



## Montesano Groundwater Investigation of Leaking Underground Storage Tanks, October 2006 and March 2007

### Abstract

Groundwater beneath downtown Montesano is contaminated with petroleum products. The contamination is largely the result of releases from leaking underground storage tanks. To characterize the lateral extent of contamination, the Washington State Department of Ecology (Ecology) collected groundwater samples from 25 monitoring wells during October 2006 and March 2007. Samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX), total petroleum hydrocarbons as gasoline (TPH-G), and volatile organic compounds (VOCs).

The highest concentrations of gasoline-range petroleum hydrocarbons were detected in monitoring wells at or near three previously identified source areas: Tony's Short Stop/Grays Harbor Grange, Whitney's Inc./Key Bank (Sterling), and Brumfield-Twidwell (GeoEngineers, 2005). BTEX and TPH-G concentrations in samples collected from these wells were above (exceeded) the Model Toxic Control Act (MTCA) cleanup levels for groundwater. Benzene concentrations across the site ranged from non-detect to 28,000  $\mu\text{g/L}$ . TPH-G concentrations ranged from non-detect to 490,000  $\mu\text{g/L}$ . Free-phase petroleum product was also observed in wells at the three source areas, which continue to serve as sources of dissolved phase contamination.

Chlorinated solvents have also been detected in some wells at the three source areas. Most VOC concentrations were near or below the laboratory practical quantitation limits. However, tetrachloroethene exceeded the MTCA Method A cleanup level for groundwater (5  $\mu\text{g/L}$ ) in well KBMW-1. The occurrence of chlorinated solvents in wells at Whitney's Inc./Key Bank (Sterling) suggests the presence of a VOC contaminant plume in this portion of the project area.

Ecology also collected water samples from the City's storm drain and abandoned sanitary sewer to determine if these underground utilities were providing another contaminant migration pathway. Petroleum related contaminants were detected in some of the samples.

Because of the high concentrations of groundwater contamination and the potential for contaminants to continue to migrate from the three source areas, additional investigations are being conducted to better define the nature and extent of the contamination.

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## Background

The city of Montesano is located in Grays Harbor County in western Washington along U.S. Highway 12 (Figure 1). Montesano offered a major stopping place for travelers prior to the repositioning of the highway south of town in the late 1960s. With the highway relocation, the demand for gas stations lessened and several of the downtown gas stations closed. It is suspected that many underground storage tanks (USTs) were left in place, possibly still containing petroleum products. Tanks from past and still-operating gas stations have leaked, creating large areas of soil and groundwater contamination beneath downtown Montesano.

In 2004 Ecology began an investigation to determine the extent of the groundwater contamination underlying downtown Montesano. The project area encompassed several blocks, primarily from Pioneer Avenue south along Main Street. Existing monitoring wells on properties with known releases of petroleum were used in the early phases of this investigation. The wells are located at Tony's Short Stop, Grays Harbor Grange (Montesano Farm & Home), Key Bank (Sterling Savings Bank), P.J. MaxiMart (Montesano 76), Montesano City Shop, and Brumfield-Twidwell (Figure 1). Petroleum contamination was detected at all six of these locations.

During the 2004 monitoring, Ecology also detected chlorinated solvents in the groundwater at some of the well locations (Marti, 2006). Past or present activities within the project area that are potential sources of chlorinated solvents are related to auto repair and paint shops.

In 2005, Ecology contracted GeoEngineers, Inc. to conduct further investigations. Ground penetrating radar was used to locate any remaining underground storage tanks at Whitney's Chevrolet and Brumfield-Twidwell. Soil and groundwater samples were collected from direct push borings throughout the project area to determine if utility corridors were acting as preferential migration pathways for contaminants. Water samples were collected from the city's storm drain and abandoned sanitary sewer.

Results from the GeoEngineer investigation identified three source areas where soil and groundwater contamination have impacted the shallow aquifer: Tony's Short Stop/Grays Harbor Grange, Whitney's Inc./Key Bank (Sterling), and Brumfield-Twidwell. The contamination at the three sites also included the presence of light non-aqueous phase liquid (LNAPL) in the form of free-phase petroleum product. (GeoEngineers, 2005.)

In the spring of 2006, Ecology contracted GeoEngineers to install nine additional wells between the three source areas to monitor off-site contaminant migration (GeoEngineers, 2006). These wells have been added to Ecology's monitoring network (Marti, 2007).

In addition to the work that Ecology has been conducting, additional investigations began in 2005 at three of the identified source areas (Tony's Short Stop, Grays Harbor Grange, Brumfield-Twidwell) to better define the nature and extent of contamination. At Tony's Short Stop and Brumfield-Twidwell, some remediation work has already been completed. Work on these three projects is continuing.

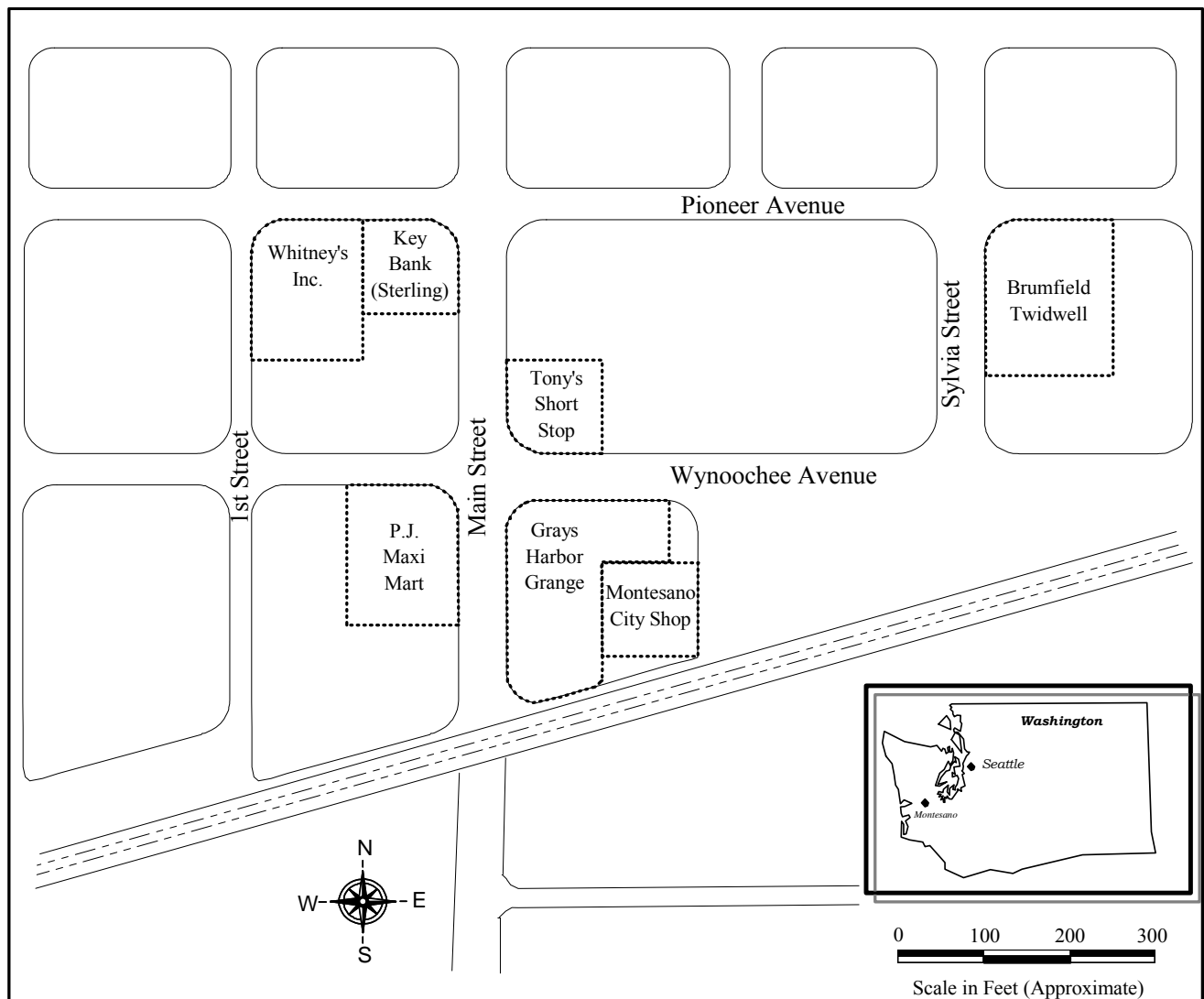


Figure 1. Montesano Groundwater Investigation Site Location Map.

Downtown Montesano is situated on the north side of the Chehalis River valley. The ground surface in the project area generally slopes gently downward (south-southeast) to the Chehalis River over a distance of about 3,000 feet. The geology of the area is comprised mostly of alluvial deposits, consisting of unconsolidated to partly consolidated fluvial and glaciofluvial sand and gravels with interbeds of clay and silt up to 20 feet thick. The alluvial deposits are underlain by a relatively impermeable silt or clay unit of unknown thickness. Regional groundwater flow is to the south-southeast direction toward the Chehalis River. The water table occurs approximately 3 to 15 feet below the ground surface.

## Methods

### Groundwater Sampling

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The primary contaminants of concern in the project area are gasoline-range hydrocarbons. Ecology collected and analyzed groundwater samples for benzene, toluene, ethylbenzene, and xylene (BTEX), as well as total petroleum hydrocarbons as gasoline (TPH-G). Samples were collected from 25 monitoring wells in October 2006 and March 2007 (Figure 2). Samples were also collected and analyzed for 72 target volatile organics compounds (VOCs) from six of the wells in October 2006 and 12 of the wells in March 2007. These wells were selected based on their proximity to potential sources such as auto repair and paint shops.

The monitoring wells have been installed on, or adjacent to, sites with known releases: Tony's Short Stop, Grays Harbor Grange, Key Bank (Sterling), Brumfield-Twidwell, P.J. MaxiMart, and Montesano City Shop (Figure 2). The wells were installed between 1995 and 2006. All wells are constructed of either 2" or 4" I.D. PVC and range in depth from approximately 12 to 25 feet, with screen lengths of 10 and 15 feet. In May 2006, Ecology had nine additional wells installed throughout the project area to address data gaps in the existing monitoring network. The new wells are constructed of 2" PVC and range in depth from about 15 to 22 feet, with 10 foot screen lengths. Well construction details are provided in Appendix A.

Static water levels were measured in wells that did not have LNAPL using a calibrated Solinst water level meter prior to well purging and sampling. Measurements were recorded to 0.01 foot and are accurate to 0.03 foot. The probe was rinsed with deionized water between measurements. In wells known to be contaminated, the probe was washed with laboratory grade detergent and rinsed with deionized water.

Ecology purged and sampled most of the monitoring wells using a Grundfos® Redi-Flo2 stainless steel submersible pump, using low-flow sampling techniques. The pump intake was placed at the mid-screen interval in each well, and purged and sampled at a pump rate of 0.5 to 1-liter/ minute. Wells were purged through a continuous flow cell until pH, specific conductivity, and temperature readings stabilized. At the completion of purging, samples were collected directly from the dedicated pump discharge tubing into laboratory supplied containers. The pump was decontaminated between each well by circulating laboratory-grade detergent/ water through the pump followed by a clean water rinse, with each cycle lasting five minutes. Rinsate blanks were collected to determine if the field cleaning procedures were sufficient to prevent cross contamination of samples from the sample equipment.

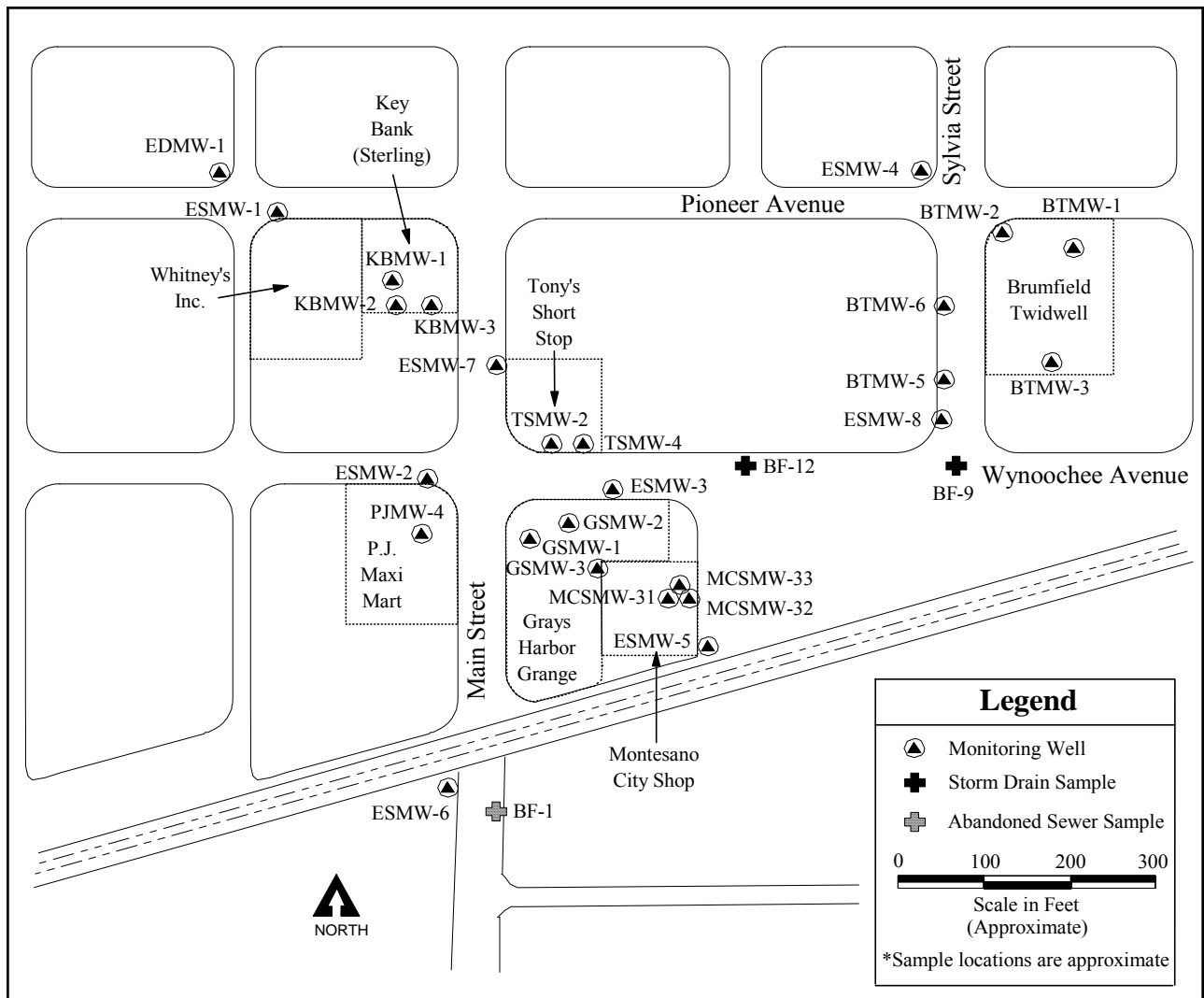


Figure 2. Montasano Groundwater Investigation, Sample Locations October 2006 and March 2007.

Because of the presence of free-phase petroleum product in the groundwater in wells TSMW-2 and TSMW-4 at Tony's Short Stop, KBMW-2 at Key Bank (Sterling), and BTMW-2 at Brumfield-Twidwell, these wells were purged and sampled with decontaminated Teflon bailers. At the completion of purging, samples were transferred from the bailer to the laboratory-supplied bottles using a bottom-emptying, controlled flow assembly. The bailers had been pre-cleaned with a Liquinox® wash and sequential rinses of hot tap water, 10% nitric acid, deionized water, and pesticide-grade acetone. After cleaning, the bailers were air-dried and wrapped in aluminum foil.

In addition to the monitoring well samples Ecology collected water samples in March 2007 from the City of Montesano’s storm drain and abandoned sanitary sewer system. Both of these drains appear to collect groundwater. To ensure the samples would be representative of groundwater leaking into the drains, samples were collected during a period of dry weather. Two samples were collected from manholes on the storm drain along Wynoochee Avenue, and one sample from the abandoned sanitary sewer system on Main Street (Figure 2).

Samples from the storm and sewer drains were collected using pre-cleaned glass beakers. The glass beakers were pre-cleaned with a Liquinox® wash and sequential rinses of hot tap water, deionized water, and pesticide-grade acetone. After cleaning, the beakers were air-dried and wrapped in aluminum foil. Samples were transferred from the beaker into the laboratory-supplied bottles. Water samples collected from the storm and sewer drains were analyzed for VOCs and TPH-G.

BTEX/TPH-G and VOC samples were each collected free of headspace in three 40-mL glass vials with Teflon-lined septa lids and preserved with 1:1 hydrochloric acid. After sample collection and proper labeling, all samples were stored in ice-filled coolers. Samples were transported to Ecology’s Operation Center in Lacey. Samples were kept in the walk-in cooler until taken by courier to Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocols (Ecology, 2005).

Purge water from the wells was collected and stored at a secure facility in 55-gallon drums. Purge water is transported and disposed of in accordance with Washington State Dangerous Waste Regulations (Chapter 173-303 WAC).

## Laboratory

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Analytes, analytical methods, and detection limits for both field and laboratory parameters are listed in Table 1. Samples were analyzed for the gasoline-range hydrocarbons of benzene, toluene, ethylbenzene, and xylene (BTEX); total petroleum hydrocarbons as gasoline (TPH-G); and volatile organics (VOCs).

Table 1. Field and Laboratory Methods.

Field Measurements	Instrument Type	Method	Accuracy
Water Level	Solinst Water Level Meter	EPA SOP 2043	±0.03 feet
pH	Orion 25A Field Meter	EPA Method 150.1	±0.1 std. units
Temperature	YSI 3510 Temperature Probe	EPA Method 150.1	±0.1 °C
Specific Conductance	YSI 3520 Conductivity Cell	EPA Method 120.1	±10 µmhos/cm
Laboratory Analytes	Method	Reference	Reporting Limit
BTEX	EPA SW-846 Method 8021B	EPA 1996	1 µg/L
TPH-G	TPH-Gx	Ecology 2003	0.14 mg/L
VOCs	EPA SW-846 Method 8260B	EPA 1996	1-5 µg/L

SOP = Standard Operating Procedure.

EPA = Environmental Protection Agency.

## Data Quality

Quality control samples collected in the field consisted of blind field duplicate samples and equipment rinsate blanks. Field duplicates were collected by splitting the pump discharge between two sets of sample bottles, which provides a measure of the overall sampling and analytical precision. Precision estimates are influenced not only by the random error introduced by collection and measurement procedures, but also by the natural variability of the concentrations in the media being sampled. Field duplicates were collected from wells GSMW-2, KBMW-3, and BTMW-2 in October 2006, and wells KBMW-3, BTMW-2, and ESMW-3 in March 2007. These wells were selected to represent the range of concentrations found over the project area.

Tables 2 and 3 show results of the duplicate samples and the relative percent difference (RPD). RPD is calculated as the difference between sample results, divided by the mean and expressed as a percent.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results ( $\mu\text{g/L}$ ) for October 2006.

Sample ID:	GS MW-2	GS MW-2A	RPD	KB MW-3	KB MW-3A	RPD	BT MW-2	BT MW-2A	RPD
	$\mu\text{g/L}$	$\mu\text{g/L}$	%	$\mu\text{g/L}$	$\mu\text{g/L}$	%	$\mu\text{g/L}$	$\mu\text{g/L}$	%
Benzene	140	150	7	10	160	<b>176</b>	150	160	6
Toluene	2 U	2 U	--	4.4 J	80 J	--	230	170	30
Ethylbenzene	2 U	2 U	--	38	680	<b>179</b>	1200	710	<b>51</b>
m- & p-xylene	4 U	4 U	--	44	710	<b>177</b>	2900	2000	37
o-xylene	26	26	0	20	350	<b>178</b>	1200	770	44
TPH-G	280 U	280 U	--	16,000	17,000	6	46,000	19,000	<b>83</b>

U – Analyte was not detected at or above the reported value.

J – Analyte was positively identified. The associated numerical result is an estimate.

**Bold** – Does not meet data quality objectives of 50%.

Table 3. Relative Percent Difference (RPD) of Duplicate Sample Results ( $\mu\text{g/L}$ ) for March 2007.

Sample ID:	KB MW-3	KB MW-3A	RPD	BT MW-2	BT MW-2A	RPD	ES MW-3	ES MW-3A	RPD
	$\mu\text{g/L}$	$\mu\text{g/L}$	%	$\mu\text{g/L}$	$\mu\text{g/L}$	%	$\mu\text{g/L}$	$\mu\text{g/L}$	%
Benzene	40	45	12	450	360	22	8300	8400	1
Toluene	2.5	3	18	1300	460	<b>95</b>	9000	9100	1
Ethylbenzene	4.5	5.8	25	2200	1400	44	950	930	2
m- & p-xylene	2.1	2.6	21	9600	5700	<b>51</b>	2900	2900	0
o-xylene	8	10	22	4600	2400	<b>63</b>	1100	1000	9
TPH-G	1200	1300	8	84,000	78,000	7	43,000	43,000	0

**Bold** – Does not meet data quality objectives of 50%.

In October 2006, duplicate samples were collected from wells GSMW-2, KBMW-3, and BTMW-2. The RPD for analytes detected in duplicate samples from monitoring well GSMW-2 was good. The RPD for the BTEX results from well KBMW-3 did not meet the data quality objectives of 50%. When the BTEX samples were collected the pump discharge water did not have a steady flow. Because the samples were not collected under uniform conditions and the BTEX results have very high RPDs, these data have been rejected. Duplicate results for ethylbenzene and TPH-G from well BTMW-2 also did not meet the data quality objectives, while the remainder of the analytes had RPDs that ranged from 6% to 44%.

In March 2007, duplicate samples were collected from wells KBMW-3, BTMW-2, and ESMW-3. The RPDs for the March results from wells KBMW-3 and ESMW-3 were acceptable and ranged from 0% to 25%. As with the October 2006 duplicates for well BTMW-2, some of the sample results did not meet the data quality objectives of 50%, while the remainder of the RPDs ranged from 7% to 44%.

Field duplicates are expected to have higher variability compared to other quality control samples because they incorporate environmental and sampling variability. The variability in well BTMW-2 duplicate results and subsequent high RPD values may be attributed to the presence of free-phase petroleum product in this well during both sample rounds. Because of the uncertainty introduced by the presence of a LNAPL, average concentrations of the duplicate samples will be used in the remainder of this report and will be “J” qualified as estimated. Data for the other wells where free-phase petroleum product was encountered will also be “J” qualified because of the possibility that these data have not met the data quality objectives. These wells are KBMW-2, TSMW-2, and TSMW-4.

Rinsate blanks were also collected in the field to determine if field cleaning procedures were sufficient to prevent cross contamination of samples from the sample equipment. Rinsate blanks were collected by pumping deionized water through the submersible pump after the pump had been cleaned. BTEX and TPH-G were not detected in any of the rinsate blanks.

Most of the data met the measurement quality objectives established in the Quality Assurance Project Plan (Marti, 2004). A review of the data quality control and quality assurance from laboratory case narratives indicates that overall analytical performance was good. The reviews include descriptions of analytical methods, holding times, instrument calibration checks, blank results, surrogate recoveries, and laboratory control samples. It was noted that certain samples did not appear to be homogeneous since dilutions made from the triplicate bottles did not produce linear dilutions. In a few cases, some analytes exceeded the upper calibration limit, and the associated results are qualified. No major problems were reported that compromised the usefulness or validity of the sample results; therefore, all results are usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

All field measurements and analytical result data are available in electronic format from Ecology’s EIM data management system: [www.ecy.wa.gov/eim/index.htm](http://www.ecy.wa.gov/eim/index.htm) at study ID, PMART004.

## Results

### Field Observations

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Depth-to-water of each monitoring well was measured prior to purging. End-of-purge specific conductivity readings, as well as the total purge volume, are listed in Table 4. Temperature measurements recorded during purging were collected for comparative purposes only and have not been included in Table 4. Because temperatures are measured in a flow cell which is influenced by ambient air conditions, they are not considered to be representative of in-situ groundwater conditions. pH measurements have been rejected due to a faulty probe.

Completion depths for the monitoring wells range from approximately 12 to 25 feet. Depth-to-groundwater below the land surface ranged from about 6 to 19 feet in October 2006 and 4 to 15 feet in March 2007.

During the monitoring period, specific conductivity measurements ranged from 94 to 1228  $\mu\text{mhos/cm}$ . Groundwater temperatures measured in the flow cell averaged 16.4°C in October and 14°C in March. The higher temperatures in October are partly caused by the influence of warmer ambient air.

While purging at the lowest flow possible, water levels dropped in well ESMW-7 in October, in well ESMW-1 in March, and in wells EDMW-1, ESMW-2, and ESMW-3 during both sample rounds. In October, the water level dropped below the pump intake in wells ESMW-1 and KBMW-3. The pump was shut off during purging to allow the water in these two wells to recover. Well ESMW-6 purged dry in October and March and required several hours to recover for the well to have enough water for sample collection.

In October 2006 and March 2007, free-phase petroleum product was present in water bailed from Brumfield-Twidwell well BTMW-2 and the wells at Tony's Short Stop (TSMW-2 and TSMW-4). Free-phase petroleum product was present in water bailed from well KBMW-2 at Key Bank (Sterling) in October 2006, but was not present in March 2007, although the purge water did have a strong petroleum odor and a visible sheen on the surface. Approximate product thickness as measured in the bailer is listed in Table 4.

Table 4. Summary of Field Parameter Results for October 2006 and March 2007.

Monitoring Well Sample ID	Total Depth (feet) <sup>1</sup>	Depth-to-Water Below Ground Surface (feet)		Water Table Elevation (feet msl)		Specific Conductivity (umhos/cm)		Purge Volume (gallons)	
		10/06	3/07	10/06	3/07	10/06	3/07	10/06	3/07
<i>Brumfield-Twidwell</i>									
BTMW-1	23.30	15.77	9.31	21.83	28.29	120	113	5	5
BTMW-2	24.9	Product (~6")	Product (~0.25")	--	--	--	--	3	3
BTMW-3	22.28	13.23	9.38	17.14	20.99	188	233	5.5	5
BTMW-5	24	14.36	13.88	16.34	16.82	163	163	5	3.5
BTMW-6	24	14.94	10.20	19.50	24.24	201	281	4	5
<i>Whitney's Inc./ Key Bank (Sterling)</i>									
KBMW-1	21.97	18.61	15.42	21.11	24.30	207	196	4	4.5
KBMW-2	20.16	Product (~14")	13.90	--	24.60	--	--	2	3
KBMW-3	20.17	17.58	14.29	20.10	23.39	319	457	3.5 <sup>(2)</sup>	4
<i>P.J. MaxiMart</i>									
PJMW-4	20	13.52	9.88	17.66	21.30	148	179	4	4
<i>Tony's Short Stop</i>									
TSMW-2	18.77	Product (~2")	--	--	--	--	--	2	--
TSMW-4	--	--	Product (~12")	--	--	--	--	--	4
<i>Grays Harbor Grange</i>									
GSMW-1	22.7	11.64	9.32	16.60	18.92	182	170	4	4
GSMW-2	21.74	11.54	9.26	16.38	18.66	243	255	3.5	5
GSMW-3	17.73	7.71	5.13	15.32	17.90	326	504	5.5	4.5
<i>Montesano City Shop</i>									
MCSMW-31	12.50	6.62	4.15	14.77	17.24	297	434	5	5
MCSMW-32	12.50	7.30	5.23	14.59	16.66	294	412	3.25	3.5
MCSMW-33	12.11	7.76	5.72	14.74	16.78	337	331	5	4
<i>Ecology Wells</i>									
ESMW-1	20.08	18.15	14.45	23.36	27.06	263	186	2 <sup>(1)</sup>	3.5 <sup>(2)</sup>
ESMW-2	20.08	13.43	10.41	19.29	22.31	218	200	3.5 <sup>(2)</sup>	4.5 <sup>(2)</sup>
ESMW-3	17.53	11.03	8.92	18.53	20.64	367	339	2 <sup>(2)</sup>	3 <sup>(2)</sup>
ESMW-4	20.09	15.88	9.71	22.14	28.31	120	94	5	6
ESMW-5	14.73	6.45	4.04	14.76	17.17	264	116	6	4
ESMW-6	14.70	10.06	9.08	12.64	13.62	1325	1228	2.5 <sup>(1)</sup>	4 <sup>(1)</sup>
ESMW-7	19.53	16.61	14.09	19.84	22.36	351	309	3.75 <sup>(2)</sup>	3.5
ESMW-8	15.10	10.31	8.95	15.14	16.50	198	163	5	4.5
EDMW-1	22.61	16.36	13.01	25.95	29.03	214	198	4 <sup>(2)</sup>	4 <sup>(2)</sup>

-- Not measured

<sup>1</sup> Purged dry

<sup>2</sup> Water level dropped while purging

Product: Free-phase petroleum product present in the groundwater with approximate bailed thickness.





















































