Letter Health Consultation

SUNLAND PARK ELEMENTARY SCHOOL

FORT LAUDERDALE, BROWARD COUNTY, FLORIDA

Prepared by:
Florida Department of Health

NOVEMBER 23, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

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Prepared By:

Florida Department of Health
Division of Environmental Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Charlie Crist
Governor

Ana M. Viamonte Ros, M.D., M.P.H.
State Surgeon General

November 22, 2010

James Notter
Superintendant of Schools
Broward County Public Schools
600 SE Third Avenue
Fort Lauderdale, Florida 33301

RE: **Sunland Park Elementary School**

Mr. Notter:

The Florida Department of Health (FDOH) completed this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). This health consultation reports the FDOH's evaluation of environmental contamination associated with dry cleaner solvents and low levels of breakdown products discovered under the Sunland Park Elementary School (SPES). In June 2007, the Broward County Health Department and the School Board of Broward County (SBBC) requested that FDOH assess the potential health threat and put any health risk into context. Additionally, parents of students attending the school expressed concern about possible impacts to their children's health.

In a June 2007 technical assist, the FDOH found no apparent health risk for students or teachers from the dry cleaner solvents or their breakdown products in the soil or ground water [4]. In this report FDOH uses a recently developed irrigation well exposure model to evaluate the health threat from past exposure to volatile organic compounds (VOCs) from irrigation well water. The assessment and recommendations presented in this report are site-specific. Assumptions and judgments in this assessment err on the side of protecting public health and may overestimate the risk.

Background

The 6.75-acre SPES campus is at 919 Northwest 13th Terrace, Fort Lauderdale, Broward County, Florida (Figure 1). A city park defines the school's western boundary. West Sunset Boulevard defines the northern boundary. Thirteenth (13th) Avenue defines the eastern boundary. Private single-family homes define the southern boundary (Figure 2). Access is unrestricted; no fences or other manmade barriers surround the SPES campus.

Land uses within one (1)-mile of the school are predominately commercial and residential with notable growth within the past 20 years. SPES receives drinking water from the City of Fort Lauderdale's municipal water distribution system. The nearest surface water feature, within one (1) mile, is the North Fork of the New River to the south-southwest [2].

An irrigation well (IRR-02) was on the northeastern border of the SPES campus (Figure 2). The well was four (4) inches in diameter with a total depth of 93 feet below land surface (bls) [1]. The school used this well to irrigate small landscape islands near Sunset Boulevard. According to site assessment reports and conversations with SBBC maintenance staff, irrigation took place during the early morning, a few months out of the year starting in 1992 (Broward County School Board, unpublished data, 2008).

In May 2007, contractors for the Florida Department of Environmental Protection (FDEP) collected one (1) groundwater sample from the school's irrigation well. The well was not being used [2]. They tested for chlorinated solvents but only found vinyl chloride and *cis*-1,2-dichlorethylene (*cis*-1,2-DCE) . Only vinyl chloride exceeded the EPA maximum contaminant level (MCL) of one (1) part per billion (ppb). The concentration of vinyl chloride did not, however, exceed ATSDR screening values (Table 1**).** Immediately after FDEP discovered the irrigation well was contaminated, contractors for SBBC pressure grouted and removed it from service (Broward County Health Department, unpublished data, 2007).

The source of contamination of the school's irrigation well is the former Dry Cleaning Depot (DCD) just east of the school. In May 1996, consultants for DCD found tetrachloroethylene and its breakdown products *cis*-1,2-DCE and vinyl chloride in the both soil and ground water [1]. In March 2008, FDEP concluded the ground water contamination in the school's irrigation well was from DCD.

Beginning in the summer of 2009, contactors for the FDEP excavated approximately 565 cubic tons of the subsurface soil contamination from the DCD site. They put clean fill back in the hole and installed a soil vapor extraction/groundwater remediation system. This system is designed to prevent DCD groundwater contamination from migrating beneath the school's property and reduce the likelihood of exposures [3].

Discussion

Exposure Pathway Evaluation

FDOH determines exposure to environmental contamination by identifying exposure pathways. An exposure pathway is generally classified by the environmental medium (e.g., water, soil, air, food). A completed exposure pathway consists of five elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of exposure, and a receptor population. A completed exposure pathway exists when people are actually exposed to contaminants through ingestion, inhalation, or by skin contact.

FDOH reviewed the irrigation well test results to determine if it was a public health threat. Since the well was abandoned in June 2007, there is no current or future exposure. In addition, FDOH assessed the potential for exposure to chemical vapors accumulating inside portions of the school above the contaminated groundwater. FDOH determined dermal exposure to soil contaminants is not likely since the contamination is deeper than 40 feet below land surface.

Incidental ingestion, inhalation, and dermal absorption are three (3) possible past irrigation well water exposure pathways. To determine exposure from use of the irrigation wells, FDOH used a model developed by toxicologists at the University of Florida (Dr. Steve Roberts, University Florida, personal communication, 2009). This model uses assumptions protective of the most sensitive individuals, children, and the elderly. This model estimates exposure for non-potable uses of irrigation well water. The model considers the potential intake of contaminants through inhalation, dermal contact, and incidental ingestion (Appendix)**.**

As a first step, we evaluated the worst-case scenario that students were within close proximity while the contaminated irrigation well was in use. This exposure scenario likely represents an overestimation of the health threat. To assess site-specific non-cancer health risks, children and adult exposure doses for each contaminant were compared to the health guideline for that contaminant. FDOH used ATSDR's Minimal Risk Level (MRL) of 0.003 milligrams per kilogram per day (mg/kg/day) for vinyl chloride to evaluate chronic (long-term) exposure. A person can be exposed daily to the MRL without having any adverse health effects. If the exposure dose for a substance exceeds its non-cancer health guideline, it is evaluated further (Table 2).

The evaluation was limited, however, by the existence of only one test of the irrigation well. In the past concentrations of chemicals in this well may have been higher or lower.

Public Health Implications

Vinyl Chloride Exposure

Vinyl chloride is a colorless, flammable gas at room temperature, with a mild, sweet odor above a concentration of 3,000 parts per million. Vinyl chloride is a manufactured chemical used to make a common plastic product called polyvinyl chloride (PVC). PVC is used to make a variety of plastic products, including pipes, wire and cable coatings, furniture and automobile upholstery. Vinyl chloride also results from the breakdown of other chemicals, such as trichloroethylene, tetrachloroethylene, and *cis-1,* 2-dichloroethylene.

Vinyl chloride is a known human carcinogen. Vinyl chloride has been consistently associated with elevated incidences of rare angiosarcomas of the liver in humans, but only by inhalation and only at the extremely high worker exposures [3].

Non Cancer Health Effects

At the maximum concentration of vinyl chloride detected in the irrigation well (15.4 ppb), the long-term estimated combined (ingestion, dermal contact, and inhalation) exposure dose of 0.0000005 mg/kg/day from the irrigation well water is 6,000 times below ATSDR's MRL for non-cancer health effects (0.003 mg/kg/day). Thus, exposure to the irrigation well water is not likely to result in non-cancer health effects (Table 2).

Cancer Effects

Workers near this irrigation well may have been exposed to vinyl chloride in the water via skin absorption, inhalation, or incidental ingestion. The irrigation well exposure model estimates a dose for each of these routes of exposure (Table 2). There is no EPA slope factor from which to estimate the cancer risk from skin absorption. There is a unit risk factor for inhalation, but using it to estimate the cancer risk requires an estimate of the air concentration. Unfortunately, the irrigation well model only estimates an inhalation dose, not an air concentration. Therefore the only remaining route of exposure from which to estimate the cancer risk is incidental ingestion.

To estimate the cancer risk from exposure to vinyl chloride via incidental ingestion, FDOH used the 2006 EPA oral slope factor of 0.72 $(mg/kg\text{-}day)^{-1}$. Since the exact date the school's irrigation well first became contaminated is unknown, FDOH estimated 30 years as a maximum exposure period. The school stopped using the well in 2007. Assuming a continuous 30-year exposure to the maximum vinyl chloride incidental ingestion dose from the irrigation well water (0.0000005 mg/kg/day), the estimated increased cancer risk at the SPES is 0.0000002 or about 2 in 10,000,000. This is virtually no increased theoretical cancer risk. All of the uncertainties and conservative exposure assumptions associated with the dose calculations are included in the risk estimation as well as the uncertainty in deriving the cancer slope factor.

CHILD HEALTH CONSIDERATIONS

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults. This means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate of air results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health. In this assessment, FDOH considered the unique vulnerabilities of children at Sunland Park Elementary School.

CONCLUSIONS

1. Past exposure to vinyl chloride contaminated irrigation well water is not expected to harm the health of visitors, school staff, or students.

RECOMMENDATIONS

1. For landscape irrigation, SPES should not switch from municipal water back to a well until DCD completes its groundwater remediation.
2. FDEP should continue the groundwater remediation system at the DCD to prevent further migration of contaminated groundwater.
3. FDEP should continue to monitor the contaminated groundwater. If groundwater concentrations increase, SPES should collect soil vapor samples directly under the school buildings.

PUBLIC HEALTH ACTION PLAN

In November 2008, the School Board of Broward County (SBBC) notified parents and school staff of the presence of groundwater contamination. SBBC explained there was no threat of exposure since the school was on a public water supply. SBBC provided parents and school staff the contaminant levels and toll-free numbers for both the FDEP and FDOH.

Concerned parents or school staff should contact their health care provider. They may also call the Florida Department of Health at 1-877-798-2772 for information about the SPES site.

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REFERENCES

[1] School Board of Broward County Site, 2007 Site Assessment Report. Sunland Elementary School, Fort Lauderdale, Broward County, Florida. May 2007

[2] Metcalf and Eddy. April 2008. Assessment Summary Report, Dry Cleaning Depot 1320 W. Sunrise Blvd. Ft. Lauderdale, Florida. April 2008.

[3] Agency for Toxic Substances and Disease Registry. Toxicological Profile for Vinyl Chloride (Update). Atlanta: US Department of Health and Human Services; January 2006.

[4] Agency for Toxic Substances and Disease Registry. Technical Assist. Sunland Elementary School, Fr. Lauderdale. Prepared by Connie Garrett, Florida Department of Health. June 26, 2007.

Figure 1. Site Location

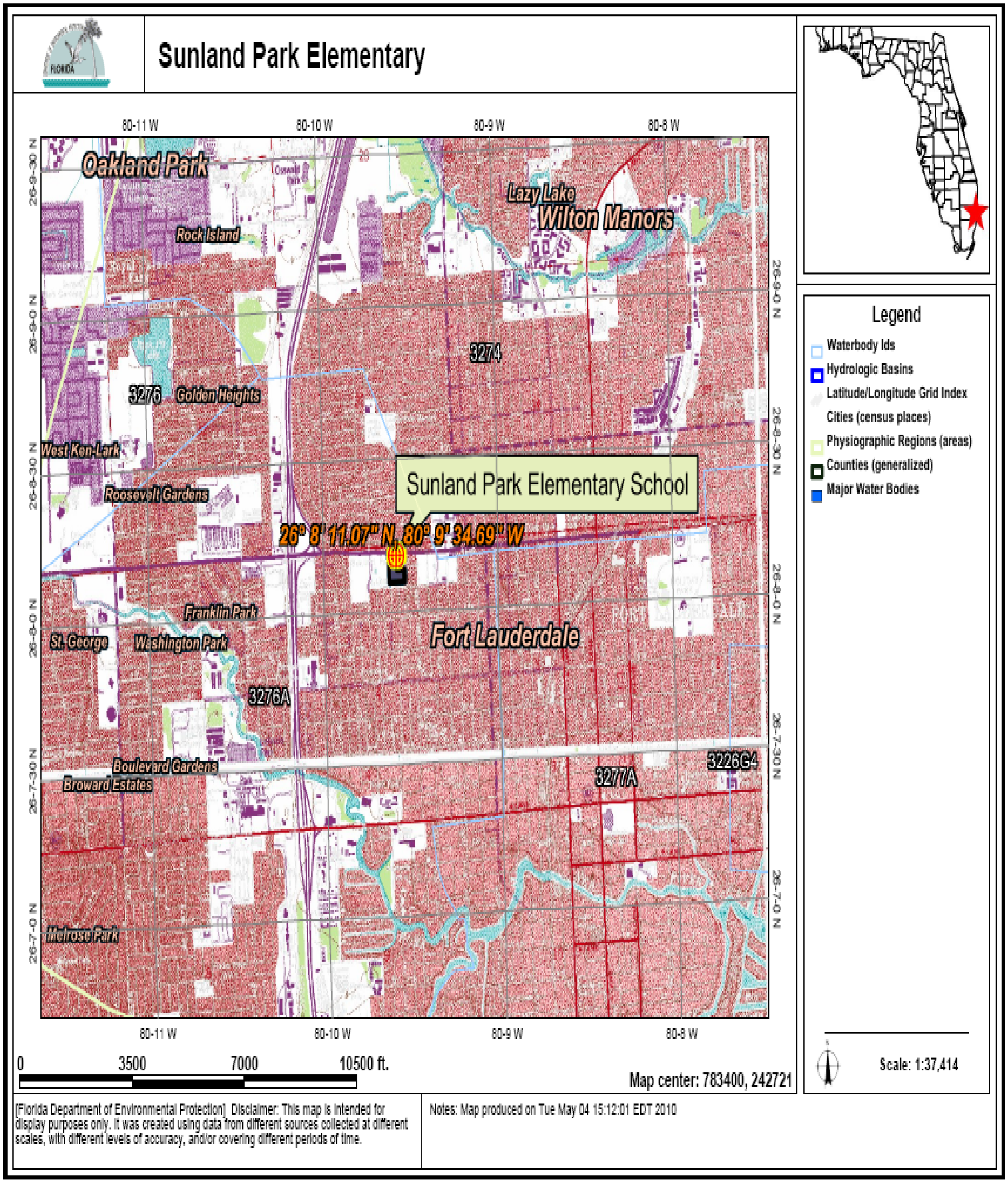

Figure 2. Sunland Park Elementary Site Features

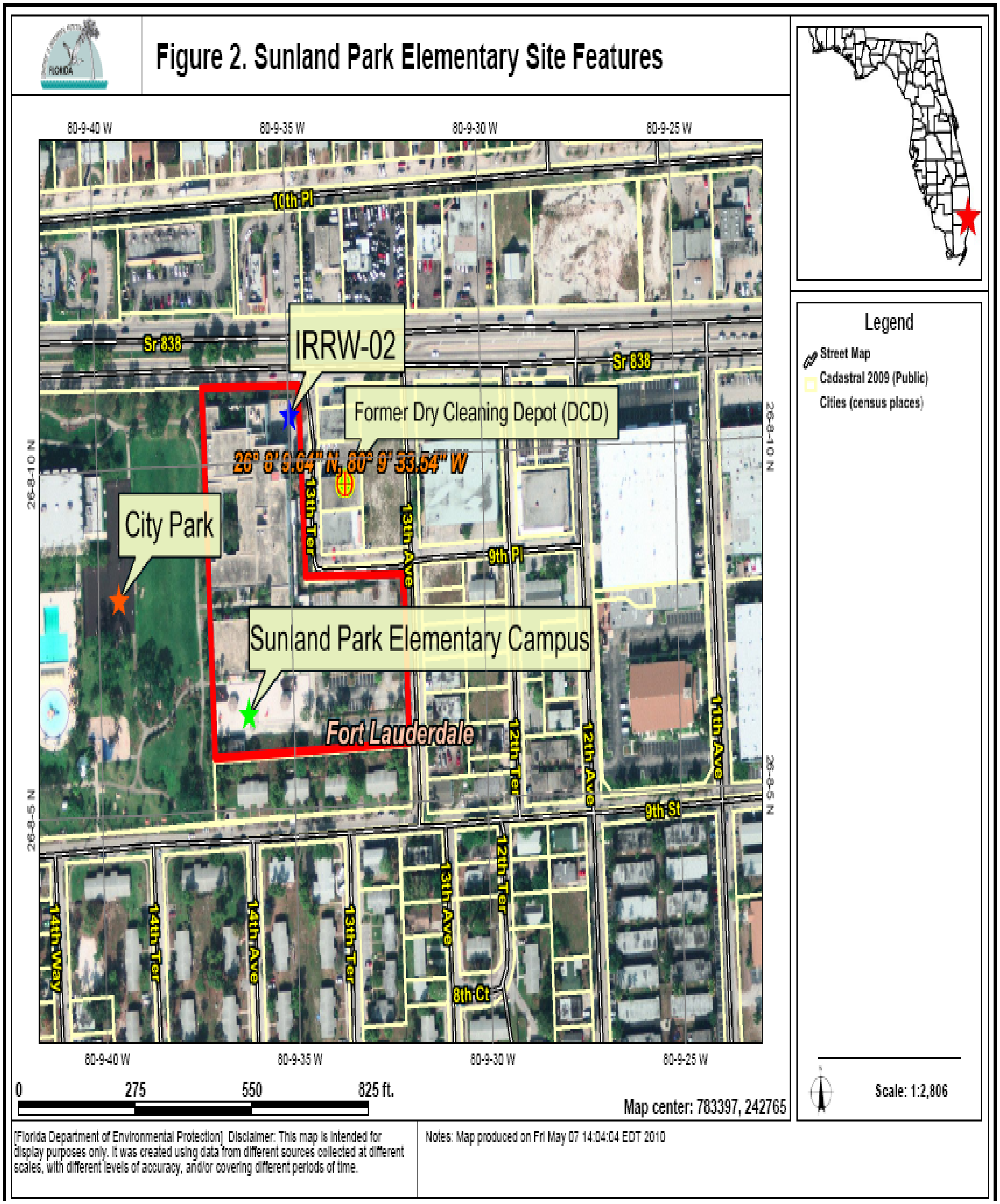

Table 1. Chemicals Detected in Sunland Park Elementary Irrigation Well (May 2007)

Contaminants	Number of Samples	Highest Measured Concentration (ppb)	Comparison Value (ppb)	Source of Comparison Value	Number of Detections Greater Than Comparison Value
Vinyl Chloride	1	15.4	2	EPA MCL	1
cis-1,2-DCE	1	11.7	70	EPA MCL	None

Source of data: [2]

***cis*-1,2-DCE**: *cis*-1,2-dichloroethene

EPA: Environmental Protection Agency

MCL: maximum contaminant level

ppb: parts per billion

Table 2. Sunland Park Elementary Irrigation Well Dose Estimates

Chemical	CAS #	Groundwater Concentration	Irrigation Well Water Dose			
			Dose from Ingestion (mg/kg-d)	**Dose from Inhalation (mg/kg-d)**	**Dose from Dermal (mg/kg-d)**	**Total Dose (mg/kg-d)**
Vinyl Chloride	75014	15.4 ppb	0.00000018	0.00000029	0.00000007	0.00000054

ppb = parts per billion
mg/kg-d = milligrams per kilogram per day

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January 14, 2009

Ligia Mora-Applegate
Bureau of Waste Cleanup
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Methodology for the development of irrigation water risk-based criteria

Dear Ms. Mora-Applegate:

At your request we have developed a methodology for the derivation of groundwater cleanup target levels for organic chemicals that are protective of human health under an irrigation scenario (IGCTLs). In the irrigation scenario, receptors are exposed to contaminated groundwater outdoors while irrigating lawns, ornamental beds, and vegetable crops. From this scenario, separate criteria were developed based upon: 1) exposure for residents using contaminated water for lawn and ornamental bed irrigation, including exposure from recreational use of the lawn sprinklers by children; 2) exposure for landscape maintenance workers using contaminated water for the irrigation of lawns and ornamental beds at commercial facilities; and 3) exposure for residents who use contaminated water to grow fruit and vegetables for personal consumption.

Irrigation of lawns and ornamental beds

The exposure models used to derive groundwater cleanup target levels for the irrigation (IGCTLs) of lawns and ornamental beds are shown in Figure 1. These models consider potential intake of contaminants in groundwater through inhalation, dermal contact, and incidental ingestion. Conservative exposure assumptions were taken from standard sources (e.g., U.S. EPA guidance) or selected based on professional judgment.

Air concentrations resulting from irrigation of lawns and ornamental beds were estimated using a simple box model and were dependent upon water usage rate, water-to-air stripping efficiency, and the volume of the box. There are several non-technical publications aimed at informing residents on the proper watering of Florida lawns. According to the University of Florida Institute of Food and Agricultural Sciences (IFAS), lawns in Florida need to be watered on the average 2 d/wk during spring, 1 d/wk during summer, and every two weeks during fall and winter. These seasonal watering rates correspond to an annual average of 1 d/wk or 52 d/yr. IFAS recommends irrigating at a rate of 1-2" per watering event. A value of 2" per watering event was selected so as not to underestimate the watering rate. The recommended irrigation rate is a total water rate and was meant to include rainfall events. Average yearly rainfall for central and south

Florida taken over the last 25 years average 1" of rainfall per week (Ali et al., 2000). Therefore, total irrigation is estimated at 1" per week of contaminated groundwater and 1" per week of rainfall for a total of 2" of water per watering event. For a sprinkler covering a radius of 10 ft., this irrigation rate requires a total of approximately 1450 L water per event, which corresponds to a water flow rate of 50 L/min for 29 min. For the box model, the dimensions of the box were determined by the width of the sprinkler area (20 ft., or 6 m) times the breathing height of the adult receptor (1.5 m), the assumed wind speed (2 m/sec), and the duration of the watering event (29 min), which corresponds to 31,320 m^3.

The proportion of a contaminant volatilizing into the air depends on many factors specific for the contaminant in question and factors related to the physical characteristics of the water-air interface through which the chemical moves. The chemical concentration in air was estimated using data from empirical studies relating the decrease in the water concentration that occurs by the stripping effect caused by the passage of contaminated water through a shower system. It is assumed that stripping of contaminants passing through a sprinkler head is similar to that occurring in a shower. The relationship between the dimensionless Henry's law constant (H) of a chemical and the stripping efficiency (SE) of a typical shower has been found to be adequately predicted by the equation (Moya et al., 1999):

$$SE = [7.95*\ln(H)]+68.17$$

This stripping efficiency was multiplied times the total volume of water used per event (1450 L, see above) to derive the amount of chemical released to air. This amount was assumed to be distributed equally in the volume of air specified by the box model (31,320 m^3) to obtain the breathing zone air concentration.

Inhalation rates for children and adults (as appropriate for the scenario examined) were combined with exposure frequency, exposure duration, and air concentration values to estimate inhalation exposure. Dermal exposure for a child playing in the sprinkler was estimated based on the dermal permeability coefficient for each chemical and the skin surface area assumed to be in contact with water. A small volume of water was assumed to be ingested incidentally for both children and adults each time there was contact with irrigation water. The exposure frequency and duration of contact were assumed to equal the frequency and duration of irrigation events.

Homegrown fruit and vegetable consumption

Several models are available for estimating the concentration of chemicals in fruit and vegetables cultivated on contaminated soil or using contaminated water (Briggs et al., 1982, 1983; McKone, 1994; Ryan et al., 1988; Trapp and Pussemier, 1991). Based upon our evaluation of these models, we consider the Briggs model to have the greatest utility in estimating uptake of a contaminant into produce from known concentrations in irrigation water. Equations for the Briggs model are presented in Figure 2 and inputs are listed in Table 1. The Briggs model develops criteria based on contaminant concentrations in soil solution. It is assumed that the concentration of contaminant in soil solution equals the concentration in irrigation water minus the loss from volatilization to air during the irrigation process. The relationships between soil solution concentration and concentration in plant tissues are calculated based on the K_{ow} for the chemical using the expressions shown in Figure 2.

Calculation of a contaminant intake rate from homegrown produce requires assumptions regarding consumption rate. Values for root and shoot fruit and vegetable consumption were obtained from the U.S. EPA's Exposure Factors Handbook (1997). The Exposure Factors Handbook recommends using a daily average adult root consumption rate of 0.0418 kg (or about 1.5 oz) per day and a shoot ingestion rate of 0.3132 kg (or about 11 oz) per day. The recommended child root consumption rate is 0.0099 kg (or about 0.5 oz) per day and the shoot consumption rate is 0.0604 kg (or about 2 oz) per day.

The calculations from the Briggs model are conservative in that they do not include estimates of contaminant loss from the plant due to transpiration or metabolism. Additionally, the model does not estimate loss of the contaminant from preparation techniques such as washing, peeling, or cooking. The amount of contaminant lost from these practices varies depending upon the vegetable and the habits of the consumer. The worst-case scenario assumes that washing, peeling, and cooking do not occur.

Please let us know if you have any questions regarding this methodology.

Sincerely,

Stephen M. Roberts, Ph.D.   Leah D. Stuchal, Ph.D.

References:

Ali, A., Abtew, W., Van Horn, S., and Khanal, N. Temporal and spatial characterization of rainfall over central and south Florida. *Journal of the American Water Resources Association* **36**(4): 833-848, 2000.

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Trapp, S. and Pussemier, L. Model calculations and measurements of uptake and translocation of carbamates by bean plants. *Chemosphere* **22** (3-4): 327-339, 1991.

US EPA. Exposure Factors Handbook. National Center for Environmental Assessment. Office of Research and Development. 1997.

Figure 1 – IGCTLs for irrigation of lawns and ornamental beds

Residential scenario, carcinogens:

$$IGCTL = \frac{TR \times AT_c}{\left[\left(\frac{EF_i \times CSF_o \times IR_o \times ED_{ag}}{BW_{ag}}\right) + \left(\frac{EF_i \times CSF_d \times SA \times T_t \times K_p \times \left(1 - \frac{SE}{100}\right) \times 10^{-3} L/cm^3 \times ED_c}{BWc}\right) + \left(\frac{EF_i \times CSF_i \times IR_{iag} \times T_t \times V_w \times \frac{SE}{100} \times ED_{ag}}{BW_{ag} \times V_a}\right)\right]}$$

Residential scenario, non-carcinogens:

$$IGCTL = \frac{THI \times AT_{nc}}{\left[\left(\frac{EF_i \times IR_o \times ED_c}{RfD_o \times BW_c}\right) + \left(\frac{EF_i \times SA \times T_t \times K_p \times \left(1 - \frac{SE}{100}\right) \times 10^{-3} L/cm^3 \times ED_c}{RfD_d \times BW_c}\right) + \left(\frac{EF_i \times IR_{ic} \times T_t \times V_w \times \frac{SE}{100} \times ED_c}{RfD_i \times BW_c \times V_a}\right)\right]}$$

For this scenario, residential exposure is based on the “aggregate resident”, which is an individual that lives at the residence as a child, adolescent, and young adult. Exposure to contaminants by inhalation and incidental ingestion is assumed to occur throughout this period. However, dermal exposure (from playing in the sprinklers) occurs only as a child.

Landscape maintenance worker scenario, carcinogens:

$$IGCTL = \frac{TR \times AT_c}{\left[\left(\frac{EF_i \times CSF_o \times IR_o \times ED_w}{BW_w}\right) + \left(\frac{EF_i \times CSF_i \times IR_w \times T_t \times V_w \times \frac{SE}{100} \times ED_w}{BW_w \times V_a}\right)\right]}$$

Landscape maintenance worker scenario, non-carcinogens:

$$IGCTL = \frac{THI \times AT_{nc}}{\left[\left(\frac{EF_i \times IR_o \times ED_w}{RfD_o \times BW_w}\right) + \left(\frac{EF_i \times IR_w \times T_t \times V_w \times \frac{SE}{100} \times ED_w}{RfD_i \times BW_w \times V_a}\right)\right]}$$

This scenario corresponds to a landscape worker at a commercial facility. The worker is assumed to be an adult exposed through inhalation and incidental ingestion

Figure 2 – IGCTLs for homegrown produce; Briggs model

Carcinogens:

$$\mathrm{IGCTL} = \frac{\mathrm{TR} \times \mathrm{AT_c}}{\left(\dfrac{\mathrm{EF_v} \times \mathrm{CSF_o} \times \left[\left(\mathrm{RCF} \times \mathrm{Ir_r}\right) + \left(\mathrm{SCF} \times \mathrm{Ir_s}\right)\right] \times \left(1 - \dfrac{\mathrm{SE}}{100}\right) \times \mathrm{RD} \times \mathrm{ED_{ag}}}{\mathrm{BW_{ag}}}\right)}$$

Non-carcinogens:

$$\mathrm{IGCTL} = \frac{\mathrm{THI} \times \mathrm{AT_{nc}}}{\left(\dfrac{\mathrm{EF_v} \times \mathrm{ED_c} \times \left[\left(\mathrm{RCF} \times \mathrm{Ir_r}\right) + \left(\mathrm{SCF} \times \mathrm{Ir_s}\right)\right] \times \left(1 - \dfrac{\mathrm{SE}}{100}\right) \times \mathrm{RD}}{\mathrm{RfD_o} \times \mathrm{BW_c}}\right)}$$

Supporting Equations:

$$\mathrm{SE} = \left[7.95 \times \ln(\mathrm{H})\right] + 68.17$$

$$\mathrm{RCF} = 10^{0.77 \log \mathrm{K_{ow}} - 1.52} + 0.82$$

$$\mathrm{SCF} = \left(10^{0.95 \log \mathrm{K_{ow}} - 2.05} + 0.82\right)\left(0.784 \times 10^{-0.434\left(\log K_{ow} - 1.78\right)^2 / 2.44}\right)$$

Table 1 – Values used in the derivation of irrigation GCTLs

Abbreviation	Definition	Value
AT_c	Carcinogenic Averaging Time	25550 d
AT_{nc}	Non-carcinogenic Averaging Time	(365 x ED) d
BW_a	Adult Body Weight	70.0 kg
BW_{ag}	Aggregate Resident Body Weight	51.9 kg
BW_c	Child Body Weight	15.0 kg
CSF_d	Dermal Cancer Slope Factor	chemical-specific $(mg/kg\text{-}d)^{-1}$
CSF_i	Inhalation Cancer Slope Factor	chemical-specific $(mg/kg\text{-}d)^{-1}$
CSF_o	Oral Cancer Slope Factor	chemical-specific $(mg/kg\text{-}d)^{-1}$
ED_a	Adult Exposure duration	24 y
ED_{ag}	Aggregate Resident Exposure Duration	30 y
ED_c	Child Exposure Duration	6 y
EF_i	Irrigation Exposure Frequency	52 d/y
EF_v	Vegetable Exposure Frequency	350 d/y
H	Dimensionless Henry's Law Constant	chemical-specific
IGCTL	Irrigation GCTL	(mg/L)
IR_{iag}	Aggregate Resident Inhalation Rate	1.04 m^3/h
IR_{ic}	Child Inhalation Rate	1.2 m^3/h
IR_o	Water Incidental Ingestion Rate	0.01 L/d
Ir_f	Aggregate Ingestion of Root Vegetables	0.0354 kg/d
Ir_{rc}	Child Ingestion of Root Vegetables	0.0099 kg/d
Ir_s	Aggregate Ingestion of Shoot Vegetables	0.2626 kg/d
Ir_{sc}	Child Ingestion of Shoot Vegetables	0.0604 kg/d
K_{oc}	Octanol-Carbon Partition coefficient	chemical specific (L/kg)
K_{ow}	Octanol-Water Partition Coefficient	chemical-specific
K_p	Permeability Coefficient	chemical-specific (cm/h)
RCF	Root Concentration Factor	chemical-specific (L/kg)
RD	Rainfall Dilution	0.5
RfD_d	Dermal Reference Dose	chemical-specific (mg/kg-d)
RfD_i	Inhalation Reference Dose	chemical-specific (mg/kg-d)
RfD_o	Oral Reference Dose	chemical-specific (mg/kg-d)
SA	Child Surface Area	7023 cm^2
SCF	Shoot Concentration Factor	chemical-specific (L/kg)
SE	Water-to-air Chemical Stripping Efficiency	chemical-specific
THI	Target Hazard Index	1
TR	Target Cancer Risk	1.00E-06
T_t	Irrigation Time	0.483 h/d
V_a	Volume of Air for Volatilization	31320 m^3
V_w	Volume of Water Used	1450 L

CERTIFICATION

The Florida Department of Health, Division of Environmental Health prepared this Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It followed approved methodology and procedures existing at the time it began and completed editorial review.

Jennifer a Freed

Jennifer Freed
Technical Project Officer,
CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.

Alan W. Yarbrough

Alan Yarbrough
Team Lead
CAT, CAPEB, DHAC, ATSDR