



## Montesano Groundwater Investigation of Leaking Underground Storage Tanks, October 2004 and March 2005

### Abstract

Groundwater beneath downtown Montesano is contaminated with petroleum products. The contamination is likely the result of historic releases from leaking underground storage tanks. To determine the lateral extent of groundwater contamination in the downtown area, samples were collected from existing monitoring wells during October 2004 and March 2005. Samples were submitted for analysis of benzene, toluene, ethylbenzene, and xylene (BTEX), as well as total petroleum hydrocarbons as gasoline (TPH-G).

The highest concentrations of gasoline-range petroleum hydrocarbons were detected in monitoring wells from three sites which have been identified as potential source areas. These sites include Tony's Short Stop/Grays Harbor Grange, Key Bank (Sterling)/Whitney's Inc., and Brumfield-Twidwell. BTEX and TPH-G concentrations in samples collected from these wells did not meet (exceeded) the Model Toxic Control Act (MTCA) cleanup standards. Benzene concentrations exceeded the MTCA Method A cleanup standard of 5 ug/L in ten of the sampled wells, with concentrations ranging from 5.1 to 8500 ug/L. TPH-G concentrations exceeded the MTCA Method A cleanup standard of 800 ug/L in nine of the sampled wells, with concentrations ranging from 1100 to 81,000 ug/L.

Results of this project confirm that the surficial aquifer throughout the project area is contaminated with gasoline-range petroleum hydrocarbons, including the presence of free-phase petroleum product at the Key Bank (Sterling) site. Because of the potential for contaminants to migrate downgradient from source areas, additional investigations are being conducted to better define the nature and extent of the contamination at the three potential source areas.

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## Background

The city of Montesano is located in western Washington along U.S. Highway 12 (Figure 1). Montesano was a major stopping place for travelers before the highway was moved south of town in the late 1960s. When the highway was relocated, 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 stations have leaked, creating large areas of soil and groundwater contamination in the downtown Montesano area.

The Washington State Department of Ecology (Ecology) has identified several properties with known releases of petroleum products. These include Key Bank (Sterling), Tony's Short Stop, Grays Harbor Grange, P.J. MaxiMart, Brumfield-Twidwell, two sites at the Montesano City Shop, Grays Harbor County Shops, and Jackpot Station 392 (Figure 1).

Between 1991 and 2004, monitoring wells were installed at each site and sampled for benzene, toluene, ethylbenzene, and xylene (BTEX), as well as total petroleum hydrocarbons as gasoline (TPH-G). Reported concentrations for TPH-G from these wells have ranged from near the detection limit (50 ug/L) to 30,000 ug/L, with the exception of the two wells at Tony's Short Stop with reported concentrations of 79,000 ug/L and 192,000 ug/L in 1998. The Model Toxic Control Act (MTCA) cleanup level for TPH-G is 800 ug/L.

Monitoring wells previously installed at the above sites were used to define the project area, which encompasses several blocks in downtown Montesano, primarily from Pioneer Avenue south along Main Street (Figure 1). Results from an investigation conducted by GeoEngineers (GeoEngineers, 2005) identified three potential source areas where soil and groundwater contamination (including the presence of free-phase petroleum product) have impacted the downtown area. The three areas are Tony's Short Stop/Grays Harbor Grange, Key Bank (Sterling)/Whitney's Inc., and Brumfield-Twidwell.

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, 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, and the watertable occurs approximately 3 to 15 feet below the ground surface.

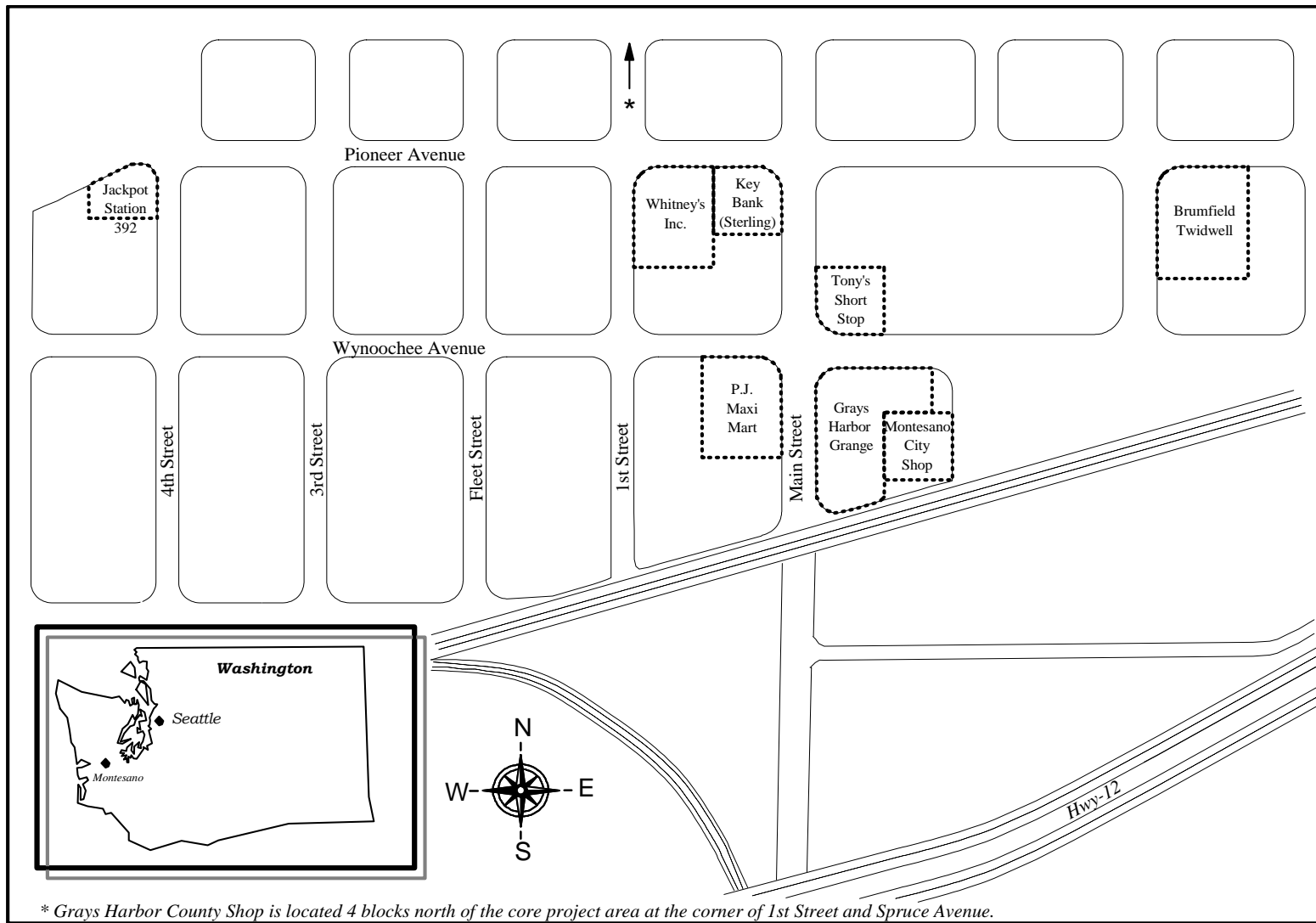


Figure 1. Montesano Groundwater Investigation Site Location Map

## Methods

### Groundwater Sampling

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The primary contaminants of concern in the project area are gasoline-range hydrocarbons. Groundwater samples were collected primarily for benzene, toluene, ethylbenzene, and xylene (BTEX), and total petroleum hydrocarbons as gasoline (TPH-G). Samples were collected from 32 monitoring wells in October 2004 (Figure 2). Based on the 2004 results, samples were collected from only 20 wells in March 2005. In March, samples were also collected for volatile organics contaminants (VOCs) from three wells located next to an auto repair and paint shop.

The monitoring wells have been installed at or around sites with known releases, including Jackpot Station 392, P.J. MaxiMart, Key Bank (Sterling), Brumfield-Twidwell, Tony's Short Stop, Grays Harbor Grange, Montesano City Shop, and Grays Harbor County (Figure 2). The wells were installed between 1991 and 2004. All wells are constructed of either 2" or 4" I.D. PVC and range in depth from 8 to 25 feet, with varying screen lengths. Well construction details are provided in Appendix A.

Static water levels were measured in all wells using a 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 with high contaminant concentrations, the probe was washed with laboratory grade detergent and rinsed with deionized water.

Most of the monitoring wells were purged and sampled 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 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.

Because of the presence of free-phase petroleum product (a light non-aqueous phase liquid) in the groundwater in well MW-2 (KBMW-2) at the Key Bank (Sterling) site, this well was purged and sampled with a decontaminated Teflon bailer. In October 2004, wells MW-2 (BTMW-2) at Brumfield-Twidwell and MW-2 (TSMW-2) at Tony's Short Stop were also sampled with clean bailers because of the suspected high concentrations of gasoline-range hydrocarbons. The bailers were 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.

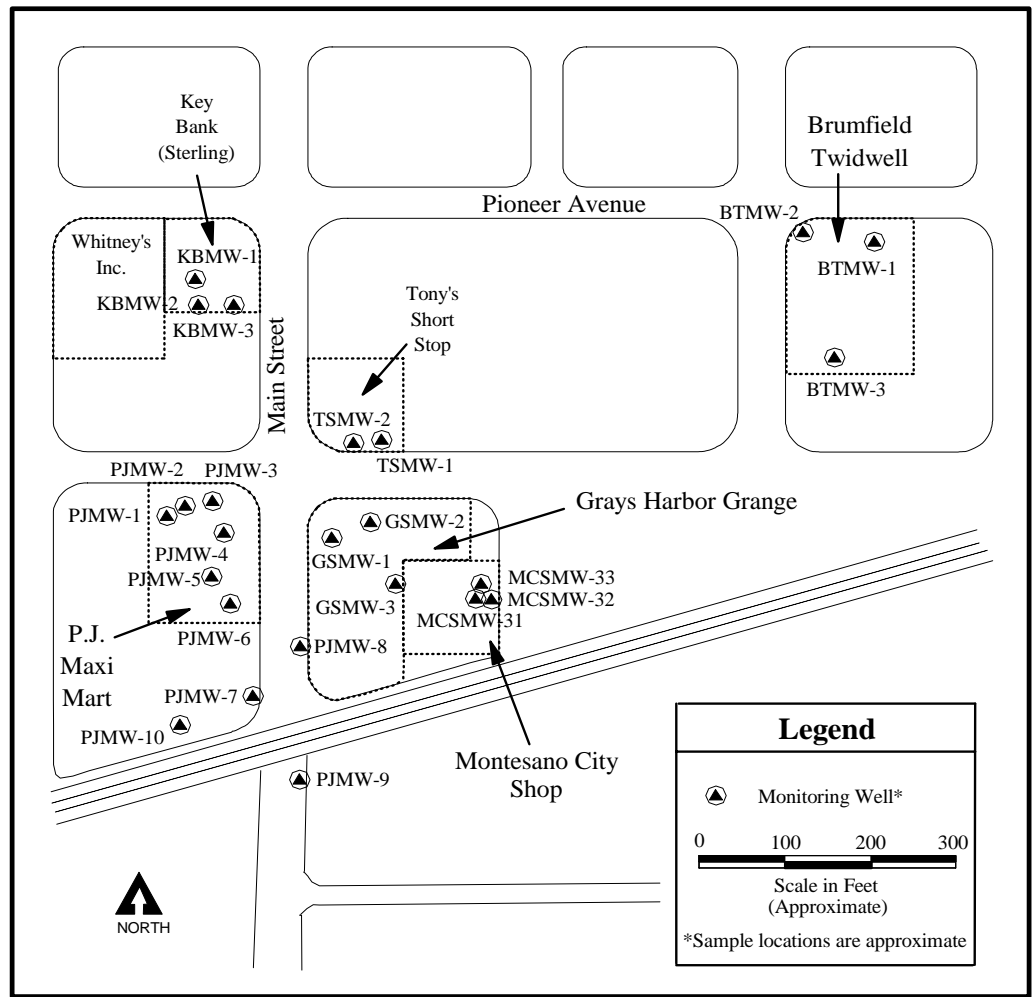
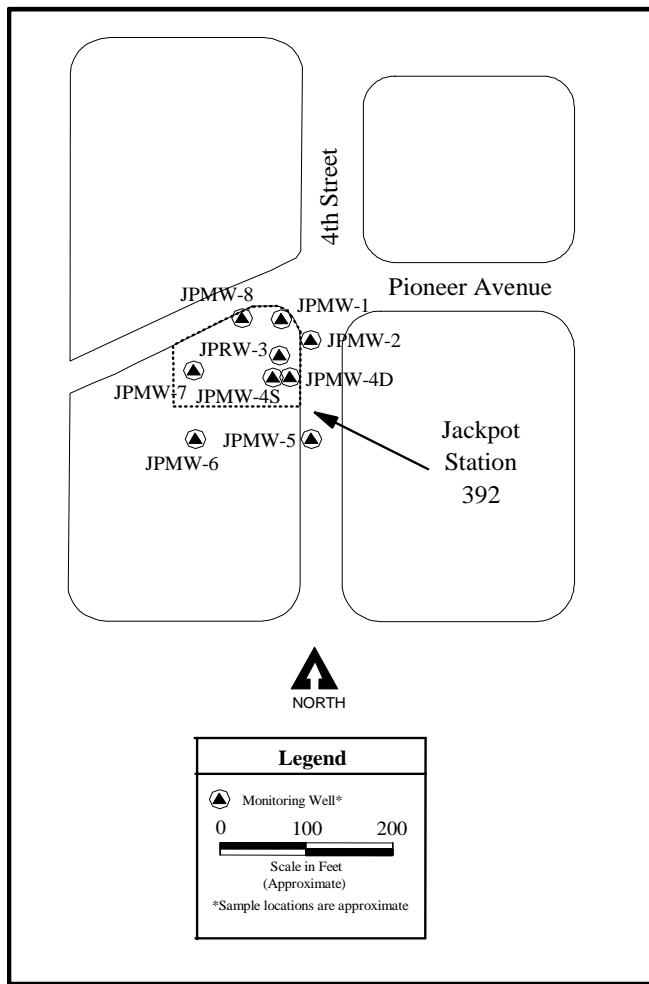


Figure 2. Montesano Groundwater Investigation - Sample Locations

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. Upon 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 picked up by the courier to Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Environmental Laboratory protocol (Ecology, 2003).

Purge water from the wells was collected and stored at a secure facility in 55-gallon drums. This purge water was transported and disposed of in accordance with Washington State Dangerous Waste Regulations (Chapter 173-340 WAC).

## Laboratory

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Analytes, analytical methods, and detection limits for both field and laboratory parameters are listed in Table 1. All groundwater samples were analyzed for gasoline-range hydrocarbons of benzene, toluene, ethylbenzene, and xylene (BTEX) as well as total petroleum hydrocarbons as gasoline (TPH-G). In March 2005, three samples were analyzed for volatile organics (VOCs).

Table 1: Field and Laboratory Methods

Parameter	Method	Reference	Reporting Limit
<i>Field</i>			
Water Level	Solinst Water Level Meter	NA	0.03 feet
pH	Orion 25A Field Meter	NA	0.1 std. units
Temperature	YSI 3510 Temperature Probe	NA	0.1 °C
Specific Conductance	YSI 3520 Conductivity Cell	NA	10 umhos/cm
<i>Laboratory</i>			
BTEX	EPA SW-846 Method 8021B	U.S. EPA 1996	1 ug/L
TPH-G	TPH-Gx	Ecology 2003	0.14 mg/L
VOCs	EPA SW-846 Method 8260B	U.S. EPA 1996	1-5 ug/L



## 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 are also influenced by the natural variability of the concentrations in the media being sampled. Field duplicates were collected from wells JPRW-3 and MCSMW-33 during both sample rounds, as well as TSMW-2 in October 2004. These wells were selected to represent the range of concentrations found over the project area.

Table 2 shows the 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 (ug/L) for October 2004 and March 2005.

Sample ID	JPRW-3	JPRW-3A	RPD	MCS MW-33	MCS MW-33A	RPD	TSMW-2	TSMW-2A	RPD
	ug/L	ug/L	%	ug/L	ug/L	%	ug/L	ug/L	%
<i>October 2004</i>									
Benzene	17	9.8	54	980 J	1000 J	2	8500	12,200 J	36
Toluene	nd	nd	--	nd	nd	--	13,000 J	19,500 J	40
Ethylbenzene	55	33	50	nd	nd	--	1300	2000	42
m- & p-xylene	55	37	39	nd	nd	--	5300	8300	44
o-xylene	nd	nd	--	nd	nd	--	2000	3100	43
TPH-G	1400	970	36	220	230	4	81	130	47
<i>March 2005</i>									
Benzene	4.1	4.1	0	1500	1800	18	--	--	--
Toluene	nd	nd	--	nd	nd	--	--	--	--
Ethylbenzene	17	18	6	nd	56	--	--	--	--
m- & p-xylene	29	31	7	nd	nd	--	--	--	--
o-xylene	nd	nd	--	nd	nd	--	--	--	--
TPH-G	470	520	10	730	710	3	--	--	--

In October the RPD for duplicate samples from monitoring wells JPRW-3 and TSMW-2 ranged from 36% to 54%. In general, data met measurement quality objectives established in the Quality Assurance Project Plan (Marti, 2004). Field duplicates are expected to have higher variability because they incorporate environmental and sampling variability. RPD for duplicate samples from well MCSMW-33 were 2% to 4%. In March the RPD of duplicate samples was much smaller, with the majority of the calculated RPD being 10% or below as shown in Table 2.

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 it had been cleaned. BTEX and TPH-G were not detected in any of the rinsate blanks.

Overall, a review of the data quality control and quality assurance from laboratory case narratives indicates analytical performance was good. The reviews include descriptions of analytical methods, holding times, instrument calibration checks, blank results, surrogate recoveries, and laboratory control samples. No problems were reported that compromised the usefulness or validity of the sample results. In October 2004, due to the high BTEX concentrations, some results are qualified as estimates ('J') because the analyte concentrations exceeded the calibration curve. No data were rejected, and all results were 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)

## Results

### Field Observations

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Total depth and depth-to-water of each monitoring well were measured prior to sampling. pH and specific conductivity readings measured at the time of sampling, as well as the total purge volume, are listed in Table 3. Temperature measurements recorded during purging were collected for comparative purposes only and have not been included in Table 3. Because they are measured in a flow cell which is influenced by ambient air conditions they are not considered to be representative of actual groundwater conditions.

Completion depths for the monitoring wells ranged from approximately 8 to 25 feet, with depth-to-water ranging from 3.18 to 17.13 feet below the measuring point in October 2004 and 2.67 to 16.70 feet in March 2005. Water levels fluctuated less than one foot at the north end of the project area to over three feet in the lower southeast part of the project area. A groundwater flow pattern for the project area is shown in Figure 3. The location of the water-table contours was determined using a geostatistical gridding method known as kriging which was applied to the groundwater elevation data for March 2005. The groundwater flow direction is approximately perpendicular to the contours. The overall flow direction appears to be to the south and southeast, toward the Chehalis River.

During the monitoring period, the pH of groundwater had an average range of 6.1 to 6.7. Specific conductivity measurements ranged from 104 to 495 umhos/cm over the monitoring period. Groundwater temperatures measured in the flow cell averaged 17.9°C in October and 15.1°C in March.

Although the monitoring wells were purged at a low flow rate, water levels dropped in several wells at Jackpot Station 392 and P.J. MaxiMart to the point that the pump had to be shut off to allow the water in the wells to recover. Jackpot Station well RW-3 (JPRW-3) recovers at such a slow rate that in March 2005 the well was allowed 36 hours to recover before it was sampled. Well logs in these two areas indicate that the site geology in the screened interval is composed of silt and silty-sands.

Wells at Grays Harbor Grange (GSMW-2 and GSMW-3) and Montesano City Shop (MCSMW-33) had strong petroleum odors. A visible sheen was present on the surface of the purge water from wells at Tony's Short Stop (TSMW-2), Brumfield-Twidwell (BTMW-2), and Key Bank (KBMW-3). Free-phase petroleum product was in the groundwater in well MW-2 (KBMW-2) at Key Bank (Sterling).

Table 3: Summary of Field Parameter Results for October 2004 and March 2005

Monitoring Well Sample ID	Total Depth (feet) <sup>1</sup>	Depth to Water (feet) <sup>1</sup>		pH (standard units)		Specific Conductivity (umhos/cm)		Purge Volume (gallons)	
		10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05
GHCSMW-1	7.6	3.18	2.67	6.0	6.2	250	203	1.5	3
JPMW-1	14.5	8.28	--	6.3	--	495	--	2	--
JPMW-2	15	7.55	7.43	6.7	7.0	465	333	2.5	2
JPRW-3	14.5	8.78	8.40	5.8	6.4	357	443	3	4
JPMW-4S	15	9.62	9.57	5.3	6.0	333	318	2	2.5
JPMW-4D	25	16.17	13.55	6.3	6.8	313	285	2.5	2.5
JPMW-5	15.5	8.33	--	5.4	--	104	--	2	--
JPMW-6	14.5	6.58	--	5.7	--	188	--	1.5	--
JPMW-7	15.5	9.20	--	5.7	--	171	--	3.5	--
JPMW-8	13.5	7.53	--	6.1	--	452	--	2	--
BTMW-1	25	13.95	12.16	6.4	6.5	117	113	6	3.5
BTMW-2	24.9	13.91	12.21	5.4	6.7	360	158	5	5
BTMW-3	22.3	12.24	11.56	6.5	6.6	205	213	4.5	5
KBMW-1	21.9	17.13	16.70	6.5	6.4	208	204	2.5	3
KBMW-2	20.16	--	~15.5	--	--	--	--	--	--
KBMW-3	20.1	16.18	14.83	6.6	6.8	415	428	3	3
PJMW-1	19.8	11.67	--	6.3	--	238	--	4	--
PJMW-2	20	12.01	--	6.2	--	122	--	4	--
PJMW-3	19.9	12.66	--	6.1	--	132	--	4	--
PJMW-4	20	11.65	11.02	6.0	6.4	146	149	3	5.5
PJMW-5	16.5	13.16	--	6.3	--	148	--	1	--
PJMW-6	22.5	11.52	9.40	6.4	6.9	133	146	3.5	8
PJMW-7	18	8.23	7.44	6.6	7.1	186	187	3.5	8
PJMW-8	18.5	9.20	--	6.2	--	193	--	3	--
PJMW-9	18	8.66	--	6.1	--	357	--	2.5	--
PJMW-10	15	7.32	--	5.6	--	219	--	3	--
TSMW-2	19.2	11.95	--	5.8	--	340	--	2	--
GSMW-1	22.7	10.64	9.47	6.1	6.8	202	161	3	3.5
GSMW-2	21.7	9.88	9.16	6.1	6.9	275	280	5	5
GSMW-3	17.7	6.75	5.21	6.5	6.8	324	347	2.5	5
MCSMW-31	12.5	7.91	4.30	6.5	6.7	332	340	3	3.5
MCSMW-32	12.5	8.40	4.82	6.3	6.8	274	314	3	4
MCSMW-33	12.1	6.43	5.90	6.0	6.9	286	329	3	4

<sup>1</sup> Measured from top of PVC casing.

-- Not measured.

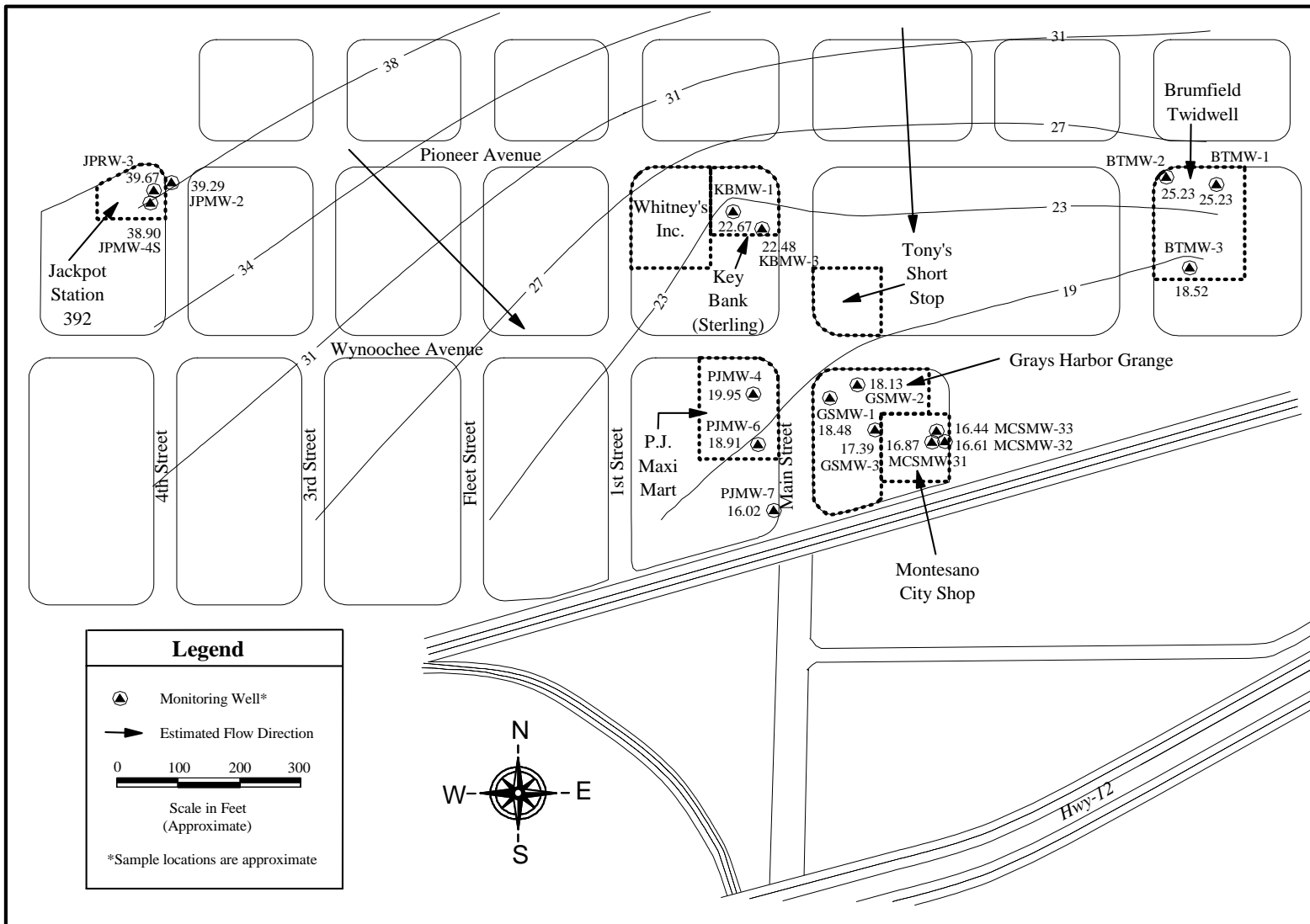


Figure 3. Monteseano Groundwater Investigation - Water Table Elevation (feet), March 2005

## Analytical Results

Analytical results, as well as Model Toxic Control Act (MTCA) cleanup standards, for BTEX and TPH-G are summarized in Tables 4 through 8. For comparison, a summary of historical data for this project is presented in Appendix B. Volatile organic results are summarized in Table 6.

Project results have been separated into three potential contaminant source areas as identified in a previous study (GeoEngineers, 2005): Tony's Short Stop/Grays Harbor Grange, Key Bank (Sterling)/Whitney's Inc., and Brumfield-Twidwell. Results for these potential source areas are also shown in Figure 4. Table 8 presents results for the remaining wells, which are located at Jackpot Station 392, P.J. MaxiMart, Montesano City Shop, and Grays Harbor County Shop.

### Tony's Short Stop/Grays Harbor Grange

The highest concentrations of petroleum-related contamination in the project area was detected in groundwater samples collected from monitoring well MW-2 (TSMW-2) at Tony's Short Stop in October 2004. Water purged from this well had a strong petroleum odor and sheen on the water surface. BTEX and TPH-G concentrations, which are shown in Table 4, exceeded MTCA Method A cleanup standards. This well could not be sampled in March because of water and mud that had accumulated in the outer protective casing.

Table 4: BTEX and TPH-G Results (ug/L) for Tony's Short Stop and Grays Harbor Grange for October 2004 and March 2005

	Benzene (ug/L)		Toluene (ug/L)		Ethylbenzene (ug/L)		m- & p-Xylene (ug/L)		o-Xylene (ug/L)		WTPH-G (ug/L)	
MTCA Cleanup Std	5 ug/L		1000 ug/L		700 ug/L		1000 ug/L				800 (1000*) ug/L	
Sample ID	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05
<i>Tony's Short Stop</i>												
TSMW-2	<b>8500</b>	--	<b>13000 J</b>	--	<b>1300</b>	--	<b>5300</b>	--	<b>2000</b>	--	<b>81,000</b>	--
<i>Grays Harbor Grange</i>												
GSMW-1	<b>5.1</b>	10 U	1 U	10 U	<b>1.3</b>	<b>91</b>	<b>9.6</b>	<b>180</b>	1 U	<b>120</b>	<b>110 J</b>	<b>2200</b>
GSMW-2	<b>54</b>	<b>140</b>	2 U	10 U	2 U	<b>15</b>	4 U	20 U	2 U	10 U	140 U	<b>170</b>
GSMW-3	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U

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

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

**Bold** – Analyte was detected.

-- Not sampled.

Monitoring wells at the Grays Harbor Grange, MW-1 (GSMW-1) and MW-2 (GSMW-2) which are downgradient of Tony's Short Stop, had much lower BTEX and TPH-G concentrations. In well GSMW-1, benzene slightly exceeded the cleanup standard in October, while TPH-G exceeded the standard in March. Benzene was the primary contaminant detected in GSMW-2 at concentrations above the cleanup standard during both sample rounds. Ethylbenzene and xylene were also detected, but at concentrations below the cleanup standards.

### Key Bank (Sterling)/Whitney's Inc.

Two of the three monitoring wells located at Key Bank (Sterling) also had high concentrations of BTEX and TPH-G in the groundwater samples as shown in Table 5. Monitoring well MW-2 (KBMW-2) which had free-phase petroleum product in the groundwater exceeded MTCA cleanup standards for benzene, toluene, xylene, and TPH-G. Water purged from well MW-3 (KBMW-3) had a strong petroleum odor and sheen on the water surface. Benzene and TPH-G exceeded the cleanup standards in this well during both sample rounds. Benzene and ethylbenzene were also detected in well MW-1 (KBMW-1) at concentrations near the practical quantitation limit of 1 ug/L.

Table 5: BTEX and TPH-G Results (ug/L) for Key Bank (Sterling) for October 2004 and March 2005

Sample ID	Benzene (ug/L)		Toluene (ug/L)		Ethylbenzene (ug/L)		m- & p-Xylene (ug/L)		o-Xylene (ug/L)		WTPH-G (ug/L)	
	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05
MTCA Cleanup Std	5 ug/L		1000 ug/L		700 ug/L		1000 ug/L				800 (1000*) ug/L	
KBMW-1	1 U	<b>2.2</b>	1 U	1 U	1 U	<b>0.82 J</b>	2 U	2 U	1 U	1 U	140 U	140 U
KBMW-2	--	<b>338</b>	--	<b>3320</b>	--	<b>654</b>	--	<b>2290</b>	--	<b>977</b>	--	<b>56,000</b>
KBMW-3	<b>160</b>	<b>118</b>	<b>82</b>	<b>58 J</b>	<b>430</b>	<b>331</b>	<b>700 J</b>	<b>354</b>	<b>280</b>	<b>218</b>	<b>12000</b>	<b>4700</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** – Analyte was detected.

-- Not sampled.

In March, samples were also collected for volatile organics from the three Key Bank (Sterling) wells. The Key Bank site is located next to Whitney's Inc. which has an auto repair and painting shop. In addition to other petroleum related contaminants, low concentrations of some chlorinated compounds, such as cis-1,2-dichloroethene (4.2 J ug/L) and tetrachloroethene (0.69 J to 8.1 J ug/L) were detected in the wells as shown in Table 6.

Table 6: VOC Results (ug/L) for Key Bank (Sterling) for March 2005

Volatile Organics	Monitoring Well Sample ID		
	KBMW-1	KBMW-2	KBMW-3
Chloromethane	1 U	<b>2.5 J</b>	<b>1.8 J</b>
Acetone	10 U	<b>73 J</b>	<b>55 J</b>
2-Butanone	2 U	<b>27 J</b>	2 UJ
Cis-1,2-Dichloroethene	1 U	1 UJ	<b>4.2 J</b>
1,2-Dichloroethane	<b>0.99 J</b>	<b>3.5 J</b>	<b>1.4 J</b>
4-Methyl-2-Pentanone	2 U	2 UJ	<b>3.6 J</b>
Tetrachloroethene	<b>0.69 J</b>	<b>8.1 J</b>	1 UJ
1,2-Dibromoethane (EDB)	2 U	<b>3.3 J</b>	2 UJ
Isopropylbenzene (Cumene)	<b>1.8</b>	<b>60</b>	<b>49 J</b>
n-Propylbenzene	<b>1.3</b>	<b>194</b>	<b>81</b>
1,3,5-Trimethylbenzene	<b>0.18 J</b>	<b>358</b>	<b>93</b>
Tert-Butylbenzene	<b>0.14 J</b>	1 UJ	<b>0.51 J</b>
1,2,4-Trimethylbenzene	<b>0.32 J</b>	<b>1160</b>	<b>222</b>
Sec-Butylbenzene	<b>1.6</b>	<b>23 J</b>	<b>13 J</b>
p-Isopropyltoluene	<b>0.18 J</b>	<b>27 J</b>	<b>5.7 J</b>
n-Butylbenzene	<b>0.43 J</b>	<b>46 J</b>	<b>12 J</b>
Naphthalene	1 U	<b>645</b>	<b>168</b>

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

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

UJ – Analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

**Bold** – Analyte was detected.

## Brumfield-Twidwell

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Of the three wells sampled at the Brumfield-Twidwell site, only monitoring well MW-2 (BTMW-2) contained petroleum-related contaminants in the groundwater samples as shown in Table 7. This well had a strong petroleum odor and sheen on the surface of the purged water. Of the contaminants detected, benzene and xylene exceeded the cleanup standards in October, while the standard for TPH-G was exceeded during both sample rounds.

Table 7: BTEX and TPH-G Results (ug/L) for Brumfield-Twidwell for October 2004 and March 2005

	Benzene (ug/L)		Toluene (ug/L)		Ethylbenzene (ug/L)		m- & p-Xylene (ug/L)		o-Xylene (ug/L)		WTPH-G (ug/L)	
MTCA Cleanup Std	5 ug/L		1000 ug/L		700 ug/L		1000 ug/L				800 (1000*) ug/L	
Sample ID	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05
BTMW-1	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U
BTMW-2	<b>75</b>	20 U	<b>23</b>	20 U	<b>430</b>	<b>58</b>	<b>1280</b>	<b>300</b>	<b>310</b>	<b>160</b>	<b>14,000</b>	<b>1500 J</b>
BTMW-3	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U

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

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

**Bold** – Analyte was detected.



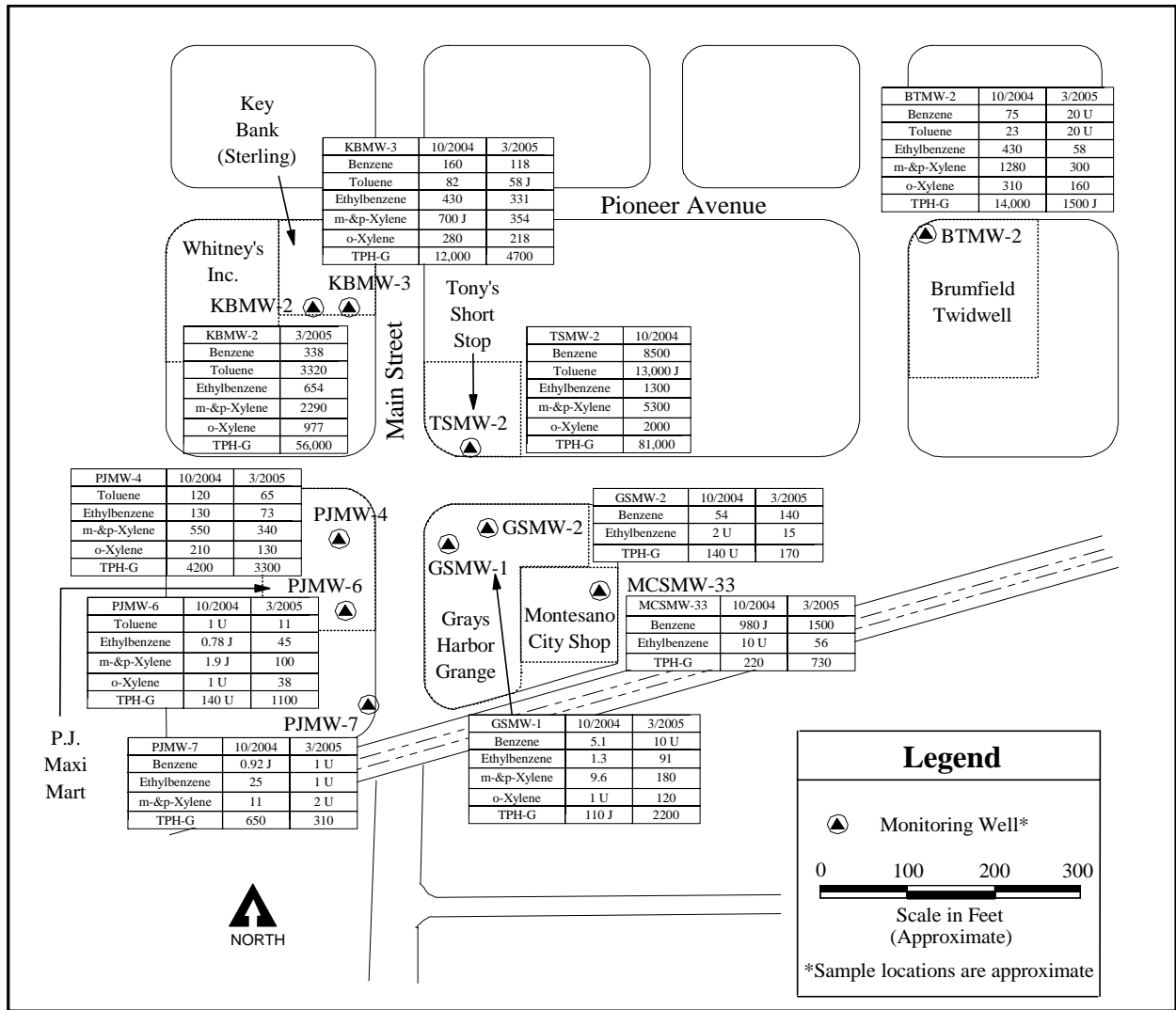


Figure 4: Montesano Groundwater Investigation, BTEX and TPH-G Concentrations (ug/L)

## Remaining Wells

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Monitoring wells were also sampled at Jackpot Station 392, P.J. MaxiMart, Montesano City Shop, and Grays Harbor County Shop. Jackpot Station and P.J. MaxiMart sites have had groundwater monitoring as part of recent remedial activities. Since petroleum contaminant concentrations at these two sites in October 2004 were similar to those reported by consultants in April 2004, only select wells were sampled at these locations in March 2005.

The most recent historical data for most of the project area sites has been included as Appendix B. Analytical results for the remaining wells for this monitoring period are shown in Table 8.

Petroleum-related contaminants were detected in four of the nine wells at the Jackpot Station. Groundwater cleanup levels were exceeded for benzene in three of those wells and for TPH-G in two of the wells. Samples from well JPMW-4S exceeded the cleanup standard for benzene in March, and the TPH-G standard during both sample rounds. Benzene and TPH-G exceeded the cleanup standards in well RW-3 (JPRW-3) in October. Because the March samples from this well were collected 36 hours after the well was purged dry, the data have been qualified. Benzene also was detected above the cleanup standards in the deep well (JPMW-4D). BTEX and TPH-G were not detected above the laboratory reporting limits in the remaining wells.

BTEX and TPH-G were detected in samples from three of the ten wells at P.J. MaxiMart. The highest concentrations were detected in well MW-4 (PJMW-4). Wells MW-6 (PJMW-6) and MW-7 (PJMW-7), which are part of the operating vacuum extraction system, had much lower concentrations. The cleanup standard for TPH-G was exceeded in well PJMW-4 during both sample rounds and PJMW-6 in March. BTEX and TPH-G were not detected above the laboratory reporting limits in the remaining wells.

Of the three wells sampled at the Montesano City Shop, petroleum-related contaminants were only detected in well MW-33 (MCSMW-33). Benzene was the primary contaminant detected, along with lower concentrations of ethylbenzene and TPH-G. Benzene concentrations in this well exceeded the cleanup standard of 5 ug/L.

Table 8: BTEX and TPH-G Results (ug/L) for Jackpot Station, P.J. MaxiMart, Montesano City Shop, and Grays Harbor County Shop for October 2004 and March 2005

Sample ID	Benzene (ug/L)		Toluene (ug/L)		Ethylbenzene (ug/L)		m- & p-Xylene (ug/L)		o-Xylene (ug/L)		WTPH-G (ug/L)	
	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05
<i>Jackpot Station</i>												
JPMW-1	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
JPMW-2	1 U	1 U	1 U	1 U	<b>3.5</b>	1 U	2 U	2 U	1 U	1 U	<b>150</b>	140 U
JPRW-3	<b>17</b>	<b>4.1 J</b>	1 U	1 U	<b>55</b>	<b>17 J</b>	<b>55</b>	<b>29 J</b>	1 U	1 U	<b>1400</b>	<b>470 J</b>
JPMW-4S	1 U	<b>10</b>	1 U	5 U	<b>11</b>	<b>6.3</b>	2 U	10 U	<b>2</b>	5 U	<b>2100</b>	<b>1700</b>
JPMW-4D	<b>12</b>	<b>15</b>	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U
JPMW-5	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
JPMW-6	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
JPMW-7	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
JPMW-8	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
<i>P.J. MaxiMart</i>												
PJMW-1	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
PJMW-2	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
PJMW-3	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
PJMW-4	10 U	10 U	<b>120</b>	<b>65</b>	<b>130</b>	<b>73</b>	<b>550</b>	<b>340</b>	<b>210</b>	<b>130</b>	<b>4200</b>	<b>3300</b>
PJMW-5	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
PJMW-6	1 U	5 U	1 U	<b>11</b>	<b>0.78 J</b>	<b>45</b>	<b>1.9 J</b>	<b>100</b>	1 U	<b>38</b>	140 U	<b>1100</b>
PJMW-7	<b>0.92 J</b>	1 U	1 U	1 U	<b>25</b>	1 U	<b>11</b>	2 U	1 U	1 U	<b>650</b>	<b>310</b>
PJMW-8	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
PJMW-9	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
PJMW-10	1 U	--	1 U	--	1 U	--	2 U	--	1 U	--	140 U	--
<i>Montesano City Shop</i>												
MCSMW-31	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U
MCSMW-32	1 U	1 U	<b>3.7</b>	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U
MCSMW-33	<b>980 J</b>	<b>1500</b>	10 U	50 U	10 U	<b>56</b>	20 U	100 U	10 U	50 U	<b>220</b>	<b>730</b>
<i>Grays Harbor County Shop</i>												
GHCSMW-1	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U

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

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

**Bold** – Analyte was detected.

-- Not sampled.

## Discussion and Conclusions

The highest concentrations of gasoline-range petroleum hydrocarbons were detected in monitoring wells at the three potential source areas: Tony's Short Stop/ Grays Harbor Grange, Key Bank (Sterling)/Whitney's Inc., and Brumfield-Twidwell. BTEX and TPH-G concentrations in samples collected from these wells exceeded the Model Toxic Control Act (MTCA) cleanup standards. Table 9 and Figure 5 provide a summary of those wells where contaminant concentrations exceeded the cleanup standards.

Table 9: BTEX and TPH-G Concentrations (ug/L) that Exceeded MTCA Method A Cleanup Standards for Groundwater during October 2004 and March 2005

MTCA Cleanup Standards	Benzene (ug/L)		Toluene (ug/L)		Ethylbenzene (ug/L)		m- & p-Xylene (ug/L)		o-Xylene (ug/L)		WTPH-G (ug/L)	
	5 ug/L		1000 ug/L		700 ug/L		1000 ug/L				800 (1000*) ug/L	
Monitoring Well	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05	10/04	3/05
TSMW-2	<b>8500</b>	--	<b>13,000 J</b>	--	<b>1300</b>	--	<b>5300</b>	--	<b>2000</b>	--	<b>81,000</b>	--
GSMW-1	<b>5.1</b>	10 U	1 U	10 U	1.3	91	9.6	180	1 U	120	110 J	<b>2200</b>
GSMW-2	<b>54</b>	<b>140</b>	2 U	10 U	2 U	15	4 U	20 U	2 U	10 U	140 U	170
KBMW-2	--	<b>338</b>	--	<b>3320</b>	--	654	--	<b>2290</b>	--	977	--	<b>56,000</b>
KBMW-3	<b>160</b>	<b>118</b>	82	58 J	430	331	700 J	354	280	218	<b>12,000</b>	<b>4700</b>
BTMW-2	<b>75</b>	20 U	23	20 U	430	58	<b>1280</b>	300	310	160	<b>14,000</b>	<b>1500 J</b>
JPRW-3	<b>17</b>	4.1	1 U	1 U	55	17	55	29	1 U	1 U	<b>1400</b>	470
JPMW-4S	1 U	<b>10</b>	1 U	5 U	11	6.3	2 U	10 U	2	5 U	<b>2100</b>	<b>1700</b>
JPMW-4D	<b>12</b>	<b>15</b>	1 U	1 U	1 U	1 U	2 U	2 U	1 U	1 U	140 U	140 U
PJMW-4	10 U	10 U	120	65	130	73	550	340	210	130	<b>4200</b>	<b>3300</b>
PJMW-6	1 U	5 U	1 U	11	0.78 J	45	1.9 J	100	1 U	38	140 U	<b>1100</b>
MCSMW-33	<b>980 J</b>	<b>1500</b>	10 U	50 U	10 U	56	20 U	100 U	10 U	50 U	220	730

\* MTCA Method A cleanup level for TPH-G is 1,000 ug/L if benzene is not detectable in groundwater.

-- Not sampled

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

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

**Bold** – Analyte was detected above MTCA Method A cleanup standards.

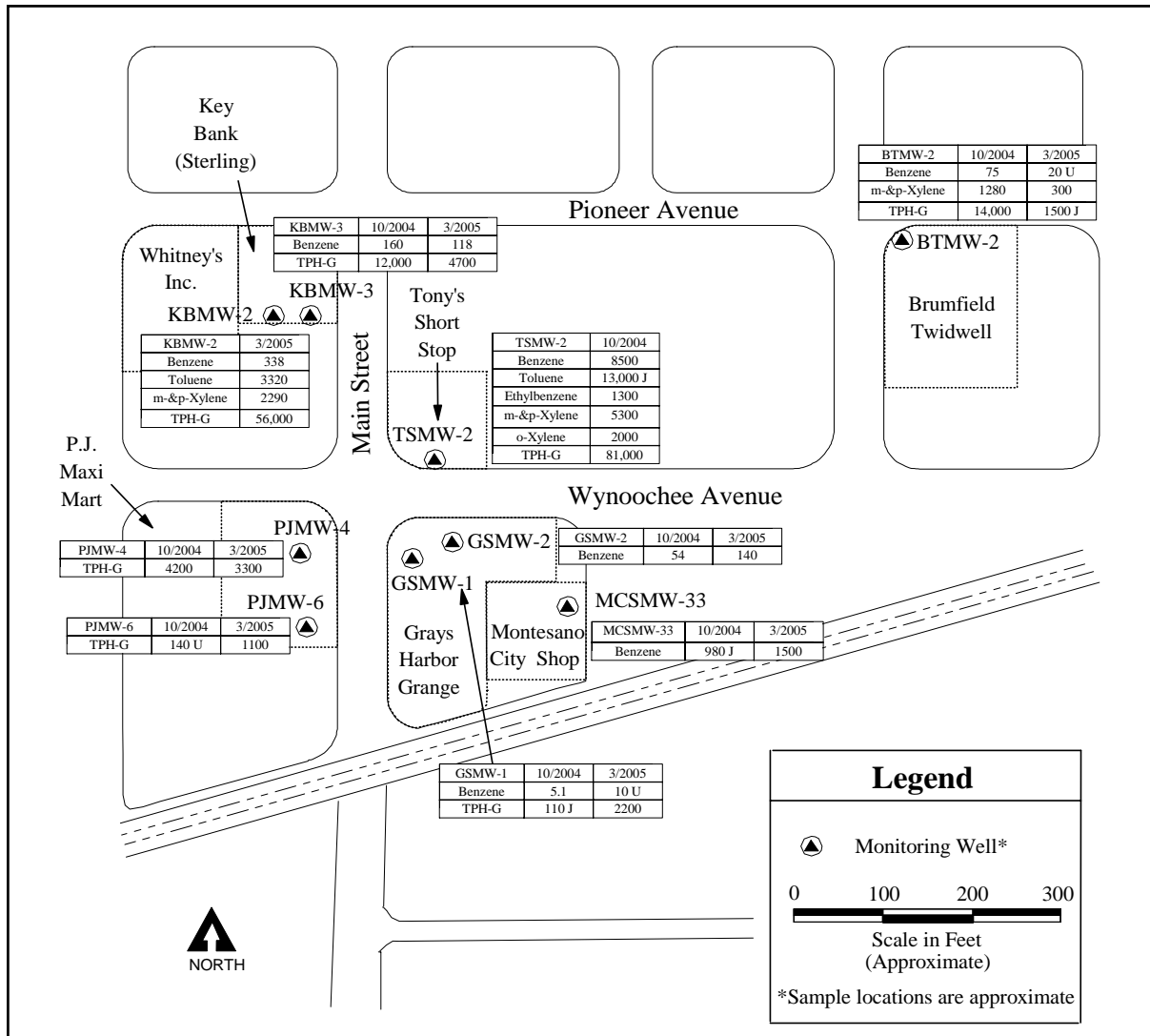


Figure 5: Montezano Groundwater Investigation, BTEX and TPH-G Concentrations (ug/L) that Exceed MTCA Method A Cleanup Standards

Benzene concentrations exceeded the MTCA Method A cleanup standard of 5 ug/L in ten of the sampled wells over the project area. Benzene concentrations in these wells ranged from 5.1 to 8500 ug/L. TPH-G concentrations also exceeded the cleanup standard of 800 ug/L in nine of the sampled wells. TPH-G concentrations ranged from 1100 to 81,000 ug/L. Overall, the highest concentrations of gasoline-range petroleum hydrocarbons were detected in monitoring wells at the three potential source areas. The one exception is the benzene concentrations detected in the Montesano City Shop well MW-33 (MCSMW-33). The elevated benzene concentrations in the absence of the other BTEX may indicate the front edge of a contaminant plume.

Water quality results over the monitoring period confirm that the surficial aquifer throughout the project area is contaminated with gasoline-range petroleum hydrocarbons. The contaminants present at the various sites were likely released from leaking tanks and piping over time. Because of the potential for contaminants to migrate downgradient from source areas, additional investigations are being conducted to better define the nature and extent of the contamination at the three potential source areas.

## Recommendations

Based on the results of this monitoring, the following recommendations are provided:

- Wells MW-1 (TSMW-1) and MW-2 (TSMW-2) at Tony's Short Stop should be refurbished or decommissioned. Additional investigation of this site, including the installation of new monitoring wells, is needed to better determine the extent of contamination.
- Additional investigation is needed at the Key Bank (Sterling) site to determine the source of free-phase petroleum product in the groundwater in monitoring well MW-2 (KBMW-2).
- Sampling should continue at monitoring wells associated with, and downgradient of, the three potential source areas – Tony's Short Stop/Grays Harbor Grange, Key Bank (Sterling)/Whitney's Inc., and Brumfield-Twidwell – to collect additional data from wells that had contaminants exceeding MTCA cleanup standards.

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## Appendix A. Well Construction Details

Table A-1. Montesano Well Construction Details

Monitoring Well	Address	Well Installed	Well #	Well Type	Total Depth (feet)	Screen Interval (feet)
GHCSMW-1	310 Spruce Ave.	1991	MW-1	2" PVC	8	2.5-7.5
JPMW-1	501 W. Pioneer	2004	MW-1	2" PVC	16.5	4.5-14.5
JPMW-2		2004	MW-2	2" PVC	15.5	4.5-14.5
JPRW-3		2004	RW-3	4" PVC	14.5	5-15
JPMW-4S		2004	MW-4S	2" PVC	16.5	5-15
JPMW-4D		2004	MW-4D	2" PVC	26.5	20-25
JPMW-5		2004	MW-5	2" PVC	15.5	5-15
JPMW-6		2004	MW-6	2" PVC	14.5	4.5-14.5
JPMW-7		2004	MW-7	2" PVC	15.5	5.5-15.5
JPMW-8		2004	MW-8	2" PVC	15.5	5-13.5
BTMW-1	301 E. Pioneer	2000	MW-1	2" PVC	25	10-25
BTMW-2		2000	MW-2	2" PVC	25	10-25
BTMW-3		2000	MW-3	2" PVC	25	10-25
KBMW-1	301 S. Main	1998	MW-1	2" PVC	20	10-20
KBMW-2		1998	MW-2	2" PVC	20	10-20
KBMW-3		1998	MW-3	2" PVC	20	10-20
PJMW-1	405 S. Main	1995	MW-1	4" PVC	20	5-20
PJMW-2		1995	MW-2	4" PVC	20	5-20
PJMW-3		1995	MW-3	4" PVC	20	5-20
PJMW-4		1995	MW-4	4" PVC	20	8-20
PJMW-5		1995	MW-5	4" PVC	16	6-16
PJMW-6		1995	MW-6	4" PVC	20	3-20
PJMW-7		1995	MW-7	4" PVC	18	2-17.5
PJMW-8		1995	MW-8	2" PVC	18.5	3.5-18.5
PJMW-9		1995	MW-9	2" PVC	18	3.5-18.5
PJMW-10		1995	MW-10	2" PVC	15	5-15
TSMW-2	326 S. Main	1996	MW-2	2" PVC	21	5-20
GSMW-1	412 S. Main	2003	MW-1	2" PVC	22	7-22
GSMW-2		2003	MW-2	2" PVC	21	7-21
GSMW-3		2003	MW-3	2" PVC	17	6-17
MCSMW-31	201 S. River	--	MW-31	2" PVC	12.42	--
MCSMW-32		--	MW-32	2" PVC	11.87	--
MCSMW-33		--	MW-33	2" PVC	12.11	--



## Appendix B. Historical Data

Table B-1. Historical BTEX and TPH-G Results (ug/L)

Monitoring Well	Date of Last Samples	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylene (ug/L)	WTPH-G (ug/L)
GHCSMW-1*						
JPMW-1	4/2004	1 U	1 U	1 U	3 U	50 U
JPMW-2	4/2004	1 U	1 U	<b>2</b>	<b>5</b>	<b>88</b>
JPRW-3	4/2004	<b>12</b>	1 U	<b>32</b>	<b>54</b>	<b>870</b>
JPMW-4S	4/2004	<b>18</b>	1 U	<b>14</b>	<b>6</b>	<b>1600</b>
JPMW-4D	4/2004	<b>12</b>	1 U	1 U	3 U	50 U
JPMW-5	4/2004	1 U	1 U	1 U	3 U	50 U
JPMW-6	4/2004	1 U	1 U	1 U	3 U	50 U
JPMW-7	4/2004	1 U	1 U	1 U	3 U	50 U
JPMW-8	4/2004	1 U	1 U	1 U	3 U	50 U
BTMW-1	12/2002	1 U	<b>4.1</b>	1 U	1 U	ND
BTMW-2	12/2002	<b>35</b>	<b>170</b>	<b>430</b>	<b>2,400</b>	<b>30,000</b>
BTMW-3	12/2002	1 U	1 U	1 U	1 U	ND
BTMW-4	12/2002	1 U	1 U	1 U	1 U	ND
KBMW-1*						
KBMW-2*						
KBMW-3*						
PJMW-1	4/2004	1 U	1 U	1 U	3 U	50 U
PJMW-2	4/2004	1 U	1 U	1 U	3 U	50 U
PJMW-3	4/2004	1 U	1 U	1 U	3 U	50 U
PJMW-4	4/2004	<b>14</b>	<b>540</b>	<b>390</b>	<b>2,200</b>	<b>12,000</b>
PJMW-5	4/2004	1 U	1 U	1 U	3 U	50 U
PJMW-6	4/2004	<b>1</b>	<b>16</b>	<b>24</b>	<b>74</b>	<b>450</b>
PJMW-7	4/2004	1 U	1 U	<b>1</b>	3 U	<b>180</b>
PJMW-8	4/2004	1 U	1 U	1 U	3 U	50 U
PJMW-9	4/2004	1 U	1 U	1 U	3 U	50 U
PJMW-10	4/2004	1 U	1 U	1 U	3 U	50 U
TSMW-1	7/1998	<b>21,750</b>	<b>23,425</b>	<b>2,650</b>	<b>15,500</b>	<b>192,250</b>
TSMW-2	7/1998	<b>11,200</b>	<b>10,300</b>	<b>780</b>	<b>4,580</b>	<b>79,600</b>
GSMW-1	1/2004	1 U	1 U	1 U	1 U	100 U
GSMW-2	1/2004	<b>1000</b>	<b>6.9</b>	1 U	<b>170</b>	<b>2700</b>
GSMW-3	1/2004	<b>3.3</b>	1 U	1 U	1 U	<b>270</b>
MCSMW-31	6/1996	<b>1570</b>	<b>797</b>	<b>101</b>	<b>274</b>	<b>3000</b>
MCSMW-32	6/1996	<b>4140</b>	<b>1460</b>	<b>249</b>	<b>317</b>	<b>6760</b>
MCSMW-33	6/1996	<b>6280</b>	<b>2700</b>	<b>763</b>	<b>2770</b>	<b>19,100</b>

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

**Bold** = Analyte was detected.

\* = Data are not available for these wells.