Training Primer for Sampling of MSWLF Emissions as part of a Post Closure Care (PCC) Reduction and/or Termination Plan (4-23-14)

by

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Introduction and Objective - It is of paramount importance that leachate and landfill gas (LFG) samples be taken properly if future decisions based on the data collection efforts are to be successful. Properly means that representative samples are taken and analyzed so that errors are minimized and the resultant data can be used to facilitate an approved PCC plan. Errors fall into two categories: sampling and laboratory errors. Laboratory errors will not be discussed in this document but it should be recognized that sampling errors can cause laboratory errors, e.g., if a sample is improperly preserved, then the resulting analysis could result in a laboratory error. It is the objective of this primer to provide a general review of the steps associated with the sampling efforts in order to minimize errors and to provide a demonstration of some of the required steps. Most of the required steps are common to both types of emissions; however, if there are differences, these will be noted in following text with italicize type (*leachate* or *LFG*).

Supporting Documents – Several helpful references are available to support this primer by providing more detailed information.

1. **Laboratory Operations and Quality Assurance Manual** by USEPA, Science and Ecosystem Support Division, Athens, GA (2-14-13).
2. **Standard Methods for the Examination of Water and Wastewater** by AWWA, WEF and APHA, 22nd Edition (2012).
3. **Divisional Quality Assurance Management Policies and Procedures**, KDHE, Division of Environment, Part I, Revision 2 (9-7-10).
4. **Bureau of Waste Management Quality Assurance Management Plan**, Division of Environment; Parts II and III (1-25-11).
5. **Leachate Sampling Plan for the Determination of Post Closure Care (PCC) Termination**, BWM Technical Guidance Document SW-2013-G3 (April 2014).
6. **Comprehensive List of Leachate Parameters for Post Closure (PCC) Care Terminations** by Carl E. Burkhead (3-27-12).
7. **Post Closure Care (PCC) Termination Plans: Principles and Needs** by Carl E. Burkhead (11-27-12). This is a revised paper of the one presented at the November 2012 SWANA/KDHE in Salina.
8. **A Simple, Overlooked Set of Parameters for Judging MSW Stabilization** by Carl E. Burkhead (2-29-13).
9. **Landfill Gas Primer – An Overview for Environmental Health Professionals;** expecially **Chapter 4: Monitoring of Landfill Gas** by the Agency for Toxic Substances & Disease Registry (no date given).
10. **Landfill Gas Sampling Plan for Reduction/Termination of Postclosure** BWM Technical Guidance Document SW-2014-XX (April 2014)
11. **Preparation of a Post Closure Care (PCC) Termination Plan**, BWM TGD SW-2014-G-1 (April 2014).

Representative Sample – This is an analytical chemistry term that suggests that a regime can be represented by a portion of the regime if the regime is well mixed; or if it is not, then by multiple portions taken at strategic locations in order to represent the regime. Since *leachate* is liquid, the liquid must be mixed in order to take a representative sample; or if stratified, then proportionate sampling must be done to represent the total mass. *LFG* in situ sampling is not common; however, samples can be obtained from gas wells at the wellhead and the resultant samples can be analyzed on-site or after a batch sample is taken to a laboratory. Batch samples have uniform compositions since the gas components diffuse into a uniform mixture in the sample container. It is recognized that higher density gas components in a MSW

mass can "settle" which means separate gas samples must be taken at different depths in order to obtain a representative sample; however, this is not common practice. Surface and emission sampling is not considered in this document since these gases are not part of the gas collection and control system (GCCS).

Another aspect of both kinds of sampling is when flow is involved. The flow can come from a well mixed regime which makes it easy to sample; or, the regime may be stratified meaning that a composite sample should be taken in proportion to the flow. Leachate and LFG flow is like the latter but typically composite samples are not taken; hence, the need to take a sample closest to the point of origin. **Reference 5** discusses the best way to sample *leachate.* Sampling of *LFG* in a landfill GCCS is easier than leachate collection in that samples can be taken directly from the wellhead sampling port. They can be sampled from different parts of the MSW mass by lowering a sample devise/or sensor into the well itself; again, this is not a common practice. Either way, care must be exercised due to the effect of moisture in the samples and the presence of water in the sampling well.

Leachate and LFG Sampling - A successful sampling effort will consist of the following stages:

1. **Preliminary Planning** – Considerations which must be made prior to sampling include:
    a. **Scheduling**
        1) **Personnel –** Landfill, consultant and/or laboratory personnel can collect the required samples. Some types of samples may require more than one person which could involve a combination of the mentioned participants. Different samplers for different sampling dates are not recommended because of potential subjective differences in the sampling procedures. However, long term sampling will likely involve different personnel. At least two persons are recommended since one can check the other to keep the correct sampling protocol. An ideal sampling team consists of landfill and laboratory personnel since each provides expertise from their chosen areas necessary for obtaining representative samples.
        2) **Frequency** – **Reference 5** recommends quarterly sampling during the PCC period. One of the quarterly *leachate* samples can be used to satisfy the KAR 28-29-104(i)(6)(A) requirement as well as the PCC requirement. *LFG* monitoring should be conducted quarterly along with explosive gas monitoring as given in KAR 28-29-108(e)(3). It is preferable that both types of emission sampling be done at the same time in order to better correlate the results. Also, exact quarterly dates are not necessary but should be as close as possible to three months apart.
        3) **Weather** – Extreme weather conditions may create sampling problems due to freezing or high temperatures and/or atmospheric pressure changes. Although information about these events can provide useful information, they should be normally avoided when scheduling a sampling event, e.g., it is likely that elevated temperatures will cause sample compositions to change unless the sample is properly preserved. Also, the environment sampled will change more quickly at higher temperatures.
        4) **Field Tests** – Certain tests must be conducted in the field since the values will change when samples are taken to the laboratory for analyses, e.g., temperature, possibly pH and dissolved gases (e.g., O_2, H_2S and NH_3). There are numerous field test procedures (see **Supplement 1** for *leachate* tests}. On-site *LFG* sampling is common; especially with handheld monitoring devices (see **Supplement** 2a) that can be used to eliminate the need to collect samples for laboratory analyses (see **Supplement 2b**). In each case, the analytical devise must be used in a sample location which best represents

the actual field value. Field devices should be calibrated according to manufacturer's instructions.

5) **Samplers** – Obtaining the leachate and LFG samples to be placed in the sample containers [see Item 7)c) below] depends on leachate and LFG regimes being sampled. **Reference 5** discusses the various *leachate* regimes and the best samples to take. Typically, *leachate* is collected from a flowing stream, a closed tank or an open storage basin, or a wet well sump. The sample container or a ladle may be place in the flowing stream or tank discharge. A bailer can be used to collect a basin sample or leachate flowing into a wetwell. *LFG* samplers can be purchased (see **Supplements 2a and b**) or are provided by the test laboratory. With all types of sampling efforts, the sample lines should be flushed to provide a representative sample.
6) **Laboratory Selection** – Only KDHE certified laboratories can be used to test emissions (see **Supplement 3** for current list). Arrangements must be made prior to sampling to coordinate sample collection and analysis tasks.
7) **Coordination with Laboratory**
    a) **Test Day**– BOD_5 samples are tested five days after they are set up; hence, samples collected on Monday or Tuesday would require laboratory testing on Saturday or Sunday which is not a common practice. Also, laboratories may only test certain parameters on certain days.
    b) **Sample Load** – Laboratory must be able to handle your samples along with samples from other sources; hence, the need to confirm the best sampling date(s).
    c) **Sample Containers** – Most laboratories have pre-prepared *leachate* sample bottles for each kind of analytical test. Typically, the bottles contain the required preservative so that the analyte(s) of interest is (are) not altered between time of collection and testing. *LFG* sample containers are typically pre-prepared glass, stainless steel or inert polymers to minimize interaction with the gas components.
    d) **Sample Size** – Enough sample volume should be collected to conduct the required analytical tests. Typically, laboratories provide the correct sized container.
    e) **Refrigerated Samples** – It is recommended that all samples be refrigerated to minimize changes due to temperature even if a preservative is used. However, the sampler should check with the laboratory to verify this requirement.
    f) **Completion of Laboratory Request Form** – Samples delivered to the laboratory for testing must be accompanied by a completed test request form which identifies the Chain of Custody for the samples. Two sample forms are shown in **Supplements 4 and 5**. **Supplement 4** is a general form and **Supplement 5** is a listing of parameter suites [see b.1) below}.
    g) **Replicates (or Duplicate) and Split Samples** – All certified laboratories conduct additional tests to validate their methodologies (see **Supplement 6**); however, it may be useful to submit identified or unidentified replicates or split samples to confirm the validation. Replicate or duplicate samples are where samples are taken at essentially the same time from the same site with a common chain of custody for the purpose of determining natural variability and precision of the procedures. A split

sample is one that is divided in the field to determine the effect of un-identification or where the samples are sent to different laboratories for comparison. Both types of sampling demonstrate laboratory precision, but a comparison of the two eliminates the subjectivity of the replicates samples.

h) **Required Format of Test Results** – Laboratories differ in the way their results are reported to their clients. All provide hard copies of the results but some also provide electronic versions which are suitable for analyzing and/or demonstrating the resulting data (e.g., in a spreadsheet and/or graphically) at a later date. Most laboratories keep historical records although this effort is not usually required by their clients.

i) **Delivery of Samples** – The sampling effort must be planned so that the field collection will allow the delivery of the samples to the laboratory location at a time when the laboratory will be able to process the reception of the samples. If the samples are to be mailed, then the effect of the delay must be considered.

b. **Selection of Required Test Parameters** – **Reference 6** can be use to select a comprehensive list of *leachate* parameters to tested. The more common parameters are BOD_5, COD, pH, TSS, and NH_3. The more common *LFG* parameters are CH_4, NMOC, CO_2 and O_2. It should be remembered that these test results are just part of the PCC termination data collection effort. Other supplemental data needs are discussed in **Reference 7**. A complete listing of test parameters and methods for air and non-potable water (e.g., *leachate*) is given at the following website: http://nelac-institute.org/lams. Considerations for the parameter selection process include:

1) **Suite of Analytes** – The desired list of tests to be made will likely involve the use of specialized laboratory instrumentation, e.g., gas chromatograph-mass spectrophotometer (GCMS), inductively coupled plasma (ICP), ion electrodes, etc. Many of these instruments will actually analyze a suite of analytes at no extra cost. However, if certain parameters are specified without knowledge of the suite results, the laboratory will just provide the requested results even though they may keep of a record of other results, which may prove useful. Also, some of the suites may offer testing of the same parameter which allows for the cross checking of results.

2) **Validation of Test Results** – Besides the normal validation tests [see 1(a)(5)(g)] conducted by the testing laboratory, there are two other ways to validate the combined results. The first is to do an ion balance to see if the positive and negative equivalent sums are equal. The second is to compare the sum of the soluble analytes (ions and molecular species) with the gravimetric TDS value which should also be equal to 1.0. Filtrate sample are need for these comparisons. Each of these checks requires a complete analysis for all significant analytes which can be more expensive.

3) **Soluble and Total BOD_5, COD and TOC** – The identification of the form (soluble versus insoluble) of the sample's organic content can be useful for the interpretation of *leachate* results as discussed in **Reference 8**. In general, soluble constituents originate from the MSW and/or are by-products of the microbial stabilization of the MSW. These are typically non-biodegradable and/or non-COD oxidizable substances. Insoluble constituents typically escape from the stored MSW and originate from the MSW or are from microbial particles which have grown on the MSW and are loosened by leachate flow through the MSW mass.

4) **Bioassay of *Leachate*** – Batch bioassays using fat head minnow or daphnia are recommended to determine if the *leachate* contains any substance(s) which was (were) not tested for [see Item 1) above] and which can be harmful to the receiving stream if this is the method of leachate disposal.
5) **Cost of Sampling and Analyses** – This is important since the cost of sampling increases proportionally with the number of samples taken and the types of analyses required. In general, the analytical needs for both types of emissions are small except for the regulatory requirements as stated in Item 1.a.2). Of course, trend analysis as required by a PCC reduction/termination plan suggests that samples are taken over time. **References 7 and 11** discuss the use of trend analysis for the determination of PCC termination.

2. **Sampling Exercise and Event** – A new sampling event should be practiced or checked out prior to the actual event to ensure that unforeseen obstacles (e.g., the desired place to take the samples on the day of the planed event may be obstructed or damaged so that the samples have to be taken at another location. Or, the weather may affect the ability of the sampler to collect the samples), do not foil the sampling efforts
3. **Post Sampling Log**– The sampler should maintain a log of the sampling event. The log should be recorded ASAP after the event and should include pertinent details which may be helpful when future considerations of the event are reviewed.
4. **Operational Situations** - It is important that the sampler be aware of any unusual landfill activities that could affect the sample results, e.g., *leachate* quantity and quality which will be affected by antecedent rainfall or *LFG* quantity and quality which can be affected by the stored MSW temperature**. This means that these activities must be known throughout the evaluation period.** Landfill management must keep activity records so that the resultant sample data can be interpreted properly.
5. **Success** – Attention to the fundamental principles outlined in this primer will assure that proposed sampling plan and its implementation will be as successful as it can be. It is recognized that every plan has it weaknesses but one that is improved whenever possible will be better than one lacking attention to detail and the use of rationale steps.

Supplemental Information

Supplement 1 – Field Testing: List of EPA Approved Hach Methods

Source: http://www.hach.com/epa

EPA Compliant Methods

EPA-Approved Methods

The EPA has evaluated and approved new technological methods developed by Hach Company. All EPA-Approved methods are cited in the Federal Register and compiled in the Code of Federal Regulations at 40 CFR 136 and CFR 141.

EPA-Accepted Methods

The EPA has reviewed Hach methods and accepted them for use in compliance monitoring. These methods are defined by EPA as Acceptable versions of previously approved methods. These methods are generally not

published in the Federal Register or in the Code of Federal Regulations. A facsimile of the EPA- Acceptance letter is available upon request.

EPA-Equivalent Methods

All EPA-Approved methods have specification criteria built into their procedural steps. When an approved or accepted EPA method has been packaged by Hach from the EPA reference method as a test method that meets or exceeds these specification criteria, these methods are deemed to be equivalent for use in EPA compliance monitoring (40 CFR 136.6). EPA does not normally issue equivalence letters for packaged reference methods. Hach maintains the formulation and procedures, and data demonstrating equivalency is available on request.

These methods may be used for compliance monitoring. They have either obtained an EPA Approval or Acceptance letter, or the method is a packaged product that follows an EPA Reference method and is deemed Equivalent by Hach. With any method used for compliance reporting, always consult with your local regulatory authority.

Analyte	Sample Matrix	Hach Method	Approval Type	Reference Method
Acidity, Phenolphthalein, Buret	WW	8010	Accepted	SM 2310 B
Acidity, Phenolphthalein, Digital Titration	WW	8202	Equivalent	SM 2310 B
Alkalinity, Digital Titration	WW	8203	Equivalent	SM 2320 B, EPA 310.2
Ammonia as Nitrogen	WW	TNT830	Equivalent	EPA 350.1, EPA 351.1, EPA 351.2
Ammonia as Nitrogen	WW	TNT831	Equivalent	EPA 350.1, EPA 351.1, EPA 351.2
Ammonia as Nitrogen	WW	TNT832	Equivalent	EPA 350.1, EPA 351.1, EPA 351.2
Ammonia Nitrogen, Electrode	WW	10001	Equivalent	SM 4500-NH3 D, E, F, or G
Ammonia Nitrogen, Known Addition, Electrode	WW	10002	Equivalent	SM 4500-NH3 D, E, F, or G
Ammonia, as Nitrogen, Nessler	WW	8038	Accepted	SM 4500-NH3 C
Arsenic, Total	WW	8013	Accepted	SM 3500-As B or C
BOD	WW	8043	Accepted	SM 5210 B
Calcium, Total, Buret	DW	8222	Accepted	SM 3500-Ca B or D
Calcium, Total, Buret	WW	8222	Accepted	SM 3500-Ca B or D
Chemical Oxygen Demand	WW	8000	Approved	40 CFR 136.3
Chemical Oxygen Demand, TNTplus	WW	TNT821/ 8000	Approved	Hach Method 8000, 40 CFR 136.3
Chemical Oxygen Demand, TNTplus	WW	TNT822/ 8000	Approved	Hach Method 8000, 40 CFR 136.3
Chloride, Mercuric Nitrate, Digital Titration	WW	8206	Equivalent	SM 4500-Cl C
Chloride, Silver Nitrate, Buret	WW	8225	Accepted	SM 4500-Cl B
Chloride, Silver Nitrate, Digital Titration	WW	8207	Equivalent	SM 4500-Cl B

Chlorine, Free, DPD	DW	8021	Accepted	SM 4500-Cl G
Chlorine, Free Amperometric Titration	DW	8334	Equivalent	SM 4500-Cl D
Chlorine, Free Amperometric Titration	WW	8334	Equivalent	SM 4500-Cl D
Chlorine, Total, DPD ULR	DW	8370	Accepted	SM 4500-Cl G
Chlorine, Total Amperometric Forward Titration	DW	10026	Accepted	SM 4500-Cl D
Chlorine, Free, DPD MR	DW	10245	Accepted	SM 4500-Cl G
Chlorine, Free, DPD MR	WW	10245	Accepted	SM 4500-Cl G
Chlorine, Free, DPD HR	DW	10069	Accepted	SM 4500-Cl G
Chlorine, Free, DPD HR	WW	10069	Accepted	SM 4500-Cl G
Chlorine, Free, DPD TNT	DW	10102	Accepted	SM 4500-Cl G
Chlorine, Free, DPD TNT	WW	10102	Accepted	SM 4500-Cl G
Chlorine, Free and Total, TNTplus	WW	TNT867	Equivalent	SM 4500-Cl G
Chlorine, Total Residual, DPD	DW	8167	Accepted	SM 4500-Cl G
Chlorine, Total Residual, DPD	WW	8167	Accepted	SM 4500-Cl G
Chlorine, Total Residual	DW	8168	Accepted	SM 4500-Cl D
Chlorine, Total Residual	WW	8168	Accepted	SM 4500-Cl D
Chlorine, Total Residual, Amperometric Back Titration	WW	10025	Accepted	SM 4500-Cl C
Chlorine, Total Residual, DPD, ULR	WW	10014	Accepted	SM 4500-Cl G
Chlorine, Total, DPD, ULR	DW	8370	Accepted	SM 4500-Cl G
Chlorine, Total, DPD, ULR	WW	8370	Accepted	SM 4500-Cl G
Chlorine, Total Residual, DPD MR	DW	10250	Accepted	SM 4500-Cl G
Chlorine, Total Residual, DPD MR	WW	10250	Accepted	SM 4500-Cl G
Chlorine, Total Residual, DPD HR	DW	10070	Accepted	SM 4500-Cl G
Chlorine, Total Residual, DPD HR	WW	10070	Accepted	SM 4500-Cl G
Chlorine, Total Residual, DPD TNT	DW	10101	Accepted	SM 4500-Cl G
Chlorine, Total Residual, DPD TNT	WW	10101	Accepted	SM 4500-Cl G
Chlorine Dioxide, DPD/Glycine	DW	10126	Accepted	SM 4500-ClO2 D
Chromium VI, TNTplus	WW	TNT854	Accepted	SM 3500-Cr B or D
Chromium VI, Dissolved	WW	8023	Accepted	SM 3500-Cr B or D
Coliform, Fecal, EC Medium with/MUG	DW		Approved	Approved Media
Coliform, Fecal, m-FC and m-FC/RA	DW/WW	8074	Approved	SM 9222 D
Coliform, Total and E. coli, m-ColiBlue24	DW	10029	Approved	40 CFR 141.21, page 349
Coliforms, E. coli, m-TEC	SW	8367	Equivalent	EPA 1103.1
Coliforms, Fecal and Total, MPN, A1 Medium	DW	8368	Equivalent	SM 9221 B
Coliforms, P/A Media	DW		Equivalent	Approved Media
Conductivity	DW	8160	Accepted	SM 2510 B
Copper, Bicinchoninate Procedure	WW	8506	Approved	40 CFR 136
E. coli in Wastewater	WW	10029	Approved	40 CFR 136

E. coli, m-ColiBlue24, Enumeration	SW	10029	Approved	40 CFR 136
E. coli, m-ColiBlue24, P/A	DW	10029	Approved	40 CFR 141.21
Fecal and Total Coliform	WW	8001	Accepted	SM 9221 B/E
Fecal and Total Coliform	DW	8001	Accepted	SM 9221 B/E
Fecal and Total Coliform	SW	8001A	Accepted	SM 9221 E
Fecal and Total Coliform	SS	8001A	Accepted	SM 9221 E
Fecal and Total Coliform	DW	8001A	Accepted	SM 9221 E
Fecal Coliform, Sludge, MPN, A1 Medium	WW	10028	Equivalent	SM 9221 D/E
Fecal Coliform, Sludge, MPN, LTB/EC Medium	WW	10027	Equivalent	SM 9221 D/E
Fecal Streptococci, MPN	WW	8172	Equivalent	SM 9230 B
Fluoride, SPADNS	DW	8029	Accepted	SM 4500-F B/D
Fluoride, SPADNS	WW	8029	Equivalent	SM 4500-F B/D
Fluoride, Electrode	WW	8323	Equivalent	SM 4500-F B or C
Fluoride, SPADNS2, Arsenic Free	DW	10225	Approved	40 CFR 141
Fluoride, SPADNS2, Arsenic Free	WW	10225	Equivalent	SM 4500-F B or C
Hardness, Calcium, Digital Titration	WW	8204	Equivalent	SM 3500-Ca B or D
Hardness, Calcium and Total, Buret	WW	8222	Accepted	SM 3500-Ca B or D
Hardness, Total, Buret	WW	8226	Accepted	SM 2340 B or C
Hardness, Total, Digital Titration	WW	8213	Equivalent	SM 2340 B or C
Hydrogen Ion, pH	WW	8156	Accepted	SM 4500-H+ B
Iron, 1,10-Phenanthroline	WW	8008	Approved	40 CFR 136
Iron, 1,10-Phenanthroline	WW	TNT858	Equivalent	Hach Method 8008
Lead, Total, Voltammetry	DW	1001	Approved	40 CFR 141.23
Lead, Total, Dithizone	WW	8033	Accepted	SM 3500-Pb B or D
Manganese, Periodate Oxidation	WW	8034	Approved	40 CFR 136
Nickel, Total	WW	8037	Accepted	SM 3500-Ni D
Nitrate, Dimethylphenol	DW	TNT835/ 10206	Approved	40 CFR 141
Nitrate, Dimethylphenol	DW	TNT836/ 10206	Approved	40 CFR 141
Nitrite as Nitrogen	WW	TNT839/ 8507	Equivalent	EPA 353.2
Nitrite as Nitrogen	WW	TNT840/ 8507	Equivalent	EPA 353.2
Nitrite Nitrogen	WW	8507	Approved	40 CFR 136
Oil and Grease, Gravimetric	WW	10056	Equivalent	EPA 1664 or SM 5220 B
Oxygen, Dissolved, Luminescence	WW	10360	Approved	40 CFR 136
Oxygen, Dissolved, Polargraphic	WW	8157	Accepted	SM 4500-O G
Oxygen, Dissolved, Winkler, Buret	WW	8229	Accepted	SM 4500-O C
Oxygen, Dissolved, Digital Titration	WW	8215	Equivalent	SM 4500-O C

pH	DW	8156	Accepted	EPA 150.1, 150.2; SM 4500-H+ B
Phenols, 4AAP	WW	8047	Accepted	EPA 420.1
Phosphate, Ortho	WW	8048	Accepted	EPA 365.1
Phosphate, Ortho	WW	TNT843/ 8048	Equivalent	EPA 365.1
Phosphate, Ortho	WW	TNT844/ 8048	Equivalent	EPA 365.1
Phosphate, Ortho	WW	TNT845/ 8048	Equivalent	EPA 365.1
Phosphorus, Total	WW	8190	Accepted	EPA 365.1, 365.3
Phosphorus, Total	WW	TNT843/ 8190	Equivalent	EPA 365.1, 365.3
Phosphorus, Total	WW	TNT844/ 8190	Equivalent	EPA 365.1, 365.3
Phosphorus, Total	WW	TNT845/ 8190	Equivalent	EPA 365.1, 365.3
Solids, Dissolved	WW	8277	Equivalent	SM 2540 C
Solids, Filterable	WW	8163	Equivalent	SM 2540 C
Solids, Settleable	WW	8165	Equivalent	SM 2540 F
Solids, Total	WW	8271	Equivalent	SM 2540 B
Solids, Total Non-filterable	WW	8158	Accepted	SM 2540 D
Solids, Volatile, Non-filterable	WW	8164	Equivalent	EPA 160.4
Specific Conductance	WW	8160	Accepted	EPA 120.1; SM 2510 B
Sulfate	WW	8051	Accepted	ASTM D516-90, 02
Sulfide	WW	8131	Accepted	SM 4500-S2 E or F
Sulfite, Buret	WW	8071	Accepted	SM 4500-SO3 B
Sulfite, Digital Titration	WW	8216	Equivalent	SM 4500-SO3 B
Turbidity	DW	8195	Approved	40 CFR 141
Turbidity	DW	GLI	Approved	40 CFR 141
Zinc, Zincon	WW	8009	Approved	40 CFR 136.3

†DW = Drinking Water; SS = Sewage Sludge; SW = Surface Water; WW = Wastewater

Supplement 2a – Portable LFG Sampling Equipment by specified vendors:

QED Wellhead Installation with Precision Flow Meter (Source: http://www.qedenv.com/Newsflashes/Newsflash/QED_Introduces_New_Line_of_Landfill_Gas_Wellhead_Products)

Landtec Portable Gas Monitors (Source: http://argus-hazco.com/gas-section/methane-analyzers/landtec-gem-2000.htm)

The GEM™2000 Plus gives you all the features of the GEM™2000 landfill gas monitor, plus built-in detection of Hydrogen Sulfide (H2S) and Carbon Monoxide (CO). You no longer need to store, carry and use external gas pods. The GEM™2000, the newest handheld landfill gas monitoring instrument from LANDTEC, is designed for analyzing LFG composition and calculating flow. The GEM™2000 combines the capabilities of the now discontinued GA-90 for monitoring gas migration probes and the GEM-500 for monitoring gas extraction systems. The GEM™2000 is certified Intrinsically Safe and offers improved speed and accuracy.

Features:
- Measures %CH4, CO2, O2, CO, H2S gases, static pressure, and differential pressure
- Displays CH4 in % LEL
- Displays user-defined comments
- Calculates balance gas, flow (SCFM) and calorific value (KW or BTU)
- Records site and well conditions
- Used in gas extraction wells, flare monitoring, landfills, and biogas sites

Landtec GEM5000 Handheld CO_2/CH_4/LEL/O_2/Pressure Monitor; Starting at ***$10,485.00***
(Source: http://www.equipcoservices.com/sales/landtec/gem5000.html?gclid=CInB5e3bv70CFWXl7AodoWEAVQ)

The GEM5000 is the latest in the line of Landtec's GEM landfill gas analyzers. The GEM is now lighter, smaller, and features an improved user interface. Not only is the GEM 5000 the only instrument you need to take into the field, it also features increased accuracy, and reduced operational times. The GEM 5000 has also been updated with a full color LCD screen and the ability to connect directly to Landtec via the Internet, reducing the amount of factory calibrations required.

> The GEM5000 landfill gas analyzer is the suggested replacement for the GEM2000.

The GEM5000 is available in two versions. The standard version measures Methane, Carbon Dioxide, Oxygen, static pressure, and differential pressure. The GEM 5000 Plus adds Hydrogen Sulfide and Hydrogen compensated Carbon Monoxide measurements. Both versions are capable of calculating calorific value, balance gas, and flow. The GEM5000 is certified intrinsically safe for landfill use, comes calibrated to ISO/IEC 17025 standards and with a 3 year warranty.

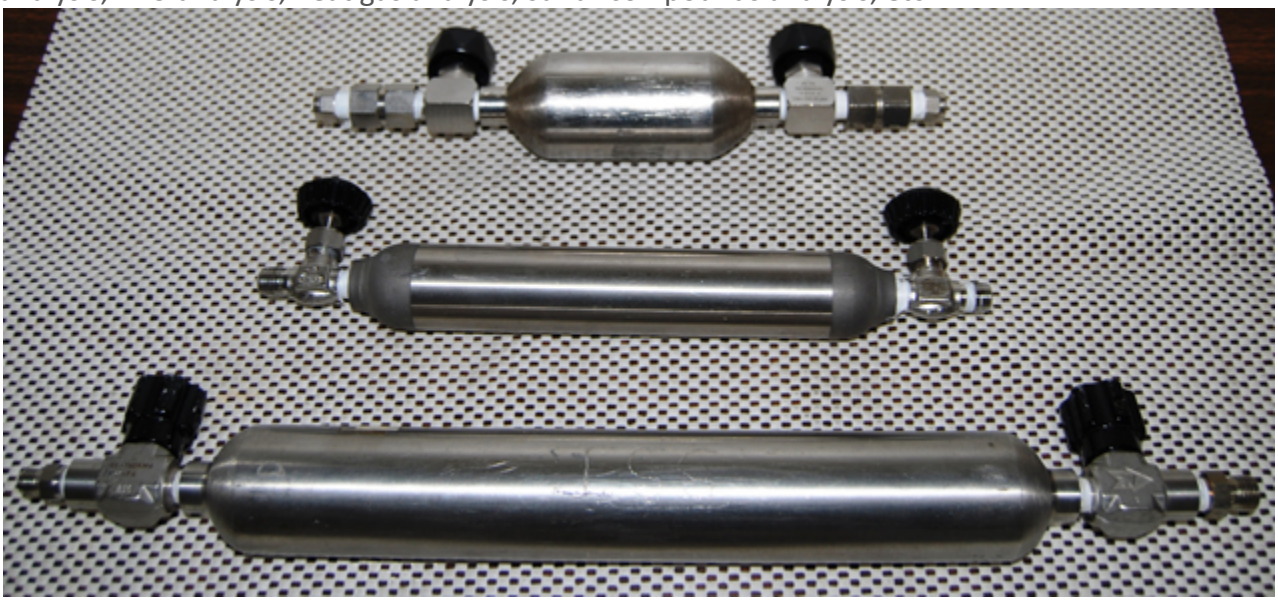
Supplement 2b – LFG Sample Equipment and Media by Atmospheric Analysis and Consulting, Inc.

Source: http://www.aaclab.com/analytical-services/sampling-equipment-media.html

A partial list of the media is listed below:

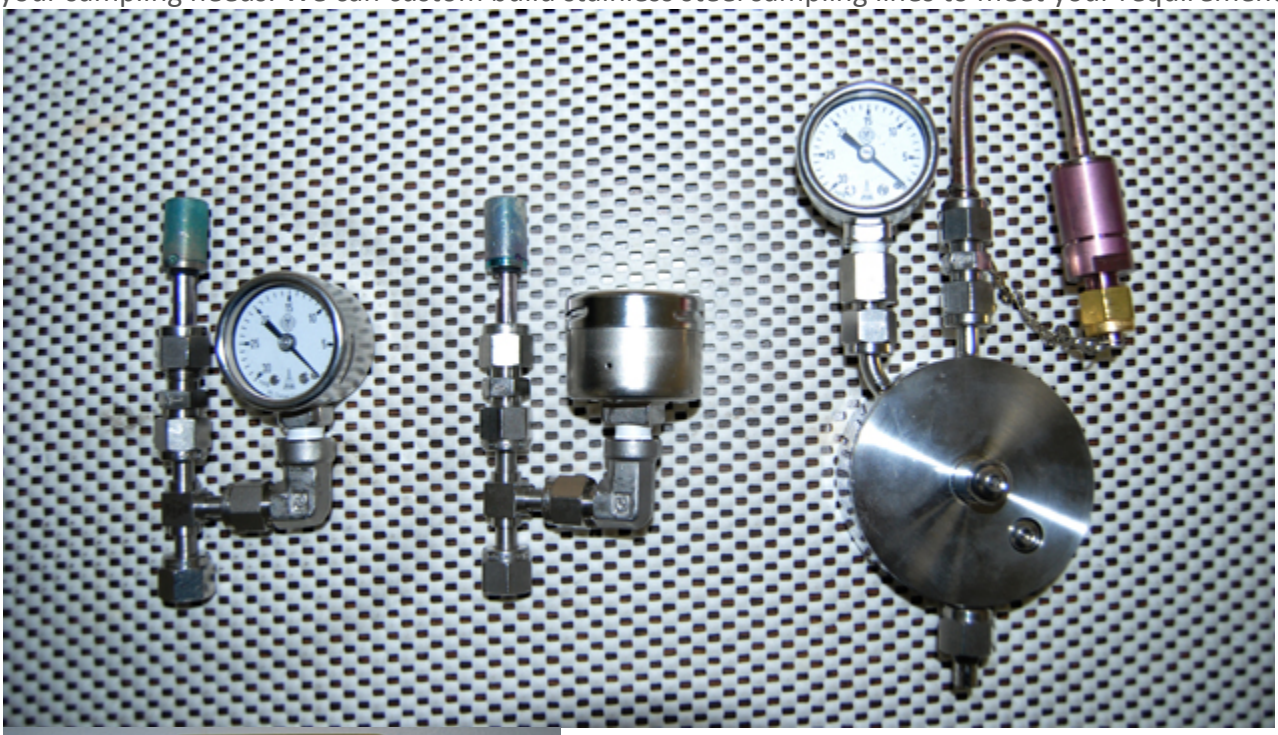
- **Summa® Canisters** – We have a large inventory of 6 Liter and 1.4 Liter canisters pre-cleaned and either batch or individually certified depending on your sampling needs. We have several varieties of canisters available for different applications including Restek TO-cans™ for low-level ambient toxics and ozone precursors monitoring as well as Restek SilcoCan™ and Entech Silonite™ Canisters for ultra inert sampling needs including speciated sulfur compounds. Canisters can be certified to meet EPA TO-15 SCAN or low-level SIM requirements.

- **High-Pressure Sample Cylinders** – We have a variety of sizes of high-pressure sample cylinders available that are pre-cleaned and either batch or individually certified depending on your sampling needs. These cylinders can be used for an array of applications including LNG, LPG, Biogas, fixed gases analysis, BTU analysis, neat gas analysis, sulfur compounds analysis, etc.



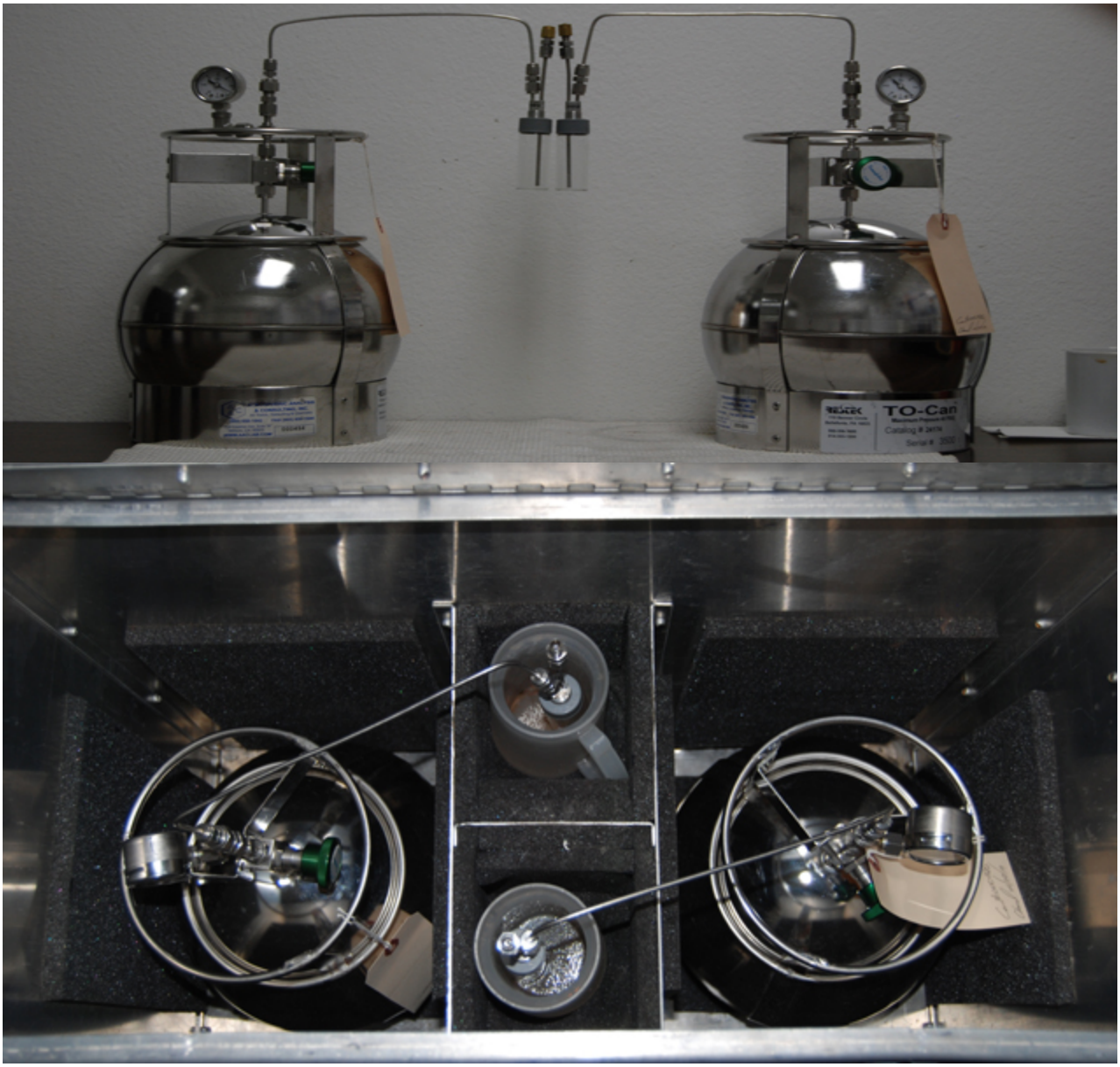
- **Tedlar and Teflon Bags** – We can supply Tedlar or Teflon bags upon request.
- **Vost, Tenax, Charcoal, Silica Gel, Chromosorb, and other Sampling Tubes** – A variety of sampling tubes can be provided upon request.
- **Flow Controllers, Filters and Sampling Lines** – We have a full supply of pre-cleaned flow controllers available for our Summa® canisters for fill times ranging from 15 minutes to 24 hours. All flow

controllers are set prior to use with a digital calibration device accurate to 0.1mL/min. Flow controllers can be provided individually certified and paired to a specific canister for either EPA TO-15 SCAN or low-level SIM requirements. Both end-of-line and inline stainless steel filters can be provided to meet your sampling needs. We can custom build stainless steel sampling lines to meet your requirements.



- **Custom Built Hydrocarbon Samplers and Manifolds** – We can build a variety of custom hydrocarbon samplers to meet your indoor, outdoor and stack testing needs. Samplers can be provided to supply a purge or sweep volume from a clean source for vapor intrusion or other needs.
- **SCAQMD 25.1 and 25.3 and EPA 25 Sampling Trains** – We can provide pre-assembled SCAQMD 25.1 and 25.3 and EPA 25 sampling trains in Heavy Duty Aluminum Boxes. Each box contains two identical sampling trains for the method required duplicate sample. Each sampling train consists of a 6 Liter Summa@ canister, a pre-attached flow controller, and either a stainless steel trap (25.1) or water

impinger (25.3) along with all necessary connections, plugs, filters, and instructions. The flow controllers are pre-cleaned and typically adjusted for a one hour sampling event. Other flow rates can be custom ordered to fulfill your project needs. All you have to do is add ice (25.3) or dry ice (25.1) and you're ready to sample!



- **DNPH Carbonyl Sampling Cartridges** – We can supply DNPH cartridges for sampling and analysis by EPA TO-11A, IP-6A and other methods. We can pre-certify the cartridges as needed. We can also coat specialty cartridges to meet your sampling needs and provide a variety of ozone-scrubber devices
- **DNPH Coated Filters and Passive Samplers** – We offer DNPH coated filters and passive samplers for sampling and analysis by EPA IP-6C and other methods. We provide pre-coated and certified DNPH filters pre-installed in a variety of passive samplers including GMD and SKC badges.

AAC can provide a large variety of sampling and spiking solutions, impingers and vials and other accessories to accommodate your wet sampling needs. A partial list of what we provide is included below.

- Sampling Solutions
  - DNPH solutions for sampling and analysis by EPA-0011 and CARB 430/430M methods – All of our sampling solutions are pre-certified and shipped overnight on ice to you to maintain their integrity. We can provide a modified DNPH solution for Acrolein sampling (CARB 430M) that has been proven to minimize the breakdown of Acrolein in acidified DNPH solutions.
  - BHA solutions for sampling and analysis by NCASI method 105.01.
  - EPA CTM-027 solutions for ammonia sampling and analysis.

- A modified CTM-027 solution for speciated amines sampling and analysis developed by AAC
- EPA TO-8 NaOH solution for Phenol and Cresols analysis.
- EPA 26/26A acidic and basic solutions.

- Spiking Solutions for field use for CARB 430/430M, EPA-0011, NCASI 99.02, 105.01 and other methods.
- We provide accurate pre and post sampling weighing for all types of filters including quartz and glass fiber 8x10 filters for TSP or PM10 HI-VOL sampling..
- Precoated solutions and filters for Isocyanate Sampling.
    - Midget 20mL glass impinger sampling trains for CARB 430/430M and other methods.

Supplement 3 – KDHE Certified Laboratories for Wastewater Analysis

Source:
http://public1.kdhe.state.ks.us/LabAccredit/LabAccredit.nsf/SelWebVC?SearchView&SearchMax=1000&SearchOrder=4&SearchWV=TRUE&SearchFuzzy=TRUE&Query=field+LabWWAni+contains+**BIOMONITORING

Certificate / Location	Mailing Address
Certificate # : E-10382 EA Engineering, Science & Technology, Inc. 231 Schilling Circle Hunt Valley, MD 21031	Phone #: (410) 584-7000 231 Schilling Circle Hunt Valley, MD 21031
Certificate # : E-10391 ENVIRON International Corporation 201 Summit View Drive, Suite 300 Brentwood, TN 37027	Phone #: (615) 377-4775 201 Summit View Drive, Suite 300 Brentwood, TN 37027
Certificate # : E-10277 Environmental Science Corporation (ESC Lab Science 12065 Lebanon Road Mt. Juliet, TN 37122	Phone #: (615) 758-5858 12065 Lebanon Road Mt. Juliet, TN 37122
Certificate # : E-10402 Midwest Laboratories Inc. 13611 B Street Omaha, NE 68144-3693	Phone #: (402) 334-7770 13611 B Street Omaha, NE 68144-3693
Certificate # : E-10116 Pace Analytical Services, Inc. 9608 Loiret Boulevard Lenexa, KS 66219-2406	Phone #: (913) 599-5665 9608 Loiret Boulevard Lenexa, KS 66219-2406
Certificate # : E-10116 Pace Analytical Services, Inc.	Phone #: (913) 599-5665 9608 Loiret Boulevard

9608 Loiret Boulevard
Lenexa, KS 66219-2406

Lenexa, KS 66219-2406

Supplement 4 – Sample Submittal Form for Leachate by Midwest Laboratories, Inc.

Source: https://www.midwestlabs.com/cgi-bin/subforms/subform_creator.pl?form_name=env_sample

Ship samples together with this sheet to

Midwest Laboratories, Inc.
13611 B St. Omaha, NE 68144 402-334-7770
13611 B Street • Omaha, NE 68144-3693 • 402-334-7770 • FAX 402-334-9121

PRINT FORM

REPORT AND BILL TO		IDENTIFICATION	COPY TO	
NAME:			NAME:	
ADDRESS:			ADDRESS:	
CITY:			CITY:	
STATE:			STATE:	
ZIP:			ZIP:	
ACCOUNT:		P.O.:	ACCOUNT:	
SUBMIT DATE:	2013-10-09		SAMPLE DATE:	2013-10-09

Environmental Sample Submittal Form

SAMPLE ID	CBOD	BOD	COD	pH	SOLIDS (TS,TSS,TDS, TVS, TVSS)	Ammonia Nitrogen	Nitrate Nitrogen	TKN	HEM	Cl	Cyanide	Samples - Regulatory Use(Y/N)	Metals(List Metals- Total or Dissolved)

Comments (Other Analysis)

MIDWEST LABORATORIES - LAB USE ONLY	MIDWEST LABORATORIES - RECEIVING USE ONLY
Temp On Arrival	Date/Time
No. of Containers	Received By
Samples Preserved Properly	Comments
Comments	

Unless otherwise requested, all samples will be analyzed by accredited test methods when available.
PRINT FORM

Supplement 5 – KDHE Laboratory: Summary of Analytical Suites and Selected Analyses

RM - RCRA Metals in water by EPA 200.7 or in solid by EPA 6010. Water or solid sample will be analyzed by ICP for the following parameters:

Ag, As, Ba, Cd, Cr, Pb, Se **(NO MERCURY will be analyzed)**

Requires a Nitric Acid preserved HM bottle for water samples or a 250ml jar or plastic zipper bag for solid samples.

AM - Other non-RCRA metals in water by EPA 200.7 or in solid by EPA 6010. Water or solid sample will be analyzed by ICP for the following parameters

Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sr, Tl, V and Zn. Al, B, Be, Ca, Co, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Sb, Si, Sr, Tl, V and Zn.

Requires a Nitric Acid preserved HM bottle for water samples or a 250ml jar or plastic zipper bag for solid samples.

PM - PWS Metals by EPA 200.8 and 200.7. Water **s**ample will be analyzed by both ICP and ICP-MS for the following parameters:

ICP-MS: Ag, Al, As, Ba, Be, Cd, Cr, Cu, Mn, Ni, Pb, Sb, Se and Tl.

ICP: B, Ca, Co, Fe, K, Mg, Mo, Na, Si, Sr, V and Zn.

Requires a Nitric Acid preserved HM bottle for water samples or a 250ml jar or plastic zipper bag for solid samples.

HG - Mercury in water or solid by EPA 245.1/7471. Water or solid sample will be analyzed by CVAA for Hg.

Requires a Nitric Acid preserved HM bottle for water samples or a 250ml jar or plastic zipper bag for solid samples.

TP - TCLP Metals by EPA 1311. Solid or liquid sample will be analyzed by ICP and CVAA for the following parameters.

ICP: Ag, As, Ba, Cd, Cr, Pb and Se. CVAA: Hg.

Requires a 8ozjar or plastic bag for solid samples (minimum150g) or 2 unpreserved CU bottles for

liquid samples.

NU - Nutrients by EPA 350.1 and 365.1. Water sample will be analyzed for Ammonia and Total Phosphate.
Requires a Sulfuric Acid preserved NU bottle.

MN - Minerals by EPA 300.0, 150.1 and 310.2. Water sample will be analyzed for the following parameters:
Fluoride, Chloride, Nitrate, Nitrite, Ortho-phosphate, Sulfate, pH and Alkalinity.
Requires an unpreserved CU bottle.

NO - Nitrate by EPA 300.0. Water or solid sample will be analyzed for Nitrate by Ion Chromatography.
Requires an unpreserved CU or IC bottle.

MI - Misc Inorganic Parameter. Please list miscellaneous Inorganic parameters.
BOD, COD, DO, TSS, TDS, Hardness, Conductance, Bromide, Turbidity, TOC and TKN.
Collection requirements vary, please contact lab for instructions.

VG -Volatiles by EPA 8260. Requires 40ml VOA vial preserved with HCL.

PX - Pesticides by EPA 608. PE - Pesticides by EPA 8080. Please use solvent rinsed 4L amber glass bottle.

Radiological parameters please specify: Gross Alpha, Gross Beta, Gamma, C-14, Ni-63, or Other.

Other analyses: Individual analysis may be requested by using individual analyte names

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Supplement 6 – List of Test Validation Results: For Allen County Landfill by ESC Lab Sciences

Attachment A
List of Analytes with QC Qualifiers

Sample Number	Work Group	Sample Type	Analyte ID	Run Qualifier
L630416-01	WG656564	SAMP	pH R2623060	T8
WG657146	SAMP	Potassium,Dissolved R2632202		V
WG657146	SAMP	Sodium,Dissolved R2632202		V
WG656084	SAMP	BOD R2625820		J4
WG656140	SAMP	2-Chloroethyl vinyl ether R2623400		J6J3
L630416-02	WG656564	SAMP	pH R2623060	T8
WG656084	SAMP	BOD R2625820		J4

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning

J3 The associated batch QC was outside the established quality control range for precision.
J4 The associated batch QC was outside the established quality control range for accuracy.
J6 The sample matrix interfered with the ability to make any accurate determination; spike value is low
T8 (ESC) - Additional method/sample information: Sample(s) received past/too close to holding time expiration.
V (ESC) - Additional QC Info: The sample concentration is too high to evaluate accurate spike recoveries.

Qualifier Report Information
ESC utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program and as required by most certifying bodies including NELAC. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC.

Data qualifiers are intended to provide the ESC client with more detailed information concerning the potential bias of reported data. Because of the wide range of constituents and variety of matrices incorporated by most EPA methods, it is common for some compounds to fall outside of established ranges. These exceptions are evaluated and all reported data is valid and useable "unless qualified as 'R' (Rejected)."

Definitions
Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries,
surrogate recoveries, etc.
Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and is represented by Relative Percent Difference.
Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromatography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.
TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.Bottom of Form