TECHNICAL MEMORANDUM

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ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Sunny Becker and Hun Seak Park, Washington State Department of Ecology

FROM: Chip Halbert and Martin Powers, Landau Associates

DATE: October 31, 2005

RE: **VAPOR ASSESSMENT**
HARBOR SQUARE COMPLEX
EDMONDS, WASHINGTON

INTRODUCTION

The Harbor Square complex is located near the southwestern corner of the intersection of West Dayton Street and State Route 104 in Edmonds, Washington (Figure 1). Included within the Harbor Square complex are the 180 and 190 West Dayton Street buildings (Figure 2). Residual petroleum contamination was observed along the perimeter of two excavation areas during the remedial action activities conducted at the site between August 2004 and February 2005. Specifically, residual contamination was observed adjacent to Building 1 (190 West Dayton Street) and Building 4 (180 West Dayton Street).

The results of an initial vapor intrusion assessment were submitted to the Washington State Department of Ecology (Ecology) in a technical memorandum dated June 27, 2005 (Landau Associates 2005a). The initial vapor intrusion assessment used the Ecology-recommended four-phase partitioning model to predict the potential risk created by the residual contaminant concentration remaining in soil near Buildings 1 and 4. In response to comments provided by Ecology, Landau Associates then proposed, and Ecology approved, a revised vapor intrusion assessment plan based on the U.S. Environmental Protection Agency (EPA)-recommended Johnson-Ettinger model. The vapor assessment work plan (Landau Associates 2005b) was prepared following a series of communications between Landau Associates and Ecology. This technical memorandum summarizes the result of that vapor assessment.

SOIL VAPOR SAMPLING

A soil vapor sample and field duplicate sample were collected from the headspace of recovery well RW-1 on October 11, 2005, in accordance with the methodology described in the vapor assessment work plan. The samples were analyzed for vapor phase petroleum hydrocarbons by the ENSR International analytical laboratory using Massachusetts Method MA APH. The laboratory report is included in Attachment 1, and analytical results are summarized in Table 1.

VAPOR INTRUSION MODELING

Appendix B of the vapor assessment work plan described the relationship between soil vapor concentrations (C_{source}) and indoor air concentrations ($C_{building}$) as presented in the Johnson-Ettinger model documented in the *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (Environmental Quality Management 2004). As noted in the introduction of the work plan, Ecology recommended either of two acceptable approaches for estimating the vapor attenuation coefficient (VAC, where the VAC is the inverse of the steady-state attenuation coefficient, α, identified in the Johnson-Ettinger model) at the site – developing a site-specific VAC, or using a conservative default estimate of 1,000.

For the purposes of conducting a conservative and expedient evaluation, it was determined that the approach would be based on the more conservative default assumption of a VAC value of 1,000 for all constituents at the site. If the results of the conservative vapor assessment yielded risk estimates near the threshold risk level for individual constituents (i.e., excess cancer risk of 1×10^{-6} and hazard quotient of 1) or multiple constituents (i.e., excess cancer risk of 1×10^{-5} and hazard index of 1), then additional site-specific soil characterization could have later refined the assessment. As shown below, the risk estimates were significantly less than threshold levels, so collection of additional data to develop a site-specific VAC is not recommended.

Indoor air concentrations were estimated based on the Johnson-Ettinger model relationship presented in Appendix B of the work plan; these indoor air concentrations are presented in Table 1. Although only four of the 13 constituents (or petroleum carbon ranges) analyzed in the vapor samples were actually detected, all of the nondetected constituents were conservatively assumed to be present at the reporting limit (the concentration at which the laboratory certifies the constituent is *not* present, if it is present at all) to provide a conservative overestimate of potential risk associated with indoor air impacts. Standard practice for handling nondetect data is to assume that nondetected constituents are present at a concentration of one-half of the reporting limit, based on the simplifying assumption that the constituent may be present following a normal distribution between zero and the laboratory reporting limit. The conservative overestimation of nondetect data by evaluation at the reporting limit represents a factor of safety for nondetect data that is twice as high as standard practice.

The carcinogenic and noncarcinogenic risk estimates shown for individual constituents in Table 1 are all at least five times less than the threshold levels of 1×10^{-6} excess cancer risk and a hazard quotient of 1, respectively. The carcinogenic and noncarcinogenic risk estimates for all constituents combined, inclusive of the nine non-detected constituents, are one to two orders of magnitude less than the threshold levels of 1×10^{-5} excess cancer risk and a hazard index of 1, respectively.

CONCLUSION

The default VAC (1,000) recommended by Ecology was used in conjunction with conservative exposure factors and conservative assumptions about the presence of constituents not detected in the samples. The result of this vapor assessment is a determination that the corresponding potential human health risk associated with indoor air impacted by residual subsurface petroleum contamination is significantly less than levels determined to be acceptable by Ecology. Therefore, we conclude that the concentrations of residual petroleum contamination are fully protective of indoor air quality.

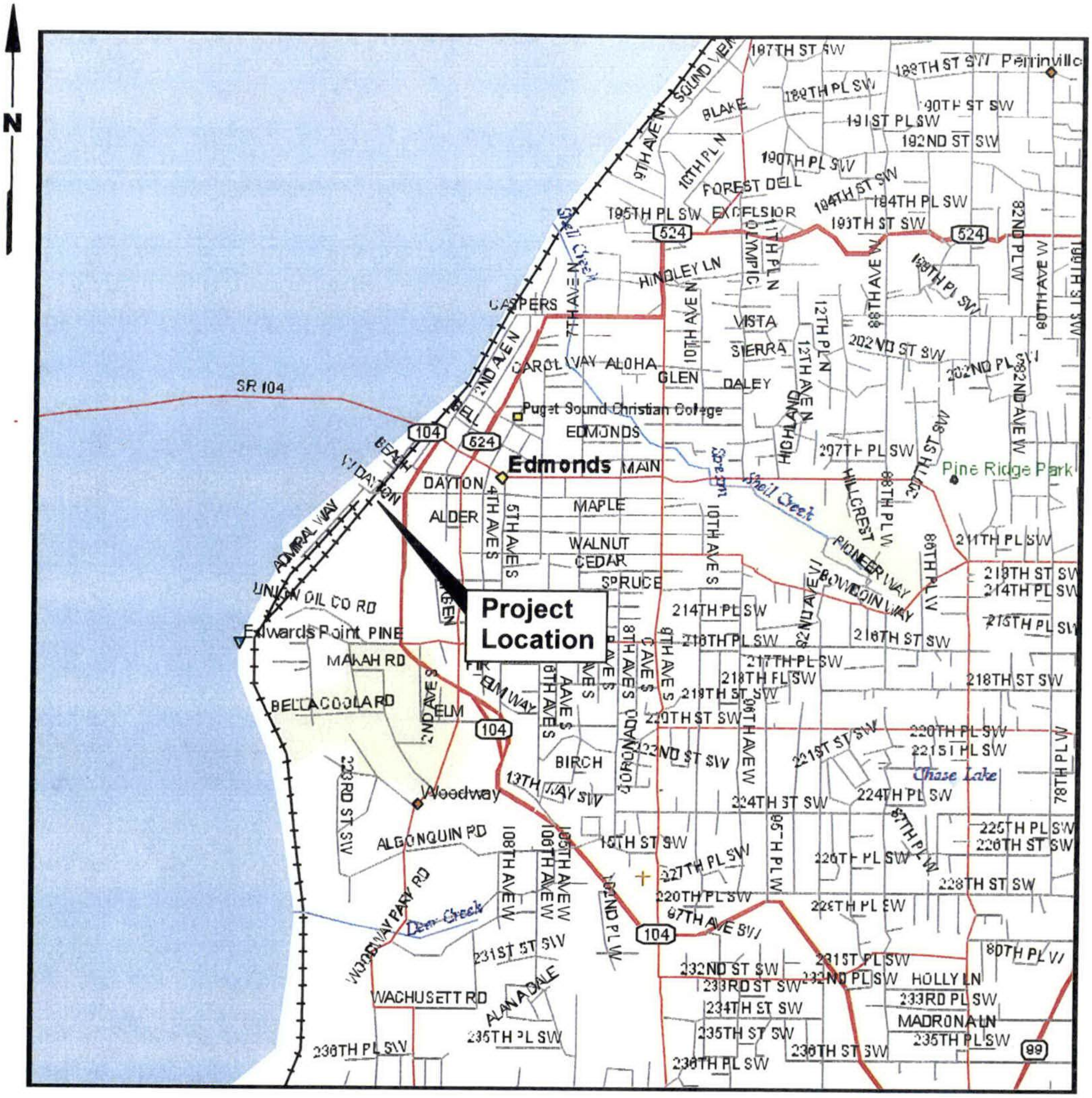
REFERENCES

Ecology. 2005. Online version of the *Cleanup Levels and Risk Calculations* database, accessed October 25. URL: https://fortress.wa.gov/ecy/clarc/Reporting/CLARCReporting.aspx. Washington State Department of Ecology.

Environmental Quality Management, Inc. 2004. *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings*. Prepared for U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. Washington, D.C. February 22.

Landau Associates. 2005a. Technical Memorandum: *Vapor Intrusion Assessment, Harbor Square Complex, Edmonds, Washington.* From David Nelson and Martin Powers to Christopher W. Keuss, CMM, Executive Director, Port of Edmonds. June 27.

Landau Associates. 2005b. *Vapor Assessment Work Plan, Harbor Square Complex, Edmonds, Washington.* Prepared for Port of Edmonds. October 10.



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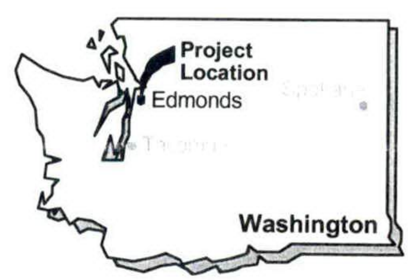

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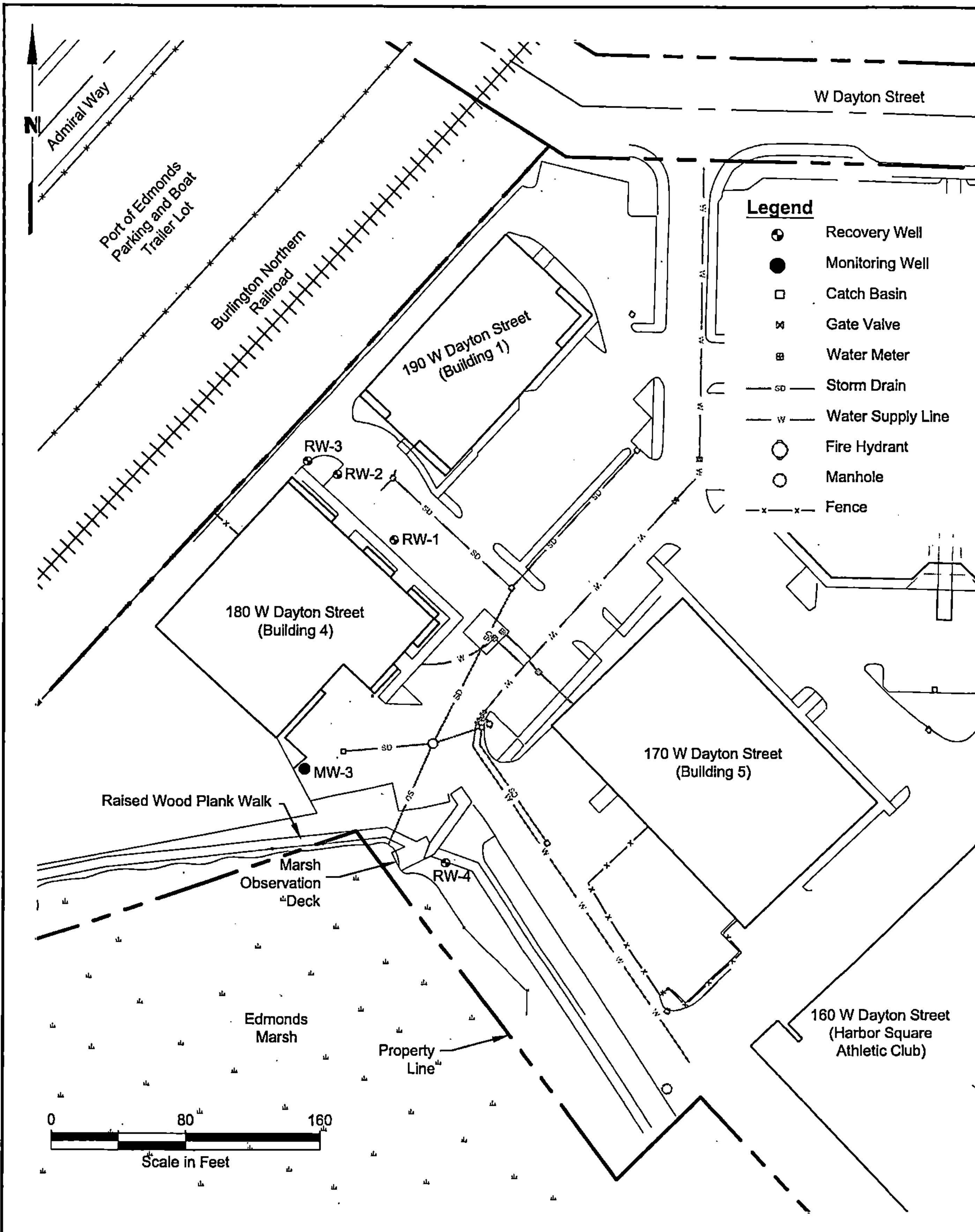
HarborSquare Edmonds,Washington	**Vicinity Map**	Figure 1



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Harbor Square
Edmonds, Washington

Additional Vapor Intrusion Assessment

Figure 2

TABLE 1
VAPOR ASSESSMENT
HARBOR SQUARE COMPLEX

Constituent (a)	Soil Vapor Concentration (C_{source}, µg/m^3) SV-RW-1A (b)	SV-RW-1B (b)	Vapor Attenuation Factor (c) (α, unitless)	Indoor Air Concentration (d) ($C_{building}$, µg/m^3)	Inhalation Cancer Potency Factor (e) (CPF_i, kg-d/mg)	Inhalation Reference Dose (f) (RfD_i, mg/kg-d)	Excess Cancer Risk (g) (Risk, unitless)	Hazard Quotient (h) (HQ, unitless)
1,3-Butadiene	2	2	1E-03	2.0E-03	0.98	--	1.6E-07	--
Methyl tert-butyl ether	2	2	1E-03	2.0E-03	--	0.86	--	4.7E-07
Benzene	2	2	1E-03	2.0E-03	0.027	0.0085	4.3E-09	4.7E-05
Toluene	12	11	1E-03	1.2E-02	--	0.11	--	2.2E-05
Ethylbenzene	2	2	1E-03	2.0E-03	--	0.29	--	1.4E-06
m&p-Xylenes	15	15	1E-03	1.5E-02	--	0.029	--	1.0E-04
o-Xylene	5.6	5.5	1E-03	5.6E-03	--	0.029	--	3.9E-05
Naphthalene (i)	4	4	1E-03	4.0E-03	--	0.00086	--	9.3E-04
2-Methylnaphthalene (i)	10	10	1E-03	1.0E-02	--	0.00086	--	2.3E-03
1-Methylnaphthalene (i)	20	20	1E-03	2.0E-02	--	0.00086	--	4.7E-03
C5-C8 Aliphatics	40	40	1E-03	4.0E-02	--	1.7	--	4.7E-06
C9-C12 Aliphatics	1100	1200	1E-03	1.2E+00	--	0.085	--	2.8E-03
C9-C10 Aromatics	40	40	1E-03	4.0E-02	--	0.11	--	7.3E-05

Default Exposure Parameters for Carcinogens (j)		Default Exposure Parameters for Noncarcinogens (j)	
Air breathing rate, BR (m^3/d):	20	Air breathing rate, BR (m^3/d):	20
Inhalation absorption fraction, ABS (unitless):	1.0	Inhalation absorption fraction, ABS (unitless):	1.0
Average body weight, ABW (kg):	70	Average body weight, ABW (kg):	70
Exposure duration, ED (yrs):	30	Exposure duration, ED (yrs):	6
Exposure frequency, EF (unitless):	0.7	Exposure frequency, EF (unitless):	0.7
Averaging time, AT (yrs):	75	Averaging time, AT (yrs):	6
Unit conversion factor, UCF (µg/mg):	1E+03	Unit conversion factor, UCF (µg/mg):	1E+03

Notes:

a. Constituents shown in red were not detected; risk was conservatively overestimated at the reporting limit, as noted in the text of this technical memorandum. Black and white reproduction of this color table may lead to misinterpretation of data presented.

b. Soil vapor sample SV-RW-1B is a field duplicate of sample SV-RW-1A. For evaluation purposes, the maximum detected value for each compound was used to estimate impacts to indoor air.

c. Vapor attenuation factor of $1x10^{-3}$ assumed based on discussions with Ecology.

d. The indoor air concentration is calculated based on the relationship between soil vapor concentration and indoor air concentration ($C_{building} = \alpha C_{source}$), as described in Appendix B of the *Vapor Assessment Work Plan, Harbor Square Complex, Edmonds, Washington* (Landau Associates 2005b).

e. Inhalation cancer potency factors obtained from online CLARC database search system (https://fortress.wa.gov/ecy/clarc/Reporting/CLARCReporting.aspx, 2005)

f. Inhalation reference doses obtained from online CLARC database search system (https://fortress.wa.gov/ecy/clarc/Reporting/CLARCReporting.aspx), accessed October 25, 2005, and associated documentation regarding reference doses for petroleum mixtures.

g. Excess cancer risk calculated using equation 750-2 from MTCA (Chapter 173-340-750 WAC).

h. Hazard quotient calculated using equation 750-1 from MTCA (Chapter 173-340-750 WAC).

i. Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene are included in the assessment of the C9-C10 aromatic range.

j. Exposure parameters for carcinogens and noncarcinogens were obtained from MTCA [Chapter 173-340-750(3)(b) WAC], except that average body weight and breathing rate for noncarcinogens were adjusted to reflect the values for an adult rather than a child, and the exposure frequency for an occupational setting was adjusted to 0.7 (250 d/yr versus 365 d/yr).