Table 1

Water Supply Wells Within a 1-Mile Radius
BSB Property, Kent, Washington

Well Number on Map	Listed Owner	Year Installed	Reported Location T	Reported Location R	Reported Location S	Drilled Depth	Open Interval	Use	In DOH Databases	Notes
Wells that likely no longer exist										
1	Liesinger	1914	23	5	31N	220	NA	D, Irr?	Yes	Flowed at 25 gpm
2	Liesinger	1916	22	5	6D	196	NA	D, Irr?	Yes	Flowed at 15 gpm
3	Liesinger	1921	22	4	1A	260	255 - 260	S, Irr	No	Flowed at 55 gpm
4	Wilson	1955	22	5	6N	212	202	D, Irr?	Yes	Flowed, yielded 1730 gpm, may be well referenced in a 1986 abandonment log
5	Komoto	1956	22	4	12H	321	313 - 321	D, Irr?	Yes	Flowed at 75 gpm
6	Brewer	NA	22	5	6M	300	NA	D	Yes	Well not found in field search
7	Bridges	NA	22	5	6E	200	NA	D	Yes	Well not found in field search
8	Carrll	NA	23	5	31M	60	NA	D	Yes	
9	Dickison	NA	23	5	31M	385	NA	D	Yes	
10	Hickson	NA	23	5	31M	116	NA	D	Yes	
11	Ikuta	NA	23	4	36R	370	NA	D	Yes	
12	Nash	NA	22	5	7E	92	NA	D	Yes	
13	Nowotny	NA	22	5	6N	210	NA	D	Yes	
14	Tanaka	NA	22	4	12D	20	NA	D	Yes	
15	Wilson	NA	22	5	6N	155	NA	D	Yes	
Wells that are likely to exist or are known to exist										
16	Krohn	1980	22	5	6B	49	49	D	Yes	Yields 20 gpm; reported address = 9235 South 192nd Street
17	City of Kent	1982	22	5	7F	367	336 - 367	M	Yes	Located SE of 212th and Hwy 167, flows at 450 gpm, "Well #1"; unused per DOH
18	City of Kent	1983	22	5	6P	395	184 - 221	M	Yes	S 208th Street well, flows at 450 gpm; public supply per DOH
19	City of Kent	1983	22	5	7F	463	331 - 356	M	Yes	Located at 212th and Hwy 167, flows at 550 gpm, "Well #2"; public supply per DOH
20	Koopmans	1984	22	5	7C	55	50 - 55	D	No	Yields 16 gpm
21	City of Kent	1998	22	4	1P	100	85 - 95	T	No	Located at 72nd Ave S next to fire station, not currently in use
22	City of Kent	2001	22	5	7F	522	290 - 480	M	Yes	Located at SE corner of 212th and Hwy 167, flows > 200 gpm, "Well #3"
23	Jolly	NA	22	5	6K	NA	NA	D, S	Yes	Reported address = 9455 South 202nd Street
24	K-T Supply	NA	22	5	6G	NA	NA	NA	Yes	Reported address = 19903 92nd Avenue South
25	Sloan	NA	22	5	6K	NA	NA	D	Yes	Reported address = 9206 South 200th Street
26	Anderson	NA	22	5	6K	100	NA	D	Yes	
27	Bunkowski	NA	22	5	6Q	90	NA	D	Yes	
28	Canyon Home	NA	22	5	6G	200	NA	D	Yes	

Table 1

Water Supply Wells Within a 1-Mile Radius
BSB Property, Kent, Washington

Well Number on Map	Listed Owner	Year Installed	Reported Location T	R	S	Drilled Depth	Open Interval	Use	In DOH Databases	Notes
29	DeWitt	NA	22	5	6K	161	NA	D	Yes	
30	Engle	NA	22	5	6P	150	NA	D	Yes	
31	McComb	NA	22	5	6Q	45	NA	Irr	Yes	
32	Minshall	NA	22	5	6L	178	NA	D	Yes	
33	Upper	NA	22	5	6C	30	NA	D	Yes	
34	Wagner Jacob	NA	22	5	6L	196	NA	D	Yes	
35	Warehime	NA	22	5	6P	132	NA	D	Yes	
36	Wieser	NA	22	4	1H	209	NA	Ind	Yes	Conflicting information in DOH database; well existence and/or location questionable

Notes:
1. Well locations shown on Figure 4.
2. Well logs provided in Appendix A.
3. Location abbreviations: T = township (north), R = range (east), S = section and subsection identifier.
4. Information about wells 1 through 5 and 16 through 22 from the Washington State Department of Ecology's well log database.
5. Information about wells 6 through 15 and 23 through 36 from the Washington State Department of Health's (DOH's) databases.
6. Drilled depths and open interval depths in feet below grade.
7. NA = not available.
8. Well uses: D = domestic supply, M = municipal supply, Irr = irrigation supply, S = stock watering, Ind = industrial supply, T = test well

Table 2

Parcel G and South 200th Street Well Completion Data
BSB Property, Kent, Washington

Well	Date Installed	Northing	Easting	Monitoring Point Elevation	Surface Casing Rim Elevation	Well Type	Monument	Log	Boring Depth	Screen Depth	Filter Pack Depth	Seal Depth
Shallow Aquifer Zone Monitoring Wells												
Ls	07/15/87	157,158.27	1,294,518.78	24.02	25.18	2" SS, 0.010"-slot size	Above	C	18	5 - 15	4 - 19	0 - 4
HY-1s	06/25/82	157,370.32	1,294,202.23	24.19	24.33	2" PVC	Above	B	20.5	14 - 19	10 - 20.5*	0 - 10
HYCP-2	12/03/84	157,370.41	1,294,617.54	20.47	21.57	2" Sch 80 PVC, 0.010" slots	Above	B	28	8 - 28	6 - 28	0 - 6
HYCP-3s	12/04/84	157,190.45	1,294,417.09	24.03	24.47	2" Sch 80 PVC, 0.010" slots	Above	C	13	8 - 13	7 - 13	0 - 7
HYCP-4	12/03/84	157,188.39	1,294,297.21	23.90	24.36	2" Sch 80 PVC, 0.010" slots	Flush	B	33	11 - 33	7 - 33	0 - 7
HYCP-5	03/15/89	157,331.49	1,294,674.50	22.31	23.01	2" SS, 0.010"-slot size	Above	B	31.5	10 - 30	7 - 31.5	0 - 7
HYCP-6	03/14/89	157,247.92	1,294,672.18	23.52	23.69	2" SS, 0.010"-slot size	Above	B	31.5	10 - 30	7 - 31.5	0 - 7
HYO-2	11/29/84	157,368.19	1,294,678.22	20.27	20.62	2" Sch 80 PVC, 0.010" slots	Flush	C	18.5	8.5 - 18.5	7 - 18.5	0 - 7
Intermediate Aquifer Zone Monitoring Wells												
HY-1i	12/13/85	157,364.56	1,294,202.34	24.89	25.15	2" Sch 80 PVC, 0.010" slots	Above	C	80	30 - 40	28 - 42	0 - 28, 42 - 52^
HYCP-1i	12/03/04	157,367.28	1,294,673.31	21.33	21.35	2" Sch 80 PVC, 0.010" slots	Above	C	73	16 - 36	14 - 45	0 - 14
HYCP-3i	12/01/84	157,190.43	1,294,408.33	23.45	24.25	2" Sch 80 PVC, 0.010" slots	Above	C	33	22 - 32	20 - 33	0 - 20
Deep Aquifer Zone Monitoring Wells and Piezometers												
I	07/13/87	157,361.79	1,294,379.27	24.14	24.36	2" Sch 80 PVC, 0.010" slot size	Above	B	86	74 - 84	66 - 84	0 - 66
Ld	07/15/87	157,154.91	1,294,506.20	24.19	24.45	2" SS, 0.010"-slot size	Above	B	82.5	69 - 79	67 - 82.5	0 - 67
HY-1d	12/18/85	157,352.31	1,294,202.00	25.60	21.35	2" Sch 80 PVC, 0.010" slot size	Above	C	96	84 - 94	81 - 96	0 - 81
HYCP-1d	12/03/84	157,367.28	1,294,673.31	21.27	21.35	2" Sch 80 PVC, 0.010" slot size	Above	C	73	53 - 73	14 - 45, 47 - 49.5, 52 - 73	0 - 14, 45 - 47, 49.5 - 52
HYO-1	11/29/84	157,366.84	1,294,678.28	21.13	21.20	3" Sch 80 PVC, 0.020" slot size	Above	B	84.5	53.5 - 83.5	15 - 84.5*	0 - 15
Extraction Wells												
HYR-1	03/28/89	157,345.31	1,294,623.18	18.69	20.89	6" SS, 0.010" slot size	Above	B	35	10 - 30	8 - 35	0 - 8
HYR-2	02/27/90	157,355.66	1,294,386.77	19.49	22.74	6" SS, 0.010/0.015" slot sizes&	Flush	B	35	9 - 29	7 - 35	0 - 7
Abandoned Monitoring Wells and Piezometers												
HTP-1	01/24/81	–	–	–	–	2" stainless steel well point	Above	B	10.5	7 - 10.5	None	0 - 6
HTP-2	01/24/81	–	–	–	–	2" stainless steel well point	Above	B	10.5	7 - 10.5	None	0 - 6
HTP-3	01/24/81	–	–	–	–	2" stainless steel well point	Above	B	10.5	7 - 10.5	None	0 - 6
HTP-4	01/24/81	–	–	–	–	2" stainless steel well point	Above	B	10.5	7 - 10.5	None	0 - 6
HTP-5	01/24/81	–	–	–	–	2" stainless steel well point	Above	B	10.5	7 - 10.5	None	0 - 6
HTP-6	01/24/81	–	–	–	–	2" stainless steel well point	Above	B	10.5	7 - 10.5	None	0 - 6
HYCP-1s	11/29/84	–	–	–	–	2" PVC, 0.010" slots	Flush	C	13	8 - 13	6 - 13	0 - 6

Table 2

Parcel G and South 200th Street Well Completion Data
BSB Property, Kent, Washington

Well	Date Installed	Northing	Easting	Monitoring Point Elevation	Surface Casing Rim Elevation	Well Type	Monument	Log	Boring Depth	Screen Depth	Filter Pack Depth	Seal Depth
HYCP-3d	12/01/84	–	–	–	–	2" Sch 80 PVC, 0.010" slot size	Above	C	79	59 - 79	56 - 79	33 - 56
HYO-3	11/30/84	–	–	–	–	3" Sch 80 PVC, 0.020" slot size	Above	B	91	47 - 77	35 - 78	0 - 35, 78 - 91
HYO-4	11/30/84	–	–	–	–	2" PVC, 0.010" slots	Flush	C	18	8 - 18	7 - 18	0 - 7

Notes: Northing/Easting in feet relative to the WA State Plane System North Zone (NAD 83).
Monitoring point (top of well casing) in feet relative to the National Geodetic Vertical Datum (NGVD 29).
All depths shown in feet below ground surface.
SS = stainless steel. Above = above-grade completion. Below = below grade completion.
B = boring log with well completion shown. C = well completion figure.
* = lower portion of filter pack includes native material. ^ = boring wall caved in 52 - 80 feet bgs.
& = 0.010" slot size, 8.85 - 18.85'; 0.015" slot size, 18.85 - 28.85'.

HYCP-1i and HYCP-1d completed in the same borehole.
HTP piezometers (completions approximate) abandoned during 1987 and 1988 closure activities.
HYCP-1s and HYO-4 abandoned sometime after June 1988.
HYO-3 abandoned sometime after January 1986 due to grout intrusion into the filter pack.

Table 3

Off-Site Well Completion Data
BSB Property, Kent, Washington

Well	Date Installed	Well Type	Monument	Log	Boring Depth	Screen Depth	Filter Pack Depth	Seal Depth	Comments
Shallow Aquifer Zone Monitoring Wells and Piezometers									
Bs	06/19/87	2" SS, 0.010" slot size	Above	C	17	4 - 14	3 - 17	0 - 3	
Cs	06/11/87	2" SS, 0.010" slot size	Above	C	17	4 - 14	3 - 17	0 - 3	
Gs	07/09/87	2" SS, 0.010" slot size	Above	C	17.5	5.5 - 15.5	3.5 - 15.5	0 - 3.5	
Hs	07/06/87	2" SS, 0.010" slot size	Flush	C	18	5 - 15	3 - 18	0 - 3	
Ks	07/29/87	2" SS, 0.010" slot size	Flush	C	19	5 - 15	4 - 18	0 - 4	
HY-2	06/25/82	2" PVC	Above	B	20	9 - 14	5 - 20	0 - 5	Heave from 14 to 20 feet
HY-3	06/25/82	2" PVC	Above	B	20	10 - 15	5 - 20	0 - 5	Heave from 13 to 20 feet
HY-4	06/25/82	2" PVC	Above	B	20	9.5 - 14.5	5 - 20	0 - 5	Heave from 15 to 20 feet
HY-5	10/05/83	2" PVC	Flush	B	23.5	13.5 - 23.5	12.5 - 23.5	0 - 12.5	Formation sand used as filter pack
HY-6	10/05/83	2" PVC	Flush	B	26	16 - 26	10 - 26	0 - 10	Formation sand and silt used as filter pack
HY-7s	10/06/83	2" PVC	Flush	B	30.5	12.5 - 22.5	11.5 - 30.5	0 - 11.5	Formation sand used as filter pack
HY-7ss	12/30/85	2" SS, 0.010" slot size	Flush	C	25	12.5 - 22.5	11.5 - 25	0 - 11.5	Completion from 1/7/86 well completion sketch
HY-9	09/05/84	2" PVC	Flush	B	25.5	12 - 22	8 - 25.5	0 - 8	Heave from 20 to 25.5 feet
HY-11s	12/20/85	2" PVC, 0.010" slots	Flush	C	18	8 - 18	6 - 18	0 - 6	Completion from 1/7/86 well completion sketch
HY-12s	07/11/03	2" Sch 40 PVC, 0.010" slots	Flush	B	30	20 - 30	17 - 30	0 - 17	
HY-13s	07/11/03	2" Sch 40 PVC, 0.010" slots	Flush	B	30	20 - 30	17 - 30	0 - 17	
HYHT-1[^]	Sep-84	2" stainless steel well point	Above	NA	15	13 - 15	None	NA	
HYHT-4[^]	Dec-85	2" stainless steel well point	Above	C	15	13 - 15	None	NA	
Intermediate Aquifer Zone Monitoring Wells and Piezometers									
D	07/01/87	2" Sch 80 PVC, 0.010" slots	Flush	B	100	43 - 53	40 - 57.5	0 - 40, 57.5 - 76	
Gi	07/09/87	2" SS, 0.010" slot size	Above	C	41	28 - 38	25 - 41	0 - 25	
Hi	07/06/87	2" SS, 0.010" slot size	Flush	C	40	28 - 38	25 - 40	0 - 25	
Ki	07/29/87	2" SS, 0.010" slot size	Flush	C	39	23 - 33	22 - 38	0 - 22	
HY-7i	12/30/85	2" Sch 80 PVC, 0.010" slot size	Flush	C	50.5	40.5 - 50.5	35 - 50.5*	0 - 35	Completion from 1/7/86 well completion sketch
HY-8i	01/26/84	2" Sch 80 PVC	Flush	B	78.5	35 - 45	32 - 47	0 - 32, 47 - 49	Completed in same boring as HY-8d
HY-11i	12/20/85	2" Sch 80 PVC, 0.010" slot size	Flush	C	38	26 - 36	24 - 38	0 - 24	Completion from 1/7/86 well completion sketch
Deep Aquifer Zone Monitoring Wells and Piezometers									
A	07/23/87	2" Sch 80 PVC, 0.010" slot size	Flush	B	60	45 - 55	43 - 55	0 - 43	
Bd	06/19/87	2" SS, 0.010" slot size	Above	B	65	47 - 57	45 - 59	0 - 45	
Cd	06/11/87	2" SS, 0.010" slot size	Above	B	71	57 - 67	55 - 71	0 - 55	
E	07/17/87	2" Sch 80 PVC, 0.010" slot size	Flush	B	81	68 - 78	65 - 81	0 - 65	
F	06/16/87	2" Sch 80 PVC, 0.010" slot size	Above	B	96	80 - 90	77 - 96	0 - 77	

Table 3

Off-Site Well Completion Data
BSB Property, Kent, Washington

Well	Date Installed	Well Type	Monument	Log	Boring Depth	Screen Depth	Filter Pack Depth	Seal Depth	Comments
Gd	07/09/87	2" SS, 0.010" slot size	Above	B	73.5	56 - 66	53 - 70	0 - 53	
Hd	07/06/87	2" SS, 0.010" slot size	Flush	B	71	57 - 67	53 - 71	0 - 53	
J	07/23/87	2" Sch 80 PVC, 0.010" slot size	Above	B	100	89 - 99	66 - 100	0 - 66	
Kd	07/29/87	2" SS, 0.010" slot size	Flush	B	81	65 - 75	59 - 78	0 - 59	
HY-7d	12/24/85	2" Sch 80 PVC, 0.010" slot size	Flush	C	81	69 - 79	66 - 81	0 - 66	Completion from 1/7/86 well completion sketch
HY-8d	01/26/84	4" Sch 40 PVC	Flush	B	78.5	50 - 60	49 - 65	47 - 49, 65 - 78.5	Completed in same boring as HY-8i
HY-11d	12/20/85	2" Sch 80 PVC, 0.010" slot size	Flush	C	94.5	82 - 92	80 - 94.5	0 - 80	Completion from 1/7/86 well completion sketch
Recovery Wells									
CG-1	04/19/89	6" SS, 0.015" slot size	Above	B	36	15 - 30	12 - 30	0 - 12, 30 - 36	
CG-2	04/19/89	6" SS, 0.010" and 0.015" slot size	Above	B	36	15 - 30	12 - 30	0 - 12, 30 - 36	
CG-3	04/18/89	6" SS, 0.010" and 0.020" slot size	Above	B	36	15 - 30	12 - 30	0 - 12, 30 - 36	
CG-4	04/13/89	6" SS, 0.010" and 0.020" slot size	Above	B	36	15 - 30	12 - 30	0 - 12, 30 - 36	
Observation Wells									
OW-2A	03/20/89	2" Sch 40 PVC, 0.010" slot size	Above	B	31.5	10 - 30	7 - 31.5	0 - 7	
OW-2B	03/20/89	2" Sch 40 PVC, 0.010" slot size	Flush	B	31.5	10 - 30	7 - 31.5	0 - 7	
OW-2C	03/21/89	2" Sch 40 PVC, 0.010" slot size	Above	B	31.5	10 - 30	5 - 31.5	0 - 5	
OW-3	03/17/89	2" Sch 40 PVC, 0.010" slot size	Above	B	31.5	10 - 30	7 - 31.5	0 - 7	
OW-4	03/16/89	2" Sch 40 PVC, 0.010" slot size	Above	B	31.5	10 - 30	7 - 31.5	0 - 7	
Abandoned Monitoring Wells and Piezometers									
HY-10	09/06/84	2" PVC	Flush	B	25.5	14 - 24	10 - 25.5	0 - 10	Well destroyed during sidewalk construction in 5/00
HYHT-2^	Sep-84	2" stainless steel well point	Above	NA	15	13 - 15	None	NA	Piezometer abandoned sometime after December 1987
HYHT-3^	Sep-84	2" stainless steel well point	Above	NA	15	13 - 15	None	NA	Piezometer abandoned sometime after December 1987
HYHT-5^	Dec-85	2" stainless steel well point	Above	C	15	13 - 15	None	NA	Piezometer abandoned sometime after December 1987

Note: All depths shown in feet below ground surface.
SS = stainless steel.
Above = above-grade completion.
Below = below grade completion.
B = boring log with well completion shown.
C = well completion figure.
# = boring wall caved in 52 - 80 feet bgs.
* = native material in lower portion of filter pack.
TOC elev = top of casing elevation in feet above mean sea level.
NA = not available.
^ = incomplete completion logs available; information estimated based on other groundwater leve monitoring completions installed in the mid-1980's.

Table 4

Summary of Soil Physical Properties
BSB Property, Kent, Washington

Location	Sample Depth (ft)	Layer Sampled	Unified Soil Classification	Percent Sand	Percent Silt	Vertical Hydraulic Conductivity (cm/sec)	Moisture Content (%)	Bulk Density (pcf)	Dry Density (pcf)
Direct-Push Borings									
GP-1	16	B	ML	36.4	63.6	–	40	–	–
GP-1	38	C	ML	8.9	91.1	–	39	–	–
GP-2	16	B	ML	12.4	87.6	–	44	–	–
GP-2	38	B	SM	63.0	37.0	–	35	–	–
GP-2	40	C	SM	62.3	37.7	–	37	–	–
GP-3	20	B	ML	49.4	50.6	–	60	–	–
GP-3	44	D	SM	58.4	41.4	–	31	–	–
GP-4	18	B	ML	19.6	80.4	–	44	–	–
GP-5	16	B	SM	86.3	13.7	–	35	–	–
GP-5	20	B	ML	4.0	96.0	–	51	–	–
GP-5b	31	C	ML	–	–	2.6E-07	43	–	77.3
GP-6	26	B	SP	95.2	4.8	–	23	–	–
GP-7b	18	B	ML	–	–	6.9E-07	45	–	75.0
GP-7b	41	C	ML	–	–	2.1E-07	38	–	80.5
GP-8	30	B	SP	95.7	4.3	–	29	–	–
GP-9	36	C	ML	33.3	66.7	–	37	–	–
GP-9	38	D	SM	56.9	43.1	–	34	–	–
GP-10	17	B	SM	–	–	3.5E-06	44	–	73.6
GP-11	44	C	ML	22.0	78.0	–	48	–	–
GP-11	46	C	SM	68.0	32.0	–	28	–	–
GP-12	40	C	ML	14.2	85.8	–	34	–	–
GP-13	17	B	ML	29.6	70.4	–	48	–	–
GP-14	17	B	ML	41.4	58.6	–	48	–	–
SP-3	39	C	ML	–	–	1.6E-07	42	123.1	86.6
SP-4	42	C	CL	–	–	1.3E-07	47	109.7	74.9
SP-21	39	C	CL	–	–	1.3E-07	41	111.6	79.4
SP-35	34	C	CL	–	–	2.3E-07	45	104.6	72.4
Piezometers									
I	40 - 41	C	ML	28.5	71.5	–	–	–	–
L	29.5 - 31	B	SM	77.0	23.0	–	–	–	–
L	49 - 51	D	SP	89.2	10.8	–	–	–	–
Monitoring Wells									
HYCP-6	5	A	ML	25.7	74.3	–	–	–	–
HYCP-6	10	B	SM	83.1	16.2	–	–	–	–
HYCP-6	15	B	ML	2.3	97.7	–	–	–	–
HYCP-6	20	B	ML	20.1	77.3	–	–	–	–
HYCP-6	25	B	ML	1.5	88.5	–	–	–	–

Notes:
1. Depths in feet below ground surface.
2. NP = non plastic.
3. pcf = pounds per cubic foot.
4. The HYCP-6 sample at 25 feet also contained 10 percent clay.

Table 5

Parcel G Layer C Elevations and Thicknesses
BSB Property, Kent, Washington

Well or Boring	Northing	Easting	Ground Surface Elevation (ft)	Depth to Top of Layer C (ft)	Top of Layer C Elevation (ft)	Layer C Thickness (ft)	Plotted Layer C Thickness (ft)
GP-1	157,359.0	1,294,502.0	20.50	38.0	-17.5	> 6.0	>6.0
GP-2	157,343.0	1,294,670.0	20.60	40.0	-19.4	1.5	1.5
GP-3	157,357.0	1,294,573.0	20.50	38.0	-17.5	2.0	2.0
GP-4	157,228.0	1,294,670.0	21.70	30.0	-8.3	> 6.0	>6.0
GP-5	157,181.4	1,294,597.7	22.00	30.5	-8.5	> 5.5	>5.5
GP-6	157,360.0	1,294,401.0	22.70	38.5	-15.8	> 5.5	>5.5
GP-7	157,361.0	1,294,302.0	22.70	39.8	-17.1	> 6.3	>6.3
GP-8	157,352.0	1,294,540.0	20.50	38.0	-17.5	1.5	1.5
GP-9	157,294.0	1,294,670.0	21.20	30.0	-8.8	6.0	6.0
GP-10	157,356.0	1,294,646.0	20.60	40.0	-19.4	3.5	3.5
GP-11	157,361.0	1,294,452.0	22.50	39.5	-17.0	8.3	8.3
GP-12	157,360.0	1,294,354.0	22.70	39.1	-16.4	> 8.9	>8.9
GP-13	157,324.0	1,294,588.0	20.90	42.0	-21.1	2.0	2.0
GP-14	157,207.4	1,294,633.7	21.70	28.9	-7.2	> 6.1	>6.1
GP-15	157,269.4	1,294,553.7	21.20	42.0	-20.8	4.0	4.0
SP-1	157,297.6	1,294,329.5	23.24	40.0	-16.8	> 3.0	>3.0
SP-2	157,293.4	1,294,430.5	22.72	40.5	-17.8	> 0.5	>0.5
SP-3	157,299.8	1,294,533.6	20.88	37.5	-16.6	> 3.5	>0.5
SP-4	157,246.0	1,294,378.7	23.13	40.7	-17.6	3.8	3.8
SP-5	157,239.8	1,294,470.0	22.77	41.3	-18.5	> 1.5	>1.5
SP-6	157,211.4	1,294,588.7	21.71	35.0	-13.3	> 3.0	>3.0
SP-7	157,197.5	1,294,328.3	23.69	43.0	-19.3	> 2.0	>2.0
SP-8	157,195.0	1,294,378.5	23.33	43.5	-20.2	4.5	4.5
SP-9	157,198.8	1,294,427.4	23.09	27.2	-4.1	> 10.8	>10.8
SP-10	157,197.0	1,294,531.5	21.69	32.5	-10.8	> 3.5	>3.5
SP-11	157,145.2	1,294,380.5	24.75	34.5	-9.8	> 0.5	>0.5
SP-12	157,141.4	1,294,480.1	24.00	32.0	-8.0	> 9.0	>9.0
SP-13	157,135.5	1,294,578.2	24.89	32.2	-7.3	> 1.8	>1.8
SP-14	157,305.7	1,294,633.0	21.22	38.0	-16.8	> 1.0	>1.0
SP-15	157,301.3	1,294,238.8	23.61	39.0	-15.4	> 2.0	>2.0
SP-16	157,323.7	1,294,293.5	23.09	40.5	-17.4	> 2.5	>2.5
SP-17	157,249.9	1,294,223.4	23.93	39.8	-15.9	> 1.2	>1.2
SP-18	157,177.7	1,294,259.7	24.39	43.0	-18.6	> 1.0	>1.0
SP-19	157,160.9	1,294,306.3	24.54	32.7	-8.2	2.8	2.8
SP-20	157,145.9	1,294,360.9	24.75	33.0	-8.3	> 1.0	> 1.0
SP-21	157,117.8	1,294,215.7	25.64	32.0	-6.4	> 10.0	>10.0
SP-22	157,118.6	1,294,405.5	25.20	33.9	-8.7	> 0.1	>0.1
SP-23	157,116.6	1,294,454.7	24.65	32.5	-7.9	> 2.5	>2.5
SP-24	157,114.4	1,294,503.0	24.41	32.0	-7.6	> 4.0	>4.0
SP-25	157,110.6	1,294,566.5	25.11	40.0	-14.9	0.8	0.8
SP-26	157,047.2	1,294,583.8	26.36	44.0	-17.6	1.7	1.7
SP-27	156,976.4	1,294,210.5	27.16	41.0	-13.8	> 3.0	>3.0
SP-28	156,968.2	1,294,371.7	27.02	36.0	-9.0	> 3.0	>3.0
SP-29	156,969.1	1,294,579.2	27.03	34.9	-7.9	> 6.1	>6.1
SP-30	157,122.3	1,294,369.0	25.14	33.5	-8.4	> 1.5	>1.5
SP-31	157,233.0	1,294,435.8	22.84	40.2	-17.4	> 3.8	>3.8
SP-32	157,193.7	1,294,472.6	23.04	29.0	-6.0	> 3.0	>3.0

Table 5

Parcel G Layer C Elevations and Thicknesses
BSB Property, Kent, Washington

Well or Boring	Northing	Easting	Ground Surface Elevation (ft)	Depth to Top of Layer C (ft)	Top of Layer C Elevation (ft)	Layer C Thickness (ft)	Plotted Layer C Thickness (ft)
SP-33	157,247.7	1,294,588.2	21.63	29.0	-7.4	> 7.0	>7.0
SP-34	157,249.4	1,294,537.7	21.32	39.0	-17.7	> 3.0	>3.0
SP-35	157,143.9	1,294,429.8	24.22	33.0	-8.8	> 4.0	>4.0
SP-36	157,279.1	1,294,471.6	22.68	39.8	-17.1	2.4	2.4
SP-37	157,168.6	1,294,409.6	23.65	32.0	-8.4	> 3.0	>3.0
SP-38	157,078.4	1,294,471.5	24.97	32.9	-7.9	> 4.1	>4.1
HYCP-3d	157,190.4	1,294,408.3	23.45	33.0	-9.5	> 6.5	>6.5
I	157,361.8	1,294,379.3	24.14	40.0	-15.9	7.0	7
Ld	157,154.9	1,294,506.2	24.20	33.0	-8.8	15.0	15
HY-1d	157,352.3	1,294,202.0	25.60	40.7	-15.1	> 5.8	>5.8
HYCP-1d	157,367.3	1,294,673.3	Layer C not identified; only sampled at 5-ft intervals				–
HYR-1	157,345.31	1,294,623.18	Layer C not identified; well not deep enough				–
HYR-2	157,355.66	1,294,386.77	Layer C not identified; well not deep enough				–
					Arithmetic Mean:	3.9	
					Geometric Mean:	2.9	
					Median:	3.0	

Notes: Northing/Easting in feet relative to the WA State Plane System North Zone (NAD 83).
Monitoring point (top of well casing) in feet relative to the National Geodetic Vertical Datum (NGVD 29).
All depths shown in feet below ground surface.
HYCP-3d, I, Ld, HY-1d, and HYCP-1d ground surface elevations approximate.
Mean and median thickness calculated including partially penetrated thickness values.

Table 6

Summary of Parcel G Groundwater Elevations
BSB Property, Kent, Washington

Well	Layer Screened	Screen Depth	Maximum Depth to Water	Minimum Depth to Water	Maximum Groundwater Elevation	Minimum Groundwater Elevation
Shallow Parcel G Locations						
HYCP-2	A/B	8 - 28	8.64	2.33	18.14	11.83
HYCP-3s	A/B	8 - 13	10.86	3.21	20.82	13.17
HYO-2	A/B	8.5 - 18.5	8.93	2.57	17.70	11.34
Ls	A/B	5 - 15	11.02	4.71	19.31	13.00
HY-1s	B	14 - 19	11.23	3.79	20.40	12.96
HYCP-4	B	11 - 33	11.13	3.78	20.12	12.77
HYCP-5	B	10 - 30	11.00	4.60	17.71	11.31
HYCP-6	B	10 - 30	11.52	5.78	17.74	12.00
Intermediate Parcel G Locations						
HY-1i	B	30 - 40	12.22	5.38	19.51	12.67
HYCP-1i	B	16 - 36	9.85	3.57	17.76	11.48
HYCP-3i	B	22 - 32	11.16	4.42	19.03	12.29
Deep Parcel G Locations						
HYCP-1d	D/E	53 - 73	7.69	2.82	18.45	13.58
HYO-1	D/E	53.5 - 83.5	7.42	2.70	18.43	13.71
I	D/E	74 - 84	10.02	4.07	20.07	14.12
HY-1d	E	84 - 94	11.27	6.62	18.98	14.33
Ld	E	69 - 79	9.83	3.16	21.03	14.36
Upgradient Off-site Locations						
HY-11s	A/B	8 - 18	11.25	2.97	22.20	13.92
HY-11i	B	26 - 36	10.71	3.38	21.70	14.37
HY-11d	D/E	82 - 92	11.14	5.04	19.99	13.89
J	D/E	89 - 99	12.39	5.16	21.90	14.67
Nearby Downgradient Off-site Locations						
Gs	A/B	5.5 - 15.5	9.31	3.48	17.47	11.64
Gi	B/C	28 - 38	9.71	3.81	17.52	11.62
Gd	D	56 - 66	8.11	2.63	18.16	12.68
Hs	A/B	5 - 15	7.42	2.32	17.67	12.57
Hi	B/C	28 - 38	7.29	2.41	17.68	12.80
Hd	D/E	57 - 67	5.93	1.92	19.35	14.22

Notes:
1. Data collected between July 1992 and December 2004.
2. All depths shown in feet below ground surface.
3. MP elevation = monitoring point elevation (top of PVC casing).
4. All elevations in feet relative to the National Geodetic Vertical Datum (NGVD 29).

Table 7

Parcel G Hydraulic Conductivities
BSB Property, Kent, Washington

Well	Date Tested	Layer Screened	Testing Method	Q (gpm)	Analytical Method	K (cm/sec)	K (ft/day)	T (gpd/ft)	T (ft^2/day)	S	Comments
Parcel G Locations											
HYO-2	01/14/85	A/B	Observation Well	–	Jacob	5.99E-02	170	12,700	1,698	0.065	K calculated from drawdown data; HYCP-1i pumping
HYO-2	01/14/85	A/B	Observation Well	–	Theis	6.15E-02	174	13,000	1,738	–	K calculated from drawdown data; HYCP-1i pumping
HYO-2	04/24/89	A/B	Observation Well	–	Theis	1.6E-02	45	10,170	1,360	–	K calculated from drawdown data; HYR-1 pumping
HYO-4	01/14/85	A/B	Pumping Well	20	Jacob	3.37E-02	96	14,300	1,912	–	K calculated from recovery data
HYCP-1s	01/14/85	A/B	Observation Well	–	Theis	1.5E-01	425	16,000	2,139	0.64	K calculated from recovery data; HYCP-1i pumping
HYCP-1s	01/14/85	A/B	Observation Well	–	Jacob	1.3E-01	369	13,800	1,845	0.44	K calculated from recovery data; HYCP-1i pumping
HYCP-1s	01/15/85	A/B	Pumping Well	1.46	Jacob	5.2E-03	15	551	74	–	K calculated from recovery data
HYCP-2	01/15/85	A/B	Pumping Well	16.6	Jacob	2.1E-02	60	8,980	1,200	–	K calculated from recovery data
HYCP-3s	01/14/85	A/B	Observation Well	–	Theis	3.6E-01	1,020	37,800	5,053	–	K calculated from recovery data; HY-04 pumping
HYCP-3s	01/14/85	A/B	Observation Well	–	Jacob	2.8E-01	794	29,300	3,917	0.37	K calculated from drawdown data; HY-04 pumping
HYCP-3s	01/16/85	A/B	Pumping Well	0.15	Jacob	5.3E-04	1.5	56.6	7.6	–	K calculated from drawdown data
HY-1s	09/02/83	B	Slug Test	–	Cedergren	7.3E-04	2.1	–	–	–	H_o derived from slug volume calculations
HYCP-4	01/15/85	B	Pumping Well	18.8	Jacob	6.5E-02	184	27,500	3,676	–	K calculated from recovery data
HYCP-5	04/24/89	B	Observation Well	–	Jacob	1.5E-02	42	9,500	1,270	–	K calculated from drawdown data; HYR-1 pumping
HYCP-6	04/24/89	B	Observation Well	–	Theis	1.7E-02	48	10,850	1,450	–	K calculated from recovery data; HYR-1 pumping
HYCP-6	04/24/89	B	Observation Well	–	Jacob	1.8E-02	51	11,370	1,520	3.0E-04	K calculated from drawdown data; HYR-1 pumping
GP-1c	04/14/99	B	Pumping Well	0.2	Jacob	1.0E-04	0.3	15.3	2.0	–	K calculated from drawdown/recovery data
GP-1d	04/14/99	B	Pumping Well	1.7	Jacob	3.1E-03	8.8	991	132	–	K calculated from recovery data
GP-2b	04/06/99	B	Pumping Well	1.7	Thiem	3.2E-03	9.1	1,024	137	–	K calculated from drawdown data
HYCP-1i	01/14/85	B	Pumping Well	12.5	Jacob	1.95E-02	55	8,250	1,103	–	K calculated from recovery data
HYCP-1i	04/24/89	B	Observation Well	–	Jacob	1.58E-02	45	10,020	1,339	–	K calculated from drawdown data; HYR-1 pumping
HYR-1	04/05/89	B	Pumping Well	5/10/20	Sp. Capacity	1.96E-02	56	12,492	1,670	2.5E-04	K calculated from the first step specific capacity
HYR-1	04/24/89	B	Pumping Well	20.8	Jacob	1.58E-02	45	10,020	1,339	–	K calculated from drawdown data
HYR-1	04/24/89	B	Pumping Well	20.8	Theis	1.51E-02	43	9,570	1,279	–	K calculated from recovery data
Upgradient Off-site Location											
HY-11s	10/09/84	A/B	Pumping Well	0.21	Jacob	4.1E-04	1.2	80 - 163	10.7 - 21.8	–	

Notes:
1. K = horizontal hydraulic conductivity, shown in centimeters per second and feet per day.
2. T = transmissivity, shown in gallons per day per foot and square feet per day.
3. S = storage coefficient.
4. gpm = gallons per minute.
5. Analytical methods discussed in Kruseman and deRidder (1990).

Table 8

Summary Statistics for Groundwater VOCs
BSB Property, Kent, Washington

Site	Date	Vinyl Chloride µg/L	Methylene Chloride µg/L	trans-1,2-Dichloro-ethene µg/L	cis-1,2-Dichloro-ethene µg/L	1,1-Di-chloro-ethene µg/L	1,1-Di-chloro-ethane µg/L	1,2-Di-chloro-ethane µg/L	1,1,1-Tri-chloro-ethane µg/L	Tri-chloro-ethene µg/L	Tetra-chloro-ethene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Total Xylenes µg/L	Benzene µg/L	Dissolved Arsenic mg/L	Total Cyanide mg/L
HY-1s	04/22/99	65	5 U	6.8	350	2.5	5.6	0.8	0.5 U	5.7	0.5 U	1 U	1 U	1 U	0.5 U	0.009	0.01 U
HY-1s	10/05/99	75	5 U	8.4	480	3.2	6.5	0.8	0.5 U	6.5	0.5 U	1 U	1 U	1 U	0.5 U	0.01	0.01 U
HY-1s	04/14/00	48	5 U	5.8	320	2	4.6	0.5 U	0.5 U	4.6	0.5 U	1 U	1 U	1	0.5 U	0.01	0.01 U
HY-1s	10/10/00	76	1 U	15	430	3	6.9	0.71	0.5 U	5.3	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.012	0.01
HY-1s	04/25/01	70	1 U	6.8	340	2	5.9	0.78	0.5 U	6.2	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0155	0.01
HY-1s	10/25/01	53	7.3	6	310	2.5 U	5.1	2.5 U	2.5 U	7.9	2.5 U	2.5 U	2.5 U	5 U	2.5 U	0.0086	0.01 U
HY-1s	04/23/02	50	2 U	5.5	240	1.3	4.9	1 U	0.5 U	4.7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.01	0.02
HY-1s	10/16/02	23	2 U	3.1	150	0.86	3.2	0.66	0.5 U	2.8	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0097	0.01 U
HY-1s	04/09/03	22	0.2 U	2.6	78	0.54	1.2	0.28 J	0.12 U	1.4	0.11 U	0.14 J	0.13 U	0.299 U	0.11 U	0.01	0.01
HY-1s	10/21/03	36 J	2 UJ	5.4 J	250 J	1.3 J	4.4 J	0.63 J	0.5 UJ	2.7 J	0.5 UJ	0.5 UJ	0.5 UJ	1 UJ	0.5 UJ	0.0101	0.01
HY-1i	04/22/99	22	5 U	0.8	65	0.5 U	1.2	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HY-1i	10/05/99	6.2	5 U	0.7	41	0.5 U	0.8	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HY-1i	04/14/00	10	5 U	0.5 U	29	0.5 U	0.7	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HY-1i	10/10/00	6.1	1 U	0.57	22	0.5 U	0.65	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HY-1i	04/26/01	22	1 U	0.5 U	39	0.5 U	0.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HY-1i	10/25/01	6.5	1 U	1.3	33	0.5 U	0.53	0.5 U	0.5 U	5.1	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HY-1i	04/23/02	14	1 U	0.5 U	33	0.5 U	0.59	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01
HY-1i	10/16/02	15	2 U	0.56	31	0.5 U	0.66	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HY-1i	04/09/03	18	0.2 U	0.41 J	22	0.18 J	0.42 J	0.12 U	0.12 U	0.12 U	0.11 U	0.13 J	0.13 U	0.299 U	0.11 U	0.005 U	0.01 U
HY-1i	10/21/03	11	2 U	0.5 U	23	0.5 U	0.51	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HY-1d	04/22/99	0.5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HY-1d	10/05/99	0.5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HY-1d	04/14/00	0.5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.007	0.01 U
HY-1d	10/10/00	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.008	0.01 U
HY-1d	04/26/01	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HY-1d	10/25/01	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HY-1d	04/24/02	0.5 U	2 U	0.5 U	1.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HY-1d	10/16/02	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0052	0.01 U
HY-1d	04/09/03	0.22 U	0.2 U	0.14 U	0.12 U	0.12 U	0.091 U	0.12 U	0.12 U	0.12 U	0.11 U	0.14 J	0.13 U	0.299 U	0.11 U	0.0053	0.01 U
HY-1d	10/21/03	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0089	0.01 U
HYCP-1i	04/23/99	650	5 U	8.1	380	1.4	15	0.5 U	0.5 U	1.2	0.5 U	1 U	1 U	1	0.5 U	0.005 U	0.01 U
HYCP-1i	10/05/99	600	12 U	61	1600	1 U	2	1 U	1 U	2	1 U	2 U	2 U	2 U	1 U	0.005 U	0.01 U
HYCP-1i	04/17/00	560	5 U	72	1600	6	2	0.5 U	0.5 U	35	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-1i	10/10/00	1300	1 U	180	4500	14	1.6	0.5 U	0.5 U	74	0.5 U	1.7	0.5 U	0.5 U	0.5 U	0.005 U	0.01 U
HYCP-1i	04/26/01	860	6	78	2500	10	11	2.5 U	2.5 U	270	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	0.005 U	0.01 U
HYCP-1i	10/24/01	1000	27	190	6100	22	13 U	13 U	13 U	21	13 U	13 U	13 U	13 U	13 U	0.005 U	0.01 U
HYCP-1i	04/24/02	1000	40 U	150	5000	10 U	10 U	10 U	10 U	160	10 U	10 U	10 U	10 U	10 U	0.01 U	0.01 U
HYCP-1i	10/18/02	580	10 U	37	1300	6.3	5	2.5 U	2.5 U	2.7	2.5 U	2.5 U	2.5 U	5 U	2.5 U	0.005 U	0.01 U
HYCP-1i	04/10/03	590	2 U	63	2200	11	3.7 J	1.2 U	1.2 U	30	1.1 U	0.98 U	1.3 U	2.99 U	1.1 U	0.005 U	0.01 U
HYCP-1i	10/21/03	920	10 U	56	1700	5.8	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	2.5 U	0.005 U	0.01 U
HYCP-1d	04/23/99	8	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-1d	10/05/99	37	5 U	0.5 U	0.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-1d	04/17/00	52	5 U	0.5 U	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.006	0.01 U
HYCP-1d	10/10/00	80	1 U	0.5 U	1.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1	0.5 U	1 U	0.5 U	0.005	0.01 U
HYCP-1d	04/26/01	21	1 U	0.5 U	2.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1	0.5 U	1 U	0.5 U	0.01 U	0.01 U

Table 8

Summary Statistics for Groundwater VOCs
BSB Property, Kent, Washington

Site	Date	Vinyl Chloride µg/L	Methylene Chloride µg/L	trans-1,2-Dichloro-ethene µg/L	cis-1,2-Dichloro-ethene µg/L	1,1-Di-chloro-ethene µg/L	1,1-Di-chloro-ethane µg/L	1,2-Di-chloro-ethane µg/L	1,1,1-Tri-chloro-ethane µg/L	Tri-chloro-ethene µg/L	Tetra-chloro-ethene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Total Xylenes µg/L	Benzene µg/L	Dissolved Arsenic mg/L	Total Cyanide mg/L
HYCP-1d	10/24/01	47	1 U	0.5 U	2.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HYCP-1d	04/24/02	74	1 U	0.5 U	4.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HYCP-1d	10/18/02	55	2 U	0.5 U	6.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HYCP-1d	04/15/03	65	2 U	0.5 U	11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0105	0.01 U
HYCP-1d	10/21/03	76	2 U	0.5 U	9.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-2	04/22/99	42 J	1 U	0.5 U	33	0.5 U	7.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.014	0.01 U
HYCP-2	10/05/99	74	1 U	1	62 J	0.6	6.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.027	0.01 U
HYCP-2	04/17/00	8	5 U	0.5 U	23	0.5 U	2	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.024	0.01 U
HYCP-2	10/10/00	220	1 U	2.5	240	1.3	11	0.5 U	0.5 U	0.5 U	0.5 U	0.78	0.5 U	1 U	0.5 U	0.02	0.01 U
HYCP-2	04/26/01	0.84	1 U	0.5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.027	0.01 U
HYCP-2	10/24/01	1.4	1 U	0.5 U	5 U	0.5 U	0.84	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.023	0.01 U
HYCP-2	04/25/02	14	1 U	0.5 U	0.87	0.5 U	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0217	0.01 U
HYCP-2	10/24/02	16	2 U	0.5 U	3.2	0.5 U	1.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0176	0.01 U
HYCP-2	04/10/03	1.2	0.2 U	0.14 U	0.27 J	0.12 U	0.49 J	0.12 U	0.12 U	0.12 U	0.11 U	0.12 J	0.13 U	0.299 U	0.11 U	0.0207	0.01 U
HYCP-2	10/21/03	20	2 U	0.5 U	0.5 U	0.5 U	0.62	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0274	0.01 U
HYCP-3s	04/22/99	8.9	5 U	0.5 U	67	0.5 U	1.3	0.5 U	0.5 U	6.8	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-3s	10/05/99	510 J	5 U	1	59	0.5 U	24	0.5 U	1.5	0.5 U	0.5 U	9 B	2	5	0.5 U	0.005 U	0.01 U
HYCP-3s	04/14/00	7	5 U	0.5 U	49	0.5 U	1	0.5 U	0.5 U	5	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-3s	10/10/00	150	10 U	5 U	5 U	5 U	26	5 U	5 U	5 U	5 U	6.6	5 U	5 U	5 U	0.005 U	0.01 U
HYCP-3s	04/26/01	1.6	1 U	0.5 U	46	5 U	0.85	0.5 U	0.5 U	6.2	0.5 U	0.5 U	0.5 U	5 U	5 U	0.005 U	0.01 U
HYCP-3s	10/25/01	1100	26	13 U	1900	13 U	67	13 U	13 U	13	13 U	19	13 U	14	13 U	0.005 U	0.01 U
HYCP-3s	04/23/02	4.1	2 U	0.5 U	49	0.5 U	0.5 U	0.5 U	0.5 U	5.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.01 U	0.01 U
HYCP-3s	10/16/02	4900	200 U	72	26000	80	270	50 U	78	710	50 U	69	50 U	97	50 U	0.005 U	0.01 U
HYCP-3s	04/09/03	1.7	0.2 U	0.14 U	6.5	0.12 U	0.18 J	0.12 U	0.12 U	1.6	0.11 U	0.13 J	0.13 U	0.299 U	0.11 U	0.005 U	0.01 U
HYCP-3s	10/22/03	580	4 U	2.4	390	1.7	9.3	1 U	1 U	4.5	1 U	2.6 B	1.3	2.9	1 U	0.0067	0.01 U
HYCP-3i	04/22/99	4700	500 U	170	33000	50 U	50 U	50 U	50 U	75000	50 U	180	100 U	100 U	50 U	0.011	0.04
HYCP-3i	10/05/99	5100	500 U	180	32000	52	50 U	50 U	50 U	63000	50 U	100 U	100 U	100 U	50 U	0.01	0.02
HYCP-3i	04/14/00	3600	5000 U	500 U	30000	500 U	500 U	500 U	500 U	67000	500 U	1000 U	1000 U	1000 U	500 U	0.012	0.02
HYCP-3i	10/10/00	8200	1 U	200 U	41000	46	32	1.1	0.5 U	72000	3.8	500 U	55	130	1.6	0.012	0.04
HYCP-3i	04/26/01	730	20 U	10 U	760	10 U	11	10 U	10 U	960	10 U	22	18	19	10 U	0.015	0.02
HYCP-3i	10/25/01	630	110	50 U	3000	50 U	50 U	50 U	50 U	4100	50 U	50 U	50 U	50 U	50 U	0.011	0.03
HYCP-3i	04/24/02	3700	400 U	130	32000	100 U	100 U	100 U	100 U	76000	100 U	140	100 U	100 U	100 U	0.0103	0.02
HYCP-3i	10/16/02	7500	500 U	190	42000	130 U	130 U	130 U	130 U	59000	130 U	170	130 U	260 U	130 U	0.0107	0.04
HYCP-3i	04/09/03	1400	9.7 U	24 U	5500	11 J	10 J	5.7 U	5.7 U	8500	5.5 U	45	43	53	5.3 U	0.0122	0.01
HYCP-3i	10/22/03	240	2 U	2	200	0.5 U	3.1	0.5 U	0.5 U	110	0.5 U	7.8	7	31	0.5 U	0.0147	0.04
HYCP-5	04/23/99	280	1 U	26	1300	8.4	3	0.5 U	0.5 U	12	0.5 U	1	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-5	10/05/99	780	25 U	40	3600	10	3	2 U	2 U	2 U	2 U	5 U	5 U	5 U	2 U	0.005 U	0.01 U
HYCP-5	04/17/00	570	250 U	25 U	2400	25 U	25 U	25 U	25 U	25 U	25 U	50 U	50 U	50 U	25 U	0.008	0.01 U
HYCP-5	10/10/00	660	50 U	26	2100	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U	50 U	25 U	0.005 U	0.01 U
HYCP-5	04/26/01	70	1 U	2.1	150	0.52	0.73	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.005 U	0.01 U
HYCP-5	10/23/01	490	1 U	19	1500	5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.005 U	0.01 U
HYCP-5	04/25/02	360	10 U	12	1100	3.1	2.5 U	2.5 U	2.5 U	4.3	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	0.005 U	0.01 U
HYCP-5	10/16/02	110	2 U	5.3	380	1.3	1.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HYCP-5	04/09/03	180	0.39 U	5.2	440	1.5	0.8 J	0.23 U	0.23 U	0.24 U	0.22 U	0.2 J	0.26 U	0.6 U	0.21 U	0.0057	0.01 U
HYCP-5	10/21/03	8.4	2 U	0.5 U	2.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	1 UJ	0.5 U	0.0051	0.01 U
HYCP-6	04/23/99	42	5 U	1.7	88	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.02

Table 8

Summary Statistics for Groundwater VOCs
BSB Property, Kent, Washington

Site	Date	Vinyl Chloride µg/L	Methylene Chloride µg/L	trans-1,2-Dichloro-ethene µg/L	cis-1,2-Dichloro-ethene µg/L	1,1-Di-chloro-ethene µg/L	1,1-Di-chloro-ethane µg/L	1,2-Di-chloro-ethane µg/L	1,1,1-Tri-chloro-ethane µg/L	Tri-chloro-ethene µg/L	Tetra-chloro-ethene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Total Xylenes µg/L	Benzene µg/L	Dissolved Arsenic mg/L	Total Cyanide mg/L
HYCP-6	10/05/99	80	5 U	2	63	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.005 U	0.01
HYCP-6	04/17/00	63	5 U	2	81	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.006 U	0.01
HYCP-6	10/10/00	75	1 U	1.9	54	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2	0.5 U	1.18	0.5 U	0.005 U	0.03
HYCP-6	04/26/01	68	1 U	1.1	35	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-6	10/23/01	48	1 U	0.69	14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-6	04/25/02	36	1 U	0.72	20	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.01 U	0.01 U
HYCP-6	10/16/02	26	2 U	0.5 U	2.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.53	0.5 U	1 U	0.5 U	0.005 U	0.01 U
HYCP-6	04/09/03	29	0.2 U	0.67	22	0.19 J	0.15 J	0.12 U	0.12 U	0.12 U	0.11 U	0.28 J	0.13 U	0.3 U	0.11 U	0.005 U	0.01 U
HYCP-6	10/21/03	11	2 U	0.5 U	11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0078	0.01 U
HYR-1	04/05/99	1100	50 U	50	5 U	27	20	5 U	5 U	4200	5 U	NA	NA	NA	NA	NA	NA
HYR-1	04/04/00	870	1000 U	100 U	7300	100 U	100 U	100 U	100 U	5100	100 U	NA	NA	NA	NA	NA	NA
HYR-1	11/08/01	1100	200 U	100 U	8400	100 U	100 U	100 U	100 U	5300	100 U	100 U	100 U	200 U	100 U	NA	NA
HYR-1	07/02/02	690	50 U	43	7900	19	13 U	13 U	13 U	6900	13 U	NA	NA	NA	NA	NA	NA
HYR-1	05/01/03	850	50 U	42	8200	25 U	25 U	25 U	25 U	5300	25 U	NA	NA	NA	NA	NA	NA
HYR-1	08/11/03	580	100 U	36	6400	25 U	25 U	25 U	25 U	4000	25 U	NA	NA	NA	NA	NA	NA
HYR-1	11/11/03	370	40 U	51	6500	17	10 U	10 U	10 U	4400	10 U	NA	NA	NA	NA	NA	NA
HYR-2	04/02/99	47	5 U	0.8	75	0.6	4.1	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA
HYR-2	04/04/00	27	5 U	1.1	44	0.5 U	1.8	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA
HYR-2	11/08/01	34	1 U	0.62	42	0.5 U	1.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	NA	NA
HYR-2	07/02/02	21	2 U	0.5 U	25	0.5 U	1.3	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA
HYR-2	05/01/03	22	2 U	0.5 U	19	0.5 U	0.85	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA
HYR-2	08/11/03	19	2 U	0.5 U	20	0.5 U	0.89	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA
HYR-2	11/11/03	19	2 U	0.5 U	18	0.5 U	0.83	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA
Ls	04/22/99	80	5 U	0.7	23	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	2	0.5 U	0.02	0.01 U
Ls	10/05/99	6.2	5 U	0.5 U	1.2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	0.5 U	0.014	0.01 U
Ls	04/17/00	2.4	5 U	0.5 U	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1	0.5 U	0.019	0.01 U
Ls	10/10/00	6.3	1 U	0.5 U	0.85	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1	0.5 U	1 U	0.5 U	0.014	0.01 U
Ls	04/26/01	1.6	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.75	1.7	0.5 U	0.016	0.01 U
Ls	10/25/01	3.7	1 U	0.5 U	0.53 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.015	0.01 U
Ls	04/23/02	2.2	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.0139	0.01 U
Ls	10/16/02	4.9	2 U	0.5 U	0.75	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.014	0.01 U
Ls	04/09/03	1.6	0.2 U	0.14 J	0.41 J	0.12 U	0.091 U	0.12 U	0.12 U	0.12 U	0.11 U	0.21 J	0.24 J	0.75 U	0.11 U	0.0163	0.01 U
Ls	10/22/03	21	2 U	0.5 U	29	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.0175	0.01 U
Total Samples Analyzed		124	124	124	124	124	124	124	124	124	124	112	112	112	112	110	110
Non-Detections		10	119	62	18	88	61	116	122	77	123	83	104	98	111	57	90
Qualified Detections		3	0	3	4	4	8	2	0	1	0	10	1	0	0	0	0
Unqualified Detections		111	5	59	102	32	55	6	2	46	1	19	7	14	1	53	20
Frequency of Detection		92%	4.0%	50%	85%	29%	51%	6.5%	1.6%	38%	0.8%	26%	7.1%	13%	0.9%	48%	18%
Maximum		8,200	110	190	42,000	80	270	1.1	78	76,000	3.8	180	55	130	1.6	0.0274	0.04
Minimum		0.84	6	0.14 J	0.6	0.18 J	0.18 J	0.66	1.5	1.2	3.8	0.12 J	0.24 J	1	1.6	0.0051	0.01

Table 9
Potentially Applicable Groundwater Cleanup Levels and Standards
BSB Property, Kent, Washington

CAS Number	Chemical of Potential Concern	Frequency of Detection (%)	Maximum Detected Concentration (µg/L)	Potentially Applicable Cleanup Levels and Standards: Surface Water Cleanup Levels and Standards (µg/L): Protection of Human Health: Method B Surface	EPA Recommended Criteria (National Toxics Rule): Water + Organism	EPA Recommended Criteria (National Toxics Rule): Organism Only	Protection of Aquatic Organisms: State Surface Water Quality Standards: Freshwater Acute	State Surface Water Quality Standards: Freshwater Chronic	Groundwater Cleanup Levels and Drinking Water Maximum Contaminant Levels (µg/L): Method A	Method B	State MCL	Federal MCL	Retained as IHS?: Human Health	Retained as IHS?: Aquatic Organisms
57-12-5	Cyanide	18	40	51,900	140	140	22.0[b]	5.2[b]	–	320	200	200	No	No[c]
75-34-3	1,1-Dichloroethane (1,1-DCA)	51	270	–	–	–	–	–	–	800	–	–	No	No
75-35-4	1,1-Dichloroethene (1,1-DCE)	29	80	1.93	330	7,100	–	–	–	400	7[a]	7	No	No
107-06-2	1,2-Dichloroethane (1,2-DCA or EDC)	6.5	1.1	59.4	0.38	37	–	–	5	0.481	5[a]	5	No	No
156-59-2	cis-1,2-Dichloroethene (cis-1,2-DCE)	85	42,000	–	–	–	–	–	–	80	70[a]	70	Yes	No
156-60-5	trans-1,2-Dichloroethene (trans-1,2-DCE)	50	190	32,800	140	10,000	–	–	–	160	100[a]	100	No	No
100-41-4	Ethylbenzene	7.1	55	6,910	530	2,100	–	–	700	800	700[a]	700	No	No
79-01-6	Trichloroethene (TCE)	38	76,000	55.6	2.5	30	–	–	5	0.11	5[a]	5	Yes	No
108-88-3	Toluene	26	180	48,500	1,300	15,000	–	–	1,000	1,600	1,000[a]	1,000	No	No
1330-20-7	Total Xylenes	13	130	–	–	–	–	–	1,000	1,600	10,000[a]	10,000	No	No
75-01-4	Vinyl Chloride	92	8,200	3.69	0.025	2.4	–	–	0.2	0.0291	2[a]	2	Yes	No

Notes: 1. CUL = cleanup level, – = not available.
2. Method A groundwater cleanup levels from WAC 173-340-900, Table 720-1.
3. Method B groundwater and surface water cleanup levels from Ecology's on-line Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation (CLARC) tool, (https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx).
4. State MCL = Washington State maximum contaminant level (from WAC 246-290-310).
5. Federal MCL = Federal maximum contaminant level (from http://www.epa.gov/safewater/mcl.html#mcls; last accessed 5/26/05).
6. Washington State surface water quality standards from WAC 173-201A-040.
7. EPA National Recommended Water Quality Criteria from http://www.epa.gov/waterscience/criteria/wqcriteria.html; last accessed 5/26/05.

[a] Federal MCLs adopted by reference.
[b] Surface water standards are for free cyanide; test results represent total cyanide.
[c] See Section 7.4.1 for rationale regarding not including cyanide as an IHS.

Table 10
Final Indicator Hazardous Substances
BSB Property, Kent, Washington

Final IHS	Cleanup Level (μg/L)
cis-1,2-Dichloroethene (cis-1,2-DCE)	70[a]
Trichloroethene (TCE)	30[b]
Vinyl Chloride	2.4[b]

Notes:
[a] Cleanup level based on state and federal MCLs.
[b] Cleanup level based on National Toxics Rule (40 CFR Part 131).

Table 11

Preliminary Cleanup Action Technologies
BSB Property, Kent, Washington

General Response Action	Preliminary Technology
Groundwater Containment	Groundwater Pumping Vertical Barriers (Containment Walls) Permeable Reactive Barriers
Ex Situ Groundwater Treatment/Discharge	King County Sanitary Sewer[1]
In Situ Groundwater Source Treatment	
Biological Treatment	Natural Attenuation Enhanced Aerobic Biodegradation Enhanced Anaerobic Biodegradation
Chemical/Physical Treatment	Air Sparging Steam Stripping *In Situ* Thermal Treatment Dual-Phase Extraction Surfactant/Co-Solvent Flushing Reactive Metal Injection *In situ* Oxidation
Engineering Controls (Soil and Groundwater)	Surface Cap[2] Subsurface Vapor Barrier[2]
Institutional Controls (Soil and Groundwater)	Water- and Land-Use Restrictions[2] Worker Protection Measures[2] Access Restrictions[2]

Notes –
1 – Presumed method of managing extracted groundwater (see Section 9.1 for discussion)
2 – Technologies included in presumed response actions to address (1) trench worker exposure pathway and (2) potential future groundwater/soil to indoor air exposure pathway.

Table 12

Cleanup Action Technology Screening
BSB Property, Kent, Washington

Technology	Description	General Applicability/Limitations	Comments Specific to BSB Site: Effectiveness[a]	Implementability[b]	Relative Cost[c]	Retained?
Groundwater Containment						
Groundwater Extraction	Groundwater is pumped to extract contaminants and generate hydraulic gradients that contain the contaminant plume. Extracted groundwater is treated above ground.	**Applicability.** Groundwater pumping is currently in use at the site to achieve hydraulic control and is a common technology for achieving hydraulic control and recovering contaminant mass. Extracted groundwater would be treated on-site as necessary to meet pretreatment standards and then discharged to the King County treatment works. **Limitations.** The potential limitations of groundwater pumping include site hydrogeology and sorption processes, biofouling and precipitation of inorganics (e.g., iron), and high operational costs. These factors are well understood at the BSB site based on operation of the current CMS.	**Medium to High** Concepts and performance of groundwater pumping are well understood at the site. Groundwater extraction provides reliable containment and removal of groundwater contamination. Can effectively reduce contaminant migration and remove some contaminant mass, although potential presence of NAPL in source area may require very long-term operation.	**Easy to Moderate** Lack of aboveground structures and underground utilities make construction relatively easy. Requirement for long-term operations and maintenance increases difficulty of implementation.	**Capital:** Low to Moderate **O&M:** High **Overall:** Moderate to High	Yes
Vertical Barriers (Containment Walls)	Subsurface barriers, such as slurry walls or sheet piles, are installed to contain impacted groundwater.	**Applicability.** Containment barriers are proven technologies that can contain or divert contaminated groundwater or can be used to isolate portions of a plume undergoing different types of treatment. **Limitations.** Typically requires heavy construction techniques to install. Technology contains contaminants and provides no treatment. Generally higher capital costs than groundwater pumping system, but often have lower long-term O&M costs.	**High** Barriers could control groundwater movement and contaminant migration. Use of physical barriers can reduce some uncertainties relative to groundwater pumping systems.	**Moderate** Significant subsurface construction required for installation, although methods are well established and equipment and materials readily available. Lack of aboveground structures and underground utilities increases constructability.	**Capital:** Moderate **O&M:** Low **Overall:** Moderate	Yes
Permeable Reactive Barrier	Permeable reactive barriers treat contaminants as groundwater passes through the barrier and contacts reactive material. Barriers designed for treatment of CVOCs typically constructed of zero-valent iron (ZVI).	**Applicability.** PRBs constructed using ZVI are well documented for treatment of CVOCs. Effectiveness of ZVI for treating CVOCs present at site is well documented. **Limitations.** Typically requires significant subsurface construction. Hydrogeology must be compatible with application. Barriers may lose hydraulic or reactive capacity over long-term.	**Medium to High** Reactive media (e.g., ZVI) apply to contaminants present at site. High iron content in groundwater could result in fouling of permeable walls over time. Technology can be used alone (i.e., permeable reactive barrier) or in conjunction with barrier wall technologies (i.e., funnel and gate).	**Moderate** Significant subsurface construction required for installation, although methods are well established and equipment and materials readily available. Lack of aboveground structures and underground utilities increases constructability.	**Capital:** Low to High (application dependent) **O&M:** Low **Overall:** Low to High (application dependent)	Yes
Ex Situ Groundwater Treatment/Discharge						
On-Site Groundwater Treatment (Air Stripping)	Extracted groundwater would be treated, if necessary, to meet the King County pretreatment standards. Air stripping would be the primary treatment technology for VOC removal.	**Applicability.** Air stripping used previously for treatment of CMS groundwater and would be effective at reducing VOC concentrations to below King County pretreatment standards. VOCs in vapor discharge from air stripper would be removed using vapor-phase granular activated carbon adsorption. **Limitations.** High dissolved iron content in groundwater will increase O&M requirements. Potential concentrations of TCE in vapor discharge from air stripper will likely require treatment prior to discharge.	**Medium to High** Air stripping effective at reducing VOC concentrations in groundwater to below pretreatment standards, and activated carbon adsorption effective at removing TCE from vapor stream.	**Moderate** Construction methods for treatment system are well established and equipment and materials readily available. Permitting requirements with King County and Puget Sound Clean Air Agency straightforward.	**Capital:** Moderate **O&M:** Moderate to High **Overall:** Moderate to High	Yes

Table 12

Cleanup Action Technology Screening
BSB Property, Kent, Washington

Technology	Description	General Applicability/Limitations	Comments Specific to BSB Site: Effectiveness[a]	Comments Specific to BSB Site: Implementability[b]	Comments Specific to BSB Site: Relative Cost[c]	Retained?
King County Sanitary Sewer	Groundwater is discharged to King County Sanitary Sewer system (either with or without pretreatment, depending on application) for treatment.	**Applicability.** This is the current treatment and discharge approach for the existing CMS and would be used for future groundwater discharges. Depending on the nature of the groundwater extraction system, on-site pretreatment may be required to meet discharge standards. **Limitations.** Primary limitation is concentration of VOCs in discharged water. If concentrations exceed occupational health-based threshold values established by King County, pretreatment may be required to lower VOC levels. Current concentrations in groundwater extracted from Parcel G are well below threshold values.	**High** Provides effective water treatment and disposal for the concentrations of VOCs currently present in extracted groundwater from downgradient boundary of Parcel G. Pretreatment may be required in alternative extraction scenarios (e.g., extraction from within slurry wall containment cell).	**High** Current method for water treatment and disposal.	**Capital:** Low **O&M:** Moderate to High **Overall:** Moderate	Yes
In Situ Groundwater Treatment						
Biological Treatment						
Natural Attenuation	Natural processes—such as dilution, volatilization, biodegradation, adsorption, and chemical reactions—are used to reduce contaminant concentrations, potentially to acceptable levels.	**Applicability.** Natural attenuation is potentially applicable to the VOCs present at the site. Can potentially be applied in combination with other technologies to address residual contamination. **Limitations.** Process can be slow and many site conditions can limit or modify effectiveness of biodegradation. Significant data needed to document performance. Degradation products can be mobile and toxic. Typically applied after residual sources of contamination or NAPL have been controlled or removed. Requires adequate space downgradient of source area for attenuation processes to reduce contamination concentrations.	**Low** Site data suggest ongoing anaerobic biodegradation of VOCs, although concentrations exceed cleanup levels at downgradient property boundary. Specific factors affecting long-term performance are uncertain and would require evaluation and monitoring. Technology very unlikely to achieve low cleanup levels at downgradient property boundary.	**Moderately Difficult** Substantial work including monitoring and modeling would be required to document natural attenuation at the site. Natural attenuation components of remedy do not require expensive and disruptive construction.	**Capital:** Low to Moderate **O&M:** Moderate **Overall:** Moderate	No
Enhanced *In situ* Aerobic Biodegradation	Adding oxygen, nutrients, or other co-factors to the groundwater increases the rate of biodegradation.	**Applicability.** Aerobic bioremediation is applicable to petroleum hydrocarbons, some solvents, and other organic chemicals. Effective for remediating low level residual contamination in conjunction with source removal. **Limitations.** Applies only to particular classes of compounds that can be degraded aerobically. Contaminant, oxygen, and contaminant-degrading microorganisms must be in contact. Fouling can result from biomass accumulation. Hydrogeologic conditions, nutrient limitations, toxic conditions (heavy metals or adverse pH) can limit effectiveness. Groundwater extraction and treatment might be required for plume control.	**Low** Key site contaminants (e.g., TCE) are not amenable to aerobic biodegradation without a suitable co-substrate. Current site conditions are highly reducing and anaerobic, and would make creating and maintaining aerobic conditions difficult.	**Difficult** Effective implementation requires mechanisms to provide uniform delivery of oxygen, nutrients, and inoculum. Substantial study required to document potential for biodegradation and to develop design.	**Capital:** Moderate **O&M:** Moderate **Overall:** Moderate	No

Table 12

Cleanup Action Technology Screening
BSB Property, Kent, Washington

Technology	Description	General Applicability/Limitations	Comments Specific to BSB Site: Effectiveness[a]	Comments Specific to BSB Site: Implementability[b]	Comments Specific to BSB Site: Relative Cost[c]	Retained?
Enhanced *In situ* Anaerobic Biodegradation	Adding electron acceptors or electron donors, nutrients, or co-factors to the groundwater increases or sustains the rate of biodegradation.	**Applicability.** Site contaminants are known to degrade under anaerobic conditions. **Limitations.** Anaerobic biodegradation rates are typically slower than aerobic biodegradation rates. Microorganisms are typically strict anaerobes that are sensitive to even low oxygen concentrations. Delivery of co-factors is often restricted by site hydrogeologic conditions. Groundwater extraction and treatment might be required for plume control and to enhance electron donor and nutrient delivery.	**Medium** Anaerobic biodegradation appears to be occurring at site. Effectiveness of anaerobic degradation is typically limited by degradation kinetics. Important consideration is ensuring that degradation products (e.g., vinyl chloride) are themselves degraded. Technology very unlikely to achieve low cleanup levels at downgradient property boundary.	**Moderately Difficult to Difficult** Effective enhancement requires mechanisms to uniformly deliver co-factors and amendments. Subsurface geology could limit effectiveness of delivery systems.	**Capital:** Low to Moderate **O&M:** Moderate **Overall:** Moderate	No
Chemical/Physical Treatment						
Air Sparging	Air is injected into groundwater to volatilize contaminants. Contaminants sparged from groundwater air are typically recovered in vadose zone by soil vapor extraction (SVE). Groundwater containment is almost always required around the sparged area to minimize migration of contaminants	**Applicability.** Target contaminants for sparging include VOCs. Removal mechanisms can include stripping and enhanced bioremediation. Methane can be used as an amendment to sparged air to enhance cometabolism of chlorinated organics. Sparging wells could be used as injection points to enhance cometabolic bioremediation. **Limitations.** Effectiveness requires uniform flow of air through saturated soil. Heterogeneous soils can result in non-uniform treatment and uncontrolled movement of potentially dangerous vapors. High contaminant solubility limits transfer to gas phase. Oxygen could cause oxidation and precipitation of iron and stop anaerobic biological systems. SVE typically required to recover sparged contaminants.	**Low** Site contaminants are generally volatile and amenable to air sparging. High solubility can limit transfer to vapor phase. Presence of interbedded low permeability layers, including the intermediate silt layer present throughout much of Parcel G, could significantly limit effectiveness in lower portion of shallow aquifer.	**Moderately Difficult** Sparge wells and aboveground conveyance can be installed in most areas. Low permeability layers in subsurface will complicate SVE system design and installation.	**Capital:** Moderate **O&M:** High **Overall:** Moderate to High	No
Steam Stripping	Steam is forced into groundwater to vaporize contaminants. Vaporized components rise to unsaturated zone and are removed by vacuum extraction. Groundwater containment is almost always required around the area being treat to minimize the potential migration of contaminants	**Applicability.** Steam stripping typically applies to oily wastes and semi-volatile hydrocarbons. VOCs also can be treated, but other processes are generally more cost-effective. Can be used to enhance recovery of NAPL. **Limitations.** Soil type, contaminant characteristics and concentrations, geology, and hydrogeology impact process effectiveness.	**Low to Medium** Although no NAPL has been observed at site, it may be present in a residual state. Contaminants are generally volatile. Could increase vaporization of highly soluble contaminants. Presence of interbedded low permeability layers, including the intermediate silt layer present throughout much of Parcel G, could significantly limit effectiveness in lower portion of shallow aquifer.	**Moderately Difficult to Difficult** Installation of injection and extraction points can be installed in most areas. May be difficult to uniformly deliver steam to impacted areas. Steam equipment can increase complexity of design, construction, and operation.	**Capital:** High **O&M:** High **Overall:** High	No
In Situ Thermal Treatment	Hot air or other heat source (e.g., electrical heating) are used to enhance desorption, volatilization, and mobility of contaminants. Groundwater containment is almost always required around the area being treat to minimize the potential migration of contaminants	**Applicability.** Thermal processes typically apply to NAPL or dissolved contaminants where heating would improve partitioning to vapor phase and recovery. Can improve recovery of VOCs. **Limitations.** Effectiveness requires uniform heating of saturated soil. Heterogeneous soils can result in non-uniform treatment.	**Low to Medium** Although no NAPL has been observed at site, it may be present in a residual state. Contaminants are generally amenable to conventional removal methods without thermal enhancement.	**Moderately Difficult to Difficult** Soil heating techniques are not routinely applied, and additional technology development could be required. May be difficult to uniformly heat soils in impacted area. Companion technologies, such as air sparging would likely be implemented. Heating equipment would increase implementation complexity.	**Capital:** High **O&M:** High **Overall:** High	No

Table 12

Cleanup Action Technology Screening
BSB Property, Kent, Washington

Technology	Description	General Applicability/Limitations	Comments Specific to BSB Site			Retained?
			Effectiveness[a]	Implementability[b]	Relative Cost[c]	
Dual-Phase Extraction	A vacuum is applied to an extraction well to simultaneously extract groundwater, NAPL, and vapors.	**Applicablity.** Dual-phase extraction applies to VOCs and LNAPLs in soil and groundwater. Dual-phase extraction is more effective than SVE in heterogeneous soils. Can increase groundwater recovery rates **Limitations.** Can leave isolated lenses of undissolved product in low-permeability soils. Effectiveness depends on lithology and contaminant characteristics/distribution. Requires both water treatment and vapor treatment.	**Low to Medium** Although groundwater extraction is effective and applicable at the site, the effectiveness of SVE is significantly limited by subsurface heterogeneities including the intermediate silt layer. Although no NAPL has been observed at site, it is likely present in a residual state in the form of blobs and ganglia. Would require significant drawdown of water table to be more effective than standard SVE and groundwater extraction; this would require relatively high groundwater extraction rates.	**Moderately Difficult** Significant requirements for vacuum and groundwater conveyance. May be difficult to achieve desired water table drawdown at reasonable groundwater extraction rates	**Capital:** Moderate to High **O&M:** High **Overall:** High	No
Surfactant/Co-Solvent Flushing	Chemicals are injected and subsequently extracted into source area to solubilize and/or mobilize DANPL constituents. Chemicals typically used can include co-solvents (including alcohols), aqueous surfactants, or electrolytes that enhance solubilization.	**Applicability.** CVOCs present at the site are suitable for co-solvent application. Residual contaminant levels remaining after surfactant/co-solvent flushing would likely require follow-up treatment in order to achieve cleanup levels. **Limitations.** This technology has limited full-scale application data available at this time. Accurate identification of all areas with residual DNAPL required and then uniform delivery of surfactant/co-solvent chemicals required for effective treatment. Potential for mobilization of contaminants would likely require significant hydraulic controls to be in place before application.	**Low** Although the technology has the potential to treat site contaminations, it is most often used where significant DANPL sources (i.e., pooled DANPL) are present and source areas are well defined. Technology very unlikely to achieve low cleanup levels at downgradient property boundary without substantial follow-up treatment using a different technology.	**Moderately Difficult** Effective treatment requires uniform application surfactant/co-solvent chemicals that may be difficult due to subsurface heterogeneities and nature of residual DNAPL sources. Implementation of hydraulic controls around application area increases overall operational complexity of technology.	**Capital:** Moderate to High **O&M:** Moderate to High **Overall:** Moderate to High	No
Reactive Metal Particle Injection	Very small particles (micro- or nano-scale) of zero-valent iron are injected into the DNAPL source zone where chemical reduction reactions degrade chlorinated solvents. Can be used in conjunction with pneumatic fracturing technologies to enhance delivery of ZVI particles.	**Applicability.** ZVI has been shown effective at treating CVOCs in general, and at the bench and pilot scale with micro- or nano-scale particle injection technology. Applicability of injection/ZVI delivery technologies at this site is uncertain. **Limitations.** This technology has not been demonstrated in full-scale applications at this time and bench-scale performance data is limited. Accurate identification of all areas with residual DNAPL required and then uniform delivery of ZVI particles required for effective treatment.	**Low to Medium** Although the technology has the potential to treat site contaminations, there are many uncertainties regarding this technology due to its lack of full-scale implementation data. It is likely that multiple applications would be required and it is very unlikely to achieve low cleanup levels at downgradient property boundary.	**Moderately Difficult** Effective treatment requires uniform application of ZVI particles that may be difficult due to subsurface heterogeneities and nature of residual DNAPL sources.	**Capital:** Moderate to High **O&M:** Low to Moderate **Overall:** Moderate to High	No
In situ Chemical Oxidation (e.g., Permanganate, Fenton's Reagent)	Strong oxidizer is injected into subsurface to oxidize and destroy organic contaminants.	**Applicability.** Chemical oxidation commonly applied to inorganics, although use for halogenated and nonhalogenated VOCs, SVOCs, fuel hydrocarbons has increased in recent years. **Limitations.** Incomplete oxidation results in intermediate contaminants. Process may not be cost-effective for high contaminant concentrations because large amounts of oxidizing agent required. Some oxidizers in some environments can be explosive. Uniform application of oxidants required for effective treatment. High COD reduces effectiveness (e.g., high iron in groundwater).	**Medium** Significant amount of VOCs could be oxidized. Oxidized and precipitated iron could result in aquifer fouling. High contaminant concentrations and high COD would require large amount of oxidizer. Ability to deliver oxidizer(s) to contaminants in heterogeneous subsurface could limit effectiveness. Technology very unlikely to achieve low cleanup levels at downgradient property boundary.	**Moderately Difficult** Effective treatment requires uniform application of oxidizing agent that may be difficult due to subsurface heterogeneities and nature of residual DNAPL sources. Limited long-term operation required an advantage. Handling large quantities of strong oxidizers presents significant health and safety concerns.	**Capital:** Moderate to High **O&M:** Low to Moderate **Overall:** Moderate to High	No

Table 12

Cleanup Action Technology Screening
BSB Property, Kent, Washington

Technology	Description	General Applicability/Limitations	Comments Specific to BSB Site: Effectiveness[a]	Comments Specific to BSB Site: Implementability[b]	Comments Specific to BSB Site: Relative Cost[c]	Retained?
Engineering Controls						
Surface Cap or Barrier	Low permeability cover (e.g., asphalt paving) is placed over contaminated soils and groundwater to prevent direct contact and limit infiltration of precipitation.	**Applicability.** Capping is a well established technology that is currently in use for portions of Parcel G site. **Limitations.** Currently no impediments that would limit capping. Capping design must accommodate potential future traffic and/or site development structural requirements. Cap must be sloped or graded to promote effective runoff of precipitation.	**High** Capping would be very effective at controlling direct contact with potentially contaminated soils, limit exposures to VOCs in soil gas emanating from soil or groundwater, and prevent infiltration of precipitation. Maintenance activities are straightforward and effective.	**Easy** No aboveground obstructions and adequate working pace would make construction relatively easy. Flat topography of northern portion of site may require importing soil to achieve adequate grades for surface drainage.	**Capital:** Moderate **O&M:** Low to Moderate **Overall:** Moderate	Yes
Subsurface Vapor Barriers	Low permeability barriers and/or subsurface ventilation structures placed beneath buildings to limit intrusion of VOC-containing vapors.	**Applicability.** Commonly used and well-established technology for controlling vapor migration beneath and around buildings. **Limitations.** None.	**High** Not currently used at the site, as there are no aboveground structures. If future site development includes construction of buildings, subsurface vapor barriers would be very effective at controlling this potential exposure pathway.	**Easy** Since there are no existing structures on site, there is no need for somewhat difficult retrofitting of barrier systems. Any potential new construction can have subsurface vapor barriers incorporated into the design and construction.	**Capital:** Low to Moderate **O&M:** Low to Moderate **Overall:** Low to Moderate	Yes
Institutional Controls						
Water- and Land-Use Restrictions	Restrict use of groundwater for domestic or industrial purposes where contaminant concentrations are above regulatory limits. Define requirements to limit exposure if land use changes.	**Applicability.** Common controls to reduce exposure. **Limitations.** Can be difficult to implement for off-site locations.	**Medium to High** Can effectively prevent human exposure to VOC-containing groundwater on-site.	**Easy** Easy to implement on site.	**Capital:** Low **O&M:** Low **Overall:** Low	Yes
Worker Protection Measures	Health and safety techniques such as personal protective equipment, monitoring, and planning are implemented to protect workers involved subsurface activities.	**Applicability.** Common controls to reduce exposure. **Limitations.** None.	**Medium to High** Can prevent exposure.	**Easy** Easy to implement on site.	**Capital:** Low **O&M:** Low **Overall:** Low	Yes
Access Restrictions	Restrict access by unauthorized personnel to site.	**Applicability.** Common controls to reduce potential exposure or interference/damage of other remediation systems. **Limitations.** None.	**Medium** Can prevent exposure.	**Easy** Easy to implement on site.	**Capital:** Low **O&M:** Low **Overall:** Low	Yes

NOTE:
[a] Preliminary effectiveness ratings of high, medium, and low reflect estimated relative effectiveness of the technology to treat the site contaminants and meet CAOs.
[b] Implementability rating of easy, moderately difficult, and difficult reflect estimated relative complexity of implementing the technology.
[c] Relative costs for capital, O&M, and overall costs compared to other technologies evaluated.

Table 13

Summary of Retained Technologies
BSB Property, Kent, Washington

Treatment Category	Technologies: Retained	Technologies: Screened Out
Containment	Groundwater Pumping Vertical Barriers (Containment Walls) Permeable Reactive Barriers (limited application)	Continuous Permeable Reactive Barrier
Ex Situ Groundwater Treatment/Discharge	On Site Groundwater Treatment (Air Stripping) King County Sanitary Sewer[1]	None
In Situ Groundwater Source Treatment		
Biological Treatment	None	Natural Attenuation Enhanced Aerobic Biodegradation Enhanced Anaerobic Biodegradation
Chemical/Physical Treatment	None	Air Sparging Steam Stripping *In Situ* Thermal Treatment Dual-Phase Extraction Surfactant/Co-Solvent Flushing Reactive Metal Injection *In situ* Oxidation
Engineering Controls (Soil and Groundwater)	Surface Cap[2] Subsurface Vapor Barrier[3]	None
Institutional Controls (Soil and Groundwater)	Water- and Land-Use Restrictions[2] Worker Protection Measures[2] Access Restrictions[2]	None

Notes –
1 – Presumed method of discharging extracted groundwater (see Section 9.1 for discussion); pretreatment may be required depending on application.
2 – Technologies included in presumptive general response actions to address subsurface construction worker exposure pathway
3 – Use of subsurface vapor barriers will be evaluated in the event of future Parcel G development to address the potential groundwater/soil to indoor air exposure pathway.

Table 14
Construction and Operation and Maintenance Costs
Alternative 1 - Enhanced Groundwater Extraction System

Construction Costs							
ITEM	UNIT COST low	UNIT COST high	UNITS	QUANTITY low	QUANTITY high	COST low	COST high
Construction Costs							
1. Extraction Wells/Vaults	$ 70,000	$ 80,000	LS	1	1	$ 70,000	$ 80,000
2. Piping, Electrical, Controls	$ 115,000	$ 125,000	LS	1	1	$ 115,000	$ 125,000
3. Piezometers/Monitoring Wells	$ 1,200	$ 1,400	EA	14	14	$ 16,800	$ 19,600
4. Mechanical Checkout/Startup	$ 10,000	$ 15,000	LS	1	1	$ 10,000	$ 15,000
5. Construction and O&M Reports	$ 12,000	$ 15,000	LS	1	1	$ 12,000	$ 15,000
6. Aquifer Tests and Model Calibration	$ 40,000	$ 50,000	LS	1	1	$ 40,000	$ 50,000
7. Contingency Plan	$ 15,000	$ 25,000	LS	1	1	$ 15,000	$ 25,000
						$ -	$ -
Subtotal						$ 278,800	$ 329,600
Sales Tax on Materials (8.8%)						$ 17,800	$ 19,800
System Engineering and Permitting (10%)						$ 21,200	$ 24,000
Construction Cost Contingency (15 %)						$ 41,800	$ 49,400
Total Estimated Capital Costs						**$ 360,000**	**$ 420,000**
Average Capital Cost						**$ 390,000**	

Operation and Maintenance Costs			
Activity	**Estimated Annual Cost low**	**Estimated Annual Cost high**	**PW[1] (30 Years)**
1. Baseline Extraction System O&M and Reporting	$ 180,000	$ 200,000	$ 2,921,000
2. Initial CAPMIP Performance Sampling, Modeling, and Reporting (year	$ 80,000	$ 105,000	$ 88,000
3. Additional Performance Sampling and Reporting (years 2-30	$ 25,000	$ 40,000	$ 469,000
4. Baseline EMP Groundwater Monitoring	$ 19,000	$ 19,000	$ 292,000
Subtotal			$ 3,770,000
O&M Cost Contingency (10 %)			$ 377,000
Total Estimated O&M Costs			**$ 4,150,000**
TOTAL ESTIMATED PRESENT WORTH COST			**$ 4,540,000**

[1] PW = present worth, calculated assuming a 5% discount rate using the average annual cost and years of operation indicated in the following formula:

$$PW = A\frac{(1+i)^n - 1}{i(1+i)^n}$$

where A = average annual cost
i = discount rate
n = number of years of operation

All total costs are in 2006 dollars and rounded to nearest $10,000

Table 15
Construction and Operation and Maintenance Costs
Alternative 2 - Slurry Wall around Parcel G with Zero Valent Iron Reactor Vessels

Construction Costs										
ITEM	UNIT COST low		UNIT COST high	UNITS	QUANTITY low	QUANTITY high	COST low		COST high	
Construction Costs										
1. Barrier Wall Installation	$	200	$ 350	LF	1,820	1,820	$	364,000	$	637,000
2. Mobilization/Demobilization	$	70,000	$ 80,000	LS	1	1	$	70,000	$	80,000
3. Reactor Vessel inc. infiltration gallery	$	160,000	$ 320,000	LS	1	1	$	160,000	$	320,000
4. Granular ZVI Material	$	1,000	$ 1,200	ton	140	210	$	140,000	$	252,000
5. EnviroMetal Licensing Fee (15%)							$	36,000	$	64,000
6. Cap Repair/Repaving	$	2.00	$ 2.25	SF	130,000	145,000	$	260,000	$	326,250
7. Drainage Improvements	$	15,000	$ 25,000	LS	1	1	$	15,000	$	25,000
8. Soil/Debris Disposal (Off-site as SW)	$	35	$ 40	ton	2100	2,800	$	73,500	$	112,000
9. Performance Monitoring Piezometers	$	1,200	$ 1,500	EA	8	8	$	9,600	$	12,000
10. Utility Realignment	$	10,000	$ 20,000	LS	1	1	$	10,000	$	20,000
11. Wall Alignment Investigation	$	15,000	$ 25,000	LS	1	1	$	15,000	$	25,000
						Subtotal	$	1,153,100	$	1,873,250
						Sales Tax on Materials (8.8%)	$	101,500	$	164,800
						Engineering and Permitting (10%)	$	115,300	$	187,300
						Construction Cost Contingency (20%)	$	230,600	$	374,700
						Total Estimated Capital Costs	**$**	**1,600,000**	**$**	**2,600,000**
						Average Capital Cost	**$**	**2,100,000**		

Operation and Maintenance Costs						
Activity	**Estimated Annual Cost low**		**Estimated Annual Cost high**		**Baseline O&M Case PW[1] (30 Years)**	
1. Startup Performance Sampling and Reporting (in addition to routine monitoring; years 1-3)	$	10,000	$	20,000	$	41,000
2. Additional Performance Sampling and Reporting (years 4-30)	$	5,000	$	10,000	$	95,000
3. Baseline EMP Groundwater Monitoring	$	24,000	$	24,000	$	369,000
4. Cap Maintenance	$	10,000	$	20,000	$	231,000
5. ZVI Reactor Vessel Maintenance (assumes $50,000 per "refresh" event)					$	12,000
				Subtotal	$	748,000
				O&M Cost Contingency (10 %)	$	74,800
				Total Estimated O&M Costs	**$**	**820,000**
TOTAL ESTIMATED PRESENT WORTH COST					**$**	**2,920,000**

[1] PW = present worth, calculated assuming a 5% discount rate using the average annual cost and years of operation indicated in the following formula:

$$PW = A\frac{(1+i)^n - 1}{i(1+i)^n}$$

where A = average annual cost
i = discount rate
n = number of years of operation

All total costs are in 2006 dollars and rounded to nearest $10,000.

Table 16
Construction and Operation and Maintenance Costs
Alternative 3 - Slurry Wall around Parcel G with Limited Pumping for Gradient Control

Construction Costs											
ITEM	UNIT COST				UNITS	QUANTITY		COST			
	low		high			low	high	low		high	
Construction Costs											
1. Barrier Wall Installatioı	$	175	$	350	LF	1,780	1,780	$	311,500	$	623,000
2. Mobilization/Demobilizatio	$	50,000	$	75,000	LS	1	1	$	50,000	$	75,000
3. Gradient Control Wells/vault	$	10,000	$	12,000	EA	3	5	$	30,000	$	60,000
4. Piping, Electrical, Site Preparatioı	$	60,000	$	75,000	LS	1	1	$	60,000	$	75,000
5. GW Treatment Systerr	$	50,000	$	70,000	LS	1	1	$	50,000	$	70,000
6 Cap Repair/Repaving	$	2.00	$	2.25	SF	130,000	145,000	$	260,000	$	326,250
7. Drainage Improvements	$	15,000	$	25,000	LS	1	1	$	15,000	$	25,000
8. Soil/Debris Disposal (Offsite as S\	$	35	$	40	ton	2,100	2,800	$	73,500	$	112,000
9 Performance Monitoring Wel	$	1,200	$	1,500	EA	12	12	$	14,400	$	18,000
10. Utility Realignmen	$	10,000	$	20,000	LS	1	1	$	10,000	$	20,000
11. Wall Alignment Investigatio	$	15,000	$	25,000	LS	1	1	$	15,000	$	25,000
							Subtotal	$	889,400	$	1,429,250
							Sales Tax on Materials (8.8%)	$	78,300	$	125,800
							Engineering and Permitting (10%	$	88,900	$	142,900
							Construction Cost Contingency (20%	$	177,900	$	285,900
							Total Estimated Capital Costs	**$**	**1,230,000**	**$**	**1,980,000**
							Average Capital Cost	**$**	**1,610,000**		

Operation and Maintenance Costs					Baseline O&M Case	
	Estimated Annual Cost				PW[1]	
Activity	**low**		**high**		**(30 Years)**	
1. Baseline Gradient Control System O&M and Reportin	$	60,000	$	100,000	$	1,230,000
2. Baseline Groundwater Treatment System O&N	$	30,000	$	50,000	$	615,000
3. Startup Performance Sampling and Reporting (in addition to routine monitoring; years 1-	$	10,000	$	20,000	$	65,000
4. Additional Performance Sampling and Reporting (years 6-3(	$	5,000	$	10,000	$	83,000
5. Baseline EMP Groundwater Monitorin;	$	24,000	$	24,000	$	369,000
6. Cap Maintenance	$	10,000	$	20,000	$	231,000
				Subtotal	$	2,593,000
				O&M Cost Contingency (10 %)	$	259,300
				Total Estimated O&M Costs	**$**	**2,850,000**
TOTAL ESTIMATED PRESENT WORTH COST					**$**	**4,460,000**

[1] PW = present worth, calculated assuming a 5% discount rate using the average annual cost and years o operation indicated in the following formula

$$PW = A\frac{(1+i)^n - 1}{i(1+i)^n}$$

where A = average annual cos
i = discount rate
n = number of years of operatioı

All total costs are in 2006 dollars and rounded to nearest $10,000

Table 17

Evaluation of Use of Permanent Solutions to Maximum Extent Practicable
BSB Property, Kent, Washington

Evaluation Criteria	Alternative 1 – Enhanced Groundwater Extraction System	Alternative 2 – Slurry Wall Containment and Gradient Control Using ZVI Gate	Alternative 3 – Slurry Wall Containment and Gradient Control Using Groundwater Extraction	Comparative Evaluation
Protectiveness	Potential downgradient receptors at surface water will be protected by preventing migration of VOCs from Parcel G. Containment will be achieved far upgradient of the potential exposure point. Potential future onsite receptors (potential future site and/or office workers) will be protected through maintenance of the existing surface cap, implementation of engineering controls to prevent inhalation of VOCs in indoor air if a building is constructed in the future (if determined to be necessary), and institutional controls requiring worker protection measures (e.g., personal protective equipment) during subsurface construction or maintenance activities.	See Alternative 1 discussion.	See Alternative 1 discussion.	Although the approach to achieving containment varies between the three alternatives, they are all protective of human health and the environment in both the short and long term. Alternative 2 is the most protective because it relies less on long term O&M.
Permanence	The components of the enhanced groundwater extraction system (e.g., wells, pumps, control systems) will require significant ongoing O&M, including periodic replacement of system components, until cleanup standards are met in order to maintain the effectiveness of the alternative. Also, long-term performance monitoring and modeling will be required to document the alternative's effectiveness.	The components of the slurry wall, ZVI gate, and surface cap containment system in Alternative 2 are permanent engineered systems that require very little long-term O&M. The slurry wall requires no maintenance, while the ZVI gate may require periodic "refreshing" (assumed to be every 30 years) to maintain its hydraulic properties or augment the reactive iron. The surface cap will require routine inspection and maintenance typical of all paving systems. Performance monitoring will consist of relatively straightforward water quality and water level monitoring.	The components of the slurry wall and surface cap containment system in Alternative 3 are permanent engineered systems that require modest long-term O&M. The slurry wall requires no maintenance, while the surface cap will require routine inspection and maintenance typical of all paving systems. The groundwater extraction and treatment systems will require significant ongoing O&M, including periodic replacement of system components. Performance monitoring will consist of relatively straightforward water quality and water level monitoring.	The permanence of the three alternatives is, to varying degrees, dependent on the performance of long-term O&M activities. Alternative 1 is the most O&M intensive (i.e., least permanent) as it would require considerable ongoing O&M and performance monitoring. The extraction and treatment system components of Alternative 3 also require significant O&M, but less than Alternative 1 because fewer wells will have to be operated, maintained and periodically replaced. Alternative 2 is the least dependent on ongoing O&M actions to maintain its effectiveness (i.e., the most permanent). The ZVI gate functions passively, and based on existing information on this technology, may only require periodic "refreshing" every several decades, if at all. The need for these periodic gate maintenance events will be readily determined based on performance monitoring results.
Cost	**Capital:** $390,000 **O&M (30-yr NPV):** $4,150,000 **Overall Cost:** $4,540,000	**Capital:** $2,050,000 **O&M (30-yr NPV):** $950,000 **Overall Cost:** $3,000,000	**Capital:** $1,610,000 **O&M (30-yr NPV):** $2,850,000 **Overall Cost:** $4,460,000	Although it has the highest capital cost, the much lower long-term O&M costs make Alternative 2 the least costly over the 30-year period evaluated. Alternatives 1 and 3 have essentially the same overall cost over the 30-year period. The difference in costs between Alternative 2 and Alternatives 1 and 3 will increase with longer implementation time frames.
Long-Term Effectiveness	The enhanced groundwater extraction system has been shown through modeling to effectively contain VOCs and prevent their migration downgradient of Parcel G. Refer to the PES 2004b report for the detailed description of the effectiveness of this alternative in achieving containment. If implemented, the effectiveness would continue to be demonstrated through performance monitoring and modeling activities.	The function and effectiveness of this alternative is described in Section 10.3.1 and Appendices G and H. The slurry wall encircling Parcel G in this alternative will be extremely effective in preventing migration of VOCs, and will maintain this effectiveness over the very-long term. The ZVI gate technology has been shown to be effective in treating the VOCs present at the site to levels below the applicable cleanup levels, and the available information indicates that it will maintain its effectiveness over the long term. The long-term performance of the ZVI gate can be readily monitored, and maintenance activities implemented when required to preserve its hydraulic and treatment effectiveness.	The function and effectiveness of this alternative is described in Section 10.4.1 and Appendices G and H. The slurry wall encircling Parcel G in this alternative will be extremely effective in preventing migration of VOCs, and will maintain this effectiveness over the very-long term. The groundwater extraction system used to maintain hydraulic control inside the slurry wall is somewhat less effective than the ZVI gate in Alternative 2 because Alt 3 requires more O&M.	All three alternatives will be similarly effective at preventing migration of VOCs from Parcel G over the long term as long as O&M activities are implemented. The degree of certainty of success associated with Alternatives 2 and 3 is somewhat higher compared to Alternative 1 due to the presence of the slurry wall encircling Parcel G. Alternative 2 is more certain than Alternative 3 because Alternative 2 relies on a passive system that does not require regular O&M.

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Evaluation Criteria	Alternative 1 – Enhanced Groundwater Extraction System	Alternative 2 – Slurry Wall Containment and Gradient Control Using ZVI Gate	Alternative 3 – Slurry Wall Containment and Gradient Control Using Groundwater Extraction	Comparative Evaluation
Management of Short-Term Risks	There are limited short-term risks associated with this alternative. There are no current or short-term risks to human health that need to be addressed. The potential risks associated with implementation of this alternative are limited to construction activities (e.g., drilling, trenching) and potential exposure to subsurface contaminants during construction or management of contaminated materials. These risks can be easily mitigated through development and implementation of a site-specific health and safety plan, including appropriate use of engineering controls and personal protective equipment.	There are limited short-term risks associated with this alternative. `There are no current or short-term risks to human health that need to be addressed. Implementation risks associated with this alternative are related to the heavy construction activities involved with placement of the slurry wall, ZVI gate, and surface cap. Potential volatilization of subsurface VOCs should be minimized by the nature of one pass trencher operations and because trenching activities are limited to the site perimeter where VOC concentrations are much lower compared to the source area. With appropriate engineering design and careful implementation of health and safety procedures typical for this type of activity, these risks can be minimized to the extent practicable.	There are limited short-term risks associated with this alternative. There are no current or short-term risks to human health that need to be addressed. Implementation risks associated with this alternative are related to the heavy construction activities involved with placement of the slurry wall and surface cap. Potential volatilization of subsurface VOCs should be minimized by the nature of one pass trencher operations and because trenching activities are limited to the site perimeter where VOC concentrations are much lower compared to the source area. With appropriate engineering design and careful implementation of health and safety procedures typical for this type of activity, these risks can be minimized to the extent practicable. Potential risks associated with air emissions of VOCs from the groundwater treatment system will be mitigated with the carbon adsorption system.	All three alternatives have relatively little implementation risk associated with them, and what risks are present can be readily managed through application of standard construction health and safety procedures.
Technical and Administrative Implementability	Technical – All of the components are in common use and readily available, and there are no significant technical implementability issues for this alternative. Administrative – The primary permit required for implementation of this alternative is a King County Industrial Wastewater Discharge permit. Since the existing CMS already has such a permit, implementing Alternative 1 would only require modification (and periodic renewal) of the existing permit.	Technical – All of the components used in the slurry wall/ZVI gate system have been demonstrated at full-scale at dozens of other sites and the materials are readily available. The one-pass trencher technology used to place the slurry wall and gate has been demonstrated at the anticipated depths and used many times in similar applications. There are no significant technical implementability issues for this alternative. Administrative – There are no major permits required to implement this alternative as it is constructed entirely on-site. Excavated soils and other waste would need to be characterized and disposed of consistent with state and federal solid and dangerous/hazardous waste regulations.	Technical – All of the components are in common use and readily available. The one-pass trencher technology used to emplace the slurry wall has been demonstrated at the anticipated depths and used many times in similar applications. There are no significant technical implementability issues for this alternative. Administrative – The primary permit required for implementation of this alternative is a King County Industrial Wastewater Discharge permit. The substantive requirements for an air discharge authorization from the Puget Sound Clean Air Agency (PSCAA) will also have to be met. Since the existing ICM already has a King County permit, implementing Alternative 1 would only require modification (and periodic renewal) of the existing permit. The PSCAA substantive requirements for the air stripper will be met through installation of carbon adsorption. The only other permits required to implement this alternative are construction-related permits. Excavated soils and other waste would need to be characterized and disposed of consistent with state and federal solid and dangerous/hazardous waste regulations.	Technical – Although the slurry wall and ZVI gate systems require more complicated construction techniques compared to installation of extraction wells, these techniques are well demonstrated at similar sites. There are no significant technical implementations issues with any of the alternatives. Administrative – The permits required for implementing all three alternatives are readily obtainable and there are no major administrative obstacles to implementing any of the alternatives. Alternative 2 is the easiest to administratively implement as it requires no permits. Alternatives 1 and 3 each require a discharge permit and Alternative 3 also requires compliance with PSCAA regulations.
Consideration of Public Concerns	Public concerns associated with the possible implementation of this alternative will be addressed during the public review and comment process for this FFS.	Public concerns associated with the possible implementation of this alternative will be addressed during the public review and comment period for this FFS.	Public concerns associated with the possible implementation of this alternative will be addressed during the public review and comment process for this FFS.	Public concerns will be addressed in the same fashion for all three alternatives.