Health Assessment for

PORTLAND CEMENT COMPANY

WASTE CEMENT KILN DUST SITES 2 & 3

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SALT LAKE CITY, UTAH

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Agency for Toxic Substances and Disease Registry
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HEALTH ASSESSMENT

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SUMMARY

The Portland Cement Company Waste Cement Kiln Dust Sites 2 & 3, located in Salt Lake City, Utah, was placed on the National Priority List (NPL) in June 1986. The site is situated in a mixed commercial and residential area. A large residential neighborhood is located near the site with two elementary schools. For approximately 20 years, until December 1983, waste cement kiln dust (CKD) was dumped and used as a landfill material on these properties by Portland Cement Company of Utah (PCU) and later by Lone Star Industries, Inc. (LSI), who purchased Portland Cement in 1979. CKD contaminants are likely to migrate via fugitive dusts, leaching, and shallow groundwater flow. Although the potential exists for contamination of nearby surface water bodies (Surplus Canal and the City Drain), no apparent differences have been noted between upstream and downstream samples CKD is highly alkaline, contains heavy metals (arsenic, cadmium, chromium, and lead), and silica particles. Exposure to these contaminants may occur through inhalation of fugitive dusts, ingestion of soil, ocular contact, and dermal contact with soil or ponded surface water. Site access is not adequately controlled thereby increasing the potential for exposure to soil contaminants. A soil stabilizer, which causes surficial crusting, is intermittently applied to control fugitive dust emissions. Contaminants in groundwater are at levels of potential health concern; however, groundwater does not come into contact with receptors and does not appear to be an immediate health threat.

BACKGROUND

A. SITE DESCRIPTION

The Portland Cement Waste Cement Kiln Dust Site is located in Salt Lake City, Utah, and is bounded by Redwood Road to the east, Indiana Avenue to the north, I-215 embankment to the west, and Surplus Canal to the south; a portion of the site is bisected by the City Drain. For approximately 20 years (until December 1983), CKD, an alkaline by-product of cement manufacturing, was dumped and used as fill material at the site. The site was proposed for listing on the NPL in September 1984 and was listed on June 10, 1986. The State of Utah Health Department functions as the lead agency for the site.

The Portland Cement Waste Kiln Dust Site actually consists of three sites, as shown in Appendix A. Site 2 (17 acres) and Site 3 (19 acres) are owned by Sid Horman/Cottonwood Mall Shopping Center, Inc. and the West Site (35 acres) is owned primarily by Southwest Investment Company. These three sites together are referred to as "the site" within this Health Assessment. LSI is the only potentially responsible party to have assumed responsibility for the site and has retained Dames and Moore to perform the RI/FS Report for the site, which are currently in draft.

The area west of the I-215 embankment and the area located north of the West Site and west of Site 3 were studied during the Remedial Investigation but are not included within the site boundary as defined in the FS. Therefore, these areas are considered to be off-site in this evaluation.

The total volume of waste CKD on the site is estimated to be 495,000 cubic yards. Approximately 360 tons of chromium-bearing refractory kiln brick have been dumped on-site although LSI has arranged to have spent chromium refractory bricks removed from the surface. Surficial CKD consists of extremely fine dust particles and airborne migration of fugitive dusts is of concern. Within the original site boundaries, waste CKD is present in thicknesses of from three to greater than six feet and is in contact with groundwater in some places. Ponded surface waters have occurred on-site and adjacent to the site.

Commercial and industrialized areas are located to the north, south, and west of the site. Four homes are located on the west side of Redwood Road adjacent the site. A densely populated residential area is located on the east side of Redwood Road.

Current remediation involves reducing windblown particles by the application of a vinyl-acrylic-resin dust suppressant which is intended to stabilize the CKD into a crusty material about 1/8 inch thick. The surface seal lasts around 3 to 4 months, depending on the weather conditions and site activities; the surface seal is easily destroyed by driving or walking upon.

B. SITE VISIT

A site visit was conducted July 29, 1988, by Utah Department of Health employees, ATSDR personnel, and the Health Assessment team from the Office of Risk Analysis, Oak Ridge National Laboratory.

Much of the site is unfenced although barbed wire fencing was strung in some areas. Access roads to the site are barred with a chain gate to prevent vehicle entry; however, one gate was unlocked during the visit and the chain at another gate, although locked at one end, was not secured at the other (it was wrapped around the gate post) allowing easy vehicular access.

Signs warning of caustic materials were posted around the site, but it was not clear that the soil was the object of concern. Only one sign was observed that could easily be read from the road; other signs were hidden by bushes and grass, were bleached-out and unreadable, or were knocked down. ATSDR has been informed that 25 legible signs have been placed around the site since the site visit.

Portions of the site had been sprayed with a surface stabilizer to minimize dust entrainment by creating a crust on the soil. However, approximately half of the site, including areas adjacent to access roads, did not appear to be sprayed. Two cardboard drums of stabilizer had been left on-site. One drum had been punctured, resulting in solidification of the stabilizer, the other drum was approximately one-fourth full.

The site was littered with miscellaneous debris and scattered refractory kiln bricks. The site had limited natural vegetative cover and vegetation appeared to be growing in areas where dumping had not occurred or in areas where CKD had been mixed with soil. Animals were observed on-site including: ducks, burrowing owls, and a fox. Footprints, tire tracks, shotgun shells, broken bottles, and beer cans were found on-site indicating trespassing and target practice or possibly hunting on-site.

Several trucking firms operate businesses adjacent to the site. One firm, which recycles empty steel drums, appears to be using a portion of the site for drum storage. Workers were observed unloading drums during the visit and stacking them on-site.

Four houses abut the site. Two of these houses were vacant, although one was for rent. Two of the homes have private wells; however, the wells are no longer in use according to state health officials.

During the site visit, pH measurements were taken throughout the site using pH paper and visual/colorimetric quantification. Water in the city drain was pH 7.5-8.9. Groundwater seeps flowing into the city drain were pH 12.0-13.5. Moist surface soil was pH 13. Water on marsh grass adjacent the site was pH 9.0.

C. PUBLIC CONCERNS

Public concerns were expressed during the site visit by state health officials: several complaints about fugitive dusts have been registered with the state health department, unsubstantiated allegations have been made about sheep dying from ingesting ponded surface water on-site, and it has been alleged that a child received alkali burns from direct contact with the CKD. State officials have not been able to verify these reports. On-site groundwater quality is also of potential concern.

Although the upper portion of the aquifer in the area is of marginal drinking water quality, state officials do not wish to see it further degraded. A related concern was expressed about inter-aquifer flow in Salt Lake City.

ENVIRONMENTAL CONTAMINATION AND PHYSICAL HAZARDS

A. ON-SITE CONTAMINATION

Most of the waste disposed of at the site was simply piled on the surface. CKD samples were obtained by Dames and Moore at several depths up to 30 inches maximum. Table 1 provides concentrations of contaminants in the CKD and kiln brick waste materials which may be of concern.

Ponded surface waters may be found on-site following storms. Eight samples of ponded surface waters were collected during April 1984, a very wet season which produced the largest areal ponding recorded to date. Table 2 provides a summary of results for ponded surface waters collected on-site.

Evidence of contamination in shallow groundwater has been found. Table 3 provides a summary of the contaminants of concern for groundwater under the site. Most recently reported samples were collected from sites 2 and 3 in February 1985 and from three additional wells in January 1986. Samples from the west site were collected in January 1986.

B. OFF-SITE CONTAMINATION

The Jordan River Surplus Canal (Surplus Canal) and City Drain are off-site surface water bodies adjacent the site. The Surplus Canal is located at the southern boundary of the West Site and Site 2. The City Drain is the northern boundary for the West Site and separates Site 2 from Site 3. Surface water and sediment samples were taken in January, February, and March 1986 consisting of: two samples from the Surplus Canal (upstream and downstream) and three samples from the City Drain (upstream, downstream, and CD-2, near the West Site's western boundary). Table 4 shows the results of surface water samples from the Surplus Canal; Table 5 shows the results of surface water samples from the City Drain; Table 6 shows the results of sediment samples from the Surplus Canal and City Drain. State health officials have indicated visually observing CKD erosion channels that lead directly into City Drain.

Off-site groundwater was sampled in January 1986 from eight monitor wells. The results of this survey are shown in Table 7.

TABLE 1. ON-SITE CONTAMINATION: WASTE CKD AND REFRACTORY BRICKS

Contaminant	Waste CKD Range (mg/kg)	Refractory Kiln Bricks Range (mg/kg)
Arsenic	3.0-26.9	<0.5-11.6
Cadmium	2.1-5.5	2.9-4.0
Chromium (VI)	0.1-7.3	220.0-1120.0
Total Chromium	8.7-28.2	1238.0-6977.0
Lead	90.3-1274.0	78.0-107.0
pH	11.3-13.0	11.1-11.4

TABLE 2. ON-SITE CONTAMINATION: PONDED SURFACE WATER

Contaminant	Range (mg/L)
Arsenic	<0.001-2.50
Cadmium	<0.001
Chromium (VI)	0.001-3.00
Total Chromium	0.001-3.50
Lead	<0.001-0.30
pH	8.3-13.0
Dissolved Solids	3100-19300

TABLE 3. ON-SITE CONTAMINATION: GROUNDWATER

Contaminant	Range (mg/L)	Guideline (mg/L) & Source
Arsenic	0.10-28.8	0.05 MCL
Cadmium	0.002-0.02	0.01 MCL, 0.005 PMCLG
Chromium (VI)	0.04-9.3	0.05 MCL
Total Chromium	0.05-8.2	0.12 Lifetime, 1.4 1-Day DWHA
Lead	0.10-1.5	0.05 MCL
pH	7.3-13.2	6.5-8.5 Secondary MCL
Dissolved Solids	895-89500	1000 Utah Secondary DW Standard

DWHA - USEPA Drinking Water Health Advisory
MCL - Safe Drinking Water Act, Maximum Contaminant Level
PMCLG - Safe Drinking Water Act, Proposed Maximum Contaminant Level

TABLE 4. OFF-SITE CONTAMINATION: SURPLUS CANAL - SURFACE WATER

Contaminant	Upstream Range (mg/L)	Downstream Range (mg/L)
Arsenic	0.01	0.01
Cadmium	<0.004	<0.004
Chromium (VI)	<0.01-0.05	<0.01-0.04
Total Chromium	<0.005	<0.005-0.007
Lead	<0.025	<0.025-0.030
pH	7.7-8.3	7.7-8.3
Dissolved Solids	830-970	835-960

TABLE 5. OFF-SITE CONTAMINATION: CITY DRAIN - SURFACE WATER

Contaminant	Upstream Range (mg/L)	CD-2 Range (mg/L)	Downstream Range (mg/L)
Arsenic	0.09-0.14	0.02-0.128	0.078-0.18
Cadmium	<0.004	<0.004	<0.004-<0.02
Chromium (VI)	<0.01-0.06	<0.01-0.03	<0.01-0.04
Total Chromium	<0.005	<0.005-0.015	<0.005-<0.025
Lead	<0.025-0.057	<0.025-<0.05	<0.025-<0.125
pH	7.5-7.8	7.5-8.2	7.98-8.04
Dissolved Solids	1820-2410	1450-3000	2050-3490

TABLE 6. OFF-SITE CONTAMINATION: SEDIMENT (mg/L)

	Surplus Canal		City Drain		
Contaminant	Upstream Range	Downstream Range	Upstream Range	CD-2 Range	Downstream Range
Arsenic	5.3-41.0	2.2-7.1	6.9-45.0	12.0-21.0	14.0-25.0
Cadmium	0.4-5.4	0.7-1.3	0.6-1.2	1.0-1.8	0.9-1.9
Chromium (VI)	NR	NR	NR	NR	NR
Total Chromium	<0.7-5.3	2.9-14.0	6.5-38.0	6.9-14.0	3.3-15.0
Lead	20-140	33-62	36-380	120-190	38-150
pH	7.8-9.1	8.6-9.5	7.4-9.5	9.9-10.1	8.6-9.7

NR - Not reported

TABLE 7. OFF-SITE CONTAMINATION: GROUNDWATER

Contaminant	Range (mg/L)	Guideline (mg/L) & Source
Arsenic	0.014-0.54	0.05 MCL
Cadmium	0.02-<0.08	0.01 MCL, 0.005 PMCLG
Chromium (VI)	<0.01-0.12	0.05 MCL
Total Chromium	0.025-2.1	0.12 Lifetime, 1.4 1-Day DWHA
Lead	<0.05-0.44	0.05 MCL
pH	7.3-8.9	6.5-8.5 National Secondary MCL
Dissolved Solids	4590-31700	1000 Utah Secondary DW Standard

DWHA - USEPA Drinking Water Health Advisory
MCL - Safe Drinking Water Act, Maximum Contaminant Level
PMCLG - Safe Drinking Water Act, Proposed Maximum Contaminant Level Goal

C. Physical Hazards

During the site visit, two drums of soil stabilizer were found on-site. One drum had been punctured, causing solidification of the stabilizer. The second drum was approximately one-fourth full, and may be a hazard to children or other trespassers who may investigate the drum's contents. An additional hazard observed during the site visit concerned on-site drum storage by a trucking firm bordering the site. Because site access is inadequately controlled, the storage of steel drums on the edge of the site may be a hazard for children trying to climb on them.

DEMOGRAPHICS

A. POPULATIONS AT RISK

Populations potentially at risk of exposure include workers at adjacent business, residents whose properties abut the site, and other residents living in neighborhoods near the site. Approximately 6,000-12,200 people live within a one-mile radius of the site (depending upon the method used to estimate population). A large residential area east of the site contains two elementary schools within this radius. Children are at increased risk of lead, arsenic, and cadmium toxicity. Individuals with respiratory problems such as obstructive airway disease or tuberculosis, who smoke, or of advancing age may also be at higher risk from inhalation exposure to the contaminants of concern. In addition, certain individuals may be more sensitive to the irritating effects of the dust on the eyes, skin, and upper respiratory passages. Effects of cadmium exposure will be additive and possibly synergistic with lead and are of concern to women of reproductive age who may be pregnant and individuals with renal disease or hypertension.

B. LAND USE

The waste CKD disposal site is located in an industrial area bordered by a residential neighborhood. Commercial or industrial properties adjacent to the site include an auto-body junk yard, truck-parts shop, municipal landfill, trailer storage facility, plant nursery, rental storage facility, a wood framing company, two truck freight depots, a used barrel reclamation facility, and a small cafe.

Residential areas are primarily east of the site, across Redwood Road, and include single family dwellings, mobile home parks, and some high-density multifamily residential units. Four private homes abut the waste CKD disposal site.

The Salt Lake City Planning and Zoning Department will be encouraging future light industrial and low density commercial development in the area (Dames & Moore, 1988a).

EVALUATION

A. SITE CHARACTERIZATION (DATA NEEDS AND EVALUATION)

1. Environmental Media

Soil has been adequately characterized at the site. Shallow groundwater has undergone substantial characterization although there are concerns about off-site groundwater migration and communication between surface water and the deep aquifer. There are additional concerns about other environmental media.

No air data are available for the site. Lack of these data inhibit quantitative assessment of the impact of this medium on human exposure. Because no environmental data are available to assess air exposure routes, exposure to airborne particulates is a potential health concern. Air samples should be collected from both upwind and downwind occupied areas during weather conducive to wind erosion; samples should be gravimetrically separated by respirable and nonrespirable fractions and should be analyzed using NIOSH approved methods for: percent crystalline silica, calcium oxide, and total metals including hexavalent chromium.

Concerns over whether or not the deep portion of the aquifer has been contaminated, or may become contaminated in the future, were not resolved in the draft FS. Sampling of groundwater from the deep portion of the aquifer could possibly confirm whether or not the aquifer is contaminated, although such sampling may introduce a route of contaminant migration.

Surface waters have only been sampled during a peak surface water period of the year (late winter-early spring). In addition to sampling when water levels are at their peak, sampling should be performed when water levels are low. This would give additional information about contaminant migration into and within these water bodies. The City Drain is important because it is an influent stream whereas the Surplus Canal is an effluent water body during normal conditions throughout the year.

As shown on the site map (Appendix A), sampling location CD-1, which is located furthest downstream from the site, occurs after confluence with another ditch or secondary spur of the City Drain. Surface water and sediment samples taken from this location may be affected by the other ditch. Thus, samples may be diluted by water and sediments coming from an area of low contamination.

2. Demographics and Land Use

A summary of well information from the RI was presented in the FS. The FS only provided a population estimate within one mile of the site; no other demographic information or information about populations at possibly increased risk was given. In addition, the estimated population within one mile of the site presented in the FS (6,000) was considerably different from the population estimate (12,200) given in the Health Hazard Review (USEPA, 1984). Although the FS documented the rationale for the lower number, without the original documents used for both reports, it is unclear if this rationale is acceptable. For this reason the estimated range 6,000-12,200 was used in this evaluation. Adequate land use information was provided.

A well survey was performed for the FS. Although the number of wells located upgradient and downgradient of the site and what aquifer they are believed to be screened in was provided, specific locations of the upgradient and downgradient wells were not provided in the draft FS. This information would help for understanding aquifer usage.

3. Quality Control and Quality Assurance

ATSDR relies on the information provided in the referenced documents and assumes that adequate quality assurance and quality control measures were followed with regards to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and conclusions drawn for this Health Assessment are determined by the appropriateness and reliability of the referenced information.

Elevated total dissolved solids (TDS) levels present difficulty in the laboratory analysis of water samples. Equipment used during the analysis is calibrated for use at specific operating conditions. Samples with high TDS are diluted by the laboratory to achieve acceptable operating conditions. Unfortunately, this dilutes all the elements that may be present in the sample, not just those present at appreciable concentrations, and leads to detection limits that are multiples of the dilution factor. Because detection limits may vary between samples, it is possible that contaminants may not be uniformly quantified throughout the site and low levels of contaminants may not be detected in some samples.

B. ENVIRONMENTAL PATHWAYS

CKD was disposed of by dumping, burying, slurrying, and mixing it with soil as fill. In addition to waste CKD, refractory kiln bricks containing chromium are located in some areas of the site. These bricks may serve as a reservoir for contamination, subject to leaching. The surficial waste CKD is very fine grained and can easily be suspended by winds or migrate in surface water runoff. Because site topography is flat and the CKD has low permeability, precipitation may result in ponded surface waters. Analysis of the ponded surface water indicates elevated pH levels as a result of contact with waste CKD. Leaching of contaminants from waste CKD can result in contamination of groundwater. Once in groundwater, contaminants will migrate with the groundwater flow and through man-made channels which are present at the site. Factors affecting the migration of contaminants are discussed below.

Chemical-specific Factors

Exposed waste CKD can easily be eroded by winds. Although a surface stabilizer is currently applied to the site, its effectiveness is only short-term, leaving the potential for waste CKD to migrate off-site. Conditions which could increase dust generation include dry windy weather and earth moving operations. No air data are available for the site or adjacent areas, prohibiting more complete assessment of this important media and its associated environmental pathways.

The mobility of contaminants in groundwater and surface water will be affected by pH. Shallow groundwater at the site is highly basic from contact with CKD Under oxidizing conditions and basic pH, dissolved chromium may be in the hexavalent Cr(VI) state. Hexavalent chromium is not readily adsorbed by common aquifer materials and would be expected to remain in solution until chemically reduced, forming the relatively insoluble Cr(III) species and its hydroxide complexes. The reduction of Cr(VI) to Cr(III) is dependent upon the availability of easily oxidized compounds such as the organic matter present in the aquifer materials or groundwater.

Under the basic conditions of the site, arsenic is probably present as As(V). Although As(V) is strongly adsorbed by clays and organic carbon in the neutral pH range, adsorption tends to decrease with increasing pH as a result of replacement by hydroxide anions.

Cadmium and lead exhibit similar aqueous characteristics. In neutral solutions, concentrations are limited by adsorption and coprecipitation of hydroxide complexes; however, solubility is enhanced under alkaline conditions.

In leachate, arsenic, cadmium, and lead are likely to remain in the dissolved state until the leachate is neutralized. Upon neutralization, these contaminants will coprecipitate and be adsorbed by clays and organic carbon. It is important to note that hexavalent chromium is not readily adsorbed upon neutralization. Chromium(VI) probably will remain in the dissolved state until reduced to Cr(III). In groundwater, if soil organic carbon compounds are present, Cr(VI) is expected to be reduced to Cr(III) and subsequently adsorbed.

In surface water, adsorption or precipitation of arsenic, cadmium, and lead may only serve to transfer the contaminants from the dissolved to the suspended load rather than impede transport. The suspended material may settle and accumulate in channel sediments or may be transported as suspended load. Chromium probably will not precipitate until reduced. Reduction of Cr(VI) is unlikely in surface waters and therefore, attenuation would result primarily from dilution.

<u>Site-specific Factors</u>

Groundwater in the area of the site exists under deep artesian and shallow unconfined conditions. The unconfined water table may be found from 2 to 10 feet below the ground level, and water levels fluctuate between one and six feet. Near-surface unconsolidated deposits, which comprise the shallow or unconfined aquifer, are generally lake sediments composed of interlayered clays, clayey silts, and thin-sand stringers varying in thickness from less than a tenth of an inch to several feet. This interlayering of low-permeability clays and silts with higher permeability sandy layers creates a strong anisotropic groundwater flow regime. In the area north of the City Drain, sand layers are fairly thin and are rarely greater than one inch in thickness. South of the City Drain, sand thicknesses greater than a foot often occur.

Beneath the near-surface soils, clays, silts, and fine sands make up a leaky aquitard separating the deeper confined portion of the aquifer from the shallow unconfined portion. The deeper portion of the aquifer consists of high permeability sands and gravel interbeded with silts and clays. The thickness of the shallow aquifer and aquitard vary throughout the area. Confined conditions are encountered at depths of less than 30 to 40 feet, whereas the deep productive portion of the aquifer is encountered between 95 and 125 feet.

Currently, deep groundwater supplies are believed to be protected by an artesian effect, precluding the mixing of the shallow aquifer with the deeper aquifer. A disparity of opinion exists on the adequacy and permanence of this mechanism for protection of the deep aquifer. It has been alleged that other areas of the Salt Lake Valley have shown contamination in the deep aquifer, from other sources, resulting from high pumping rates of wells. Currently, seven municipal wells and six high yield non-municipal wells exist within three miles of the site. All of the wells are upgradient of the site and are reported to be uncontaminated (data not available). No sampling of the deep aquifer has been performed at the site; however, sampling may be required to establish whether or not contamination of this aquifer has occurred. Contemplation of such sampling should be done with caution because of the possibility for introducing a man-made contaminant transport pathway.

Sources of shallow groundwater recharge at the site include water forced upward through the aquitard from the deeper portion of the aquifer, the Surplus Canal along the southern site boundary, and shallow groundwater originating northeast of the site. Groundwater at the site flows toward the sewer alignment (located along the western boundary of sites 2 and 3) and the City Drain (and possibly underneath). Groundwater near the City Drain and surface water in the drain flow north-northwest across the site. Off-site groundwater samples show decreased levels of contaminants. In addition, based on groundwater flow, groundwater at the off-site properties located between Site 2 and Site 3 is likely to be contaminated, although groundwater at these properties has not been sampled.

Although no appreciable release of contaminants into the Surplus Canal or City Drain has been detected (based upon upstream and downstream samples), the potential for such a release exists. Under normal conditions, the Surplus Canal recharges the shallow groundwater at the site; however, during periods of canal maintenance, when groundwater levels are higher than canal water levels, groundwater flow may reverse.

The City Drain is part of the urban storm sewer system and is approximately 25-30 feet wide and 10 feet deep, where it passes through the area. Water levels in the drain fluctuate greatly depending upon climatic conditions. The drain is full during the springtime and barely covered during the summer. The drain potentially may become contaminated from surface runoff from storms, erosion by high water levels in the drain, or by discharge of contaminated groundwater.

Residents downgradient of the site are reported to use surface water from the Surplus Canal for stock and lawn watering (USEPA, 1984), although no official surface water intakes exist within three miles downgradient of the site. Crops, livestock, and fish have the potential to concentrate most of the metals; however, surface water data are insufficient to demonstrate bioconcentration via the food chain. This may not be an important pathway.

C. HUMAN EXPOSURE PATHWAYS

Discussion of potential exposure pathways to contaminants in groundwater, surface water, soils, air, and food chains follows. As discussed in previous sections, shallow groundwater is contaminated. Although concentrations of contaminants exceed health guidelines for drinking water (as shown in Tables 3 and 7), it has not been demonstrated that contaminated groundwater comes into contact with human populations. Such contact with human populations would be of health concern should it occur.

Possible contamination of the deep aquifer by the shallow aquifer has not been satisfactorily addressed in the draft FS. However, contamination of drinking water supplies has not been shown at this time. Factors affecting the potential migration of contaminants to the deep aquifer are to be quantified in the final FS, but, it may be necessary to sample the deep aquifer to prove that contamination has not occurred. Should contamination of this aquifer develop in the future, notable human exposure to contaminants possibly may occur via ingestion.

Appreciable surface water contamination has not been detected in the Surplus Canal or City Drain. Although these waters have been reported to be used for livestock and lawn watering, exposure to contaminants in these waters, or via food chains accumulating contaminants from these waters, are unlikely to be of public health concern.

Important exposure pathways at the site involve soil contaminants and high pH ponded surface waters. Exposure to soil contaminants may occur through dermal contact, inhalation of airborne fugitive dusts, ocular contact with fugitive dusts, and ingestion of on-site or off-site deposited soil or dust by children and adults. Direct contact exposure to high-pH ponded surface waters may occur.

PUBLIC HEALTH IMPLICATIONS

As discussed in previous sections, air, soil, and ponded surface waters are media most likely to be of importance with respect to exposure. While the potential for exposure through the food chain exists, this medium is probably of less importance. Physical hazards identified at the site may also be of concern.

Air

Potentially important routes of exposure to soil contaminants involving airborne contaminant-laden dusts, which may blow off-site and come into contact with individuals, cannot be completely assessed because of lack of data. Important air exposure routes are inhalation, ocular contact, and possibly secondary ingestion via pulmonary toilet (clearance of secretions and captured airborne particulates from the pulmonary airways to the pharynx and subsequent ingestion). Because insufficient information is available to evaluate these exposure pathways, it is assumed that they may be of potential health concern.

Adverse health effects of airborne CKD contaminants are varied. Acute exposure to cement dust causes rhinitis, dermatitis, and pharyngitis. Arsenic, cadmium, and chromium have been shown to be respiratory carcinogens in animal studies; some epidemiological studies support associations between respiratory cancer and exposure to these toxicants in humans. Other CKD constituents e.g., silica, calcium oxide, and calcium hydroxide, also may produce adverse health effects, as discussed below. Concentrations of airborne respirable silica are unknown; however, chronic exposure to high concentrations of silica dust have been shown to cause silicosis which is exacerbated by age, smoking, pulmonary infections and chronic obstructive pulmonary disease (COPD), and cardiac problems.

Calcium oxide (CaO) is irritating to mucous membranes due to the liberation of heat and dehydration of tissues from the formation of calcium hydroxide, a relatively strong base with an aqueous pH of approximately 12.4. Inhalation exposure to CaO may exacerbate symptoms in individuals with COPD. Calcium oxide was an original constituent of CKD, but may no longer be present at the site after years of exposure.

Soil

Potential exposure to on-site soil contaminants is of concern because of inadequate access restriction and a nearby residential neighborhood with many children. Exposure to on-site contaminants may occur via inhalation (as discussed previously), ingestion, or dermal contact.

Soil at the site contains lead and arsenic at levels such that if children consistently played on the site they possibly may suffer adverse health effects from exposure via ingestion. The highest lead concentrations in waste CKD (1,274 mg/kg) exceeds the Center for Disease Control's (CDC's) recommended maximum level of 500-1000 mg/kg for lead in residential soil. Children exposed to lead may suffer from developmental and neurobehavorial effects. Lead has been implicated in hypertension. Cadmium, although not found at levels of appreciable health concern by itself, has also been implicated in hypertension, especially in the presence of elevated lead exposure. Lead and cadmium are also implicated in renal effects and poisoning of cell membrane components and heme-synthesizing enzymes. Oral exposure to arsenic increases the risk of skin cancer and may increase the risk of internal malignancies.

Ingestion of CKD is also of concern because of the possibility of alkali burns. Dermal exposure to CKD constituents is also of potential public health concern.

Dermal exposure to chromium III and VI can irritate skin and may also induce sensitization (contact dermatitis), depending upon the duration, magnitude of exposure, and the amount of individual sensitivity. Skin may also be irritated by contact with calcium hydroxide and calcium oxide as discussed previously. Dermal absorption by arsenic, cadmium, and lead is relatively poor; however, cuts and dermatologic conditions may compromise the skin barrier and enhance the importance of this exposure route with respect to these chemicals.

Ponded Surface Waters

The high pH of ponded surface waters may cause dermal irritation upon contact. Ponding occurs on-site and is of concern. Because of potentially elevated pH levels, off-site ponding and surface water runoff from the site may be of concern for adjacent residents.

Physical Hazards

Improper storage and disposal of soil stabilizer and on-site empty drum storage are potential physical hazards at the site. Soil sealant left in barrels on-site may be opened and the contents accidentally ingested, inhaled, or dermally contacted by children or adults curious about the barrels contents. Proper disposal of sealant would alleviate this problem.

Storage of empty steel drums on-site is a potential problem since there is inadequate access restriction. The drum storage area on the edge of Site 2 may be accessed by climbing a barbed wire fence or going under the chain at the gate. These measures are inadequate to keep children off the site.

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Based upon information reviewed, ATSDR has concluded that this site is of potential health concern because of the potential risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. As noted in the Exposure Pathways and Health Implications Section above, human exposure to CKD constituents including lead, chromium, arsenic, silica, calcium oxide, and calcium hydroxide may occur via inhalation and ingestion. Dermal exposures of individuals with compromises in the skin barrier to high pH surface waters and CKD constituents may also be of public health concern.

Current site control measures are inadequate to restrict site access by unauthorized persons. This increases the possibility for exposure to contaminants at the site or endangerment by physical hazards.

The storage of used drums on-site is a potential physical hazard because of inadequate site control measures.

Improper disposal and storage of excess stabilizer is a potential physical hazard at the site.

The possibility for future contamination of the deep aquifer could not be determined based upon information in the current draft of the FS.

B. RECOMMENDATIONS

1. Appropriate actions should be taken to limit site access by unauthorized individuals. Such actions may include appropriate fencing. Posting of signs warning of caustic materials in the soil may alert the public to potential hazards, but it would be insufficient for restricting site access.

2. Appropriate actions should be taken to eliminate the physical hazards previously identified. Such actions may include removal of excess sealant in drums from the site and appropriate storage and disposal measures, fencing the drum storage area, or removing drums stored on-site.

3. The interim remedial action of applying a surface sealant to control fugitive dust emissions should be continued. Appropriate measures should be implemented to ensure that application of the sealant is performed as site conditions warrant and that all areas of the site where fugitive dusts may be a problem are sprayed.

4. Appropriate actions should be taken to monitor and evaluate off-site migration of airborne contaminants. Information to help assess airborne hazards should include a windrose and air samples collected from both upwind and downwind occupied areas during weather conducive to wind erosion. The samples should be gravimetrically separated by respirable and nonrespirable fractions, and must be analyzed for percent crystalline silica, calcium oxide, and total metals including hexavalent chromium. These data are needed to help evaluate the public health implications associated with inhalation of site-related contaminants.

5. Surface waters and sediments in the City Drain should be sampled during climatic conditions when water levels will be low. Such sampling may give additional information about contaminant migration into and within the drain.

6. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, the Portland Cement Kiln Dust Waste Disposal Site has been evaluated for appropriate follow-up with respect to health effect studies. Since human exposure to on-site and off-site contaminants may currently be occurring and may have occurred in the past, this site is being considered for follow-up health effects studies. After consultation with Regional EPA staff and state and local health and environmental officials, the Epidemiology and Medicine Branch, Office of Health Assessment, ATSDR, will determine if follow-up public health actions or studies are appropriate for this site.

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APPENDIX

Appendix A: Site Map of Portland Cement Waste Disposal Area