EA Engineering, Science, and Technology

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1 May 2000

Mr. Mark Lewis
Connecticut Department of Environmental Protection
Water Management Bureau
Permitting, Enforcement, and Remediation Division
79 Elm Street
Hartford, Connecticut 06106-5127

RE: Technical Rationale for Calculation of Alternative Pollutant Mobility Criteria for
Naval Submarine Base, Lower Subase, New London, Connecticut
EA Project No. 29600.90

Dear Mr. Lewis:

EA Engineering, Science, and Technology is submitting this document to describe our proposed approach for estimation of dilution factors for calculation of Alternative Pollutant Mobility Criteria (APMC) for determination of soil remediation requirements for protection of ground water at Lower Subase, Naval Submarine Base, New London, Connecticut. The methodology described is consistent with the Regulations of Connecticut State Agencies, Section 22a-133k-2(c)(2)(E), Site-Specific Dilution in a GB Area. We are providing this information for your review and comment. If Connecticut Department of Environmental Protection (CTDEP) and U.S. Environmental Protection Agency Region I concur with the approach presented, we will submit a formal application to the Commissioner for approval of the proposed APMC. These APMC will then be used to identify constituents of concern for soil remediation in the Final Feasibility Study for Lower Subase.

SITE-SPECIFIC DILUTION FACTORS

Sections 2a-133k-2(c)(2)(D) and (E) provide methods for development of remediation standards for pollutant mobility to ground water in a GB area, based on site-specific dilution factors. Soils may be remediated to a level at which the results of Toxicity Characteristic Leaching Procedure/ Synthetic Precipitation Leaching Procedure analysis do not exceed the ground-water protection criterion for a substance multiplied by a site-specific dilution factor; or to a level at which results of mass analysis do not exceed the Pollutant Mobility Criteria (PMC) for a GA area multiplied by a site-specific dilution factor.

An equation for calculation of the dilution factor is provided in Section 22a-133k-2(c)(2)(E)(ii). This equation uses the hydraulic gradient and conductivity (Brown & Root 1997[1]), an infiltration

1. Brown & Root Environmental. 1997. Phase II Remedial Investigation Report for Naval Submarine Base, New London, Groton, Connecticut. Wayne, Pennsylvania. March.

rate based on type of geologic material, a cross-sectional dimension of the site (Table 1), and a constituent-specific ground-water background adjustment (Table 2):

$$DF = (1 + (K \times i \times d/I \times L))(1 - F_{adj})$$

DF = Site-specific dilution factor
K = Hydraulic conductivity (ft/year)
i = Horizontal hydraulic gradient (ft/ft)
d = 15 ft
I = Infiltration rate (ft/year)
L = Length (ft) of the release area parallel to the direction of ground-water flow
F_{adj} = Background concentration for ground water divided by the ground-water protection criterion.

The hydraulic conductivity ranged from 1.7 to 576 ft/day among the seven zones. The hydraulic conductivity for Zone 3 (1.7 ft/day) results in an unrealistically low estimate of ground-water flow and dilution considering the similar subsurface characteristics of the Lower Subase. Consequently, the next lowest calculated infiltration dilution factor (from adjacent Zone 2) was substituted for Zone 3 in the calculation of APMC.

The adjustment for constituent-specific background concentrations in ground water was made consistent with Section 22a-133k-2(c)(2)(E)(ii). Because site-specific data for background concentrations of inorganic constituents are not available at Lower Subase, "...½ the minimum detection limit for the subject substance divided by the ground-water protection criterion" was used to represent background. For volatile and semivolatile organic substances, pesticides, and polychlorinated biphenyls which do not occur naturally, background was assumed to be zero; thus, the background adjustment ($1-F_{adj}$) for these constituents becomes 1 in the dilution factor equation. The calculated zone- and constituent-specific dilution factors are shown in Table 3.

ALTERNATIVE POLLUTANT MOBILITY CRITERIA—SELECTION OF CONSTITUENTS OF CONCERN

When the standard Connecticut PMC for a GB area are applied, lead, total petroleum hydrocarbons, and up to 10 semivolatile constituents are identified as constituents of concern for each zone (Table 4). The zone-specific APMC for these semivolatiles and lead are provided in Table 5. APMC are not applicable to total petroleum hydrocarbons which will, therefore, remain a constituent of concern in Zones 1, 4, and 6.

Section 22a-133k-2(e)(2) establishes the procedure for determination of compliance with PMC. For a representative sampling program of not less than 20 samples, no single sample result may exceed two times the applicable PMC; for sampling programs with less than 20 samples, no single sample may exceed the applicable PMC.

Based on the proposed site-specific dilution factors and the associated APMC, lead (in Zones 1 through 4) and total petroleum hydrocarbons (in Zones 1, 4, and 6) are selected as constituents of concern. None of the polycyclic aromatic hydrocarbons compounds identified using standard PMC were retained using the APMC. The number of sampling locations for each constituent of concern in each zone that exceeds the APMC is shown in Table 6.

If you have any questions, please do not hesitate to contact me.

Sincerely yours,

Charles E. McLeod, Jr., P.E.
Project Manager

CEM/caw

cc: M. Evans (Northern Division)
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TABLE 1 SUMMARY OF PARAMETERS USED TO CALCULATE SITE-SPECIFIC DILUTION FACTORS FOR DETERMINATION OF ALTERNATIVE POLLUTANT MOBILITY CRITERIA

Zone	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (ft/day)	Depth (ft)	Infiltration Rate (ft/yr)	Length (ft)	Unadjusted Dilution Rate
1	0.00476	158	15	0.5	175	48.06
2	0.00318	74	15	0.5	175	15.72
3	0.00792	1.7	15	0.5	175	1.84
4	0.0039	576	15	0.5	175	141.56
5	0.0092	74	15	0.5	175	43.60
6	0.0092	74	15	0.5	175	43.60
7	0.00527	74	15	0.5	175	25.40

NOTE: Pollutant Mobility Criteria site-specific dilution factor, DF = (1 + (Kid/IL)) × (background adjustment) l = half the width (approximately 350 ft) of Lower Subase perpendicular to the Thames River.
Unadjusted dilution rate = 1+ (Kid/IL) × (background adjustment).

DF = Dilution factor.
i = Hydraulic gradient.
K = Hydraulic conductivity.
d = Depth.
I = Infiltration rate.
L = Length.

TABLE 2 SUMMARY OF DATA USED TO ESTIMATE BACKGROUND ADJUSTMENT FOR CALCULATION OF SITE-SPECIFIC DILUTION FACTORS FOR ALTERNATIVE POLLUTANT MOBILITY CRITERIA

Parameter	Minimum Detection Limit (μg/L)	Detection Limit (μg/L)	Ground-Water Protection Criteria (μg/L)	Background Adjust
Antimony	2.5	1.25	6	0.792
Arsenic	1	0.5	50	0.990
Barium	1.4	0.7	1000	0.999
Beryllium	0.11	0.055	4	0.986
Cadmium	0.22	0.11	5	0.978
Chromium	0.68	0.34	50	0.993
Copper	0.74	0.37	1300	1.000
Cyanide	5	2.5	200	0.988
Lead	1	0.5	15	0.967
Mercury	0.01	0.005	2	0.998
Nickel	0.75	0.375	100	0.996
Selenium	1	0.5	50	0.990
Silver	1	0.5	36	0.986
Thallium	1	0.5	5	0.900
Vanadium	0.55	0.275	50	0.995
Zinc	2	1	5000	1.000
VOC, SVOC		0	1	1.000

NOTE: One-half minimum detection limit used as surrogate for background ground-water concentration.
Background adjustment = 1-([detection limit]/Ground-Water Protection Criteria).
VOC = Volatile organic compounds.
SVOC = Semivolatile organic compounds.

TABLE 4 SOIL CONSTITUENTS OF CONCERN BASED ON CONNECTICUT POLLUTANT MOBILITY CRITERIA

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
Lead (2) Benz(a)anthracene (2) Benzo(a)pyrene (2) Benzo(b)fluoranthene (2) Benzo(k)fluoranthene (2) Carbazole (1) Chrysene (2) Dibenz(a,h)anthracene (1) Indeno(1,2,3-cd)pyrene (2) Phenanthrene (1) Pyrene (1) Total petroleum hydrocarbons (1)	Lead (2)	Lead (4) Benz(a)anthracene (1) Benzo(b)fluoran (1) Chrysene (1)	Lead (4) Benz(a)anthracene (1) Benzo(a)pyrene (1) Benzo(b)fluoranthene (1) Benzo(k)fluoranthene (1) Chrysene (1) Carbazole (1) Dibenz(a,h)anthracene (1) Indeno(1,2,3-cd)pyrene (1) Total petroleum hydrocarbons (1)		Total petroleum hydrocarbons (1)	Benz(a)anthracene (3) Benzo(a)pyrene (2) Benz(b)fluoranthene (3) Benzo(k)fluoranthene (1) Chrysene (3) Dibenz(a,h)anthracene (1) Indeno(1,2,3-cd)pyrene (2)
NOTE: Number in parenthesis following constituent of concern indicates number of locations in the zone exceeding criterion. Includes only soil samples collected above the water table. Samples from multiple depths or dates at a specific location were counted as one location.						

TABLE 5 SUMMARY OF CONSTITUENTS- AND ZONE –SPECIFIC ALTERNATIVE POLLUTANT MOBILITY CRITERIA CALCULATED FOR LOWER SUBASE, NAVAL SUBMARINE BASE, NEW LONDON

Parameter	Zone							Units
	1	2	3	4	5	6	7	
Benz(a)anthracene	47,794	NA	15,638	140,782	NA	NA	25,262	µg/kg
Benzo(a)pyrene	47,794	NA	NA	140,782	NA	NA	25,262	µg/kg
Benzo(b)fluoranthene	47,794	NA	15,638	140,782	NA	NA	25,262	µg/kg
Benzo(k)fluoranthene	47,794	NA	NA	140,782	NA	NA	25,262	µg/kg
Carbazole	47,794	NA	NA	140,782	NA	NA	NA	µg/kg
Chrysene	47,794	NA	15,638	140,782	NA	NA	25,262	µg/kg
Dibenz(a,h)anthracene	47,794	NA	NA	140,782	NA	NA	25,262	µg/kg
Indeno(1,2,3-cd)pyrene	47,794	NA	NA	140,782	NA	NA	25,262	µg/kg
Phenanthrene	267,649	NA	NA	NA	NA	NA	NA	µg/kg
Pyrene	191,178	NA	NA	NA	NA	NA	NA	µg/kg
Total petroleum hydrocarbons	2,500	NA	NA	2,500	NA	2,500	NA	mg/kg
Lead	697	228	228	2,053	NA	NA	NA	µg/L

NOTE: Total petroleum hydrocarbon reflects standard Connecticut Pollutant Mobility Criteria.
NA = Alternate Pollutant Mobility Criteria not applicable.

TABLE 6 SOIL CONSTITUENTS OF CONCERN BASED ON CONNECTICUT ALTERNATIVE POLLUTANT MOBILITY CRITERIA

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
Lead (1) Total petroleum hydrocarbons (1)	Lead (2)	Lead (4)	Lead (3) Total petroleum hydrocarbons (1)		Total petroleum hydrocarbons (1)	
NOTE: Number in parenthesis following constituent of concern indicates number of locations in the zone exceeding criterion. Includes only soil samples collected above the water table. Samples from multiple depths or dates at a specific location were counted as one location. Total petroleum hydrocarbon exceedances under all scenarios are based on a comparison to established Connecticut Pollutant Mobility Criteria for GB areas.						