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# NO-PURGE GROUNDWATER SAMPLING

An Approach for Long-Term Monitoring

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*A SUMMARY OF RESEARCH RESULTS FROM API'S SOIL & GROUNDWATER TECHNICAL TASK FORCE*

## Executive Summary

Well purging prior to groundwater sampling has been a standard practice for many years. Recently, however, comparative research shows that samples collected without prior purging of the well ("No-Purge" sampling) are not statistically different or provide conservative results compared to samples from wells which were purged using conventional techniques. Key results are:

### APPLICABILITY DEMONSTRATED BY STUDIES *(See pgs. 2, 8)*

- Fuel hydrocarbon sites
- Wells without NAPL
- Wells that are unconfined and are screened through the water table
- Wells that have prior monitoring data from conventional sampling

### COMPARISON TO OTHER METHODS *(See pg. 9)*

- No-Purge sampling provided results comparable to conventional sampling methods at lower cost.
- In the comparison studies, No-Purge *was not* compared to low-flow sampling.

### RECOMMENDED USE *(See pgs. 2, 8)*

- No-Purge sampling should be considered for situations where high-precision sampling is not needed, such as for routine monitoring at UST sites.
- It should be supplemented with conventional or low-flow techniques for key datasets.

## Six Comparative Studies *(See pgs. 3-7)*

Six key comparative studies have been performed which compare No-Purge sampling to conventional sampling with purging. Typical study conditions include unconsolidated, unconfined aquifers, with wells typically screened across the air/water interface.

## Key Conclusions from Six Studies *(See pgs. 3-5)*

*"..samples collected after standard well purging do not systematically have higher contaminant concentrations…there is a high probability that on average, unpurged sample concentrations exceed purged sample concentrations."*

Study 1, California RWQCB, Region 8 Orange County Health Care Agency/Unocal.

*"No-purge sampling methodology will not affect the overall variability in chemical data, and will provide a comparable, and in many cases more conservative estimate of petroleum hydrocarbons in groundwater."*

Study 2, Western States Petroleum Association.

*"No purging is recommended for routine sampling, while purging is recommended when a critical decision is to be made (i.e., no further action or closure)."*

Study 3, Shell Oil and EnviroTrac:Three-State Study.

*"…within a 99% confidence interval, there was no significant difference between concentrations in samples collected without well purging to samples collected after well purging."*

Study 4, Shell Oil and EnviroTrac:New York Study.

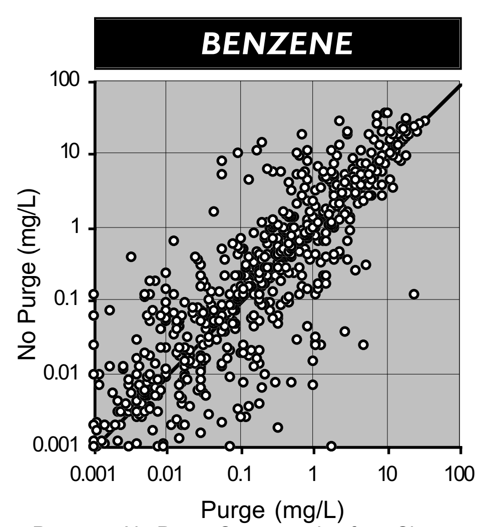
*"Clearly, if one were to estimate the location of the contaminant plume, or the magnitude of the BTEX concentration at any specific point there would not be a significant difference if these estimates were based upon the pre-purge rather than the post-purge values."*

Study 5, University of Massachusetts: Dartmouth Study.

*"…the practice of purging prior to sampling for testing does not appear to have strong justification in the environmental situations that are represented at least by the standard wells."*

Study 6, BP Amoco: Maryland Study.

## Data from Six Studies *(See pgs. 6-7)*

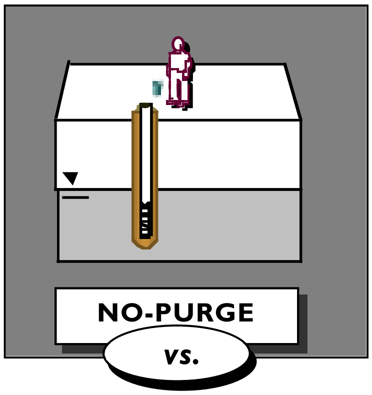



Purge vs. No-Purge Concentration from Six Studies Showing Regression Line of Log Purge vs. Log No-Purge (both in ug/L).
Slope: 0.99 $r^2 = 0.71$ n = 736

## WHAT IS NO-PURGE SAMPLING?

No-Purge sampling is defined in this API Research Bulletin as sampling groundwater from a well without any removal of water from the well prior to sampling. As described below, No-Purge sampling represents a different sampling approach than: i) conventional sampling with purging, and ii) low-flow sampling.

### *Focus of this bulletin*: USE OF NO-PURGE VS. CONVENTIONAL SAMPLING AT FUEL SITES.

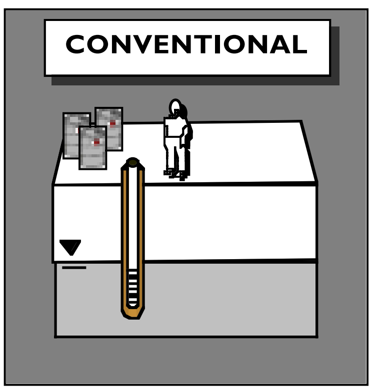



**METHOD:**
No-Purge sampling involves collecting a sample, typically by carefully lowering a bailer to the water table and allowing it to fill with minimal disturbance of the water column, without prior purging of the well.

**APPLICABILITY:**
Available data indicates that this method is applicable to sites with unconsolidated, unconfined water-bearing units, BTEX and MTBE contamination, and wells screened across the water table, with no non-aqueous phase hydrocarbon.

**ADVANTAGES:**
The method is quick, simple, inexpensive and may eliminate variability introduced by purging. Sampling costs may be as much as 50% lower due to time saved and from the elimination of purge water management and disposal costs. (Williams, K., Martinez, A., Daugherty, S., and Lundegard, P.D., 1996)

**DISADVANTAGES:**
Not applicable to all site conditions, especially sites with confined aquifers, or wells with submerged screens or free-phase. Data may not be acceptable to regulatory agency for critical decision making (e.g., site closure).



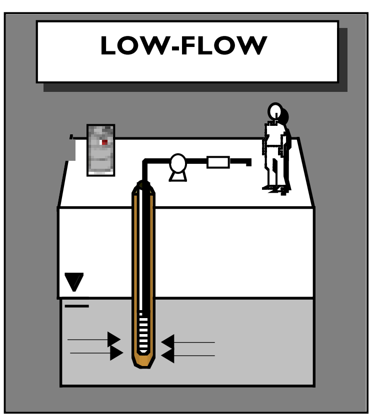

**METHOD:**
In conventional sampling, wells are purged of water in casing storage prior to sampling, by bailing or pumping 3 to 5 well casing volumes, and/or until temperature, specific conductance, and pH stabilize.

**APPLICABILITY:**
Applicable to most site conditions. The most commonly used method for UST sites, and still commonly used at sites under many other state and federal regulatory programs.

**ADVANTAGES:**
The method is commonly accepted by regulatory agencies, and does not require dedicated or highly specialized equipment. Yields representative results if performed in a manner to minimize agitation/aeration of samples.

**DISADVANTAGES:**
Variety of purging methodologies in common use can potentially result in sampler-induced variability in monitoring results. May result in significant drawdown and/or sample agitation that can alter sample chemistry. Purging also generates wastewater that must be managed.

### Other Sampling Methodologies (not evaluated in this bulletin)




**METHOD**:
Low-flow sampling (or "micropurging") assumes groundwater flow is horizontal and that pumping at a rate equal to aquifer seepage velocity will produce water from the formation only, with no mixing with water in casing storage. A pump, with the intake set within the screen interval, is pumped at a slow rate to minimize drawdown, until parameters such as temperature, specific conductance, pH, and dissolved oxygen (measured in a flow-through cell) have stabilized. The sample is then collected from the pump discharge. For low-flow sampling, dedicated pumps are preferred as they eliminate the disruption of the water column. Portable peristaltic pumps offer a possible alternative. However, peristaltic pumps are only effective when the water table is above the limit of suction lift (i.e., about 20 to 25 ft).

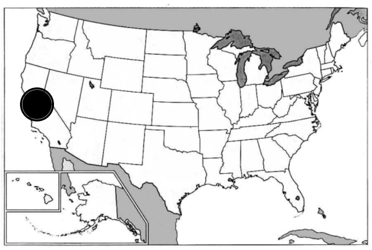
**APPLICABILITY:**
Applicable to most site conditions.

**ADVANTAGES:**
Research has shown that purging at lower rates with various types of pumps (peristaltic, low-speed submersibles, and bladder pumps) will produce low turbidity, high-quality samples (Puls and Paul, 1995). It is the preferred method for measurement of sensitive parameters, such as dissolved oxygen, needed for monitored natural attenuation. Significantly reduces purge water volumes, and may reduce sampling time (vs. conventional purging) on some sites.

**DISADVANTAGES:**
EPA guidance recommends gas-driven bladder pumps, and peristaltic pumps are "not recommended" for VOCs (US EPA, 1992). Therefore, costs can be significantly higher.

## WHAT ARE THE SIX STUDIES?

### STUDY 1: CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD (CRWQCB) REGION 8 / ORANGE COUNTY HEALTH CARE AGENCY / UNOCAL



**Location**

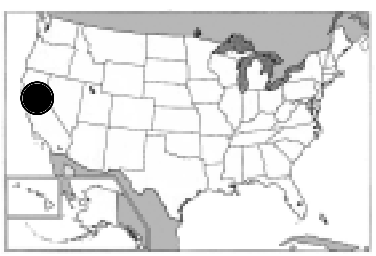
California, CRWQCB Region 8 (Santa Ana Region)

**Number sites, samples**

69 sites, 85 to 100 sample pairs (depending on number of non-detects for individual constituents)

| | |
|---|---|
| **Description** | Compared results from 69 gasoline retail sites in Santa Ana region of California for No-Purge and post-purge samples. Data evaluated using single sample t-test, non-parametric sign test. |
| **Reference** | Williams, K., Martinez, A., Daugherty, S., and Lundegard, P.D., 1996, "Groundwater Sampling - A Pilot Study of the Effects of Well Purging" in Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection, and Remediation Conference, National Ground Water Association, Houston, Texas, Nov.13-15, 1996, pp. 191 – 200.<br>Lundegard, P.D., 1995, Analysis of CRWQCB Region 8 Well Purging Study, (Unocal Corp. internal memorandum, dated March 31, 1995). |
| **Constituents** | BTEX, TPH |
| **Site Characteristics** | Leaking petroleum storage tank sites, underlain by unconsolidated, hydraulically unconfined aquifers; predominantly silty sand with some coarser and finer-grained materials; wells screened across water table. |
| **Variables and Controls** | Differing site hydrogeology, site contractors, purging methods and analytical laboratories. Purging and sampling protocols not "rigidly standardized" but in accordance with applicable state guidance and established site protocols. |
| **Agency Response** | No published response; however, study lead-author was UST Section Manager for CRWQB Region 8. |
| **KEY RESULTS** | *"..samples collected after standard well purging do not systematically have higher contaminant concentrations…there is a high probability that on average, unpurged sample concentrations exceed purged sample concentrations."* |

### STUDY 2: WESTERN STATES PETROLEUM ASSOCIATION (WSPA)



**Location**

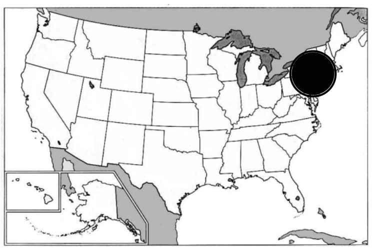
California, statewide, with sites in all Regional Water Quality Control Board (RWQCB) jurisdictions

**Number sites, samples**

101 sites, 556 wells, 2 sampling events. Approximately 480 non-zero sample pairs for benzene.

| | |
|---|---|
| **Description** | Compared results for paired No-Purge and post-purge samples from >100 gasoline retail sites throughout California. Data evaluated using non-parametric sign test. |
| **Reference** | Secor, 1996. "Final Report, California Groundwater Purging Study for Petroleum Hydrocarbons." Prepared by Secor International Incorporated, Concord, CA, October 28, 1996, for Western States Petroleum Association (WSPA). |
| **Constituents** | BTEX and TPH (all samples). MTBE (339 data pairs, 1 event only). |
| **Site Characteristics** | Leaking petroleum storage tank sites, most underlain by unconsolidated, coarse to fine-grained aquifers, and a relatively small number by fractured bedrock. All aquifers unconfined; all wells screened across water table. |
| **Variables and Controls** | All wells in study met study-specified criteria and were sampled using standardized implementation protocol developed for study. Samples collected by 13 site contractors using site-specific purging protocols (including bailers, submersible pumps, and/or vacuum trucks) developed in accordance with state and regional guidelines. Samples analyzed by the laboratories normally used for each site. |
| **Agency Response** | California EPA, San Francisco Bay RWQCB, Memorandum dated January 31, 1997, concluded "purging is not required" for sites meeting conditions including: unconfined aquifers impacted by BTEX, TPH (gasoline fraction), and MTBE with no free product; initial site sampling and final confirmation sampling should include purge and No-Purge sample pairs. |
| **KEY RESULTS** | *"There is no systematic difference between no-purge and post-purge concentrations,"* *(after correction for data subset bias showing higher concentrations for no-purge at some locations).*<br>*"No-purge sampling methodology will not affect the overall variability in chemical data, and will provide a comparable, and in many cases more conservative estimate of petroleum hydrocarbons in groundwater."*<br>*"… variability introduced by the absence of purging is in many cases smaller than the variability introduced by the choice of purging method."* |

## STUDY 3: SHELL OIL/ENVIROTRAC, NEW YORK, NEW JERSEY, CONNECTICUT



**Location**

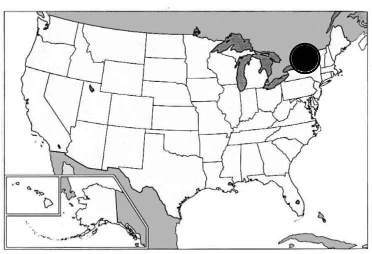
New Jersey, southern New York state and Long Island, Connecticut

**Number sites, samples**

21 sites, >80 wells, 200 samples

| | |
|---|---|
| **Description** | Compared total BTEX and MTBE results from 21 active or former gasoline retail sites for bailed No-Purge samples to samples collected after purging in accordance with applicable guidance and established site protocols. Data evaluated using least square regression method. |
| **Reference** | Bealer, L.J., Byrnes, J.P., and Springer, K. 1998, "No Purging in Ground-Water Sampling Proposal for Gasoline Compounds in New Jersey Unconfined Aquifers," in Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection, and Remediation Conference, National Ground Water Association, Houston, Texas, Nov.11-13, 1998, pp. 474-482. |
| **Constituents** | BTEX, MTBE |
| **Site Characteristics** | Leaking petroleum storage tank sites, underlain by unconfined, unconsolidated, coarse to fine-grained aquifers. All wells straddle water tables. |
| **Variables and Controls** | Differing site hydrogeology, site contractors, purging methods, and analytical laboratories. Consistent sample collection method (bailer). |
| **Agency Response** | (No documented response available). |
| **KEY RESULTS** | *"…relatively good correlation between no-purge and purged analytical results. But … at lower concentrations there is a tendency for the purged results to be higher than the no-purge results."*<br>*"No purging is recommended for routine sampling, while purging is recommended when a critical decision is to be made (i.e., no further action or closure). "* |

## STUDY 4: SHELL OIL/ENVIROTRAC, NEW YORK



**Location**

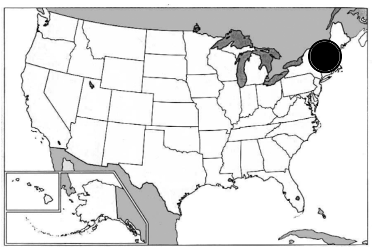
New York, Long Island (Kings, Nassau, and Suffolk Counties), and "Upstate" (Putnam and Westchester Counties)

**Number sites, samples**

13 sites, 168 samples, approximately 40 sample pairs

| | |
|---|---|
| **Description** | Compared results from 13 gasoline retail sites in southern New York state for No-Purge and post-purge samples. Data evaluated using Mann-Whitney U-test. |
| **Reference** | Envirotrac, 1995. "Evaluation of Well Purging in Ground-Water Sampling for BTEX and MTBE," Prepared by EnviroTrac Ltd. for Shell Oil Products Co., November 1995.<br>Byrnes, J.P., Briglia, J.E., and Bealer, L.J., 1996. "Evaluation of Well Purging in Ground-Water Sampling for BTEX and MTBE," in Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection, and Remediation Conference, National Ground Water Association, Houston, Texas, Nov.13-15, 1996, pp. 221 – 235.<br>Byrnes, J.P., Briglia, J.E., and Bealer, L.J., 1997. "Purge vs. No Purge for Sampling BTEX and MTBE in Groundwater Sampling" in Kostecki, et al., Contaminated Soils, Vol. 2, 1997, pp. 682-691. |
| **Constituents** | BTEX, MTBE |
| **Site Characteristics** | Leaking petroleum storage tank sites, underlain by unconsolidated, medium-coarse to fine-grained glacial or reworked sediments. All aquifers unconfined; all wells screened across water table. |
| **Variables and Controls** | Differing site hydrogeology, site contractors, purging methods and analytical laboratories. Generally consistent sample collection protocol, employing disposable bailers, at each site. |
| **Agency Response** | New York State Dept. of Environmental Conservation (NYSDEC) internal memorandum dated November 27, 1995, characterized study as "a credible argument against well purging," and agreed with study's conclusion on the need for "consistent, scientifically-defensible groundwater sampling protocol for VOCs," of which "well purging may or may not be a significant part." NYSDEC currently allows No-Purge sampling for BTEX and MTBE sites on a case-by-case basis. |
| **KEY RESULTS** | *"…within a 99% confidence interval, there was no significant difference between concentrations in samples collected without well purging to samples collected after well purging."* |

## STUDY 5: UNIVERSITY OF MASSACHUSETTS DARTMOUTH STUDY



**Location**

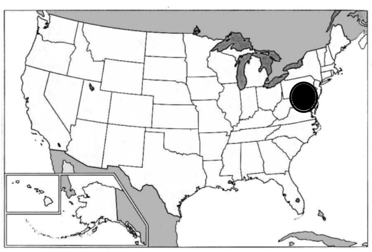
Massachusetts

**Number sites, samples**

3 sites, 17 wells, 2 sampling events, total 34 sample pairs

| | |
|---|---|
| **Description** | Compared results from 3 gasoline retail sites in Massachusetts for No-Purge samples and post-purge samples, using both conventional laboratory tests and field screening tool (ChemSensor). Data evaluated using linear regression, t-test, non-parametric sign test, wilcoxcon signed rank test. |
| **Reference** | Miller, H.J, 1998. "ChemSensor / Well Purge Study." Prepared by Dept. Civil & Environmental Engineering, UMass Dartmouth, for Strategic Envirotechnology Partnership (STEP), July 30, 1998. |
| **Constituents** | BTEX, and BTEX as xylene using ChemSensor in well screening tool. |
| **Site Characteristics** | Leaking petroleum storage tank sites, underlain by unconsolidated coarse to fine-grained glacial sediment. Aquifers mostly hydraulically unconfined, and all but two wells screened across unconfined water table. |
| **Variables and Controls** | Differing site hydrogeology, submerged screens in two wells on one site, differing site contractors, purging methods, and analytical laboratories. |
| **Agency Response** | No published response. |
| **KEY RESULTS** | *"..pre-purge BTEX concentrations tended to be slightly higher than the corresponding post-purge values."*<br>*"much stronger correlation between pre-purge and post-purge BTEX concentrations exists at sites where wells are screened above the water table in fairly coarse-grained soil deposits."*<br>*"Clearly, if one were to estimate the location of the contaminant plume, or the magnitude of the BTEX concentration at any specific point there would not be a significant difference if these estimates were based upon the pre-purge rather than the post-purge values."* |

## STUDY 6: BP AMOCO MARYLAND STUDY



**Location**

Maryland

**Number sites, samples**

3 sites, 29 wells, approximately 29 sample pairs

| | |
|---|---|
| **Description** | Compared results from 3 gasoline retail sites in Maryland for No-Purge samples and post-purge samples. Data evaluated using linear regression, t-test, non-parametric sign rank test. |
| **Reference** | van Elburg, H. , 1999. "Purge/Non-Purge Ground Water Sampling." Handex of Maryland, Report to BP Amoco.<br>Ziegel, E., 1999. "Statistical Analysis of Non-Purged Well Sampling for Groundwater Assessments from Expanded Data Set." BP Amoco Project Report HS-99-236, BP Amoco Engineering Center of Excellence, Statistics Technical Service, Naperville, IL, August 27, 1999. |
| **Constituents** | BTEX, MTBE |
| **Site Characteristics** | Leaking petroleum storage tank sites. |
| **Variables and Controls** | Differing site hydrogeology, some wells not considered conventional monitoring wells. |
| **Agency Response** | Favorably received, awaiting policy decision/approval. |
| **KEY RESULTS** | *"Therefore, it is advised that venting wells remain to be purged before sampling to obtain a sample that is representative for the ground water surrounding the well."*<br>*"With the marginal significance for the positive biases that occur if there is no purging and the considerable cost savings from not purging, the practice of purging prior to sampling for testing does not appear to have strong justification in the environmental situations that are represented at least by the standard wells."* |

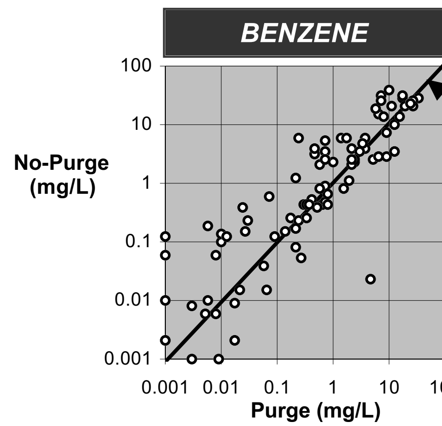
## WHAT DO THE DATA LOOK LIKE?

The next two pages present summary statistics and graphs of the data from the six studies. For each study, the following information is provided for benzene: i) the distribution of the difference between purge and No-Purge sample pairs; ii) graphs of the purge and No-Purge sample pairs, and iii) the slope of the data (shown as a solid line) and $r^2$ from a linear regression of the log-transformed data (in units of ug/L, no non-detects, intercept through origin of transformed data).

### STUDY 1: CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD (CRWQCB) REGION 8 / ORANGE COUNTY HEALTH CARE AGENCY / UNOCAL

**DIFFERENCE BETWEEN SAMPLES**

| | *(Purge-No Purge)* **(mg/L)** |
|---|---|
| Maximum | 8.500 |
| 90th Percentile | 1.952 |
| 75th Percentile | 0.050 |
| 50th Percentile | -0.086 |
| 25th Percentile | -1.300 |
| 10th Percentile | -6.548 |
| Minimum | -27.400 |
| Number Sample Pairs | 89 |



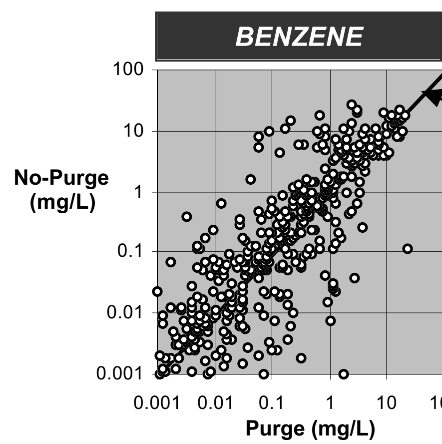

**REGRESSION**

Slope .......... 1.03
$r^2$ ................ 0.73
n............... 89

### STUDY 2: WESTERN STATES PETROLEUM ASSOCIATION (WSPA)

**DIFFERENCE BETWEEN SAMPLES**

| | *(Purge-No Purge)* **(mg/L)** |
|---|---|
| Maximum | 22.880 |
| 90th Percentile | 0.582 |
| 75th Percentile | 0.020 |
| 50th Percentile | -0.003 |
| 25th Percentile | -0.271 |
| 10th Percentile | -2.200 |
| Minimum | -25.228 |
| Number Sample Pairs | 480 |



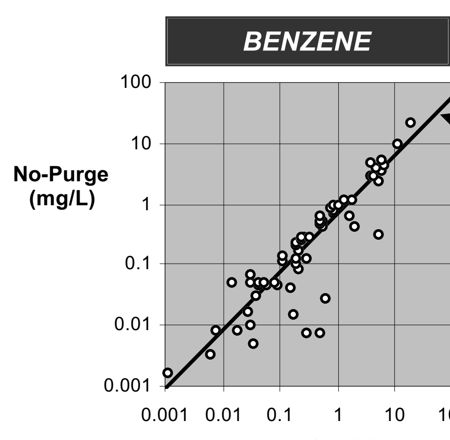

**REGRESSION**

Slope .......... 1.00
$r^2$ ................ 0.68
n............. 480

### STUDY 3: SHELL OIL/ENVIROTRAC, NEW YORK, NEW JERSEY, CONNECTICUT

**DIFFERENCE BETWEEN SAMPLES**

| | *(Purge-No Purge)* **(mg/L)** |
|---|---|
| Maximum | 4.947 |
| 90th Percentile | 0.939 |
| 75th Percentile | 0.156 |
| 50th Percentile | 0.014 |
| 25th Percentile | -0.018 |
| 10th Percentile | -0.048 |
| Minimum | -4.900 |
| Number Sample Pairs | 62 |



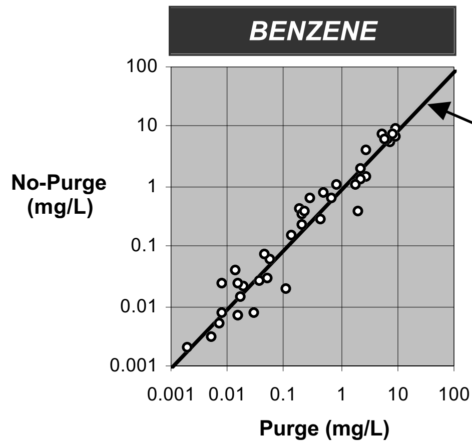

**REGRESSION**

Slope .......... 0.92
$r^2$ ................ 0.75
n............... 62

## STUDY 4: SHELL OIL/ENVIROTRAC, NEW YORK

**DIFFERENCE BETWEEN SAMPLES**

| | *(Purge-No Purge)* **(mg/L)** |
|---|---|
| Maximum | 2.400 |
| 90th Percentile | 9.700 |
| 75th Percentile | 0.079 |
| 50th Percentile | 0.001 |
| 25th Percentile | -0.038 |
| 10th Percentile | -0.395 |
| Minimum | -2.100 |
| Number Sample Pairs | 42 |



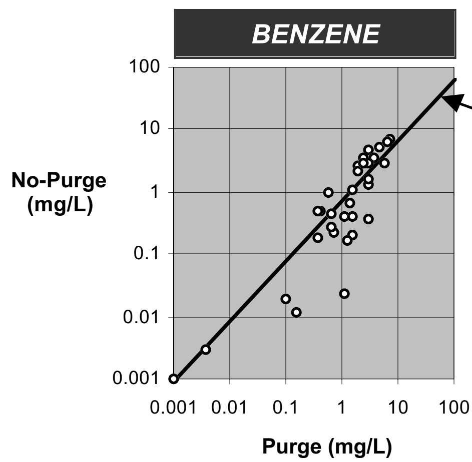

**REGRESSION**

| | |
|---|---|
| Slope | 0.98 |
| $r^2$ | 0.87 |
| n | 42 |

## STUDY 5: UNIVERSITY OF MASSACHUSETTS, DARTMOUTH

**DIFFERENCE BETWEEN SAMPLES**

| | *(Purge-No Purge)* **(mg/L)** |
|---|---|
| Maximum | 3.000 |
| 90th Percentile | 1.297 |
| 75th Percentile | 0.720 |
| 50th Percentile | 0.124 |
| 25th Percentile | -0.123 |
| 10th Percentile | -0.640 |
| Minimum | -1.700 |
| Number Sample Pairs | 34 |



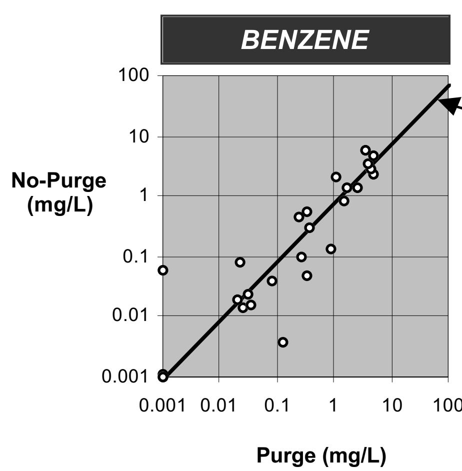

**REGRESSION**

| | |
|---|---|
| Slope | 0.92 |
| $r^2$ | 0.78 |
| n | 34 |

## STUDY 6: BP AMOCO, MARYLAND

**DIFFERENCE BETWEEN SAMPLES**

| | *(Purge-No Purge)* **(mg/L)** |
|---|---|
| Maximum | 2.630 |
| 90th Percentile | 0.819 |
| 75th Percentile | 0.280 |
| 50th Percentile | 0.010 |
| 25th Percentile | 0.000 |
| 10th Percentile | -0.204 |
| Minimum | -2.280 |
| Number Sample Pairs | 29 |




**REGRESSION**

| | |
|---|---|
| Slope | 0.93 |
| $r^2$ | 0.84 |
| n | 29 |

**KEY POINT: Data show some scatter, but have no systematic bias. Dataset is extensive.**

## WHEN AND HOW SHOULD NO-PURGE SAMPLING BE USED?

### Suggested Site Conditions:

- *Hydrogeology*: **Unconsolidated, unconfined water-bearing units with wells that are screened across the air/water interface.** In unconsolidated aquifers, groundwater flows through wells at rates generally corresponding to aquifer seepage velocities; therefore water collected from wells screened across the water table should generally represent formation conditions. By contrast, in confined aquifers, and in wells with fully submerged screens in unconfined aquifers, a stagnant zone forms above the well screen. Lowering a bailer or pump through the stagnant zone mixes stagnant and "fresh" water, potentially affecting analytical results. In aquifers composed of bedrock, in which flow is predominantly through fractures or solution features, flow is less predictable, and No-Purge sampling may not be appropriate without further study to demonstrate its applicability.
- *Well Characteristics*: **Properly constructed and developed wells free of biofouling.** Wells should be constructed with a properly sized filter pack, be properly developed to remove excess fine sediment, and be free of bacterial slimes, mineral scaling, or other effects which constrict flow through the well and may react with monitored contaminants.
- *Contaminant Chemistry*: **Fuel hydrocarbon sites, such as Underground Storage Tank sites.** Studies cited in this bulletin have demonstrated that No-Purge and post-purge samples yield comparable analytical results for volatile aromatic hydrocarbons (BTEX), gasoline fraction total petroleum hydrocarbons (TPHg), and methyl-tert-butyl-ether (MTBE). Until further research confirms the applicability of No-Purge sampling to other constituent groups, use of No-Purge sampling is proposed only for sites impacted by these gasoline constituents.
- *Contaminant Phase*: **No Non-Aqueous Phase Liquids** (NAPLs or "free-product") **present in well.** The presence of a NAPL in a well may affect the dissolved-phase concentration. In many cases, if NAPL is detected, the affected well is not sampled for dissolved constituents. Where sampling of wells containing NAPL is required, accumulated NAPL should first be removed to the extent feasible, and the well purged prior to sampling.
- *Prior Data*: **Sites and wells with prior monitoring data.** Comparison of No-Purge sample data with data from at least one set of post-purge samples is recommended. Studies cited in this bulletin typically incorporated wells with data from at least four prior quarterly monitoring events using conventional purge and sample techniques. Some regulatory agencies adopting No-Purge sampling require that, where historical data are lacking, at least one sampling event should include both No-Purge and post-purge samples. Note that some researchers have observed that the first sampling event in newly-installed wells can yield anomalous results ("well trauma"); therefore, the first sampling event for a new well may not be suitable for comparison of purge and No-Purge results.

**KEY POINT: No-Purge sampling is applicable for wells at fuel hydrocarbon sites that have no NAPL, are unconfined, are screened through the water table, and have prior monitoring data from conventional sampling.**

### Suggested Use of No-Purge Sampling as a Trend Indicator for Long-Term Monitoring:

**Advantages of No-Purge Sampling.** As shown by studies cited in this bulletin, under favorable site conditions, analytical results for No-Purge and post-purge sample populations are very similar. No-Purge sample collection (i.e., by carefully bailing a sample from the water table, with minimal disturbance of the water column) may offer several advantages over conventional purging using bailers or various types of pumps:

- ***Reduced volatile loss.*** Conventional purging by bailing or pumping may reduce VOC content due to excessive drawdown, agitation, and aeration.
- ***Reduced sample dilution.*** In a stratified water column, purging may result in underestimation of VOC concentrations by mixing of water with higher VOC concentrations near the water table and water with lower concentrations at greater depth.
- ***Reduced sampler-induced variability.*** Changes in sampling personnel and purging techniques are potential sources of variability in results from one event to the next, which may complicate evaluation of concentration trends over time.
- ***Reduced monitoring costs.*** No-Purge sampling reduces the cost of sample collection and eliminates purge water management and disposal costs, which can account for up to half of the cost of monitoring.

**Limitations of No-Purge Sampling.** For individual sample pairs, VOC concentrations in No-Purge samples may be either greater or less than concentrations in corresponding post-purge samples. Available data indicate underestimation of VOC concentrations is most likely to occur : i) in relatively low-permeability formations (with slow seepage velocities and long in-well residence time); and ii) at lower VOC concentrations. The degree to which these factors could affect results may not be predictable; therefore, no attempt is made to establish threshold values for hydraulic conductivity, seepage velocity, or VOC concentration above which No-Purge sampling can be reliably used. It should be stressed, however, that conventional purging methods may also result in underestimation of VOC content. While such data are more widely accepted by regulatory agencies, they are not necessarily more representative than No-Purge data.

**Use of No-Purge Data as Indicator of Concentration Trend.** Under appropriate conditions, No-Purge data should be very useful to track concentration trends during routine monitoring. No-Purge data can be viewed as analogous to the use of analytical indicator parameters or field screening techniques during plume delineation.

Use of indicator parameters to limit the number of more accurate, but more expensive, analyses has been recommended in EPA guidance dating back to the 1970s (EPA, 1977). Recent state and federal guidance also endorses the use of field screening methods for cost-effective, expedited site characterization. Plume extent may be determined using methods such as soil vapor testing, temporary groundwater sampling points, and a variety of field testing methods. In general, however, regulatory agencies require that plume extent be verified by samples from permanent monitoring wells, analyzed by methods with quantitation limits corresponding to regulatory limits for specific contaminants.

Once the plume has been sufficiently characterized, No-Purge sampling could be effectively used for long-term monitoring to track progress toward remediation goals. During this phase, constituent concentrations may not need to be known with the same level of precision and accuracy required for determining plume extent or site closure. Once monitoring indicates achievement of remediation goals, conditions could be verified using data from post-purged samples.

**Use of Paired No-Purge and Post-Purge Data.** The degree to which No-Purge sampling may be acceptable will depend on guidelines issued by state and local regulatory authorities, and possibly on site-specific factors (e.g., proximity of the plume to sensitive receptors). The following guidelines might be useful for incorporating No-Purge sampling into typical monitoring programs.

- ***Confirm* plume extent with sample data from purged wells.** Final delineation of the plume should be based on data which, at a minimum, have been collected in a manner consistent with applicable state guidelines. Currently, this will require purging of wells prior to sampling in most cases.
- ***Compare* No-Purge data with post-purge data.** Upon initiating No-Purge sampling, No-Purge samples should be compared with historical monitoring data to evaluate potential for bias toward lower concentrations in No-Purge samples. If historical data are not available for all wells, at least one sampling event should include analysis of paired samples. Sample pairs may not be necessary for all wells at a site, but should be of sufficient number to permit statistical comparison and establish a baseline dataset for the site.
- ***Continue* use of purged samples, where appropriate.** It may be appropriate to continue to purge some wells prior to sampling , depending on site-specific factors. For example, if a sensitive receptor (e.g., a water supply well) is present near the downgradient plume boundary, collection of purged samples at one or more key "sentry wells" may be appropriate.
- ***Confirm* attainment of cleanup standard with post-purge data.** When No-Purge monitoring data indicate that the remedy standard has been reached, site conditions can be confirmed by a sample from a purged well.

**KEY POINT: No-Purge sampling is appropriate for use in long-term sampling programs, but should be supplemented with conventional techniques for key datasets such as confirmation sampling.**

## Comparison of No-Purge Sampling with Other Methods:

Studies cited in this bulletin compared results for No-Purge samples with samples collected after *conventional* purging by methods in common use on typical sites (i.e., bailers, portable down-hole pumps, and vacuum trucks). The studies specifically *did not* compare results to more sophisticated methods, such as low-flow, minimal drawdown sampling, and no claims were made that No-Purge sampling provided results which were superior or equivalent to those obtainable by "best available technology."

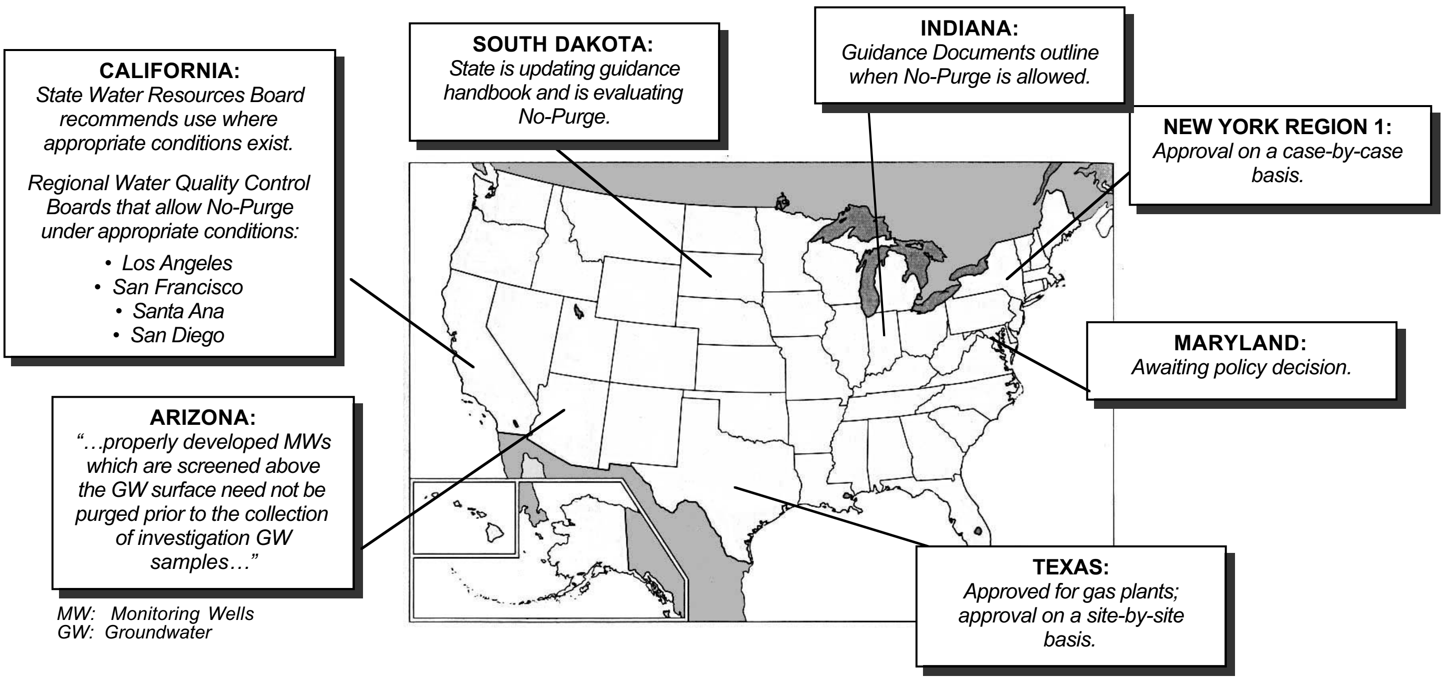
***Low-Flow Sampling.*** Recent research indicates that low-flow sampling, with minimal drawdown and continuous monitoring of parameters such as dissolved oxygen and redox potential, provides samples which more closely resemble water in the adjacent formation than samples obtained by conventional methods. EPA RCRA guidance (US EPA, 1992, Chapter 7) recommends low-flow sampling, preferably using dedicated, gas-driven bladder pumps. However, due to cost considerations, dedicated bladder pumps are less widely used on gasoline retail sites than other methods. Peristaltic pumps can operate at adequately low flow rates and could offer a lower cost alternative, since only the sample tubing needs to be dedicated. However, peristaltic pumps are only applicable to shallow water tables. Furthermore, citing potential for volatile loss, EPA "does not recommend the use of peristaltic pumps to sample groundwater, particularly for volatile organic analytes," (US EPA, 1992). Therefore, approval by the applicable regulatory agency should be confirmed before peristaltic pumps are used.

***Conventional Purging and Sampling.*** Currently, regulatory agencies throughout the country continue to rely upon groundwater sample data from wells purged by a variety of methods, including bailers, portable down-hole pumps, and vacuum trucks, to support key decisions. While these methods may not provide the *most representative* samples obtainable, their broad acceptance by regulatory agencies suggests a consensus that data so obtained are *adequately representative* of formation conditions to ensure protection of human health and the environment. Since No-Purge sampling appears to provide samples which are equally representative under appropriate conditions, No-Purge sampling may prove to be an acceptable, lower cost alternative, at least as an indicator of concentration trends over time.

**KEY POINT: Despite some inherent variability, conventional purging techniques are commonly used at most fuel hydrocarbon sites. No-Purge sampling can play a key role in long-term monitoring programs at fuel hydrocarbon sites where conventional sampling is now being performed.**

## WHAT IS NO-PURGE'S REGULATORY STATUS?

Several states are now accepting No-Purge sampling approaches for monitoring groundwater. The figure below summarizes the regulatory status of No-Purge sampling as of July 2000.




**KEY POINT: No-Purge sampling is getting increased regulatory attention as an accepted technique.**

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## OTHER REFERENCES (see pgs. 3-5 for study references)

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