA risk range (i.e., 10^{-4} to 10^{-6} cumulative individual carcinogenic risk level) for current and future workers that may reasonably be exposed to site contamination, even during site remediation. However, risk calculations indicate that there is a need to treat extracted ground water during remediation prior to discharge to surface water to protect potential offsite surface water recreators from adverse noncarcinogenic and carcinogenic risks. The proposed extraction, treatment, and discharge system to be implemented at the system will be sufficient to minimize risks to potential surface water recreators. Performance efficiency estimates suggest that the extracted ground water can be treated to achieve concentrations below the proposed effluent discharge requirements of 5 ppb for each COC. Risk calculations indicate that there are no adverse noncarcinogenic effects and the calculated carcinogenic risks are within the target EPA risk range for potential offsite surface water recreators exposed to COC concentrations at or below the proposed effluent discharge limit requirement of 5 ppb.

Carcinogenic risks posed to onsite hypothetical future residents <u>if the site were to remain unremediated and the effects of natural attenuation were not considered</u> are slightly above the target risk range of 1×10^{-4}. Additionally, carcinogenic risks posed to offsite hypothetical future residents <u>if the site were to remain unremediated and the effects of natural attenuation were not considered</u> are at the upper boundary of the target risk range as specified by the EPA. This means that the site may pose an unacceptable carcinogenic risk to hypothetical future residents if the unremediated area were developed for unrestricted residential use in the future and if shallow ground water was used for human consumption. Based on the EPA risk assessment guidance and policy, these risk estimates suggest that regulatory authorities may require remediation of the Person Generating Station site to protect human health under the most conservative future land use exposure scenarios.

In comparison, the conservative risk estimates for light industrial/commercial and construction/remediation workers, who are the most likely receptors under both current and future scenarios for this site, indicate no appreciable noncarcinogenic risks and result in individual cumulative carcinogenic risk levels below the EPA target risk range. This means that if the Person Generating Station site and adjacent areas were placed under specific land use restrictions to prohibit unrestricted residential use, remedial action may not be warranted. It is important to note, however, that because the measured concentrations of the COCs in the shallow ground water at the Person Generating Station site currently exceed their promulgated MCLs, remedial action may still be required by regulatory authorities in accordance with EPA guidance and policy.

TABLE 6.1
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 1
PUBLIC SERVICE COMPANY OF NEW MEXICO

SCENARIO 1: Current risks to onsite and nearby offsite light industrial/commercial workers.

RISKS FROM EXPOSURE TO SURFACE SOIL – ONSITE WORKERS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	4.9E–07	1.7E–07	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	2.7E–06	9.7E–07	4.9E–07	1.7E–07	NA	1.0E–02	5.2E–02	2.7E–04	100%	5.0E–08	100%
1,1,1– Trichloroethane	6.1E–01	3.0E–07	1.1E–07	4.9E–07	1.7E–07	NA	–	–	–	–	–	–
								Total Pathway HQ	3E–04	Total Pathway Risk	5E–08	

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	5.7E–05	2.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.0E–05	7.0E–06	5.7E–05	2.0E–05	2.5E–01	9.0E–03	5.8E–02	2.2E–03	100%	4.0E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.2E–06	7.8E–07	5.7E–05	2.0E–05	2.5E–01	–	–	–	–	–	–
								Total Pathway HQ	2E–03	Total Pathway Risk	4E–07	

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	6.5E–02	2.3E–02	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	1.3E–07	8.2E–09	2.9E–09	6.5E–02	2.3E–02	NA	–	2.0E–03	–	–	5.9E–12	100%
1,1,1– Trichloroethane	1.3E–06	8.7E–08	3.1E–08	6.5E–02	2.3E–02	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	6E–12	
Total Receptor Risk								Total Receptor HQ	<1	Total Receptor Risk	5E–07	

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TABLE 6.1 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 1
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE SOIL – OFFSITE WORKERS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	4.9E–07	1.7E–07	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	2.7E–06	9.7E–07	4.9E–07	1.7E–07	NA	1.0E–02	5.2E–02	2.7E–04	100%	5.0E–08	100%
1,1,1– Trichloroethane	6.1E–01	3.0E–07	1.1E–07	4.9E–07	1.7E–07	NA	–	–	–	–	–	–
								Total Pathway HQ	3E–04	Total Pathway Risk	5E–08	

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	5.7E–05	2.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.0E–05	7.0E–06	5.7E–05	2.0E–05	2.5E–01	9.0E–03	5.8E–02	2.2E–03	100%	4.0E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.2E–06	7.8E–07	5.7E–05	2.0E–05	2.5E–01	–	–	–	–	–	–
								Total Pathway HQ	2E–03	Total Pathway Risk	4E–07	

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	6.5E–02	2.3E–02	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	1.0E–06	6.7E–08	2.4E–08	6.5E–02	2.3E–02	NA	–	2.0E–03	–	–	4.8E–11	100%
1,1,1– Trichloroethane	1.4E–06	9.0E–08	3.2E–08	6.5E–02	2.3E–02	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	5E–11	

Total Receptor Risk

Total Receptor HQ	<1	Total Receptor Risk	5E–07

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3 = milligrams per cubic meter
kg/kg–day=kilogram per kilogram–day

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TABLE 6.2
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 2
PUBLIC SERVICE COMPANY OF NEW MEXICO

SCENARIO 2: Current risks to onsite construction/remediation workers.

RISKS FROM EXPOSURE TO SUBSURFACE SOIL

Incidential Ingestion of Subsurface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	4.9E–07	1.4E–08	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.6E+01	2.7E–05	7.8E–07	4.9E–07	1.4E–08	NA	1.0E–02	5.2E–02	2.7E–03	100%	4.1E–08	100%
1,1,1– Trichloroethane	1.5E+02	7.2E–05	2.1E–06	4.9E–07	1.4E–08	NA	–	–	–	–	–	–
								Total Pathway HQ	3E–03	Total Pathway Risk	4E–08	

Dermal Contact with Subsurface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	5.7E–05	1.6E–06	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+01	2.0E–04	5.7E–06	5.7E–05	1.6E–06	2.5E–01	9.0E–03	5.8E–02	2.2E–02	100%	3.3E–07	100%
1,1,1– Trichloroethane	3.7E+01	5.2E–04	1.5E–05	5.7E–05	1.6E–06	2.5E–01	–	–	–	–	–	–
								Total Pathway HQ	2E–02	Total Pathway Risk	3E–07	

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	6.5E–02	1.9E–03	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	5.2E–06	3.4E–07	9.7E–09	6.5E–02	1.9E–03	NA	–	2.0E–03	–	–	1.9E–11	100%
1,1,1– Trichloroethane	6.9E–06	4.5E–07	1.3E–08	6.5E–02	1.9E–03	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	2E–11	
Total Receptor Risk								Total Receptor HQ	<1	Total Receptor Risk	4E–07	

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
kg/kg–day=kilogram per kilogram–day

TABLE 6.3
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 3
PUBLIC SERVICE COMPANY OF NEW MEXICO

SCENARIO 3: Current risks to potential offsite recreators during remediation activities.

RISKS FROM EXPOSURE TO SURFACE WATER – OFFSITE RECREATORS (Based on performance efficiency estimates)

ADULT RECREATOR

Ingestion of Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	2.0E–03	2.5E–07	8.6E–08	1.3E–04	4.3E–05	NA	9.0E–03	6.0E–01	2.8E–05	36%	5.1E–08	85%
Tetrachloroethene	4.0E–03	5.0E–07	1.7E–07	1.3E–04	4.3E–05	NA	1.0E–02	5.2E–02	5.0E–05	64%	8.9E–09	15%
1,1,1–Trichloroethane	1.0E–03	1.2E–07	4.3E–08	1.3E–04	4.3E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	8E–05	Total Pathway Risk	6E–08	

Dermal Contact with Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	2.0E–03	1.8E–06	6.3E–07	5.8E–02	2.0E–02	1.6E–02	8.1E–03	6.7E–01	2.3E–04	16%	4.2E–07	66%
Tetrachloroethene	4.0E–03	1.1E–05	3.8E–06	5.8E–02	2.0E–02	4.8E–02	9.0E–03	5.8E–02	1.2E–03	84%	2.2E–07	34%
1,1,1–Trichloroethane	1.0E–03	9.8E–07	3.4E–07	5.8E–02	2.0E–02	1.7E–02	–	–	–	–	–	–
								Total Pathway HQ	1E–03	Total Pathway Risk	6E–07	
Total Receptor Risk								Total Receptor HQ	<1	Total Receptor Risk	7E–07	

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

TABLE 6.3 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 3
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE WATER – OFFSITE RECREATORS (Based on performance efficiency estimates) (Cont.)

CHILD RECREATOR

Ingestion of Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	2.0E–03	1.2E–06	1.0E–07	5.8E–04	5.0E–05	NA	9.0E–03	6.0E–01	1.3E–04	36%	6.0E–08	85%
Tetrachloroethene	4.0E–03	2.3E–06	2.0E–07	5.8E–04	5.0E–05	NA	1.0E–02	5.2E–02	2.3E–04	64%	1.0E–08	15%
1,1,1–Trichloroethane	1.0E–03	5.8E–07	5.0E–08	5.8E–04	5.0E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	4E–04	Total Pathway Risk	7E–08	

Dermal Contact with Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	2.0E–03	2.7E–06	2.3E–07	8.5E–02	7.3E–03	1.6E–02	8.1E–03	6.7E–01	3.4E–04	16%	1.6E–07	66%
Tetrachloroethene	4.0E–03	1.6E–05	1.4E–06	8.5E–02	7.3E–03	4.8E–02	9.0E–03	5.8E–02	1.8E–03	84%	8.1E–08	34%
1,1,1–Trichloroethane	1.0E–03	1.4E–06	1.2E–07	8.5E–02	7.3E–03	1.7E–02	–	–	–	–	–	–
								Total Pathway HQ	2E–03	Total Pathway Risk	2E–07	
Total Receptor Risk								Total Receptor HQ	<1	Total Receptor Risk	3E–07	

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

TABLE 6.3 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 3
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE WATER – OFFSITE RECREATORS (Based on proposed effluent discharge limits)

ADULT RECREATOR

Ingestion of Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	5.0E–03	6.3E–07	2.1E–07	1.3E–04	4.3E–05	NA	9.0E–03	6.0E–01	6.9E–05	53%	1.3E–07	92%
Tetrachloroethene	5.0E–03	6.3E–07	2.1E–07	1.3E–04	4.3E–05	NA	1.0E–02	5.2E–02	6.3E–05	47%	1.1E–08	8%
1,1,1–Trichloroethane	5.0E–03	6.3E–07	2.1E–07	1.3E–04	4.3E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	1E–04	Total Pathway Risk	1E–07	

Dermal Contact with Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	5.0E–03	4.6E–06	1.6E–06	5.8E–02	2.0E–02	1.6E–02	8.1E–03	6.7E–01	5.7E–04	27%	1.1E–06	79%
Tetrachloroethene	5.0E–03	1.4E–05	4.8E–06	5.8E–02	2.0E–02	4.8E–02	9.0E–03	5.8E–02	1.5E–03	73%	2.8E–07	21%
1,1,1–Trichloroethane	5.0E–03	4.9E–06	1.7E–06	5.8E–02	2.0E–02	1.7E–02	–	–	–	–	–	–
								Total Pathway HQ	2E–03	Total Pathway Risk	1E–06	
Total Receptor Risk								Total Receptor HQ	<1	Total Receptor Risk	1E–06	

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

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TABLE 6.3 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 3
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE WATER – OFFSITE RECREATORS (Based on proposed effluent dicharge limits) (Cont.)

CHILD RECREATOR

Ingestion of Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	5.0E–03	2.9E–06	2.5E–07	5.8E–04	5.0E–05	NA	9.0E–03	6.0E–01	3.2E–04	53%	1.5E–07	92%
Tetrachloroethene	5.0E–03	2.9E–06	2.5E–07	5.8E–04	5.0E–05	NA	1.0E–02	5.2E–02	2.9E–04	47%	1.3E–08	8%
1,1,1–Trichloroethane	5.0E–03	2.9E–06	2.5E–07	5.8E–04	5.0E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	6E–04	Total Pathway Risk	2E–07	

Dermal Contact with Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	5.0E–03	6.8E–06	5.8E–07	8.5E–02	7.3E–03	1.6E–02	8.1E–03	6.7E–01	8.4E–04	27%	3.9E–07	79%
Tetrachloroethene	5.0E–03	2.0E–05	1.8E–06	8.5E–02	7.3E–03	4.8E–02	9.0E–03	5.8E–02	2.3E–03	73%	1.0E–07	21%
1,1,1–Trichloroethane	5.0E–03	7.2E–06	6.2E–07	8.5E–02	7.3E–03	1.7E–02	–	–	–	–	–	–
								Total Pathway HQ	3E–03	Total Pathway Risk	5E–07	
Total Receptor Risk								Total Receptor HQ	<1	Total Receptor Risk	7E–07	

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

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TABLE 6.3 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 3
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE WATER – OFFSITE RECREATORS (Based on the 95% UCL for onsite ground water)

ADULT RECREATOR

Ingestion of Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	3.2E–02	4.0E–06	1.4E–06	1.3E–04	4.3E–05	NA	9.0E–03	6.0E–01	4.4E–04	24%	8.1E–07	77%
Tetrachloroethene	1.1E–01	1.4E–05	4.7E–06	1.3E–04	4.3E–05	NA	1.0E–02	5.2E–02	1.4E–03	76%	2.4E–07	23%
1,1,1–Trichloroethane	1.7E–02	2.1E–06	7.2E–07	1.3E–04	4.3E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	2E–03	Total Pathway Risk	1E–06	

Dermal Contact with Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	3.2E–02	2.9E–05	1.0E–05	5.8E–02	2.0E–02	1.6E–02	8.1E–03	6.7E–01	3.6E–03	10%	6.7E–06	53%
Tetrachloroethene	1.1E–01	3.0E–04	1.0E–04	5.8E–02	2.0E–02	4.8E–02	9.0E–03	5.8E–02	3.3E–02	90%	6.0E–06	47%
1,1,1–Trichloroethane	1.7E–02	1.6E–05	5.6E–06	5.8E–02	2.0E–02	1.7E–02	–	–	–	–	–	–
								Total Pathway HQ	4E–02	Total Pathway Risk	1E–05	

Total Receptor Risk

Total Receptor HQ	<1	Total Receptor Risk	1E–05

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

TABLE 6.3 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 3
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE WATER – OFFSITE RECREATORS (Based on the 95% UCL for onsite ground water) (Cont.)

CHILD RECREATOR

Ingestion of Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	3.2E–02	1.8E–05	1.6E–06	5.8E–04	5.0E–05	NA	9.0E–03	6.0E–01	2.0E–03	24%	9.5E–07	77%
Tetrachloroethene	1.1E–01	6.3E–05	5.5E–06	5.8E–04	5.0E–05	NA	1.0E–02	5.2E–02	6.3E–03	76%	2.8E–07	23%
1,1,1–Trichloroethane	1.7E–02	9.7E–06	8.4E–07	5.8E–04	5.0E–05	NA	–	–	–	–	–	–

Total Pathway HQ	8E–03	Total Pathway Risk	1E–06

Dermal Contact with Surface Water

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – C (mg/kg–day)	Intake Factor – NC (L–hr/cm–kg–d)	Intake Factor – C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–day/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	3.2E–02	4.3E–05	3.7E–06	8.5E–02	7.3E–03	1.6E–02	8.1E–03	6.7E–01	5.3E–03	10%	2.5E–06	53%
Tetrachloroethene	1.1E–01	4.4E–04	3.8E–05	8.5E–02	7.3E–03	4.8E–02	9.0E–03	5.8E–02	4.9E–02	90%	2.2E–06	47%
1,1,1–Trichloroethane	1.7E–02	2.4E–05	2.1E–06	8.5E–02	7.3E–03	1.7E–02	–	–	–	–	–	–

Total Pathway HQ	5E–02	Total Pathway Risk	5E–06

Total Receptor Risk

Total Receptor HQ	<1	Total Receptor Risk	6E–06

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

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TABLE 6.4
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 4
PUBLIC SERVICE COMPANY OF NEW MEXICO

SCENARIO 4: Future risks to onsite and nearby offsite light industrial/commercial workers.

RISKS FROM EXPOSURE TO SURFACE SOIL – ONSITE WORKERS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	4.9E–07	1.7E–07	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	2.7E–06	9.7E–07	4.9E–07	1.7E–07	NA	1.0E–02	5.2E–02	2.7E–04	100%	5.0E–08	100%
1,1,1– Trichloroethane	6.1E–01	3.0E–07	1.1E–07	4.9E–07	1.7E–07	NA	–	–	–	–	–	–
								Total Pathway HQ	3E–04	Total Pathway Risk	5E–08	

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	5.7E–05	2.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.0E–05	7.0E–06	5.7E–05	2.0E–05	2.5E–01	9.0E–03	5.8E–02	2.2E–03	100%	4.0E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.2E–06	7.8E–07	5.7E–05	2.0E–05	2.5E–01	–	–	–	–	–	–
								Total Pathway HQ	2E–03	Total Pathway Risk	4E–07	

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	6.5E–02	2.3E–02	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	1.3E–07	8.2E–09	2.9E–09	6.5E–02	2.3E–02	NA	–	2.0E–03	–	–	5.9E–12	100%
1,1,1– Trichloroethane	1.3E–06	8.7E–08	3.1E–08	6.5E–02	2.3E–02	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	6E–12	
Total Receptor Risk								Total Receptor HQ	<1	Total Receptor Risk	5E–07	

TABLE 6.4 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 4
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE SOIL – OFFSITE WORKERS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	4.9E–07	1.7E–07	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	2.7E–06	9.7E–07	4.9E–07	1.7E–07	NA	1.0E–02	5.2E–02	2.7E–04	100%	5.0E–08	100%
1,1,1– Trichloroethane	6.1E–01	3.0E–07	1.1E–07	4.9E–07	1.7E–07	NA	–	–	–	–	–	–

Total Pathway HQ	3E–04	Total Pathway Risk	5E–08

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	5.7E–05	2.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.0E–05	7.0E–06	5.7E–05	2.0E–05	2.5E–01	9.0E–03	5.8E–02	2.2E–03	100%	4.0E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.2E–06	7.8E–07	5.7E–05	2.0E–05	2.5E–01	–	–	–	–	–	–

Total Pathway HQ	2E–03	Total Pathway Risk	4E–07

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	6.5E–02	2.3E–02	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	2.5E–08	1.6E–09	5.8E–10	6.5E–02	2.3E–02	NA	–	2.0E–03	–	–	1.2E–12	100%
1,1,1– Trichloroethane	2.7E–07	1.7E–08	6.2E–09	6.5E–02	2.3E–02	NA	–	–	–	–	–	–

Total Pathway HQ	–	Total Pathway Risk	1E–12

Total Receptor Risk

Total Receptor HQ	<1	Total Receptor Risk	5E–07

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
kg/kg–day=kilogram per kilogram–day

TABLE 6.5
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 5
PUBLIC SERVICE COMPANY OF NEW MEXICO

SCENARIO 5: Future risks to onsite construction/remediation workers.

RISKS FROM EXPOSURE TO SUBSURFACE SOIL

Incidential Ingestion of Subsurface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	4.9E–07	1.4E–08	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.6E+01	2.7E–05	7.8E–07	4.9E–07	1.4E–08	NA	1.0E–02	5.2E–02	2.7E–03	100%	4.1E–08	100%
1,1,1– Trichloroethane	1.5E+02	7.2E–05	2.1E–06	4.9E–07	1.4E–08	NA	–	–	–	–	–	–

Total Pathway HQ	3E–03	Total Pathway Risk	4E–08

Dermal Contact with Subsurface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	5.7E–05	1.6E–06	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+01	2.0E–04	5.7E–06	5.7E–05	1.6E–06	2.5E–01	9.0E–03	5.8E–02	2.2E–02	100%	3.3E–07	100%
1,1,1– Trichloroethane	3.7E+01	5.2E–04	1.5E–05	5.7E–05	1.6E–06	2.5E–01	–	–	–	–	–	–

Total Pathway HQ	2E–02	Total Pathway Risk	3E–07

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	6.5E–02	1.9E–03	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	1.3E–07	8.2E–09	2.3E–10	6.5E–02	1.9E–03	NA	–	2.0E–03	–	–	4.7E–13	100%
1,1,1– Trichloroethane	1.3E–06	8.7E–08	2.5E–09	6.5E–02	1.9E–03	NA	–	–	–	–	–	–

Total Pathway HQ	–	Total Pathway Risk	5E–13

Total Receptor Risk

Total Receptor HQ	<1	Total Receptor Risk	4E–07

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
kg/kg–day=kilogram per kilogram–day

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TABLE 6.6
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 6
PUBLIC SERVICE COMPANY OF NEW MEXICO

SCENARIO 6: Future risks to both onsite and nearby offsite residents following remediation.

RISKS FROM EXPOSURE TO SURFACE SOIL – FUTURE ONSITE RESIDENTS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	1.1E–04	4.7E–05	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	6.0E–04	2.6E–04	1.1E–04	4.7E–05	NA	1.0E–02	5.2E–02	6.0E–02	100%	1.3E–05	100%
1,1,1– Trichloroethane	6.1E–01	6.7E–05	2.9E–05	1.1E–04	4.7E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	6E–02	Total Pathway Risk	1E–05	

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	7.1E–05	3.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.4E–05	1.0E–05	7.1E–05	3.0E–05	2.5E–01	9.0E–03	5.8E–02	2.7E–03	100%	6.1E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.7E–06	1.2E–06	7.1E–05	3.0E–05	2.5E–01	–	–	–	–	–	–
								Total Pathway HQ	3E–03	Total Pathway Risk	6E–07	

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	2.7E–01	1.2E–01	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	1.3E–07	3.5E–08	1.5E–08	2.7E–01	1.2E–01	NA	–	2.0E–03	–	–	2.9E–11	100%
1,1,1– Trichloroethane	1.3E–06	3.6E–07	1.6E–07	2.7E–01	1.2E–01	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	3E–11	

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TABLE 6.6 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 6
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO GROUNDWATER – FUTURE ONSITE RESIDENTS (Cont.)

Ingestion of Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	2.2E–03	6.0E–05	2.6E–05	2.7E–02	1.2E–02	NA	9.0E–03	6.0E–01	6.7E–03	53%	1.5E–05	92%
Tetrachloroethene	2.2E–03	6.0E–05	2.6E–05	2.7E–02	1.2E–02	NA	1.0E–02	5.2E–02	6.0E–03	47%	1.3E–06	8%
1,1,1– Trichloroethane	–	–	–	2.7E–02	1.2E–02	NA	–	–	–	–	–	–
								Total Pathway HQ	1E–02	Total Pathway Risk	2E–05	

Dermal Contact with Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	3.52E–05	3.5E–08	1.5E–08	6.3E–02	2.7E–02	1.6E–02	8.1E–03	6.7E–01	4.4E–06	11%	1.0E–08	56%
Tetrachloroethene	1.06E–04	3.2E–07	1.4E–07	6.3E–02	2.7E–02	4.8E–02	9.0E–03	5.8E–02	3.5E–05	89%	7.9E–09	44%
1,1,1– Trichloroethane	–	–	–	6.3E–02	2.7E–02	1.7E–02	–	–	–	–	–	–
								Total Pathway HQ	4E–05	Total Pathway Risk	2E–08	

Inhalation of Groundwater while Showering

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	4.6E–03	7.5E–06	3.2E–06	1.6E–03	7.1E–04	NA	–	1.2E+00	–	–	3.8E–06	100%
Tetrachloroethene	4.6E–03	7.5E–06	3.2E–06	1.6E–03	7.1E–04	NA	–	2.0E–03	–	–	6.4E–09	0%
1,1,1– Trichloroethane	–	–	–	1.6E–03	7.1E–04	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	4E–06	

Total Receptor Risk

Total Receptor HQ	<1	Total Receptor Risk	3E–05

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
kg/kg–day=kilogram per kilogram–day
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

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TABLE 6.6 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 6
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE SOIL – FUTURE OFFSITE RESIDENTS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	1.1E–04	4.7E–05	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	6.0E–04	2.6E–04	1.1E–04	4.7E–05	NA	1.0E–02	5.2E–02	6.0E–02	100%	1.3E–05	100%
1,1,1– Trichloroethane	6.1E–01	6.7E–05	2.9E–05	1.1E–04	4.7E–05	NA	–	–	–	–	–	–

Total Pathway HQ	6E–02	Total Pathway Risk	1E–05

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	7.1E–05	3.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.4E–05	1.0E–05	7.1E–05	3.0E–05	2.5E–01	9.0E–03	5.8E–02	2.7E–03	100%	6.1E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.7E–06	1.2E–06	7.1E–05	3.0E–05	2.5E–01	–	–	–	–	–	–

Total Pathway HQ	3E–03	Total Pathway Risk	6E–07

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (kg/kg–day)	Intake Factor –C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	2.7E–01	1.2E–01	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	2.5E–08	6.9E–09	2.9E–09	2.7E–01	1.2E–01	NA	–	2.0E–03	–	–	5.9E–12	100%
1,1,1– Trichloroethane	2.7E–07	7.3E–08	3.1E–08	2.7E–01	1.2E–01	NA	–	–	–	–	–	–

Total Pathway HQ	–	Total Pathway Risk	6E–12

TABLE 6.6 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 6
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO GROUNDWATER – FUTURE OFFSITE RESIDENTS (Cont.)

Ingestion of Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	9.3E–04	2.5E–05	1.1E–05	2.7E–02	1.2E–02	NA	9.0E–03	6.0E–01	2.8E–03	53%	6.5E–06	92%
Tetrachloroethene	9.3E–04	2.5E–05	1.1E–05	2.7E–02	1.2E–02	NA	1.0E–02	5.2E–02	2.5E–03	47%	5.7E–07	8%
1,1,1– Trichloroethane	–	–	–	2.7E–02	1.2E–02	NA	–	–	–	–	–	–

Total Pathway HQ	5E–03	Total Pathway Risk	7E–06

Dermal Contact with Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	1.44E–05	1.5E–08	6.2E–09	6.3E–02	2.7E–02	1.6E–02	8.1E–03	6.7E–01	1.8E–06	11%	4.1E–09	56%
Tetrachloroethene	4.32E–05	1.3E–07	5.6E–08	6.3E–02	2.7E–02	4.8E–02	9.0E–03	5.8E–02	1.5E–05	89%	3.2E–09	44%
1,1,1– Trichloroethane	–	–	–	6.3E–02	2.7E–02	1.7E–02	–	–	–	–	–	–

Total Pathway HQ	2E–05	Total Pathway Risk	7E–09

Inhalation of Groundwater while Showering

Chemical	Risk Assessment Concentration (mg/m³)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	1.9E–03	3.2E–06	1.4E–06	1.6E–03	7.1E–04	NA	–	1.2E+00	–	–	1.6E–06	100%
Tetrachloroethene	1.9E–03	3.2E–06	1.4E–06	1.6E–03	7.1E–04	NA	–	2.0E–03	–	–	2.7E–09	0%
1,1,1– Trichloroethane	–	–	–	1.6E–03	7.1E–04	NA	–	–	–	–	–	–

Total Receptor Risk

Total Pathway HQ	–	Total Pathway Risk	2E–06
Total Receptor HQ	<1	Total Receptor Risk	2E–05

Notes:
mg/kg=milligrams per kilogram
mg/kg–day=milligrams per kilogram–day
kg–d/mg=kilogram days per milligrams
mg/m3=milligrams per cubic meter
L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day
cm/hr=centimeters per hour

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TABLE 6.7
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 7
PUBLIC SERVICE COMPANY OF NEW MEXICO

SCENARIO 7: Future risks to both onsite and nearby offsite residents if nc action were taken at the site.

FUTURE RISKS FROM EXPOSURE TO SURFACE SOIL – ONSITE RESIDENTS EXPOSED TO CURRENT CONDITIONS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor – NC (kg/kg–day)	Intake Factor – C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	1.1E–04	4.7E–05	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	6.0E–04	2.6E–04	1.1E–04	4.7E–05	NA	1.0E–02	5.2E–02	6.0E–02	100%	1.3E–05	100%
1,1,1– Trichloroethane	6.1E–01	6.7E–05	2.9E–05	1.1E–04	4.7E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	6E–02	Total Pathway Risk	1E–05	

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor – NC (kg/kg–day)	Intake Factor – C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	7.1E–05	3.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.4E–05	1.0E–05	7.1E–05	3.0E–05	2.5E–01	9.0E–03	5.8E–02	2.7E–03	100%	6.1E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.7E–06	1.2E–06	7.1E–05	3.0E–05	2.5E–01	–	–	–	–	–	–
								Total Pathway HQ	3E–03	Total Pathway Risk	6E–07	

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor – NC (kg/kg–day)	Intake Factor – C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	2.7E–01	1.2E–01	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	2.5E–08	6.9E–09	2.9E–09	2.7E–01	1.2E–01	NA	–	2.0E–03	–	–	5.9E–12	100%
1,1,1– Trichloroethane	2.7E–07	7.3E–08	3.1E–08	2.7E–01	1.2E–01	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	6E–12	

TABLE 6.7 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 7
PUBLIC SERVICE COMPANY OF NEW MEXICO

FUTURE RISKS FROM EXPOSURE TO GROUNDWATER – ONSITE RESIDENTS EXPOSED TO CURRENT CONDITIONS (Cont.)

Ingestion of Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	3.2E–02	8.7E–04	3.7E–04	2.7E–02	1.2E–02	NA	9.0E–03	6.0E–01	9.6E–02	24%	2.2E–04	77%
Tetrachloroethene	1.1E–01	3.0E–03	1.3E–03	2.7E–02	1.2E–02	NA	1.0E–02	5.2E–02	3.0E–01	76%	6.6E–05	23%
1,1,1– Trichloroethane	1.7E–02	4.6E–04	2.0E–04	2.7E–02	1.2E–02	NA	–	–	–	–	–	–

Total Pathway HQ	4E–01	Total Pathway Risk	3E–04

Dermal Contact with Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	3.52E–05	3.5E–08	1.5E–08	6.3E–02	2.7E–02	1.6E–02	8.1E–03	6.7E–01	4.4E–06	11%	1.0E–08	56%
Tetrachloroethene	1.06E–04	3.2E–07	1.4E–07	6.3E–02	2.7E–02	4.8E–02	9.0E–03	5.8E–02	3.5E–05	89%	7.9E–09	44%
1,1,1– Trichloroethane	–	–	–	6.3E–02	2.7E–02	1.7E–02	–	–	–	–	–	–

Total Pathway HQ	4E–05	Total Pathway Risk	2E–08

Inhalation of Groundwater while Showering

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	6.6E–02	1.1E–04	4.7E–05	1.6E–03	7.1E–04	NA	–	1.2E+00	–	–	5.6E–05	99%
Tetrachloroethene	2.3E–01	3.7E–04	1.6E–04	1.6E–03	7.1E–04	NA	–	2.0E–03	–	–	3.2E–07	1%
1,1,1– Trichloroethane	3.5E–02	5.7E–05	2.5E–05	1.6E–03	7.1E–04	NA	–	–	–	–	–	–

Total Pathway HQ	–	Total Pathway Risk	6E–05
Total Receptor HQ	<1	Total Receptor Risk	4E–04

Total Receptor Risk

Notes:

mg/kg=milligrams per kilogram

mg/kg–day=milligrams per kilogram–day

kg–d/mg=kilogram days per milligrams

mg/m3=milligrams per cubic meter

L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day

cm/hr=centimeters per hour

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TABLE 6.7 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 7
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO SURFACE SOIL – OFFSITE RESIDENTS EXPOSED TO CURRENT CONDITIONS

Incidential Ingestion of Surface Soil

Chemical	Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor – NC (kg/kg–day)	Intake Factor – C (kg/kg–day)	Absorption Factor (unitless)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	1.1E–04	4.7E–05	NA	9.0E–03	6.0E–01	–	–	–	–
Tetrachloroethene	5.5E+00	6.0E–04	2.6E–04	1.1E–04	4.7E–05	NA	1.0E–02	5.2E–02	6.0E–02	100%	1.3E–05	100%
1,1,1– Trichloroethane	6.1E–01	6.7E–05	2.9E–05	1.1E–04	4.7E–05	NA	–	–	–	–	–	–
								Total Pathway HQ	6E–02	Total Pathway Risk	1E–05	

Dermal Contact with Surface Soil

Chemical	Adjusted Dermal Risk Assessment Concentration (mg/kg)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor – NC (kg/kg–day)	Intake Factor – C (kg/kg–day)	Absorption Factor (unitless)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	7.1E–05	3.0E–05	2.5E–01	8.1E–03	6.7E–01	–	–	–	–
Tetrachloroethene	1.4E+00	2.4E–05	1.0E–05	7.1E–05	3.0E–05	2.5E–01	9.0E–03	5.8E–02	2.7E–03	100%	6.1E–07	100%
1,1,1– Trichloroethane	1.5E–01	2.7E–06	1.2E–06	7.1E–05	3.0E–05	2.5E–01	–	–	–	–	–	–
								Total Pathway HQ	3E–03	Total Pathway Risk	6E–07	

Inhalation of Soil Gas

Chemical	Risk Assessment Concentration (mg/m^3)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor – NC (kg/kg–day)	Intake Factor – C (kg/kg–day)	Absorption Factor (unitless)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	–	–	–	2.7E–01	1.2E–01	NA	–	1.2E+00	–	–	–	–
Tetrachloroethene	2.5E–08	6.9E–09	2.9E–09	2.7E–01	1.2E–01	NA	–	2.0E–03	–	–	5.9E–12	100%
1,1,1– Trichloroethane	2.7E–07	7.3E–08	3.1E–08	2.7E–01	1.2E–01	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	6E–12	

TABLE 6.7 (Cont.)
RISK CALCULATIONS FOR THE PERSON GENERATING STATION SITE
EXPOSURE SCENARIO NUMBER 7
PUBLIC SERVICE COMPANY OF NEW MEXICO

RISKS FROM EXPOSURE TO GROUNDWATER – OFFSITE RESIDENTS EXPOSED TO CURRENT CONDITIONS (Cont.)

Ingestion of Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Oral RfD (mg/kg–day)	Oral SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	8.5E–03	2.3E–04	1.0E–04	2.7E–02	1.2E–02	NA	9.0E–03	6.0E–01	2.6E–02	54%	6.0E–05	93%
Tetrachloroethene	8.0E–03	2.2E–04	9.3E–05	2.7E–02	1.2E–02	NA	1.0E–02	5.2E–02	2.2E–02	46%	4.8E–06	7%
1,1,1– Trichloroethane	5.8E–04	1.6E–05	6.8E–06	2.7E–02	1.2E–02	NA	–	–	–	–	–	–
								Total Pathway HQ	5E–02	Total Pathway Risk	6E–05	

Dermal Contact with Groundwater

Chemical	Risk Assessment Concentration (mg/L)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Dermal RfD (mg/kg–day)	Dermal SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	1.44E–05	1.5E–08	6.2E–09	6.3E–02	2.7E–02	1.6E–02	8.1E–03	6.7E–01	1.8E–06	11%	4.1E–09	56%
Tetrachloroethene	4.32E–05	1.3E–07	5.6E–08	6.3E–02	2.7E–02	4.8E–02	9.0E–03	5.8E–02	1.5E–05	89%	3.2E–09	44%
1,1,1– Trichloroethane	–	–	–	6.3E–02	2.7E–02	1.7E–02	–	–	–	–	–	–
								Total Pathway HQ	2E–05	Total Pathway Risk	7E–09	

Inhalation of Groundwater while Showering

Chemical	Risk Assessment Concentration (mg/m³)	Chronic Daily Intake – NC (mg/kg–day)	Chronic Daily Intake – Car (mg/kg–day)	Intake Factor –NC (L–hr/cm–kg–d)	Intake Factor –C (L–hr/cm–kg–d)	Permeability Coefficient (cm/hr)	Inhalation RfD (mg/kg–day)	Inhalation SF (kg–d/mg)	HQ	Pathway % HQ	Risk	Pathway % Risk
1,1–Dichloroethene	1.8E–02	2.9E–05	1.2E–05	1.6E–03	7.1E–04	NA	–	1.2E+00	–	–	1.5E–05	100%
Tetrachloroethene	1.7E–02	2.7E–05	1.2E–05	1.6E–03	7.1E–04	NA	–	2.0E–03	–	–	2.3E–08	0%
1,1,1– Trichloroethane	1.2E–03	2.0E–06	8.5E–07	1.6E–03	7.1E–04	NA	–	–	–	–	–	–
								Total Pathway HQ	–	Total Pathway Risk	1E–05	
								Total Receptor HQ	<1	Total Receptor Risk	9E–05	

Total Receptor Risk

Notes:

mg/kg=milligrams per kilogram

mg/kg–day=milligrams per kilogram–day

kg–d/mg=kilogram days per milligrams

mg/m3=milligrams per cubic meter

L–hr/cm–kg–d=liter–hour per centimeter–kilogram–day

cm/hr=centimeters per hour

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Table 6.8
RISK ASSESSMENT SUMMARY TABLE
PERSON GENERATING STATION
PUBLIC SERVICE OF NEW MEXICO

Receptor	Hazard Quotient	Comment	Risk	Comment
Light Industrial/Commercial Workers – onsite or offsite, current or future	<1	No Adverse Effects	5E−7	Risks calculated for only PCE. Risks driven by dermal exposure to soil. Risks below target risk range of 1E−4 to 1E−6.
Construction/Remediation Workers – current or future onsite	<1	No Adverse Effects	4E−7	Risks calculated for only PCE. Risks driven by dermal exposure to soil. Risks below target risk range of 1E−4 to 1E−6.
Offsite Recreators (Adults) (Surface Water Exposure)				
Based on performance efficiency estimates	<1	No Adverse Effects	7E−7	Risks driven by dermal exposure to water. Risks below target risk range of 1E−4 to 1E−6.
Based on proposed effluent discharge limits	<1	No Adverse Effects	1E−6	Risks driven by dermal exposure to water. Risks within target risk range of 1E−4 to 1E−6.
Based on the 95% UCL for onsite ground water	<1	No Adverse Effects	1E−5	Risks driven by dermal exposure to water. Risks within target risk range of 1E−4 to 1E−6.
Future Residents (with anticipated groundwater remediation)				
Onsite	<1	No Adverse Effects	3E−5	Risks driven by dermal exposure. Risks within target risk range of 1E−4 to 1E−6.
Offsite	<1	No Adverse Effects	2E−5	Risks driven by dermal exposure. Risks within target risk range of 1E−4 to 1E−6.
No Action (no groundwater remediation) (Hypothetical Current Residents)				
Onsite	<1	No Adverse Effects	4E−4	Risks driven by dermal exposure. Risks slightly above target risk range of 1E−4 to 1E−6.
Offsite	<1	No Adverse Effects	9E−5	Risks driven by dermal exposure. Risks within target risk range of 1E−4 to 1E−6.

Risk estimates (based on engineering calculations on the effectiveness of the planned remedial action for the Person Generating Station site) show that anticipated cleanup levels to be achieved by implementing the planned remedial action will be protective of human health even under the most conservative land use assumptions (onsite and offsite residential and recreational use), as defined by the EPA. Thus, the remedial action described in the CMP will not pose significant adverse threats to human health during implementation and is anticipated to restore the site to a state that will not require additional, future land use restrictions.

6.2 DISCUSSION AND UNCERTAINTY ANALYSIS

It is imperative to consider a few key points when determining how best to use these risk estimates. First, carcinogenic risks were driven by dermal exposure to PCE contamination. The risk assessment concentration level for PCE was based on soil data taken from the former waste oil tank area, which is currently covered by a closure cap. These concentration levels overestimate the degree of contamination that any receptor could reasonably contact. In the absence of soil data more characteristic of onsite and offsite conditions, however, these values were used to assess the maximum exposure potential. These dermal risk estimates also represent best professional judgment in terms of toxicity, since no reference dermal toxicity values or guidance on how to develop such values have been provided by the EPA.

Second, cumulative risk estimates in many instances do not account for exposure to all three COCs found in soils at the site. Initial site characterization sampling efforts for soils focused on PCE to characterize the nature and extent of contamination. It was not the intent of the sampling efforts at that time to support a quantitative risk assessment. As a result, available soil information for 1,1,1-TCA and 1,1-DCE is limited. Thus, risk estimates could only be developed for COCs for which there was both a risk assessment concentration level and a toxicity value. The absence of either results in an incomplete quantitative expression of risk.

Third, use of a withdrawn toxicity value (slope factor) for PCE interjects additional uncertainty into the risk calculations. The EPA withdrew this toxicity value to re-evaluate the relationship between the extent of exposure to PCE and the increased likelihood and/or severity of carcinogenic effects. However, because PCE is the most well-characterized contaminant at the site, it did not seem prudent to disregard potential risks associated with exposure to this contaminant. Use of the withdrawn toxicity value for PCE may tend to underestimate or overestimate the risks due to exposure to this contaminant pending the EPA's decisions regarding the appropriate carcinogenic toxicity value. Uncertainties inherent in the calculated PCE dermal slope factor are only further exacerbated by the lack of EPA toxicity data.

Fourth, assumptions about risk assessment concentration levels and exposure potential are based on best available data and best professional judgment. Because of the nature of site characterization data available to support quantitative risk estimates, calculated risk assessment concentration levels are likely to overestimate the amount of contamination that any receptor could reasonably contact. For example, onsite and offsite soil contamination is defined by the most contaminated area, currently protected by the closure cap. Hypothetical future residents are assumed to ingest, dermally contact, and inhale vapors from ground water withdrawn for domestic purposes from only the upper 20 feet of the aquifer. This is an extremely conservative assumption since ground water is normally extracted from much deeper portions of the aquifer (Metric, 1992). Further, the use of single-point values to represent complex site and human characteristics and behavioral patterns in quantitative risk assessments can be easily (and is usually) criticized. However, these simplifying assumptions are necessary to estimate the hazard associated with exposure to site-related contamination. Without this approach (or until a better approach is developed and approved for use), no tools would exist to evaluate potential risks associated with site contamination. Conservative strategies were followed when developing risk assessment concentration levels and exposure equations for the site to ensure that a "worst case" estimate of risk for each exposure scenario was developed.

SECTION 7

PRELIMINARY REMEDIATION GOALS

The final objective of the focused risk assessment for the Person Generating Station site was to determine the concentrations of COCs that can remain onsite and still be protective of human health. These target long-term concentration goals or risk-based preliminary remediation goals (PRGs) for human health can be used to guide decisions about cleanup goals for the site. Risk-based PRGs were calculated for each of the three COCs using a cumulative target carcinogenic risk level of $1x10^{-5}$ and a cumulative hazard index of 1. This means that the adjusted cumulative risk levels used to calculate the risk-based PRGs ensure that exposure to these concentrations of all COCs would not present a cumulative individual excess carcinogenic risk level greater than $1x10^{-5}$ or cause the hazard quotient to exceed unity. The purpose of these calculations was to determine the level of contaminants that could remain onsite and still not pose a risk to any group of receptors that may reasonably be exposed to contaminated soil and shallow ground water at the site. No attempt has been made at this time to modify these risk-based PRGs based on technical limitations, detection limits, etc. Final cleanup goals for the site will be established in concert with regulatory authorities.

7.1 APPROACH AND RESULTS

Risk-based PRGs were developed for each of the three COCs using specific exposure scenarios and toxicity values. Development of risk-based PRGs are described in one of the EPA RAGS manuals (EPA, 1991a). Risk-based PRGs were developed for the Person Generating Station site using the standard default exposure variables described in this EPA risk assessment guidance document. These risk-based PRGs are target long-term concentration goals for individual chemicals for specific environmental media (i.e., soil and shallow ground water) and land use combinations (i.e., industrial and residential). Risk-based ecological PRGs were not developed as part of this evaluation for the reasons discussed earlier.

The environmental media of concern factored into the calculation of risk-based PRGs for the site were surface and subsurface soils, shallow ground water, and soil gas. Surface water is not likely to be affected by site-related contamination unless ground water is extracted and directly discharged to this medium. The proposed treatment train for extracted ground water destined for surface water discharge was shown in earlier sections of this report to be sufficient to protect human health under conservative exposure scenarios. Thus, surface water PRGs are not developed.

Risk-based PRGs were calculated for both residential and worker receptors. Routes of exposure used in the calculations were ingestion and inhalation only. No dermal component was included (i.e., used standard default equations, EPA, 1991a). Toxicity values used in the development of the risk-based PRGs were identical to those used to develop risk estimates in Section 6. The risk-based PRGs for residents, light industrial/commercial workers, and construction/remediation workers are presented in Table 7.1. Equations and inputs used to calculate PRGs are contained in Appendix B.

7.2 DISCUSSION

Long-term concentration goals can be based on either risk or on promulgated standards. The risk-based approach to determining concentration goals for soils was established since no cleanup standards for soils have been promulgated. The most stringent, calculated risk-based PRGs for soils are 8,233 ppm, 3.6 ppm, and 41 ppm for 1,1,1-TCA, 1,1-DCE, and PCE, respectively. These risk-based PRGs are designed to protect residential receptors; the risk-based PRGs are less stringent under industrial land use assumptions. These risk-based PRGs for soils can be used to guide decisions about the intensity and duration of soil remediation activities needed to protect human health. It is important to note, however, that these concentrations are only designed to account for direct exposures. That is, these concentrations are not intended to define the degree of source removal necessary to prevent contaminant migration and additional ground water degradation. As discussed previously, however, no significant vertical transport mechanism currently exists by which contaminants in the soil could migrate downward to appreciably impact shallow ground water quality.

In comparison to soils, however, Maximum Contaminant Levels (MCLs) for ground water for each of the COCs have been established by the New Mexico Water Quality Control Commission and/or the EPA. The promulgated MCLs for the COCs in ground water are as follows: 60 ppb for 1,1,1-TCA, 5 ppb for 1,1-DCE, and 5 ppb for PCE. The most stringent, calculated risk-based PRGs for ground water are 3,000 ppb, 0.1 ppb, and 4.8 ppb for 1,1,1-TCA, 1,1-DCE, and PCE, respectively. The risk-based PRG for 1,1,1-TCA is significantly higher than its promulgated MCL. The risk-based PRGs for ground water for 1,1-DCE and PCE are lower than their respective MCLs due to estimates of their combined carcinogenicity. These risk-based PRGs were calculated assuming unrestricted use of ground water resources (conservative residential scenario). Risk-based PRGs for ground water can be modified to reflect likely future land use. The risk-based PRGs developed using an industrial exposure assumption would likely be significantly higher than risk-based PRGs based on a residential assumption or their MCLs. The need to protect ground water resources, technical limitations, and cost should all be considered in balance when developing final long-term cleanup goals for this site.

Thus, when deciding how to determine appropriate cleanup goals for the site, it may be appropriate to revisit the land use and exposure assumptions inherent in the development of the most stringent risk-based PRGs. More specifically, the risk-based PRGs are likely to be overly protective in that they include many extremely conservative assumptions that do not reflect existing or reasonably foreseeable site conditions. Comparison of the most conservative risk-based PRGs to the risk estimates

TABLE 7.1
RISK–BASED AND CRITERIA–BASED PRELIMINARY REMEDIATION GOALS (PRGs)
ADJUSTED FOR A CUMULATIVE RISK OF 1E–05
PERSON GENERATING SITE
PUBLIC SERVICE COMPANY OF NEW MEXICO

RESIDENTIAL PRGs

	Toxicity Information				Risk–based PRG with inhalation				Criteria–based PRG	
Chemical Name	Carc. (SF_o) $(mg/kg/day)^{-1}$	Non–carc. (RfD_o) (mg/kg/day)	Carc. (SF_i) $(mg/kg/day)^{-1}$	Non–carc. (RfD_i) (mg/kg/day)	Soil Carc. (mg/kg or ppm)	Non–carc. (mg/kg or ppm)	Groundwater Carc. (mg/L or ppm)	Non–carc. (mg/L or ppm)	Soil (mg/kg or ppm)	Groundwater (mg/L or ppm) a/
Volatile Organics:										
1,1–Dichloroethene	6.00E–01	9.00E–03	1.20E+00	–	3.6	823	0.0001	0.11	–	0.005
Tetrachloroethene	5.20E–02	1.00E–02	2.00E–03	–	41	915	0.0048	0.12	–	0.005
1,1,1–Trichloroethane	–	9.00E–02	–	–	–	8233	–	3	–	0.06

COMMERCIAL/INDUSTRIAL PRGs

	Toxicity Information				Risk–based PRG with inhalation	
Chemical Name	Carc. (SF_o) $(mg/kg/day)^{-1}$	Non–carc. (RfD_o) (mg/kg/day)	Carc. (SF_i) $(mg/kg/day)^{-1}$	Non–carc. (RfD_i) (mg/kg/day)	Soil Carc. (mg/kg or ppm)	Non–carc. (mg/kg or ppm)
Volatile Organics:						
1,1–Dichloroethene	6.00E–01	9.00E–03	1.20E+00	–	32	6132
Tetrachloroethene	5.20E–02	1.00E–02	2.00E–03	–	367	6813
1,1,1–Trichloroethane	–	9.00E–02	–	–	–	61320

CONSTRUCTION/REMEDIATION PRGs

	Toxicity Information				Risk–based PRG with inhalation	
Chemical Name	Carc. (SF_o) $(mg/kg/day)^{-1}$	Non–carc. (RfD_o) (mg/kg/day)	Carc. (SF_i) $(mg/kg/day)^{-1}$	Non–carc. (RfD_i) (mg/kg/day)	Soil Carc. (mg/kg or ppm)	Non–carc. (mg/kg or ppm)
Volatile Organics:						
1,1–Dichloroethene	6.00E–01	9.00E–03	1.20E+00	–	397	6132
Tetrachloroethene	5.20E–02	1.00E–02	2.00E–03	–	4585	6813
1,1,1–Trichloroethane	–	9.00E–02	–	–	–	61320

Note:
SF_o = Oral Slope Factor
RfD_o = Oral Reference Dose
SF_i = Inhalation Slope Factor
RfC = Reference Concentration
RfD_i = Inhalation Reference Dose

a/ Criteria–based PRGs are from both New Mexico Water Quality Control Commission and the USEPA.

developed in Section 6 of this report also suggests that the most stringent risk-based PRGs for ground water are extremely conservative. Risk estimates developed for hypothetical future residents, assuming no action was taken at the site (Exposure Scenario 6), demonstrate a cumulative carcinogenic risk level slightly above the EPA target risk range. In summary, some level of ground water remediation may be necessary to allow unrestricted use of the land and ground water at this site. However, the intensity and length of ground water remediation should be re-evaluated under more realistic land use and exposure scenarios after contaminant recovery from the aquifer reaches its practical, technical limits.

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APPENDIX A

CHEMICAL TOXICITY PROFILES

1,1-DICHLOROETHENE

CAS NUMBER

75-35-4

COMMON SYNONYMS

1,1-Dichloroethylene, asym-dichloroethylene, vinylidene chloride, DCE.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: approximately 2,500 mg/L at 25°C [1]
Vapor Pressure: 591 mm Hg at 25°C [1]
Henry's Law Constant: 3.01×10^{-2} atm-m^3/mole [1]
Specific Gravity: 1.213 at 20/4°C [2]
Organic Carbon Partition Coefficient: 150 [1]

FATE DATA: HALF-LIVES

Soil: 4 weeks to 6 months [3]
Air: 9.9 hours to 4.1 days [3]
Surface Water: 4 weeks to 6 months [3]
Groundwater: 56 to 132 days [3]

NATURAL SOURCES

None [4].

ARTIFICIAL SOURCES

Manufacture of plastic wrap, adhesives, and synthetic fibers; metabolism of chlorinated solvents [1].

FATE AND TRANSPORT

1,1-Dichloroethene is a relatively volatile and soluble compound. Releases of this compound to soils and waters, therefore, will be lost primarily through evaporative processes. Given the low K_{oc} value, little tendency to adsorb to soils and sediments/suspended solids (in waters) is exhibited, and some percolation through soils to groundwaters can be expected. In the groundwaters, very slow hydrolysis and biodegradation (via anaerobic reductive dechlorination to vinyl chloride) will occur. Released to the atmosphere, 1,1-dichloroethene will degrade by reaction with hydroxyl radicals. Photooxidative reactions in waters are insignificant. Based on its low octanol/water partition coefficient (K_{ow} = 135), no significant bioconcentration is expected [1].

HUMAN TOXICITY

General. High levels of DCE have reportedly caused a variety of adverse health effects in animals, including liver, kidney, heart and lung damage, as well as nervous system disorders and death. Harmful effects on the developing fetus have also been demonstrated [4]. The USEPA has placed DCE in weight-of-evidence Group C, indicating that it is a possible human carcinogen [5].

Oral Exposure. A chronic RfD of 0.009 mg/kg/day is based on a LOAEL of 9 mg/kg/day determined for hepatic lesions following chronic oral administration to rats [5]. Studies in animals have demonstrated that DCE is rapidly and almost completely absorbed from the gastrointestinal tract following oral administration. The oral LD_{50} for rats is approximately 1,500 mg/kg. No information on the health effects in humans following oral exposure was located [4]. An oral slope factor of 0.6 $(mg/kg/day)^{-1}$ is based on adrenal pheochromocytomas observed in male rats following chronic oral exposure [5].

Inhalation Exposure. The RfC is currently under review by the USEPA [5], and no value is provided in HEAST [6]. Studies in animals have demonstrated that DCE is rapidly absorbed following inhalation exposure. The 4-hour LC_{50} values in fed male rats range from approximately 6,000 to 8,000 ppm, while the 4-hour LC_{50} for male rats fasted for 16 hours is 400 ppm. No information was located regarding human deaths following inhalation exposure. The limited information available indicates that humans exposed via short-term inhalation may experience neurotoxicity. Also in humans, DCE has been implicated in liver and kidney toxicity following repeated, low-level exposure. Symptoms in humans exposed via inhalation to concentrations of about 4,000 ppm include: central nervous system depression, convulsions, spasms, and unconsciousness. Pregnant mice exposed to 15 ppm or greater DCE for an unspecified duration produced offspring with skeletal anomalies [4]. An inhalation unit risk of 5.0×10^{-5} $(\mu g/m^3)^{-1}$ is based on kidney adenocarcinomas observed in male mice exposed via inhalation for 12 months [5].

Dermal Exposure. DCE is irritating when applied to the skin of humans and animals. It is also an eye irritant in humans. Studies with mice indicate that DCE applied dermally is a tumor initiator. No other information was located regarding the health effects of DCE following dermal exposure [4].

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TETRACHLOROETHENE

CAS NUMBER

127-18-4

COMMON SYNONYMS

Tetrachloroethylene, perchloroethylene, PCE.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1,503 mg/L at 25°C [1]
Vapor Pressure: 18.49 mm Hg at 25°C [1]
Henry's Law Constant: 1.49 x 10^{-2} atm-m^3/mole [1]
Specific Gravity: 1.6311 at 15/4°C [2]
Organic Carbon Partition Coefficient: 209 to 238 [1]

FATE DATA: HALF-LIVES

Soil: 0.5 - 1 year [3]
Air: 16 - 160 days [3]
Surface Water: 0.5 - 1 year [3]
Groundwater: 1 - 2 years [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Dry cleaning industry, metal finishing, organic chemical/plastics manufacturing [1].

FATE AND TRANSPORT

PCE released to surface soil will be subject to evaporation into the atmosphere and leaching to the groundwater. It is weakly adsorbed to soil organic material. Since it is only somewhat soluble in water and substantially denser, when it occurs as a separate phase it tends to sink to the bottom of the aquifer. Biodegradation of PCE occurs in soils and, to a lesser extent, in some types of groundwater. PCE released to surface water will be subject to rapid volatilization; it will not be expected to significantly biodegrade, bioconcentrate in aquatic organisms, or adsorb to sediment.

Photooxidation degrades PCE in the atmosphere, although some may be washed out in rain before this occurs [1].

HUMAN TOXICITY

General. The primary targets of PCE toxicity are the central nervous system, the liver and the kidneys [4,5]. PCE is not considered to be mutagenic. The USEPA has not adopted a final position on the weight-of-evidence cancer classification for PCE, but an oral Slope Factor and inhalation Unit Risk have been derived [7].

Oral Exposure. A chronic oral RfD of 0.01 mg/kg/day is based on a NOAEL of 14 mg/kg/day for hepatotoxicity in mice and weight gain in rats following subchronic administration of PCE [6]. PCE is readily absorbed following oral exposure. Acute oral LD_{50} values ranged from 3000 to 8850 mg/kg in rats and 5000 to 8100 mg/kg in mice [4,5]. The fatal oral dose to humans is not known. Inebriation was the only reported side effect following treatment of intestinal parasites with doses of 2.8 to 4.0 ml (40-57 mg/kg) PCE [5]. No other data regarding toxic effects in humans following oral exposure are available. PCE has been found to cause liver tumors in mice following both oral and inhalation exposure [4]. An oral Slope Factor of 0.052 $(mg/kg/day)^{-1}$ is based on the incidence of liver cancer in mice [7].

Inhalation Exposure. An inhalation RfC for PCE is not currently available [6]. PCE is rapidly absorbed following inhalation exposure [4]. Acute inhalation LC_{50} values of 5200 ppm (4 hour) and 5040 ppm (8 hour) were identified for mice and rats, respectively [5]. Acute exposure of humans to concentrations of PCE in air above 200 ppm has resulted in depression of the central nervous system characterized by dizziness, impaired memory, confusion, irritability, "inebriation-like" symptoms, tremors and numbness. Long-term exposure of humans to PCE (concentration not reported) has resulted in toxic effects on the liver, including hepatitis, cirrhosis, liver-cell necrosis and enlarged liver. Chronic kidney disease has also been noted [5]. There is no evidence that PCE causes effects on human development or reproduction [4,5]. PCE has been found to cause liver tumors in mice following both oral and inhalation exposure [4]. An inhalation Unit Risk of 5.8×10^{-7} $(ug/m^3)^{-1}$ was derived based on the incidence of liver cancer in mice [7].

Dermal Exposure. A 10-day dermal LD_{50} value of 64,680 mg/kg was defined for mice [5]. Skin contact with PCE causes dryness, irritation, blistering and burns. Mild liver and kidney damage may also occur. The exposure levels that result in these effects are not known.

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1,1,1-TRICHLOROETHANE

CAS NUMBER

71-55-6

COMMON SYNONYMS

Methylchloroform, TCA.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1,495 mg/L at 25°C [1]
Vapor Pressure: 123.7 mm Hg at 25°C [1]
Henry's Law Constant: 8 x 10^{-3} atm-m^3/mole [1]
Specific Gravity: 1.3376 at 20/4°C [2]
Organic Carbon Partition Coefficient: 183 [1]

FATE DATA: HALF-LIVES

Soil: 20 - 39 weeks [3]
Air: 225 days - 6.2 years [3]
Surface Water: 20 - 39 weeks [3]
Groundwater: 20 weeks - 1.5 years [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Metal degreasing, solvent, aerosol.

FATE AND TRANSPORT

TCA released to surface soil will be lost primarily to evaporation. It is mobile in soil, and will leach to groundwater. Since it is only somewhat soluble in water and substantially denser, when it occurs as a separate phase it tends to sink to the bottom of the aquifer. Almost all of the TCA present in surface water will be lost to evaporation. Releases to air will be transported long distances and partially returned to earth in rain. Photodegradation in the lower atmosphere is slow, while in the upper atmosphere it is rapid [1].

HUMAN TOXICITY

General. TCA is generally regarded as being of moderate to low toxicity. The primary target of TCA toxicity in humans is the central nervous system [4,5]. TCA is also a skin and eye irritant. Information regarding the mutagenicity of TCA are equivocal. The USEPA has placed TCA in weight-of-evidence Group D, indicating that it is not classifiable as to human carcinogenicity [6].

Oral Exposure. A chronic oral RfD for 1,1,1-trichloroethane is currently under review by the USEPA RfD/RfC Work Group [6,7]. TCA is absorbed following oral exposure, but the rate and extent of absorption are not known. Acute oral LD_{50} values in animals ranged from 5660 mg/kg in rabbits to 12,300 mg/kg in rats [4,5]. The fatal doses to humans has not been reported. A single, adult human who ingested 30 mL (approximately 570 mg/kg) of TCA showed initial symptoms of CNS depression and gastrointestinal upset. The patient survived and recovered within two weeks [5]. The effects of long-term oral exposure of humans to TCA are not known. In animals, TCA exposure has also resulted in effects on the liver (changes in liver enzymes). Information regarding the possible effects of TCA on the developing fetus in humans are not available, but oral studies in animals suggest that TCA is probably not a developmental toxicant [4]. There is no evidence that ingested TCA causes cancer in humans, and studies in animals are unable to assess the carcinogenic potential of TCA because the quality of the studies are poor [4]. An oral Slope Factor for cancer is not available [6].

Inhalation Exposure. A chronic inhalation RfC for 1,1,1-trichloroethane is currently under review by the USEPA RfD/RfC Work Group [6,7]. TCA is readily absorbed following inhalation exposure. Acute inhalation LC_{50} values in rats ranged from 10,305 ppm (6 hours) to 38,000 ppm (15 minutes) and in mice ranged from 3911 ppm (2 hours) to 18,358 ppm (1 hour) [4]. TCA inhalation has resulted in human deaths, with fatal concentrations estimated at 6,000 to 20,000 ppm [4]. Death is usually attributed to either depression of the central nervous system, resulting in respiratory arrest, or sensitization of the heart to epinephrine, resulting in severe cardiac arrhythmia [4]. Short-term inhalation of TCA in humans results in neurological effects. Within 20 minutes of exposure to 175 to 350 ppm TCA, deficits in motor performance have been seen [5]. Changes in reaction time, manual dexterity, and equilibrium have been reported following exposure to 350 ppm for 1-3 hours, and eye, nose and throat irritation and impaired perceptive capabilities have been found following exposure to 450 ppm for 8 hours. Exposure to TCA concentrations above 1000 ppm for 15 minutes or 2000 ppm for 5 minutes has resulted in disequilibrium in adults [5]. The effects of long-term inhalation of TCA are not known. Information regarding the possible effects of TCA on the developing fetus in humans are not available, but inhalation studies in animals suggest that TCA is probably not a developmental or reproductive toxicant [4]. There is no evidence that inhaled TCA causes cancer in humans, and inhalation studies in animals suggest that TCA is not a carcinogen via this route [4]. An inhalation Unit Risk factor for cancer is not available [6].

Dermal Exposure. Dermal exposure to TCA has not been shown to be lethal to humans, and dermal LD_{50} values are not available in animals [4]. Extended dermal contact to high concentrations of TCA results in skin irritation and a burning sensation, but TCA is not considered to be a strong skin irritant [4].

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APPENDIX B

RISK-BASED PRELIMINARY REMEDIATION GOALS (PRGS) CALCULATIONS

TABLE B-1

RESIDENTIAL USE OF GROUNDWATER - PRG EQUATIONS FOR NONCARCINOGENIC EFFECTS
PERSON GENERATING STATION
PUBLIC SERVICE COMPANY OF NEW MEXICO

$$THI = \frac{C \times IR_w \times EF \times ED}{RfD_o \times BW \times AT} + \frac{C \times K \times IR_a \times EF \times ED}{RfD_i \times BW \times AT}$$

$$C\ (mg/L) = \frac{THI \times BW \times AT}{EF \times ED \times [(1/RfD_i \times K \times IR_a) + (1/RfD_o \times IR_w)]}$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in water (mg/L)	-
THI	target hazard index (unitless)	1
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD_i	inhalation chronic reference dose (mg/kg/day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	average time (days)	ED x 365 days/yr
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR_w	daily water ingestion rate (L/day)	2 L/day
IR_a	daily indoor inhalation rate (m^3/day)	15 m^3/day
K	volatilization factor (unitless)	0.0005 x 1000 L/m^3

Source: RAGS Part B

TABLE B-2

RESIDENTIAL USE OF GROUNDWATER - PRG EQUATIONS FOR CARCINOGENIC EFFECTS
PERSONS GENERATING STATION
PUBLIC SERVICE COMPANY OF NEW MEXICO

$$TR = \frac{SF_o \times C \times IR_w \times EF \times ED}{BW \times AT} + \frac{SF_i \times C \times K \times IR_a \times EF \times ED}{BW \times AT}$$

$$C\ (mg/L) = \frac{TR \times BW \times AT}{EF \times ED \times [(SF_i \times K \times IR_a) + (SF_o \times IR_w)]}$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	-
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_o	oral cancer slope factor (1/mg/kg-day)	chemical-specific
SF_i	inhalation cancer slope factor (1/mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	average time (days)	70 yr x 365 days/yr
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR_a	daily indoor inhalation rate (m^3/day)	15 m^3/day
IR_w	daily water ingestion (L/day)	2 L/day
K	volatilization factor (unitless)	0.0005 x 1000 L/m^3

Source: RAGS Part B

TABLE B-3
RESIDENTIAL SOIL - PRG EQUATIONS FOR NONCARCINOGENIC EFFECTS

PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

$$THI = \frac{C \times 10^{-6}\ kg/mg \times EF \times IF_{soil\text{-}adj}}{RfD_o \times AT}$$

$$C\ mg/kg = \frac{THI \times AT}{1/RfD_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil\text{-}adj}}$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	-
THI	target hazard index (unitless)	1
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
AT	average time (days)	ED x 365 days/yr
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
$IF_{soil\text{-}adj}$	age-adjusted ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day

where: $IF_{soil\text{-}adj}$ (mg-yr/kg-day) $= \frac{IR_{soil\text{-}age}\ 1\text{-}6 \times ED_{age\ 1\text{-}6}}{BW_{age\ 1\text{-}6}} + \frac{IR_{soil\text{-}age}\ 7\text{-}31 \times ED_{age\ 7\text{-}31}}{BW_{age\ 7\text{-}31}}$

Parameters	Definition (units)	Default Value
$BW_{age\ 1\text{-}6}$	average body weight from ages 1-6 (kg)	15 kg
$BW_{age\ 7\text{-}31}$	average body weight from ages 7-31 (kg)	70 kg
$ED_{age\ 1\text{-}6}$	exposure duration during ages 1-6 (yr)	6 yr
$ED_{age\ 7\text{-}31}$	exposure duration during ages 7-31 (yr)	24 yr
$IR_{soil\text{-}age\ 1\text{-}6}$	ingestion rate of soil age 1 to 6 (mg/kg)	200 mg/day
$IR_{soil\text{-}age\ 7\text{-}31}$	ingestion rate of soil age 7 to 31 (mg/kg)	100 mg/day

Source: RAGS Part B

TABLE B-4
RESIDENTIAL SOIL - PRG EQUATIONS FOR CARCINOGENIC EFFECTS

PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

$$TR = \frac{C \times S_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil\text{-}adj}}{AT}$$

$$C\ mg/kg = \frac{TR \times AT}{SF_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil\text{-}adj}}$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	-
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_o	oral cancer slope factor (1/mg/kg-day)	chemical-specific
AT	average time (days)	ED x 365 days/yr
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
$IF_{soil\text{-}adj}$	age-adjusted ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day

where: $IF_{soil\text{-}adj}$ (mg-yr/kg-day) $= \frac{IR_{soil\text{-}age\ 1\text{-}6} \times ED_{age\ 1\text{-}6}}{BW_{age\ 1\text{-}6}} + \frac{IR_{soil\text{-}age\ 7\text{-}31} \times ED_{age\ 7\text{-}31}}{BW_{age\ 7\text{-}31}}$

Parameters	Definition (units)	Default Value
$BW_{age\ 1\text{-}6}$	average body weight from ages 1-6 (kg)	15 kg
$BW_{age\ 7\text{-}31}$	average body weight from ages 7-31 (kg)	70 kg
$ED_{age\ 1\text{-}6}$	exposure duration during ages 1-6 (yr)	6 yr
$ED_{age\ 7\text{-}31}$	exposure duration during ages 7-31 (yr)	24 yr
$IR_{soil\text{-}age\ 1\text{-}6}$	ingestion rate of soil age 1 to 6 (mg/kg)	200 mg/day
$IR_{soil\text{-}age\ 7\text{-}31}$	ingestion rate of soil age 7 to 31 (mg/kg)	100 mg/day

Source: RAGS Part B

TABLE B-5
WORKER/INDUSTRIAL SOILS -
PRG EQUATIONS FOR NONCARCINOGENIC EFFECTS

PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

$$THI = \frac{C \times 10^{-6}\,kg/mg \times EF \times ED \times IR_{soil}}{RfD_o \times BW \times AT} + \frac{C \times EF \times ED \times IR_{air} \times (PE)}{RfD_i \times BW \times AT}$$

$$C\ mg/kg; = \frac{THI \times BW \times AT}{ED \times EF \times [((1/RfD_o) \times 10^{-6}\,kg/mg \times IR_{soil}) + ((1/RfD_i) \times IR_{air} \times (1/PE))]}$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	-
THI	target hazard index (unitless)	1
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD_i	inhalation chronic reference dose (mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	average time (days)	ED yr x 365 days/yr
EF	exposure frequency (days/yr)	250 days/yr
ED	exposure duration (yr)	25 yr or 2 yr [a/]
IR_{soil}	soil ingestion rate (mg/day)	50 mg/day
IR_{air}	workday inhalation rate (m^3/day)	20 m^3/hr
PE	particulate emissions (kg/m^3)	4.63 x 10^9 m^3/kg

Source: RAGS Part B;

[a/] 25-year ED assumed for light commercial/industrial worker; 2-year ED assumed for construction/remediation worker. See text for detailed description.

TABLE B-6
WORKER/INDUSTRIAL SOILS - PRG EQUATIONS FOR CARCINOGENIC EFFECTS

PERSON GENERATING STATION, PUBLIC SERVICE COMPANY OF NEW MEXICO

$$TR = \frac{SF_o \times C \times 10^{-6}\ kg/mg \times EF \times ED \times IR_{soil}}{BW \times AT} + \frac{SF_i \times C \times EF \times ED \times IR_{air} \times (PE)}{BW \times AT}$$

$$C\ mg/kg; = \frac{TR \times BW \times AT}{EF \times ED \times [(SF_o \times 10^{-6}\ kg/mg \times IR_{soil}) + (SF_i \times IR_{air} \times (PE))\ ]}$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	-
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_i	inhalation cancer slope factor ($(mg/kg\text{-}day)^{-1}$)	chemical-specific
SF_o	oral cancer slope factor ($(mg/kg\text{-}day)^{-1}$)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	average time (days)	70 yr x 365 days/yr
EF	exposure frequency (days/yr)	250 days/yr
ED	exposure duration (yr)	25 yr or 2 yr[a/]
IR_{soil}	workday ingestion rate (mg/day)	50 mg/day
IR_{air}	workday inhalation rate (m^3/day)	20 m^3/day
PE	particulate emissions (kg/m^3)	$4.63 \times 10^9\ m^3/kg$

Source: RAGS Part B;

[a/] 25-year ED assured for light commercial/industrial worker; 2-year ED assumed for construction/remediation worker. See text for detailed description.

Public Service Company of New Mexico

September 19, 1994

By Federal Express

Mr. Ron Kern
Program Manager
New Mexico Environment Department
Hazardous and Radioactive Materials Bureau
525 Camino de Los Marquez
Santa Fe, NM 87502

Dear Mr. Kern:

Subject: Submittal of Draft Document,
Focused Risk Assessment For The
Person Generating Station, NMT360010342

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Toni Ristau
Toni Ristau
Director, Environmental Services

Enclosed please find two (2) copies of the draft document Focused Risk Assessment for the Person Generating Station, Public Service Company of New Mexico, RCRA Permit NMT360010342. This document was prepared pursuant to the "framework for risk assessment" document previously reviewed and approved by HRMB in your letter of August 17, 1994.

If you have any questions, please feel free to contact me at 848-2998.

Sincerely,

Ron Johnson
Ron D. Johnson
Sr. Environmental Scientist

RDJ:rdj
cc: Teri Davis - HRMB

Alvarado Square
Albuquerque, New Mexico 87158

SUBJECT FILE COPY

Public Service Company of New Mexico

AUG 1994
RECEIVED
HAZARDOUS WASTE PROGRAM

July 28, 1994

Certified Mail
Return Receipt Requested

Mr. Ron Kern
New Mexico Environment Department
Hazardous and Radioactive Materials Bureau
525 Camino de Los Marquez
Santa Fe, NM 87502

Dear Mr. Kern:

Subject: Framework for Risk Assessment,
Person Generating Station, NMT360010342

Enclosed please find our most recent revision to the document Framework for Risk Assessment, Person Generating Station, NMT360010342 which incorporates comments received from the Hazardous and Radioactive Materials Bureau (HRMB) in your letter dated July 6, 1994.

If you find the new language acceptable, I would appreciate a short letter response to that effect. At that time we will forward the draft risk assessment report to you for your review. If you have any questions, please contact me at 848-2998.

Sincerely,

Ron Johnson

Ron D. Johnson
Sr. Environmental Scientist

RDJ:rdj
enclosure
cc: Ms. Teri Davis - NMED

Engineering-Science, Inc. (ES) proposes to quantitatively characterize under both current and reasonable future exposure scenarios the potential carcinogenic and noncarcinogenic risks posed to human health from volatile organic compound (VOC) contamination in soil and shallow groundwater at the Person Generating Station site. Risks to human health will be quantitatively evaluated using a site-specific approach based on the chemical risk assessment principles and procedures outlined in EPA's Risk Assessment Guidance for Superfund (RAGS) manuals.

There are two primary objectives of the proposed risk assessment for the Person Generating Station Site. The first objective is to evaluate and document potential threats posed by existing site contamination if no action were taken at the site (commonly referred to as a baseline risk assessment). The second is to provide a basis for determining the levels of chemicals that can remain onsite and still be adequately protective of public health. This second objective is primarily aimed at defining risk-based target remediation goals for the site. However, since the Public Service of New Mexico (PNM) and the New Mexico Environment Department (NMED) have already agreed to implement a response action at the Person Generating Station site, assessment of potential site risks under future exposure scenarios should also concentrate on the risks associated with the remedial action itself plus any remaining contamination (commonly termed risk evaluation of a remedial alternative).

On February 4, 1994, representatives from NMED, PNM, and ES discussed possible approaches to quantitatively evaluate site risks for the Person Generating Station site. The group collectively agreed that quantitative risk information could be used to assess the continuing need for and effectiveness of the remedial action described in the Corrective Measures Proposal (CMP) for the Person Generating Station site. Given that PNM and NMED have reached a consensus on the initial remedial technologies to be implemented at the site, the group also agreed that a modified risk assessment strategy may be reasonable and adequate to support the decision-making process for the site. PNM and ES believe that coupling elements of the traditional baseline risk assessment and elements of an evaluation of the short- and long-term risks associated with implementing a remedial action at the site will both evaluate the need for action at the site and define the level of action which will be required to ensure that the final remedy is protective of public health. NMED requested that PNM summarize the proposed risk assessment methods to be used to evaluate site risks for review and approval, as appropriate. PNM and NMED recognized the need to cooperatively identify and approve specific data evaluation methods to be used in risk assessment for the site.

Issues that were discussed in the group forum included what types of data will be factored into the risk assessment; how such data will be evaluated to assess potential site risks; and what data will be included in final risk assessment documentation to support quantitative risk characterization. The following discussion summarizes the proposed streamlined risk assessment process to be completed for the Person Generating Station site.

Data collection and evaluation

PNM and ES propose to use existing soil, soil gas, and groundwater data collected at the Person Generating Station site to complete the risk assessment.

Data on the existing nature and extent of soil contamination at the Person Generating Station site are available (Geoscience Consultants, Ltd., 1984). These data demonstrate that the bulk of contaminated soil extends downward approximately 70 feet from the base of the below-grade source waste tank. Data indicate that soil contamination at a depth of 70 feet to the water table, which is located approximately 110 feet below ground surface, is very low. The source waste tank was removed from service in 1983; PNM subsequently installed a closure cap on the 25′ x 35′ source area to minimize downward infiltration and eliminate the surface soil exposure pathway. Without the continual addition of water to the waste tank, no significant mechanism for vertical transport through the vadose zone has existed since 1983.

PNM and ES propose to use the existing soil data to develop representative concentrations for each contaminant of concern (COC) for the surficial soil and vadose zone media to evaluate site risks under both current and potential future exposure scenarios, per EPA risk assessment guidance (EPA, 1992a). However, it is important to note that surficial and vadose zone soil data were only collected from 19 sample locations within the former waste oil tank area prior to installation of the closure cap.

Data analysis for these samples focused on 1,1,1-trichloroethane (1,1,1-TCA) and tetrachloroethene (PCE); there are no soil data for 1,1-dichloroethene (1,1-DCE). However, calculated exposure concentration levels based on these 19 samples will be conservative for three reasons. First, these data are representative of only the most contaminated soil material at the site. Use of this data to characterize potential representative soil concentrations to which potential human receptors may be reasonably exposed will overestimate the amount of soil contamination at the site. For example, even if these soil concentrations were representative of onsite conditions, it is highly unlikely that these concentrations reflect existing or potential offsite conditions. No significant lateral or vertical transport mechanism exists to allow soil contamination to migrate beyond this source area. Second, the presence of the 25′ x 35′ closure cap over the former waste oil tank area effectively makes these soils inaccessible to human receptors under most reasonable exposure assumptions. The only way that a current or potential future receptor could come into contact with these soils would be to dig beneath the closure cap. This is not a reasonable exposure assumption. Third, the remedial approach described in the CMP calls for source removal using soil vapor extraction techniques, which will rapidly decrease the concentration of VOCs in the affected soil column. Although PNM and ES propose to include soil contamination when assessing both risks to potential future receptors and potential residual risks 20 years after initiating planned remediation at the site, soil concentration data will not be adjusted to reflect either effects from either natural attenuation or the anticipated 90 percent reduction in contaminant concentrations due to planned soil vapor extraction activities. Thus, estimates of risk due to exposure to deep soil contamination under future exposure scenarios (using both baseline and residual concentrations) will be highly conservative and subject to discussion in the uncertainty analysis section of the risk analysis report. Although this approach is admittedly conservative, in the absence of soil data more representative of actual exposure conditions at the site, these are the only data available. All risk calculations based on this data will provide a "worst case" or bounding estimate of potential risks due to exposure to site soil contamination.

Representative concentrations appropriate for risk assessment are defined by EPA as the 95% upper confidence limit (UCL) on the arithmetic mean of the data; details on deriving this value are discussed later in this section.

A shallow soil gas investigation has also recently been completed at the Person Generating Station site (Tracer Research Corporation, 1990). PNM and ES propose to use representative COC concentrations from soil gas data from 40 onsite and 12 offsite sample locations to evaluate potential risks associated with inhalation of VOCs accumulating in structures in direct contact with soil. Soil gas data is available for 1,1,1-TCA, 1,1-DCE, and PCE. Again, the representative COC concentration appropriate for risk assessment is the 95% UCL of the arithmetic mean. These concentrations will then be incorporated into simple diffusion models (e.g., EPA, 1981, 1992b; Michelson, 1993) to estimate exposure point concentrations under defined exposure scenarios. As with soil contamination estimates, estimates of risk due to exposure to contaminated soil gas under potential future exposure scenarios will be highly conservative and subject to discussion in the uncertainty analysis section of the risk analysis report.

Significant groundwater quality data exists for the Person Generating Station site, which has been incorporated into the remedial design and performance assessment described in the CMP. Measured groundwater data will be used to develop representative COC concentrations to be used to assess current site risks (EPA, 1992a). As for soil and soil gas data, the representative COC concentration in groundwater appropriate for risk assessment is the 95% UCL of the arithmetic mean. However, PNM and ES propose to use the model-derived groundwater concentrations expected following implementation of the remedial action described in the CMP to assess potential future site risks (Engineering-Science, 1994). This strategy is based on EPA guidance regarding evaluation of residual risk following remedial action (EPA, 1991a). This approach will be supplemented with the development of preliminary remediation goals (PRGs) for the groundwater exposure pathway appropriate for hypothetical future exposure scenarios following the methodology outlined in Part B of the RAGS manuals (EPA, 1991b). Thus, both quantitative estimates of risk levels using modeled data and target long-term remediation goals will be developed for future exposure scenarios to provide information as to what level of treatment will be protective of human health.

PNM and ES will compute representative COC concentrations by media using the methods outlined in Supplemental Guidance to RAGS: Calculating the Concentration Term (EPA, 1992a) and the RAGS manuals. Conventional distribution tests (i.e., the Chi-Square Distribution Test and the Kolmogorov-Smirnov Test) will be used to test uncensored data sets for normality or lognormality. If the data can be described by a normal distribution, the 95% UCL of the arithmetic mean will be computed using the normal statistical approximation, per EPA guidance (1992a). If the data can be described by a lognormal distribution, the data will be transformed using the natural logarithm function (to achieve a more normal distribution). The transformed data set will then be used to compute the 95% UCL of the arithmetic mean using the lognormal statistical approximation (EPA, 1992a). This approach is consistent with EPA guidance on how to establish the exposure concentration for risk assessments.

Nondetected results for the COCs will not be omitted from the risk assessment. One-half the value of the reported result for all nondetect values will be used as a proxy concentration when determining a single concentration most representative of potential exposures at the site. Both detected and proxy values will then be used to compute the 95% UCL of the arithmetic mean using the appropriate statistical approximations. Uncertainties inherent in such statistical approximations will be fully described in the risk analysis report.

<u>Contaminants of concern</u>

PNM and ES propose to limit risk calculations to the three contaminants that have been consistently reported above detection limits in soil and groundwater: 1,1,1-TCA, 1,1-DCE, and PCE. Although several other VOCs have been occasionally measured in environmental samples from Person Generating Station site (e.g., chloroform, 1,1-DCA, 1,2-DCA, TCE, and bromochloromethane), these VOCs have been detected in less than 5 percent of the total samples (i.e., frequency of detection is < 5%). These contaminants are usually omitted from the risk assessment process as they do not illustrate potential representative exposures for the site.

Exposure assessment

Decisions regarding land use are at the heart of identifying potential receptors, potential exposure pathways, and reasonable exposure scenarios. EPA advises that the potential land use associated with the highest level of exposure and risk that can reasonably be expected to occur should be addressed in the risk assessment (EPA, 1991c). Although the exposure scenarios based on potential future residential land use provide the most conservative risk estimates and are important considerations in deciding whether to take action at a site, EPA risk assessment guidance materials state that this conservative approach may not be justifiable if the site is surrounded by operating industrial facilities that can be reasonably assumed to remain as industrial areas. In these cases, EPA recommends using other exposure scenarios, such as agricultural or recreational, and include a qualitative assessment of the likelihood that the assumed reasonable future land use will occur (55 FR 710). PNM and ES believe that the characteristics of the Person Generating Station site may prohibit future unrestricted residential development. However, NMED informed PNM and ES that the residential land use assumption should be applied to obtain the most conservative risk estimates. PNM and ES will follow NMED's technical direction but will discuss how the resulting risk estimates may be affected by more realistic land use considerations in the risk analysis report.

Thus, PNM and ES propose to assess potential risks under six different exposure scenarios:

1. Current risks to both onsite and nearby offsite light industrial/commercial workers;
2. Current risks to onsite construction/remediation workers;
3. Future risks to both onsite and nearby offsite light industrial/commercial workers;
4. Future risks to onsite construction workers;
5. Future risks to both onsite and nearby offsite residents 20 years after initiating planned remediation at the site; and
6. Future risks to both onsite and nearby offsite residents if no action were taken at the site.

Risks to light industrial/commercial workers and construction/remediation will incorporate carcinogenic and noncarcinogenic effects due to exposure to soil and soil gas contamination. No groundwater component will be included in these exposure scenarios as risk-based concentrations for groundwater affected by activities at the Person Generating Station site will be based on residential exposures. Differences in risk estimates for light industrial/commercial workers and construction/remediation workers will be attributable to possible differences in the soil exposure point concentration. Specifically, risks to light industrial/commercial workers will be due to exposure to contaminated surficial soil and accumulating soil gases. Routes of exposure to light industrial/commercial workers will include incidental ingestion and dermal contact with contaminated surficial soils and inhalation of VOCs within the outdoor breathing zone due to upward diffusion through the contaminated soils into the atmosphere. Measured soil gas concentrations can not be directly used to evaluate potential risks due to inhalation of VOCs diffusing upward through the vadose zone into the atmosphere. Because this exposure pathway may represent a source of risk for these receptors, several diffusion and dispersion models recommended by the EPA (EPA, 1992b) will be used to determine risk assessment concentration levels for volatilizing COCs in the atmosphere. A simple flux model coupled with a distance-related attenuation/dispersion equation will be used to estimate the concentration in the air a receptor may reasonably be expected to inhale. The outdoor concentration of each COC that a light industrial/commercial receptor could be reasonably expected to be exposed was based on a constant emission rate calculation. This estimated flux rate will then be incorporated into a simple virtual upwind point source dispersion equation recommended by the EPA to characterize air quality impacts (EPA 1981, 1992b). The outdoor concentration will be based on a receptor located in the middle of the Person Generating Station site, downwind of the constant emission source (i.e., the former waste oil tank area). As discussed previously, soil gas measurements used in these models will not be adjusted to reflect effects due to natural attenuation or the 90 percent reduction in contaminant concentrations due to planned soil vapor extraction activities. Essentially, all inhalation risks will be based on baseline conditions.

Risks to construction/remediation workers will be due to exposure to deeper soils and soil gas. Routes of exposure to this receptor will include incidental ingestion of and dermal contact with contaminated vadose zone soils and inhalation of VOCs within the outdoor breathing zone due to upward diffusion through the contaminated soils into the atmosphere. As before, the outdoor concentration of VOCs will be estimated using a simple flux model, although a more conservative model appropriate for potentially acute exposure scenarios will be employed. This model, also recommended by the EPA (1992b), is driven by pressure changes that can increase the concentration of VOCs "forced" from the soils (i.e., soil gas expressed because of pressure difference). Because the proposed vapor extraction system will be connected to activated carbon canisters designed to remove 99 percent of vapor contamination before the treated effluent is discharged into the environment (Engineering-Science, Inc., 1994), workers would not be exposed to this acute contamination source. However, these receptors may be working in close proximity to the former waste oil tank area. The pressure-driven flux model will provide a method to conservatively estimate the concentration of soil gas to which construction/remediation workers could potentially be exposed. The same simple virtual upwind point source dispersion equation used for light industrial/commercial workers will be used to estimate the outdoor concentration of soil gas in the workers' breathing zone. Again, soil gas measurements used in these models will not be adjusted to reflect effects due to natural attenuation or the 90 percent reduction in contaminant concentrations due to planned soil vapor extraction activities. Essentially, all inhalation risks will be based on baseline conditions.

Risks to potential future residents will reflect both carcinogenic and noncarcinogenic effects due to exposure to contaminated soil, soil gas, and groundwater. Risks from ingestion of contaminated groundwater will be factored into the total risk calculation under the residential exposure scenario. Representative chemical concentrations in water used in these equations will be based on (1) baseline concentrations to assess the risks associated with taking no action at the site and (2) baseline soil and soil gas data and the modeled groundwater quality data used to evaluate the effectiveness of the proposed remedial action. However, the vertical extent of the shallow groundwater contamination under the Person Generating Station site is currently about 20 feet below the water table. Although it is extremely unlikely that potential future residents would use even the treated upper flow zone as a source of potable water, PNM and ES will use these concentration values as an upper bounding risk calculation for both exposure scenarios 5 (residential, residual) and 6 (residential, baseline). Uncertainties inherent in this approach will be discussed in the risk analysis report. Note that ingestion of fruits and vegetables will not be considered a significant exposure pathway, even under the most conservative residential exposure scenario.

Risk calculations under the six exposure scenarios will be based on the appropriate intake equations and default parameters defined in the RAGS manuals and related EPA risk assessment guidance material.

Toxicity Assessment

Toxicity information used in the estimate of risk and the calculation of risk-based PRGs will include the reference dose (RfD) and the reference concentration (RfC) for noncarcinogenic effects and the slope factor (CSF) for carcinogenic effects. Values will be obtained from the Integrated Risk Information System (IRIS) (Micromedix, Inc., 1994). If values are not available from IRIS, the Health Effects Assessment Summary Table (HEAST) will be consulted (EPA, 1993). In addition to toxicity values, information on toxic endpoints, i.e., critical effects on target organs, will be identified for the three COCs for Person Generating Station site. This information will be incorporated into the risk calculations and development of PRGs to ensure that cumulative risk estimates account for the presence of multiple contaminants.

Only oral and inhalation values are available from IRIS or HEAST; EPA has not developed toxicity values for dermal exposure (which may be a significant route of exposure for the Person Generating Station site) due to lack of scientific studies available to quantify dermal toxicity and carcinogenic potential for most pollutants. In the absence of dermal reference toxicity values, EPA has suggested that it may be appropriate to modify an oral RfD so that it can be used to estimate the hazard incurred by dermal exposure (EPA, 1989). This modification requires that the toxic endpoints observed are the same for both oral and dermal exposure, and that a quantitative estimate of both dermal and oral absorption of the chemical be developed. Although this type of detailed information is rarely available, most risk assessments prepared using EPA guidance often rely on oral toxicity values to quantify risk associated with dermal exposure. PNM and ES will incorporate risks due to dermal exposure. Conservative estimates for oral absorption factors for the three COCs to be considered in this risk analysis will be taken from the Agency for Toxic Substance and Disease Registry (ATSDR) Profiles. If such chemical-specific information is unavailable, a conservative absorption factor of 0.90 will be used (commonly used for volatile organic compounds).

Development of target remediation goals

In order to satisfy the second objective of the proposed risk assessment for the Person Generating Station site and in keeping with EPA guidance on risk evaluation of remedial alternatives, PNM and ES propose to calculate target remediation goals or PRGs that are protective of human health at a defined target risk level. Three of the exposure scenarios presented earlier (i.e., future onsite light commercial/industrial worker, future onsite construction/remediation worker, and future onsite resident) will be used to identify chemical-specific concentrations that can be left inplace in each affected media (i.e., soil and groundwater) so that cumulative carcinogenic risks from exposure to multiple chemicals does not exceed a target risk level of 1×10^{-5}. This target risk level has been defined in the New Mexico Water Quality Control Commission (WQCC) guidelines which state that "any water contaminant or combination of the water contaminants in the list below [which includes the three COCs for the Person Generating Station site] creating a lifetime risk of more than one cancer per 100,000 exposed persons is a toxic pollutant." Cumulative risks will be developed by dividing the target risk by the number of carcinogens affecting the same target organ. Similarly, PNM and ES will develop noncarcinogenic target remediation goals by adjusting the target hazard index based on the critical effect of the chemical. If a chemical has both carcinogenic and noncarcinogenic effects, the most stringent of the two calculated PRGs will be identified as the risk-based target remediation goal.

Once these target remediation goals have been developed for each exposure scenario, PNM and ES will compare these values to both the Human Health Standards for Groundwater defined by the New Mexico WQCC and the projected removal efficiencies of the proposed remedial action. The risk analysis report will present this comparison and make recommendations on: (1) which target clean up level should be applied to the Person Generating Station site, and (2) whether the proposed remedial action to be implemented is expected to attain these levels. All uncertainties associated with this evaluation--including, for example, PRG calculations, reliability of modeled results, confidence in technology effectiveness estimates--will be fully discussed in the uncertainty section of the risk analysis report.

Risk characterization

The final step in the traditional risk assessment process is to quantitatively and qualitatively define the cumulative risks associated with exposure to site contamination under both current and future exposure scenarios. PNM and ES will evaluate both the carcinogenic and noncarcinogenic risks for each COC for each (which includes all completed exposure pathways), and sum the risks to define the total risk associated with the exposure potential at the Person Generating Station site. Thus, a cumulative cancer risk level and a cumulative hazard index will be developed for each of the six exposure scenarios considered in the risk assessment. PNM and ES will summarize these findings and explain in clear and plain language what such risk calculations mean. PNM and ES will also qualitatively discuss the differences between the most conservative risk estimates (e.g., future resident) and most reasonable risk estimates (e.g., future onsite light industrial/commercial worker) to provide summary information to support the decision-making process. Information on pathway completion, chemical parameters, and other site characteristics that may be factored in the final decision will also be presented. This section of the risk analysis report will also summarize the comparison between risk-based target remediation goals, regulatory-defined groundwater standards, and expected remedial clean up efficiencies (as discussed above). The risk analysis report will provide the necessary data in accessible format to determine what potential threats are posed by existing site contamination if no action were taken at the site and what level of chemicals can remain onsite and still be adequately protective of public health.

References

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U.S. Environmental Protection Agency. 1991b. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Publication 9285.7-01B.

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Public Service Company of New Mexico

TELECOPIER COVER SHEET

DATE: 8/2/94

TO: Teri Davis

FROM: Ron Johnson

NUMBER OF PAGES TRANSMITTED INCLUDING COVER SHEET: 2

TELECOPIER USED: MURATA M2000 - HQ 4TH FLOOR

TELEPHONE VERIFICATION NUMBER: (505) 848-2340

COMMENTS:

Page 5 of RA framework.
Changes are highlighted.

Alvarado Square
Albuquerque, New Mexico 87158
505 848-2700

PNM and ES will compute representative COC concentrations by media using the methods outlined in Supplemental Guidance to RAGS: Calculating the Concentration Term (EPA, 1992a) and the RAGS manuals. Conventional distribution tests (i.e., the Chi-Square Distribution Test and the Kolmogorov-Smirnov Test) will be used to test uncensored data sets for normality or lognormality. If the data can be described by a normal distribution, the 95% UCL of the arithmetic mean will be computed using the normal statistical approximation, per EPA guidance (1992a). If the data can be described by a lognormal distribution, the data will be transformed using the natural logarithm function (to achieve a more normal distribution). The transformed data set will then be used to compute the 95% UCL of the arithmetic mean using the lognormal statistical approximation (EPA, 1992a). This approach is consistent with EPA guidance on how to establish the exposure concentration for risk assessments.

Nondetected results for the COCs will not be omitted from the risk assessment. One-half the value of the reported result for all nondetect values will be used as a proxy concentration when determining a single concentration most representative of potential exposures at the site. Both detected and proxy values will then be used to compute the 95% UCL of the arithmetic mean using the appropriate statistical approximations. Uncertainties inherent in such statistical approximations will be fully described in the risk analysis report.

<u>Contaminants of concern</u>

PNM and ES propose to limit risk calculations to the three contaminants that have been consistently reported above detection limits in soil and groundwater: 1,1,1-TCA, 1,1-DCE, and PCE. Although several other VOCs have been occasionally measured in environmental samples from Person Generating Station site (e.g., chloroform, 1,1-DCA, 1,2-DCA, TCE, and bromochloromethane), these VOCs have been detected in less than 5 percent of the total samples (i.e., frequency of detection is < 5%). These contaminants are usually omitted from the risk assessment process as they do not illustrate potential representative exposures for the site.

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(505) 827-2850

BRUCE KING
GOVERNOR

JUDITH M. ESPINOSA
SECRETARY

RON CURRY
DEPUTY SECRETARY

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

July 6, 1994

Mr. Ron Johnson
Senior Environmental Scientist
Public Service Company of New Mexico
Albuquerque, New Mexico 87158

Dear Mr. Johnson:

On April 8, 1994 the Hazardous and Radioactive Materials Bureau (**HRMB**) received Public Service Company of New Mexico's (**PNM**) revised draft Framework for Risk Assessment, Person Generating Station, NMT360010342, April 1994. HRMB approves this document with the following modification.

The sentence on page 5, paragraph 1, "If the data cannot be described by either a normal or lognormal distribution, normality will be assumed" is not acceptable. This sentence should be modified to correct the apparent contradiction in wording.

HRMB requests the modified document within 20 days from receipt of this letter. Should you have any questions concerning this matter please contact Ms. Teri Davis of my staff at 827-4308.

Sincerely,

Ronald C. Kern

Ron Kern, Program Manager
RCRA Technical Compliance Program

cc: Barbara Hoditschek, HRMB
Teri Davis, HRMB
FILE PNM Red94
Baird Swanson, GWPRB

riskpnm.794

Public Service Company of New Mexico

April 5, 1994

Certified Mail
Return Receipt Requested

Mr. Steve Alexander
New Mexico Environment Department
Hazardous and Radioactive Materials Bureau
525 Camino de Los Marquez
Santa Fe, NM 87502

Dear Mr. Alexander:

Subject: Framework for Risk Assessment

Enclosed please find the document titled Framework for Risk Assessment, Person Generating Station, NMT360010342, April 1994. This document incorporates NMED comments dated March 8, 1994, on the draft document.

Once we have received your concurrence on the framework, we will submit a draft document of the risk assessment. If you have any questions, please contact me at 848-2998.

Sincerely,

Ron Johnson

Ron D. Johnson
Sr. Environmental Scientist

RDJ:rdj
enclosure

Alvarado Square
Albuquerque, New Mexico 87158
505/848-2700

Framework for Risk Assessment
Person Generating Station
NMT360010342
April 1994

Engineering-Science, Inc. (ES) proposes to quantitatively characterize under both current and reasonable future exposure scenarios the potential carcinogenic and noncarcinogenic risks posed to human health from volatile organic compound (VOC) contamination in soil and shallow groundwater at the Person Generating Station site. Risks to human health will be quantitatively evaluated using a site-specific approach based on the chemical risk assessment principles and procedures outlined in EPA's Risk Assessment Guidance for Superfund (RAGS) manuals.

There are two primary objectives of the proposed risk assessment for the Person Generating Station Site. The first objective is to evaluate and document potential threats posed by existing site contamination if no action were taken at the site (commonly referred to as a baseline risk assessment). The second is to provide a basis for determining the levels of chemicals that can remain onsite and still be adequately protective of public health. This second objective is primarily aimed at defining risk-based target remediation goals for the site. However, since the Public Service of New Mexico (PNM) and the New Mexico Environment Department (NMED) have already agreed to implement a response action at the Person Generating Station site, assessment of potential site risks under future exposure scenarios should also concentrate on the risks associated with the remedial action itself plus any remaining contamination (commonly termed risk evaluation of a remedial alternative).

On February 4, 1994, representatives from NMED, PNM, and ES discussed possible approaches to quantitatively evaluate site risks for the Person Generating Station site. The group collectively agreed that quantitative risk information could be used to assess the continuing need for and effectiveness of the remedial action described in the Corrective Measures Proposal (CMP) for the Person Generating Station site. Given that PNM and NMED have reached a consensus on the initial remedial technologies to be implemented at the site, the group also agreed that a modified risk assessment strategy may be reasonable and adequate to support the decision-making process for the site. PNM and ES believe that coupling elements of the traditional baseline risk assessment and elements of an evaluation of the short- and long-term risks associated with implementing a remedial action at the site will both evaluate the need for action at the site and define the level of action which will be required to ensure that the final remedy is protective of public health. NMED requested that PNM summarize the proposed risk assessment methods to be used to evaluate site risks for review and approval, as appropriate. PNM and NMED recognized the need to cooperatively identify and approve specific data evaluation methods to be used in risk assessment for the site.

Issues that were discussed in the group forum included what types of data will be factored into the risk assessment; how such data will be evaluated to assess potential site risks; and what data will be included in final risk assessment documentation to support quantitative risk characterization. The following discussion summarizes the proposed streamlined risk assessment process to be completed for the Person Generating Station site.

Data collection and evaluation

PNM and ES propose to use existing soil, soil gas, and groundwater data collected at the Person Generating Station site to complete the risk assessment.

Data on the existing nature and extent of soil contamination at the Person Generating Station site are available (Geoscience Consultants, Ltd., 1984). These data demonstrate that the bulk of contaminated soil extends downward approximately 70 feet from the base of the below-grade source waste tank. Data indicate that soil contamination at a depth of 70 feet to the water table, which is located approximately 110 feet below ground surface, is very low. The source waste tank was removed from service in 1983; PNM subsequently installed a closure cap on the 25′ x 35′ source area to minimize downward infiltration and eliminate the surface soil exposure pathway. Without the continual addition of water to the waste tank, no significant mechanism for vertical transport through the vadose zone has existed since 1983.

PNM and ES propose to use the existing soil data to develop representative concentrations for each contaminant of concern (COC) for the surficial soil and vadose zone media to evaluate site risks under both current and potential future exposure scenarios, per EPA risk assessment guidance (EPA, 1992a). However, it is important to note that surficial and vadose zone soil data were only collected from 19 sample locations within the former waste oil tank area prior to installation of the closure cap.

Data analysis for these samples focused on 1,1,1-trichloroethane (1,1,1-TCA) and tetrachloroethene (PCE); there are no soil data for 1,1-dichloroethene (1,1-DCE). However, calculated exposure concentration levels based on these 19 samples will be conservative for three reasons. First, these data are representative of only the most contaminated soil material at the site. Use of this data to characterize potential representative soil concentrations to which potential human receptors may be reasonably exposed will overestimate the amount of soil contamination at the site. For example, even if these soil concentrations were representative of onsite conditions, it is highly unlikely that these concentrations reflect existing or potential offsite conditions. No significant lateral or vertical transport mechanism exists to allow soil contamination to migrate beyond this source area. Second, the presence of the 25′ x 35′ closure cap over the former waste oil tank area effectively makes these soils inaccessible to human receptors under most reasonable exposure assumptions. The only way that a current or potential future receptor could come into contact with these soils would be to dig beneath the closure cap. This is not a reasonable exposure assumption. Third, the remedial approach described in the CMP calls for source removal using soil vapor extraction techniques, which will rapidly decrease the concentration of VOCs in the affected soil column. Although PNM and ES propose to include soil contamination when assessing both risks to potential future receptors and potential residual risks 20 years after initiating planned remediation at the site, soil concentration data will not be adjusted to reflect either effects from either natural attenuation or the anticipated 90 percent reduction in contaminant concentrations due to planned soil vapor extraction activities. Thus, estimates of risk due to exposure to deep soil contamination under future exposure scenarios (using both baseline and residual concentrations) will be highly conservative and subject to discussion in the uncertainty analysis section of the risk analysis report. Although this approach is admittedly conservative, in the absence of soil data more representative of actual exposure conditions at the site, these are the only data available. All risk calculations based on this data will provide a "worst case" or bounding estimate of potential risks due to exposure to site soil contamination.

Representative concentrations appropriate for risk assessment are defined by EPA as the 95% upper confidence limit (UCL) on the arithmetic mean of the data; details on deriving this value are discussed later in this section.

A shallow soil gas investigation has also recently been completed at the Person Generating Station site (Tracer Research Corporation, 1990). PNM and ES propose to use representative COC concentrations from soil gas data from 40 onsite and 12 offsite sample locations to evaluate potential risks associated with inhalation of VOCs accumulating in structures in direct contact with soil. Soil gas data is available for 1,1,1-TCA, 1,1-DCE, and PCE. Again, the representative COC concentration appropriate for risk assessment is the 95% UCL of the arithmetic mean. These concentrations will then be incorporated into simple diffusion models (e.g., EPA, 1981, 1992b; Michelson, 1993) to estimate exposure point concentrations under defined exposure scenarios. As with soil contamination estimates, estimates of risk due to exposure to contaminated soil gas under potential future exposure scenarios will be highly conservative and subject to discussion in the uncertainty analysis section of the risk analysis report.

Significant groundwater quality data exists for the Person Generating Station site, which has been incorporated into the remedial design and performance assessment described in the CMP. Measured groundwater data will be used to develop representative COC concentrations to be used to assess current site risks (EPA, 1992a). As for soil and soil gas data, the representative COC concentration in groundwater appropriate for risk assessment is the 95% UCL of the arithmetic mean. However, PNM and ES propose to use the model-derived groundwater concentrations expected following implementation of the remedial action described in the CMP to assess potential future site risks (Engineering-Science, 1994). This strategy is based on EPA guidance regarding evaluation of residual risk following remedial action (EPA, 1991a).. This approach will be supplemented with the development of preliminary remediation goals (PRGs) for the groundwater exposure pathway appropriate for hypothetical future exposure scenarios following the methodology outlined in Part B of the RAGS manuals (EPA, 1991b). Thus, both quantitative estimates of risk levels using modeled data and target long-term remediation goals will be developed for future exposure scenarios to provide information as to what level of treatment will be protective of human health.

PNM and ES will compute representative COC concentrations by media using the methods outlined in Supplemental Guidance to RAGS: Calculating the Concentration Term (EPA, 1992a) and the RAGS manuals. Conventional distribution tests (i.e., the Chi-Square Distribution Test and the Kolmogorov-Smirnov Test) will be used to test uncensored data sets for normality or lognormality. If the data cannot be described by either a normal or lognormal distribution, normality will be assumed. Nondetected results for the COCs will not be omitted from the risk assessment. One-half the value of the reported result for all nondetect values will be used as a proxy concentration when determining a single concentration most representative of potential exposures at the site. Both detected and proxy values will then be used to compute the 95% upper confidence limit (UCL) of the arithmetic mean using the appropriate statistical approximations. Uncertainties inherent in such statistical approximations will be fully described in the risk analysis report.

Contaminants of concern

PNM and ES propose to limit risk calculations to the three contaminants that have been consistently reported above detection limits in soil and groundwater: 1,1,1-TCA, 1,1-DCE, and PCE. Although several other VOCs have been occasionally measured in environmental samples from Person Generating Station site (e.g., chloroform, 1,1-DCA, 1,2-DCA, TCE, and bromochloromethane), these VOCs have been detected in less than 5 percent of the total samples (i.e., frequency of detection is < 5%). These contaminants are usually omitted from the risk assessment process as they do not illustrate potential representative exposures for the site.

Exposure assessment

Decisions regarding land use are at the heart of identifying potential receptors, potential exposure pathways, and reasonable exposure scenarios. EPA advises that the potential land use associated with the highest level of exposure and risk that can reasonably be expected to occur should be addressed in the risk assessment (EPA, 1991c). Although the exposure scenarios based on potential future residential land use provide the most conservative risk estimates and are important considerations in deciding whether to take action at a site, EPA risk assessment guidance materials state that this conservative approach may not be justifiable if the site is surrounded by operating industrial facilities that can be reasonably assumed to remain as industrial areas. In these cases, EPA recommends using other exposure scenarios, such as agricultural or recreational, and include a qualitative assessment of the likelihood that the assumed reasonable future land use will occur (55 FR 710). PNM and ES believe that the characteristics of the Person Generating Station site may prohibit future unrestricted residential development. However, NMED informed PNM and ES that the residential land use assumption should be applied to obtain the most conservative risk estimates. PNM and ES will follow NMED's technical direction but will discuss how the resulting risk estimates may be affected by more realistic land use considerations in the risk analysis report.

Thus, PNM and ES propose to assess potential risks under six different exposure scenarios:

1. Current risks to both onsite and nearby offsite light industrial/commercial workers;
2. Current risks to onsite construction/remediation workers;
3. Future risks to both onsite and nearby offsite light industrial/commercial workers;
4. Future risks to onsite construction workers;
5. Future risks to both onsite and nearby offsite residents 20 years after initiating planned remediation at the site; and
6. Future risks to both onsite and nearby offsite residents if no action were taken at the site.

Risks to light industrial/commercial workers and construction/remediation will incorporate carcinogenic and noncarcinogenic effects due to exposure to soil and soil gas contamination. No groundwater component will be included in these exposure scenarios as risk-based concentrations for groundwater affected by activities at the Person Generating Station site will be based on residential exposures. Differences in risk estimates for light industrial/commercial workers and construction/remediation workers will be attributable to possible differences in the soil exposure point concentration. Specifically, risks to light industrial/commercial workers will be due to exposure to contaminated surficial soil and accumulating soil gases. Routes of exposure to light industrial/commercial workers will include incidental ingestion and dermal contact with contaminated surficial soils and inhalation of VOCs within the outdoor breathing zone due to upward diffusion through the contaminated soils into the atmosphere. Measured soil gas concentrations can not be directly used to evaluate potential risks due to inhalation of VOCs diffusing upward through the vadose zone into the atmosphere. Because this exposure pathway may represent a source of risk for these receptors, several diffusion and dispersion models recommended by the EPA (EPA, 1992b) will be used to determine risk assessment concentration levels for volatilizing COCs in the atmosphere. A simple flux model coupled with a distance-related attenuation/dispersion equation will be used to estimate the concentration in the air a receptor may reasonably be expected to inhale. The outdoor concentration of each COC that a light industrial/commercial receptor could be reasonably expected to be exposed was based on a constant emission rate calculation. This estimated flux rate will then be incorporated into a simple virtual upwind point source dispersion equation recommended by the EPA to characterize air quality impacts (EPA 1981, 1992b). The outdoor concentration will be based on a receptor located in the middle of the Person Generating Station site, downwind of the constant emission source (i.e., the former waste oil tank area). As discussed previously, soil gas measurements used in these models will not be adjusted to reflect effects due to natural attenuation or the 90 percent reduction in contaminant concentrations due to planned soil vapor extraction activities. Essentially, all inhalation risks will be based on baseline conditions.

Risks to construction/remediation workers will be due to exposure to deeper soils and soil gas. Routes of exposure to this receptor will include incidental ingestion of and dermal contact with contaminated vadose zone soils and inhalation of VOCs within the outdoor breathing zone due to upward diffusion through the contaminated soils into the atmosphere. As before, the outdoor concentration of VOCs will be estimated using a simple flux model, although a more conservative model appropriate for potentially acute exposure scenarios will be employed. This model, also recommended by the EPA (1992b), is driven by pressure changes that can increase the concentration of VOCs "forced" from the soils (i.e., soil gas expressed because of pressure difference). Because the proposed vapor extraction system will be connected to activated carbon canisters designed to remove 99 percent of vapor contamination before the treated effluent is discharged into the environment (Engineering-Science, Inc., 1994), workers would not be exposed to this acute contamination source. However, these receptors may be working in close proximity to the former waste oil tank area. The pressure-driven flux model will provide a method to conservatively estimate the concentration of soil gas to which construction/remediation workers could potentially be exposed. The same simple virtual upwind point source dispersion equation used for light industrial/commercial workers will be used to estimate the outdoor concentration of soil gas in the workers' breathing zone. Again, soil gas measurements used in these models will not be adjusted to reflect effects due to natural attenuation or the 90 percent reduction in contaminant concentrations due to planned soil vapor extraction activities. Essentially, all inhalation risks will be based on baseline conditions.

Risks to potential future residents will reflect both carcinogenic and noncarcinogenic effects due to exposure to contaminated soil, soil gas, and groundwater. Risks from ingestion of contaminated groundwater will be factored into the total risk calculation under the residential exposure scenario. Representative chemical concentrations in water used in these equations will be based on (1) baseline concentrations to assess the risks associated with taking no action at the site and (2) baseline soil and soil gas data and the modeled groundwater quality data used to evaluate the effectiveness of the proposed remedial action. However, the vertical extent of the shallow groundwater contamination under the Person Generating Station site is currently about 20 feet below the water table. Although it is extremely unlikely that potential future residents would use even the treated upper flow zone as a source of potable water, PNM and ES will use these concentration values as an upper bounding risk calculation for both exposure scenarios 5 (residential, residual) and 6 (residential, baseline). Uncertainties inherent in this approach will be discussed in the risk analysis report. Note that ingestion of fruits and vegetables will not be considered a significant exposure pathway, even under the most conservative residential exposure scenario.

Risk calculations under the six exposure scenarios will be based on the appropriate intake equations and default parameters defined in the RAGS manuals and related EPA risk assessment guidance material.

Toxicity Assessment

Toxicity information used in the estimate of risk and the calculation of risk-based PRGs will include the reference dose (RfD) and the reference concentration (RfC) for noncarcinogenic effects and the slope factor (CSF) for carcinogenic effects. Values will be obtained from the Integrated Risk Information System (IRIS) (Micromedix, Inc., 1994). If values are not available from IRIS, the Health Effects Assessment Summary Table (HEAST) will be consulted (EPA, 1993). In addition to toxicity values, information on toxic endpoints, i.e., critical effects on target organs, will be identified for the three COCs for Person Generating Station site. This information will be incorporated into the risk calculations and development of PRGs to ensure that cumulative risk estimates account for the presence of multiple contaminants.

Only oral and inhalation values are available from IRIS or HEAST; EPA has not developed toxicity values for dermal exposure (which may be a significant route of exposure for the Person Generating Station site) due to lack of scientific studies available to quantify dermal toxicity and carcinogenic potential for most pollutants. In the absence of dermal reference toxicity values, EPA has suggested that it may be appropriate to modify an oral RfD so that it can be used to estimate the hazard incurred by dermal exposure (EPA, 1989). This modification requires that the toxic endpoints observed are the same for both oral and dermal exposure, and that a quantitative estimate of both dermal and oral absorption of the chemical be developed. Although this type of detailed information is rarely available, most risk assessments prepared using EPA guidance often rely on oral toxicity values to quantify risk associated with dermal exposure. PNM and ES will incorporate risks due to dermal exposure. Conservative estimates for oral absorption factors for the three COCs to be considered in this risk analysis will be taken from the Agency for Toxic Substance and Disease Registry (ATSDR) Profiles. If such chemical-specific information is unavailable, a conservative absorption factor of 0.90 will be used (commonly used for volatile organic compounds).

Development of target remediation goals

In order to satisfy the second objective of the proposed risk assessment for the Person Generating Station site and in keeping with EPA guidance on risk evaluation of remedial alternatives, PNM and ES propose to calculate target remediation goals or PRGs that are protective of human health at a defined target risk level. Three of the exposure scenarios presented earlier (i.e., future onsite light commercial/industrial worker, future onsite construction/remediation worker, and future onsite resident) will be used to identify chemical-specific concentrations that can be left inplace in each affected media (i.e., soil and groundwater) so that cumulative carcinogenic risks from exposure to multiple chemicals does not exceed a target risk level of 1×10^{-5}. This target risk level has been defined in the New Mexico Water Quality Control Commission (WQCC) guidelines which state that "any water contaminant or combination of the water contaminants in the list below [which includes the three COCs for the Person Generating Station site] creating a lifetime risk of more than one cancer per 100,000 exposed persons is a toxic pollutant." Cumulative risks will be developed by dividing the target risk by the number of carcinogens affecting the same target organ. Similarly, PNM and ES will develop noncarcinogenic target remediation goals by adjusting the target hazard index based on the critical effect of the chemical. If a chemical has both carcinogenic and noncarcinogenic effects, the most stringent of the two calculated PRGs will be identified as the risk-based target remediation goal.

Once these target remediation goals have been developed for each exposure scenario, PNM and ES will compare these values to both the Human Health Standards for Groundwater defined by the New Mexico WQCC and the projected removal efficiencies of the proposed remedial action. The risk analysis report will present this comparison and make recommendations on: (1) which target clean up level should be applied to the Person Generating Station site, and (2) whether the proposed remedial action to be implemented is expected to attain these levels. All uncertainties associated with this evaluation--including, for example, PRG calculations, reliability of modeled results, confidence in technology effectiveness estimates--will be fully discussed in the uncertainty section of the risk analysis report.

Risk characterization

The final step in the traditional risk assessment process is to quantitatively and qualitatively define the cumulative risks associated with exposure to site contamination under both current and future exposure scenarios. PNM and ES will evaluate both the carcinogenic and noncarcinogenic risks for each COC for each (which includes all completed exposure pathways), and sum the risks to define the total risk associated with the exposure potential at the Person Generating Station site. Thus, a cumulative cancer risk level and a cumulative hazard index will be developed for each of the six exposure scenarios considered in the risk assessment. PNM and ES will summarize these findings and explain in clear and plain language what such risk calculations mean. PNM and ES will also qualitatively discuss the differences between the most conservative risk estimates (e.g., future resident) and most reasonable risk estimates (e.g., future onsite light industrial/commercial worker) to provide summary information to support the decision-making process. Information on pathway completion, chemical parameters, and other site characteristics that may be factored in the final decision will also be presented. This section of the risk analysis report will also summarize the comparison between risk-based target remediation goals, regulatory-defined groundwater standards, and expected remedial clean up efficiencies (as discussed above). The risk analysis report will provide the necessary data in accessible format to determine what potential threats are posed by existing site contamination if no action were taken at the site and what level of chemicals can remain onsite and still be adequately protective of public health.

References

Engineering-Science, Inc. 1994. Corrective Measures Proposal for the Person Generating Station, Public Service Company of New Mexico. RCRA Permit: NMT360010342. Prepared for the Public Service Company of New Mexico.

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State of New Mexico
ENVIRONMENT DEPARTMENT
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1190 St. Francis Drive, P.O. Box 26110
Santa Fe, New Mexico 87502
(505) 827-2850

BRUCE KING
GOVERNOR

JUDITH M. ESPINOSA
SECRETARY

RON CURRY
DEPUTY SECRETARY

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

March 8, 1994

Mr. Ron Johnson
Senior Environmental Scientist
Public Service Company of New Mexico
Alvarado Square
Albuquerque, New Mexico 87158

Dear Mr. Johnson:

On February 14, 1994 the Hazardous and Radioactive Materials Bureau (HRMB) received Public Service Company of New Mexico's (PNM) "**draft Risk Assessment Framework**". This proposal was in response to the HRMB/PNM meeting held February 4, 1994 in Santa Fe. At that meeting HRMB directed PNM to develop a baseline Risk-Assessment (RA) to aid in determining the groundwater and soil remediation goals.

HRMB is providing the following comments to facilitate PNM's development of an acceptable RA. The results of the RA will be utilized in determining recommended remediation levels for the contamination in soil and groundwater underlying properties controlled by PNM (on-site) and adjacent properties (off-site). The analysis will consider current and possible future land use.

The comments included, below, are specific to statements within PNM's February RA proposal. The statement location within the proposal is given within parentheses; specific statement quotations are in bold print.

ITEM Location/Comment

1 (page 2., Data collection and evaluation): The RA proposal must include a more detailed and concise description of what "**existing soil, soil gas, and groundwater data**" will be utilized in the RA.

2 (page 3., second paragraph): A more definite date must be proposed for "**evaluating hypothetical potential future site risks**", other than "**...following implementation of the planned response action**".

3 (page 3., fourth paragraph): Please provide additional information concerning the discussion of "**dry soil data...**" and "**measured soil gas data...**".

4 (page 6., first paragraph, <u>Exposure assessment</u>):

1. **Current risks to both onsite and...workers:** The target risk, for this scenario, of 10^{-5} is acceptable. However, please provide details concerning the determination of risk associated with the exposure to VOCs discharged to the atmosphere during the remediation.

2. **Current risks to onsite construction/remediation workers:** The target risk, for this scenario, of 10^{-5} is acceptable. However, please provide details concerning the determination of risk associated with the exposure to VOCs discharged to the atmosphere during the remediation.

3. **Future risks to both onsite and...workers:** The target risk, for this scenario, of 10^{-5} is acceptable. However, please provide details concerning the determination of risk associated with the exposure to VOCs discharged to the atmosphere during the remediation.

4. **Future risks to onsite...workers:** The target risk, for this scenario, of 10^{-5} is acceptable. However, please provide details concerning the determination of risk associated with the exposure to VOCs discharged to the atmosphere during the remediation.

5. **Future risks to both onsite and nearby offsite residents:** To augment PNMs proposal to use the model-derived groundwater concentrations, the RA must also include in its assessment of offsite risk: 1) existing groundwater quality data, obtained from monitoring well sampling results, 2) a target risk level of 10^{-6}, and 3) all possible exposure pathways.

Please note that the results of the RA will be utilized to determine existing and potential threats to human health and the environment and will not necessarily represent remediation levels for groundwater and soil.

Should you wish further information or require clarification on this letter please contact me at (505) 827-4313.

Sincerely,

Steve M. Alexander

Steve Alexander, Program Manager
Technical Compliance Program

cc: Barbara Hoditschek, HRMB
Steve Alexander, HRMB

Public Service Company of New Mexico

FEB 1 4 1994

PNM Red 94

TELECOPIER COVER SHEET

DATE: 2/14/94

TO: Steve Alexander
HRMB

FROM: Ron Johnson

NUMBER OF PAGES TRANSMITTED INCLUDING COVER SHEET: 12

TELECOPIER USED: MURATA M2000 - HQ 4TH FLOOR

TELEPHONE VERIFICATION NUMBER: (505) 848-2340

COMMENTS:

Steve, Here is the draft Risk Assessment framework as we discussed at our mtg. Please review and let me know if you are in general agreement.

RonJ.

Alvarado Square
Albuquerque, New Mexico 87158
505/848-2700

Engineering-Science, Inc. (ES) proposes to quantitatively characterize under both current and reasonable hypothetical potential future exposure scenarios the potential carcinogenic and noncarcinogenic risks posed to human health from volatile organic compound (VOC) contamination in soil and shallow groundwater at the Person Generating Station site. Risks to ecological receptors will not be addressed as part of this effort because the site: is currently developed for industrial use only; does not support rare or economically valuable ecological resources; and concentrations of VOCs which are protective of human health are likely to protect potential ecological receptors. Evaluation of risk to human receptors is considered sufficient to adequately characterize potential site risks. Risks to human health will be quantitatively evaluated using a site-specific approach based on the chemical risk assessment principles and procedures outlined in EPA's Risk Assessment Guidance for Superfund (RAGS) manuals.

There are two primary objectives of the proposed risk assessment for the Person Generating Station Site. The first objective is to evaluate and document potential threats posed by existing site contamination if no action were taken at the site (commonly referred to as a baseline risk assessment). The second is to provide a basis for determining the levels of chemicals that can remain onsite and still be adequately protective of public health. This second objective is primarily aimed at defining risk-based target remediation goals for the site. However, since the Public Service of New Mexico (PNM) and the New Mexico Environment Department (NMED) have already agreed to implement a response action at the Person Generating Station site, assessment of potential site risks under hypothetical future exposure scenarios should also concentrate on the risks associated with the remedial action itself plus any remaining contamination (commonly termed risk evaluation of a remedial alternative).

On February 4, 1994, representatives from NMED, PNM, and ES discussed possible approaches to quantitatively evaluate site risks for the Person Generating Station site. The group collectively agreed that quantitative risk information could be used to assess the continuing need for and effectiveness of the remedial action described in the Corrective Measures Proposal (CMP) for the Person Generating Station site. Given that PNM and NMED have reached a consensus on the initial remedial technologies to be implemented at the site, the group also agreed that a modified risk assessment strategy may be reasonable and adequate to support the decision-making process for the site. PNM and ES believe that coupling elements of the traditional baseline risk assessment and elements of an evaluation of the short- and long-term risks associated with implementing a remedial action at the site will both evaluate the need for action at the site and define the level of action which will be required to ensure that the final remedy is protective of public health. NMED requested that PNM summarize the proposed risk assessment methods to be used to evaluate site risks for review and approval, as appropriate. PNM and NMED recognized the need to cooperatively identify and approve specific data evaluation methods to be used in risk assessment for the site.

Issues that were discussed in the group forum included what types of data will be factored into the risk assessment; how such data will be evaluated to assess potential site risks; and what data will be included in final risk assessment documentation to support quantitative risk characterization. The following discussion summarizes the proposed streamlined risk assessment process to be completed for the Person Generating Station site.

Data collection and evaluation

PNM and ES propose to use existing soil, soil gas, and groundwater data collected at the Person Generating Station site to complete the risk assessment.

Data on the existing nature and extent of soil contamination at the Person Generating Station site are readily available (Geoscience Consultants, Ltd., 1984). Previous site investigation activities have demonstrated that the bulk of contaminated soil extends downward approximately 70 feet from the base of the below-grade source waste tank. Data indicate that soil contamination at a depth of 70 feet to the water table, which is located approximately 110 feet below ground surface, is very low. The source waste tank was removed from service in 1983; PNM subsequently installed a closure cap on the 25' x 35' source area to minimize downward infiltration and eliminate the surface soil exposure pathway. Without the continual addition of water to the waste tank, no significant mechanism for vertical transport through the vadose zone has existed since 1983. PNM and ES propose to use this soil data to

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develop representative concentrations for each contaminant of concern (COC) for the vadose media to evaluate site risks under current exposure scenarios, per EPA risk assessment guidance (EPA, 1992). Representative concentrations appropriate for risk assessment are defined by EPA as the 95% upper confidence limit (UCL) on the arithmetic mean of the data; details on deriving this value are discussed later in this section.

Further, the remedial approach described in the CMP calls for source removal using soil vapor extraction techniques, which will rapidly decrease the concentration of VOCs in the affected soil column. PNM and ES propose to address risks associated with deep soil contamination when evaluating hypothetical potential future site risks following implementation of the planned response action. However, estimates of risk due to exposure to deep soil contamination under hypothetical potential future exposure scenarios will be highly conservative and subject to discussion in the uncertainty analysis section of the risk analysis report.

Surficial soil (i.e., 0 - 3") contamination at the Person Generating Station site has not been recorded. Installation of the protective RCRA cover eliminated the potential exposure routes to contaminated surficial soil media. Additionally, because the COCs are volatile organics, significant concentrations are not expected to be present in surficial soil media due to removal by volatilization.

A shallow soil gas investigation has also recently been completed at the Person Generating Station site (Tracer Research Corporation, 1990). Rather than develop soil gas concentration estimates using dry soil data, PNM and ES propose to derive representative COC concentrations from measured soil gas data to evaluate potential risks associated with inhalation of VOCs accumulating in structures in direct contact with soil. Again, the representative COC concentration appropriate for risk assessment is the 95% UCL of the arithmetic mean. These concentrations will then be incorporated into a simple diffusion model (e.g., Jury et al., 1983; Tucker and Hearne, 1989; Michelson et al., 1993) to estimate exposure point concentrations under defined exposure scenarios. As with soil contamination estimates, estimates of risk due to exposure to contaminated soil gas under hypothetical potential future exposure scenarios will be highly conservative and discussed in the uncertainty

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analysis section of the risk analysis report.

Significant groundwater quality data exists for the Person Generating Station site, which has been incorporated into the remedial design and performance assessment described in the CMP. Measured groundwater data will be used to develop representative COC concentrations to be used to assess current site risks (EPA, 1992). As for soil and soil gas data, the representative COC concentration in groundwater appropriate for risk assessment is the 95% UCL of the arithmetic mean. However, PNM and ES propose to use the model-derived groundwater concentrations expected following implementation of the remedial action described in the CMP to assess hypothetical potential future site risks (Engineering-Science, 1994). This strategy is based on EPA guidance regarding evaluation of residual risk following remedial action (EPA, 1991a). This approach will be supplemented with the development of preliminary remediation goals (PRGs) for the groundwater exposure pathway appropriate for hypothetical potential future exposure scenarios following the methodology outlined in Part B of the RAGS manuals (EPA, 1991b). Thus, both quantitative estimates of risk levels using modeled data and target long-term remediation goals will be developed for hypothetical potential future exposure scenarios to provide information as to what level of treatment will be protective of human health.

PNM and ES will compute representative COC concentrations by media using the methods outlined in Supplemental Guidance to RAGS: Calculating the Concentration Term (EPA, 1992) and the RAGS manuals. Conventional distribution tests (i.e., the Chi-Square Distribution Test and the Kolmogorov-Smirnoff Test) will be used to test uncensored data sets for normality or lognormality. If the data cannot be described by either a normal or lognormal distribution, normality will be assumed. Nondetected results for the COCs will not be omitted from the risk assessment. One-half the value of the reported result for all nondetect values will be used as a proxy concentration when determining a single concentration most representative of potential exposures at the site. Both detected and proxy values will then be used to compute the 95% upper confidence limit (UCL) of the arithmetic mean using the appropriate statistical approximations. Uncertainties inherent in such statistical approximations will be fully described in the risk analysis report.

OK.
XX by Willy A.

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Contaminants of concern

PNM and ES propose to limit risk calculations to the three contaminants that have been consistently reported above detection limits in soil and groundwater: 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE), and tetrachloroethene (PCE). Although several other VOCs have been occasionally measured in environmental samples from Person Generating Station site (e.g., chloroform, 1,1-DCA, 1,2-DCA, TCE, and bromochloromethane), these VOCs have been detected in less than 5 percent of the total samples (i.e., frequency of detection is < 5%). These contaminants are usually omitted from the risk assessment process as they do not illustrate potential representative exposures for the site.

Exposure assessment

Decisions regarding land use are the heart of identifying potential receptors, potential exposure pathways, and reasonable exposure scenarios. EPA advises that the potential land use associated with the highest level of exposure and risk that can reasonably be expected to occur should be addressed in the risk assessment (EPA, 1991c). Although the exposure scenarios based on hypothetical potential future residential land use provide the most conservative risk estimates and are important considerations in deciding whether to take action at a site, EPA risk assessment guidance materials state that this conservative approach may not be justifiable if the site is surrounded by operating industrial facilities that can be reasonably assumed to remain as industrial areas. In these cases, EPA recommends using other exposure scenarios, such as agricultural or recreational, and include a qualitative assessment of the likelihood that the assumed reasonable future land use will occur (55 FR 710). PNM and ES believe that the characteristics of the Person Generating Station site may prohibit future unrestricted residential development. However, NMED informed PNM and ES that the residential land use assumption should be applied to obtain the most conservative risk estimates. PNM and ES will follow NMED's technical direction but will discuss how the resulting risk estimates may be affected by more realistic land use considerations in the risk analysis report.

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Thus, PNM and ES propose to assess potential risks under five different exposure scenarios:

1. Current risks to both onsite and nearby offsite light industrial/commercial workers;
2. Current risks to onsite construction/remediation workers;
3. Future risks to both onsite and nearby offsite light industrial/commercial workers;
4. Future risks to onsite construction/remediation workers; and
5. Future risks to both onsite and nearby offsite residents.

Risks to light industrial/commercial workers and construction/remediation will incorporate carcinogenic and noncarcinogenic effects due to exposure to soil and soil gas contamination. No groundwater component will be included in these exposure scenarios. Concentrations in groundwater affected by activities at the Person Generating Station site will be used in assessing hypothetical potential future residential exposures. Routes of exposure to industrial/commercial workers are assumed to be incidental ingestion and dermal contact with contaminated surficial soils and inhalation of accumulating VOCs in above-grade structures. As discussed previously, risks due to incidental ingestion and dermal contact with contaminated surficial soil media are expected to be negligible due to the presence of the protective RCRA cap and the volatile nature of the COCs. Thus, the risks to light industrial/commercial workers will be attributable to exposure to soil gas. Routes of exposure to construction/remediation workers are assumed to be incidental ingestion of and dermal contact with contaminated vadose zone soils currently covered by the protective RCRA cap. Because the likelihood of exposure to this media is small, this analysis will represent a "worst case" or bounding estimate.

Risks to hypothetical potential future residents will reflect both carcinogenic and noncarcinogenic effects due to exposure to soil gas and groundwater. Risks to hypothetical potential future residents from exposure to surficial soils will not be evaluated because of the presence of the protective RCRA cap and the lack of evidence of surficial soil contamination. Risks from domestic use of contaminated groundwater will be factored into the total risk calculation under the residential exposure scenario. Routes of exposure to this receptor will include inhalation through showering, dermal contact, and ingestion of groundwater. Representative chemical concentrations in water used in these equations will be based on the modeled groundwater quality data used to evaluate the effectiveness of the proposed remedial action. However, the vertical extent of the shallow groundwater contamination under the Person Generating Station site is currently about 20 feet below the water table. Although it is extremely unlikely that hypothetical potential future residents would use even the treated upper flow zone as a source of potable water, PNM and ES will use these concentration values as an upper bounding risk calculation. Uncertainties inherent in this approach will be discussed in the risk analysis report. Risks from inhalation of soil gas accumulating in above-grade structures will also be evaluated for this potential receptor. Note that ingestion of fruits and vegetables will not be considered a significant exposure pathway, even under the most conservative residential exposure scenario.

Risk calculations under the five exposure scenarios will be based on the appropriate intake equations and default parameters defined in the RAGS manuals and related EPA risk assessment guidance material.

Toxicity Assessment

Toxicity information used in the estimate of risk and the calculation of risk-based PRGs will include the reference dose (RfD) and the reference concentration (RfC) for noncarcinogenic effects and the slope factor (CSF) for carcinogenic effects. Values will be obtained from the Integrated Risk Information System (IRIS) (Micromedix, Inc., 1994). If values are not available from IRIS, the Health Effects Assessment Summary Table (HEAST) will be consulted (EPA, 1993). In addition to toxicity values, information on toxic endpoints, i.e., critical effects on target organs, will be identified for the three COCs for Person Generating Station site. This information will be incorporated into the risk calculations and development of PRGs to ensure that cumulative risk estimates account for the presence of multiple contaminants.

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Only oral and inhalation values are available from IRIS or HEAST; EPA has not developed toxicity values for dermal exposure (which may be a significant route of exposure for the Person Generating Station site) due to lack of scientific studies available to quantify dermal toxicity and carcinogenic potential for most pollutants. In the absence of dermal reference toxicity values, EPA has suggested that it may be appropriate to modify an oral RfD so that it can be used to estimate the hazard incurred by dermal exposure (EPA, 1989). This modification requires that the toxic endpoints observed are the same for both oral and dermal exposure, and that a quantitative estimate of both dermal and oral absorption of the chemical be developed. Although this type of detailed information is rarely available, most risk assessments prepared using EPA guidance often rely on oral toxicity values to quantify risk associated with dermal exposure. PNM and ES will incorporate risks due to dermal exposure. Conservative estimates for oral absorption factors for the three COCs to be considered in this risk analysis will be taken from the Agency for Toxic Substance and Disease Registry (ATSDR) Profiles. If such chemical-specific information is unavailable, a conservative absorption factor of 0.90 will be used (commonly used for volatile organic compounds).

Development of target remediation goals

In order to satisfy the second objective of the proposed risk assessment for the Person Generating Station site and in keeping with EPA guidance on risk evaluation of remedial alternatives, PNM and ES propose to calculate target remediation goals or PRGs that are protective of human health at a defined target risk level. Three of the exposure scenarios presented earlier (i.e., future onsite light commercial/industrial worker, future onsite construction/remediation worker, and hypothetical potential future onsite resident) will be used to identify chemical-specific concentrations that can be left inplace in each affected media (i.e., soil and groundwater) so that cumulative carcinogenic risks from exposure to multiple chemicals does not exceed a target risk level of 1×10^{-5}. This target risk level has been defined in the New Mexico Water Quality Control Commission (WQCC) guidelines which state that "any water contaminant or combination of the water contaminants in the list below [which includes the three COCs for the Person Generating Station site] creating a lifetime risk of more than one cancer per 100,000 exposed persons is a toxic pollutant."

Cumulative risks will be developed by dividing the target risk by the number of carcinogens affecting the same target organ. Similarly, PNM and ES will develop noncarcinogenic target remediation goals by adjusting the target hazard index based on the critical effect of the chemical. If a chemical has both carcinogenic and noncarcinogenic effects, the most stringent of the two calculated PRGs will be identified as the risk-based target remediation goal. O.K. by Rauscher, EPA

Once these target remediation goals have been developed for each exposure scenario, PNM and ES will compare these values to both the Human Health Standards for Groundwater defined by the New Mexico WQCC and the projected removal efficiencies of the proposed remedial action. The risk analysis report will present this comparison and make recommendations on: (1) which target clean up level should be applied to the Person Generating Station site, and (2) whether the proposed remedial action to be implemented is expected to attain these levels. All uncertainties associated with this evaluation--including, for example, PRG calculations, reliability of modeled results, confidence in technology effectiveness estimates--will be fully discussed in the uncertainty section of the risk analysis report.

<u>Risk characterization</u>

The final step in the traditional risk assessment process is to quantitatively and qualitatively define the cumulative risks associated with exposure to site contamination under both current and future exposure scenarios. PNM and ES will evaluate both the carcinogenic and noncarcinogenic risks for each COC for each (which includes all completed exposure pathways), and sum the risks to define the total risk associated with the exposure potential at the Person Generating Station site. Thus, a cumulative cancer risk level and a cumulative hazard index will be developed for each of the six exposure scenarios considered in the risk assessment. PNM and ES will summarize these findings and explain in clear and plain language what such risk calculations mean. PNM and ES will also qualitatively discuss the differences between the most conservative risk estimates (e.g., hypothetical potential future resident) and most reasonable risk estimates (e.g., future onsite light industrial/commercial worker) to provide summary information to support the decision-making process. Information on pathway completion, chemical parameters, and other site characteristics that may be factored in the final decision will also be presented. This section of the risk analysis report will also summarize the comparison between risk-based target remediation goals, regulatory-defined groundwater standards, and expected remedial clean up efficiencies (as discussed above). The risk analysis report will provide the necessary data in accessible format to determine what potential threats are posed by existing site contamination if no action were taken at the site and what level of chemicals can remain onsite and still be adequately protective of public health.

References

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U.S. Environmental Protection Agency. 1991b. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Publication 9285.7-01B.

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2. Current risks to onsite construction/remediation workers;
3. Future risks to both onsite and nearby offsite light industrial/commercial workers;
4. Future risks to onsite construction/remediation workers; and
5. Future risks to both onsite and nearby offsite residents.

1. O.K. Target risk level of 10^{-5} is acceptable. However, include language addressing the need, or lack of, for ~~quantif~~ deter. risk associated with the proposed remediation from exposure to "vented" cont.

2. O.K. Ditto

3. O.K. Ditto

4. Ditto

5. Need to augment the ~~projected~~ proposal with
   2. Utilize actual g.w. contaminant levels in deter. risk, as well as the projected modeled results. (See text).
   1. Target risk level will be 10^{-6} for both on-off.

Please note that in the risk analysis report PNM may present its proposed remediation goals for the areas of contamination which are not contained/controlled by PNM separately from those underlying the property boundaries of PNM. In the evaluation of the remediation goals proposal HRMB will consider the suggestion by PNM to conduct a followup RA as a requirement should any lands now under control of PNM. This RA would, at that time, consider the projected land use and possibly alter the cleanup requirements at that time to match the increased/decreased need for higher to more conservative risk levels.

2/4/94

ue ☒ Quantilation of Risk

1. Modified, use RAGS

?

☒ Future Scenario

- Utilize proposed levels ~~to achieve~~ from future projected success
- 10^{-5}, look in WQCC for this (Aug 19, 1991)
  + Acceptable risk **levels**

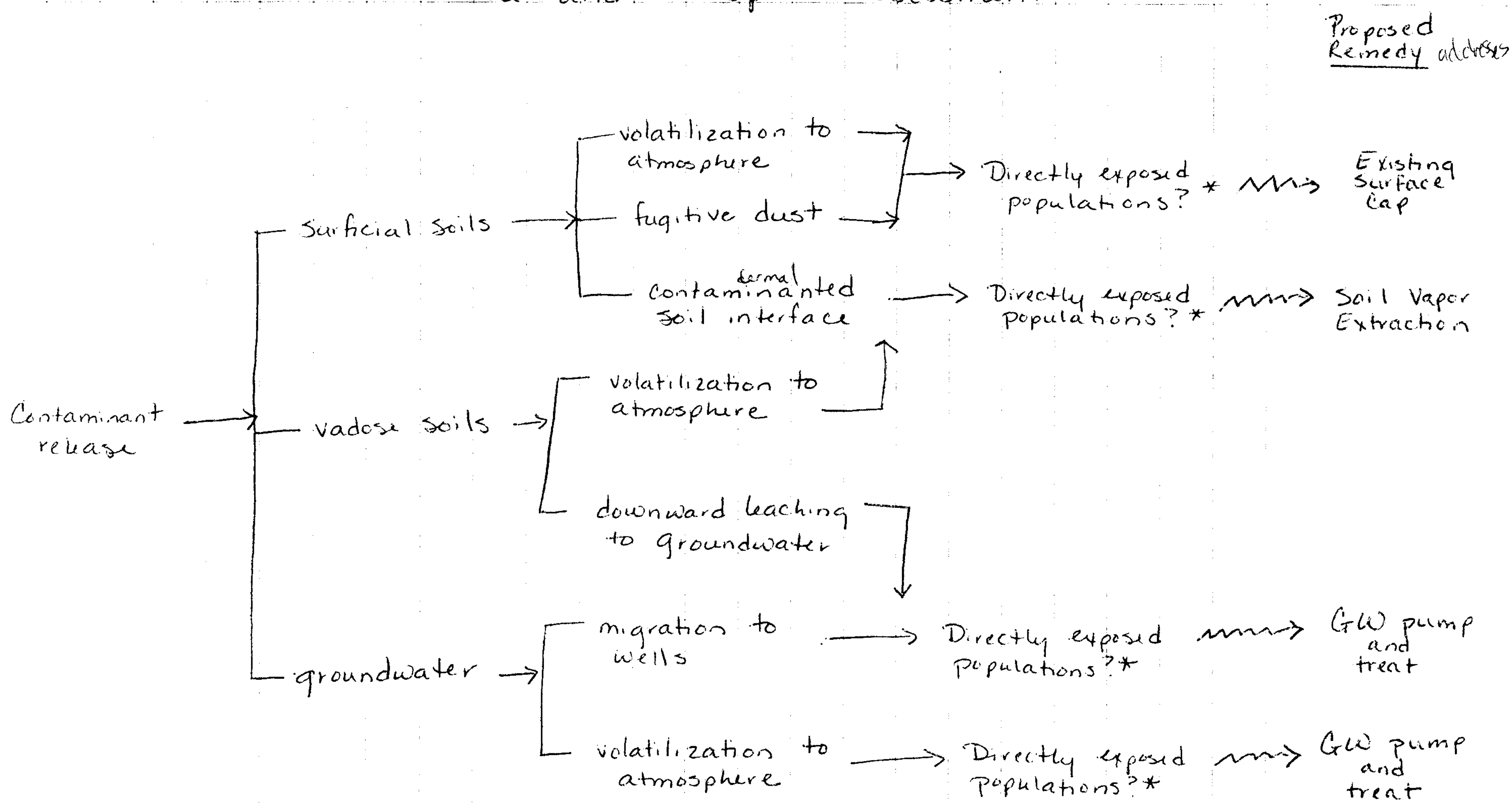
and apply to most conservative scenario.

- Apply the known changes in conc. to support RA proposal.

☒ Can they leave out some less severe pathways & look @ only most severe?

☒ Date for submittal of RA
- End of March ⟹ draft on RA

Fate and Transport Assessment



* limited to inhalation, incidental ingestion of particulates, and dermal contact. Potential risks due to ingestion of contaminated plants or animals (indirect pathway) not quantified as considered insignificant. Develop/compare to PRGs @ risk level in NMED WQCC.

Exposure Pathway Evaluation: Issues to Consider

Person Generating Station

Public Service Company of New Mexico

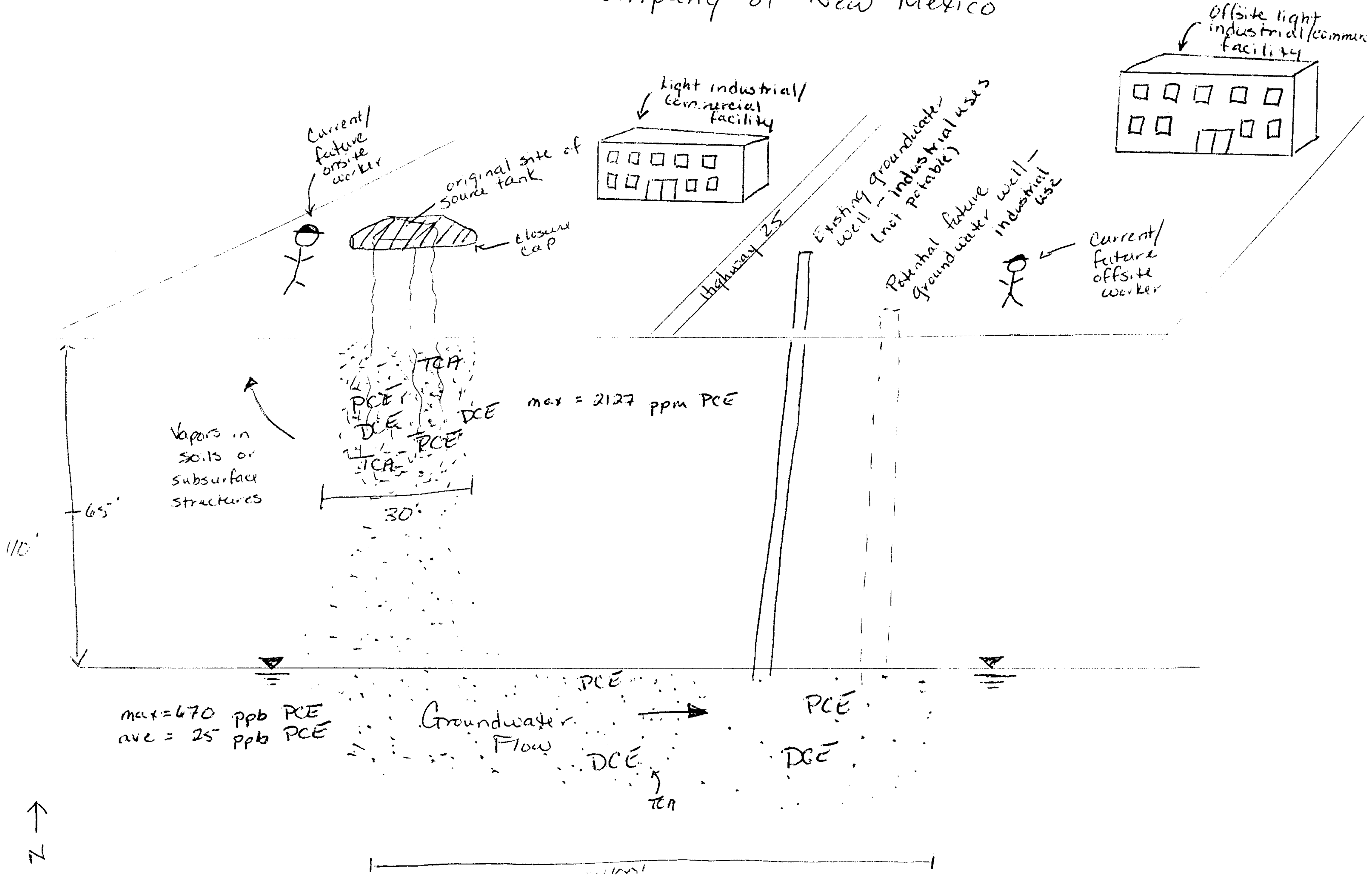


EXHIBIT 9-1

SUGGESTED OUTLINE FOR A BASELINE RISK ASSESSMENT REPORT

1.0 INTRODUCTION

1.1 Overview
- General problem at site
- Site-specific objectives of risk assessment

1.2 Site Background
- Site description
- Map of site
- General history
  - Ownership
  - Operations
  - Contamination
- Significant site reference points
- Geographic location relative to offsite areas of interest
- General sampling locations and media

1.3 Scope of Risk Assessment
- Complexity of assessment and rationale
- Overview of study design

1.4 Organization of Risk Assessment Report

2.0 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

2.1 General Site-specific Data Collection Considerations
- Detailed historical information relevant to data collection
- Preliminary identification of potential human exposure
- Modeling parameter needs
- Background sampling
- Sampling locations and media
- Sampling methods
- QA/QC methods
- Special analytical services (SAS)

2.2 General Site-specific Data Evaluation Considerations
- Steps used (including optional screening procedure steps, if used)
- QA/QC methods during evaluation
- General data uncertainty

2.3 Environmental Area or Operable Unit 1 (Complete for All Media)
- Area- and media-specific sample collection strategy (e.g., sample size, sampling locations)
- Data from site investigations

(continued)

EXHIBIT 9-1 (continued)

SUGGESTED OUTLINE FOR A BASELINE RISK ASSESSMENT REPORT

- Evaluation of analytical methods
- Evaluation of quantitation limits
- Evaluation of qualified and coded data
- Chemicals in blanks
- Tentatively identified compounds
- Comparison of chemical concentrations with background
- Further limitation of number of chemicals
- Uncertainties, limitations, gaps in quality of collection or analysis

2.4 Environmental Area or Operable Unit 2 (Repeat for All Areas or Operable Units, As Appropriate)

2.X Summary of Chemicals of Potential Concern

3.0 EXPOSURE ASSESSMENT

3.1 Characterization of Exposure Setting
- Physical Setting
  - Climate
  - Vegetation
  - Soil type
  - Surface hydrology
  - Ground-water hydrology
- Potentially Exposed Populations
  - Relative locations of populations with respect to site
  - Current land use
  - Potential alternate future land uses
  - Subpopulations of potential concern

3.2 Identification of Exposure Pathways
- Sources and receiving media
- Fate and transport in release media
- Exposure points and exposure routes
- Integration of sources, releases, fate and transport mechanisms, exposure points, and exposure routes into complete exposure pathways
- Summary of exposure pathways to be quantified in this assessment

3.3 Quantification of Exposure
- Exposure concentrations
- Estimation of chemical intakes for individual pathways

(continued)

EXHIBIT 9-1 (continued)

SUGGESTED OUTLINE FOR A BASELINE RISK ASSESSMENT REPORT

3.4 Identification of Uncertainties
- Current and future land-use
- Environmental sampling and analysis
- Exposure pathways evaluated
- Fate and transport modeling
- Parameter values

3.5 Summary of Exposure Assessment

4.0 TOXICITY ASSESSMENT

4.1 Toxicity Information for Noncarcinogenic Effects
- Appropriate exposure periods for toxicity values
- Up-to-date RfDs for all chemicals
- One- and ten-day health advisories for shorter-term oral exposures
- Overall data base and the critical study on which the toxicity value is based (including the critical effect and the uncertainty and modifying factors used in the calculation)
- Effects that may appear at doses higher than those required to elicit the critical effect
- Absorption efficiency considered

4.2 Toxicity Information for Carcinogenic Effects
- Exposure averaged over a lifetime
- Up-to-date slope factors for all carcinogens
- Weight-of-evidence classification for all carcinogens
- Type of cancer for Class A carcinogens
- Concentration above which the dose-response curve is no longer linear

4.3 Chemicals for Which No EPA Toxicity Values Are Available
- Review by ECAO
- Qualitative evaluation
- Documentation/justification of any new toxicity values developed

4.4 Uncertainties Related to Toxicity Information
- Quality of the individual studies
- Completeness of the overall data base

4.5 Summary of Toxicity Information

5.0 RISK CHARACTERIZATION

5.1 Current Land-use Conditions
- Carcinogenic risk of individual substances
- Chronic hazard quotient calculation (individual substances)
- Subchronic hazard quotient calculation (individual substances)

(continued)

EXHIBIT 9-1 (continued)

SUGGESTED OUTLINE FOR A BASELINE RISK ASSESSMENT REPORT

- Shorter-term hazard quotient calculation (individual substances)
- Carcinogenic risk (multiple substances)
- Chronic hazard index (multiple substances)
- Subchronic hazard index (multiple substances)
- Shorter-term hazard index calculation (multiple substances)
- Segregation of hazard indices
- Justification for combining risks across pathways
- Noncarcinogenic hazard index (multiple pathways)
- Carcinogenic risk (multiple pathways)

5.2 Future Land-use Conditions
- Carcinogenic risk of individual substances
- Chronic hazard quotient calculation (individual substances)
- Subchronic hazard quotient calculation (individual substances)
- Carcinogenic risk (multiple substances)
- Chronic hazard index (multiple substances)
- Subchronic hazard index (multiple substances)
- Segregation of hazard indices
- Justification for combining risks across pathways
- Noncarcinogenic hazard index (multiple pathways)
- Carcinogenic risk (multiple pathways)

5.3 Uncertainties
- Site-specific uncertainty factors
  - Definition of physical setting
  - Model applicability and assumptions
  - Parameter values for fate/transport and exposure calculations
- Summary of toxicity assessment uncertainty
  - Identification of potential health effects
  - Derivation of toxicity value
  - Potential for synergistic or antagonistic interactions
  - Uncertainty in evaluating less-than-lifetime exposures

5.4 Comparison of Risk Characterization Results to Human Studies
- ATSDR health assessment
- Site-specific health studies (pilot studies or epidemiological studies)
- Incorporation of studies into the overall risk characterization

5.5 Summary Discussion and Tabulation of the Risk Characterization
- Key site-related contaminants and key exposure pathways identified
- Types of health risk of concern
- Level of confidence in the quantitative information used to estimate risk
- Presentation of qualitative information on toxicity

(continued)

EXHIBIT 9-1 (continued)

SUGGESTED OUTLINE FOR A BASELINE RISK ASSESSMENT REPORT

- Confidence in the key exposure estimates for the key exposure pathways
- Magnitude of the carcinogenic and noncarcinogenic risk estimates
- Major factors driving risk
- Major factors contributing to uncertainty
- Exposed population characteristics
- Comparison with site-specific health studies

6.0 SUMMARY

6.1 Chemicals of Potential Concern
6.2 Exposure Assessment
6.3 Toxicity Assessment
6.4 Risk Characterization