# MONITORING PROGRAM
# FOR THE
# NORTHERN SOLID WASTE MANAGEMENT CENTER AT CHERRY ISLAND

Revision 1 – October 10, 2012

This monitoring program supercedes the "Monitoring Program for the Northern Solid Waste Management Center (May 2005) as submitted in "Volume 12: Operations and Maintenance Manual" by Geosyntec Consultants as part of the Cherry Island Permit Application for SW-06/01. This document covers monitoring plans for groundwaters, surface waters/stormwaters and leachates from Cherry Island, and includes:

- Updated maps reflecting changes to monitoring locations installed under the Cherry Island Expansion Project (2006),
- Deletion of three (3) surface water/stormwater monitoring stations, and the addition of nine (9) new surfacewater monitoring stations;
- Addition of Total Hardness, Tin, alpha Terpineol, Benzoic acid, m/p Cresol, BTEX, TPH, DROs, Aroclors, and total Phenolics to the quarterly and semi-annual surface water monitoring requirements;
- Deletion of 13 groundwater monitoring wells and the addition of 15 new groundwater monitoring wells resulting from construction of the Cherry Island Expansion project, and replacement of three (3) damaged wells (LC-114, LC-115A and P-108A).

DSWA reserves the right to increase the monitoring frequency, or subject samples to additional analysis not covered by this Program as necessary to facilitate or otherwise aid various operational and research projects, studies, or investigations without the permission of the Solid and Hazardous Waste Section of the Delaware Department of Natural Resources and Environmental Control (S&HWS). Any additional data

Whenever a change in this monitoring document becomes necessary, DSWA will inform S&HW in writing of all changes to the program, and provide a revised copy of the Program for their approval.

The format of the comprehensive monitoring program is as follows:

| | |
|---|---|
| I. | General Field and Laboratory Protocols |
| II. | Leachate Monitoring Program |
| III. | Stormwater/Surfacewater Monitoring Program |
| IV. | Groundwater Monitoring Program |
| Attachment A: | Stormwater/Surfacewater Monitoring Plan for the Cherry Island Landfill (June 2012) |
| Attachment B: | Leachate Monitoring Plan for the Cherry Island Landfill (June 2012) |
| Attachment C: | Groundwater Monitoring Plan for the Cherry Island Landfill (June 2012) |
| Attachment D: | May 23, 2000 Memorandum on Future Cherry Island Monitoring Requirements |

## I. FIELD & LABORATORY PROTOCOLS

All samples shall be collected, prepared, shipped, and analyzed using the methods provided in the following publications:

| | |
|---|---|
| A. SW-846 (Most Recent Edition) | <u>To be used first;</u> |
| B. 40 CFR-136 (Most Recent Edition) | <u>to be used only if methods are not available in A above;</u> |
| C. Standard Methods (Most Recent Edition) | <u>to be used only if methods are not available in A or B above;</u> |
| D. Other methods as jointly approved by DSWA and DNREC | <u>to be used only if methods are not available in A, B, or C above.</u> |

All groundwater and surfacewater samples shall be collected in a manner that minimizes sample turbidity. All wells shall be maintained as necessary so that they will produce low turbidity water. All groundwater samples exceeding 10 NTUs shall be field filtered.

## II. Stormwater/Surfacewater Monitoring Program

A. Surface water samples shall be collected from the surface water monitoring locations shown in Attachment A, Figure 1. These samples shall be analyzed in accordance with the schedules provided in Attachment A, Tables 1 and 2. Sample collection, preservation, Chain-of-Custody, labeling, shipment, and equipment decontamination, shall follow the same procedures as outlined in Attachment A.

B. Stormwater samples shall be collected from the stormwater monitoring locations shown in Attachment A, Figure 1 on a semi-annual basis. Sample collection, preservation, Chain-of-Custody, labeling, shipment, and equipment decontamination, shall follow the same procedures as outlined in Attachment A. These samples shall be analyzed in accordance with the schedules provided in Attachment A, Table 3.

## III. Leachate Monitoring Program

A. Leachate Monitoring

1. DSWA shall monitor all collection systems, wet-wells, pumps, flow meters, controls and recording devices each operating day to insure proper operation. DSWA shall inspect all connections to valves, pipes, and flow meters at riser houses and pump stations for leaks. The results of monitoring and inspections shall be recorded in the facility log.

2. DSWA shall measure and record the quantities of leachate pumped to the City of Wilmington's wastewater treatment plant on a weekly basis. DSWA shall also record the quantity of all leachates being transferred from the CSWMC and SSWMC to CIL for disposal. These records shall include the date of the event, the origin of the leachate, quantity of leachate, and the destination of the leachate.

3. Leachate samples from the CIL Master Pump Station (Attachment B, Figure 1) shall be collected and analyzed in accordance with the schedules provided in Attachment B, Tables 1, 2, 3, 4 and 5. Sample collection, preservation, Chain-of-Custody, labeling, shipment, and equipment decontamination, shall follow the same procedures as outlined in Attachment B.

B. Collection Line Maintenance

1. Annually, all accessible leachate collection pipes shall be cleaned with a self propelled, high pressure jetting system. DSWA shall identify and assess any blockages or areas that are inaccessible during the annual cleanings.

2. At least once every four years, DSWA shall have all accessible leachate collection systems video inspected to assess their condition. Upon completion DSWA shall generate a report discussing the condition of the leachate collection pipes including the condition of the pipes, clogging of the pipe perforations, locations and cause of blockages, and any effects the blockages had on operation of the system.

C. Spill Contingency

1. DSWA shall immediately notify DNREC regarding any incident of a leachate release.
2. DSWA shall immediately cleanup any and all areas impacted by the leachate release.
3. Should the spill be of a quantity or in an area that poses a potential release from site, the DSWA shall:

   a. Estimate the quantity of the release;
   b. Generate a map showing the location of the release;
   c. Sample free liquids in the impacted area and the closest surfacewater to the release;
   d. Test the samples listed in II.C. above for the analytes and measurements listed in Attachment B, Table 6.
   e. Report the results of analysis to the Solid and Hazardous Waste Section of the Department of Natural Resources and Environmental Control within 45 days of the release.

## IV. Groundwater Monitoring Program

Groundwater samples shall be collected from the groundwater monitoring locations shown in Attachment C, Figure 1. These samples shall be analyzed in accordance with the schedules provided in Attachment C, Table 1. Sample collection, preservation, Chain-of-Custody, labeling, shipment, and equipment decontamination, shall follow the same procedures as outlined in Attachment C.

# ENVIRONMENTAL MONITORING PROGRAM
# FOR THE
# NORTHERN SOLID WASTE MANAGEMENT CENTER AT CHERRY ISLAND
# (Revision 1 - October 10, 2012)

## ATTACHMENT A: Stormwater/Surface Water Monitoring Plan for the Cherry Island Landfill

**Background: Stages of Stormwater Management System Monitoring**

The stormwater and quarterly Surfacewater Monitoring Plan for CIL has been divided into three stages, namely: (i) Initial Stage (Stage I) corresponds to the stormwater monitoring that will take place between the construction of the foundation enhancement and prior to filling of waste to the elevation of the top of the perimeter mechanically stabilized earth (MSE) berm; (ii) Transitional Stage (Stage II) corresponds to the stormwater monitoring that will take place after waste elevation in the vicinity of the perimeter MSE berm has reached and exceeded the elevation of the top of the perimeter MSE berm; and (iii) Final Stage (Stage III) corresponds to stormwater monitoring that will take place after all the stormwater runoff is directed towards the perimeter discharge points SW-1 through Drop Inlet 5. This stormwater monitoring plan for CIL will be modified as operations move into different stages of waste filling. The following describes of Stages I through III as outlined above:

**Stage I (Initial Stage)**

This stage represents the stormwater and surface water monitoring that will take place during the construction of the MSE berm and before waste elevations in the vicinity of the MSE berm reaches the top of the MSE berm. During Stage I, grading of the landfill will direct stormwater to the following locations:

- Two (2) toe drains that direct stormwater to the Northern Stormwater Management Basin;
- Two (2) toe drains that direct stormwater to the Delaware River;
- Three (3) toe drains that direct the stormwater to the Christina River;
- Stormwater Swale Discharge Pipe (SW-6 as shown on page 9, Figure 1 of this Plan).

During Stage I, the concrete channel at the base of (four) 4 drop inlets that will go into operation after landfilling has reached the top of the MSE berm will be outfitted with:

- A weir system comprised of a square or v-notch weir, vault, visual scale and/or electronic data logging float system capable of measuring the flow of the stormwater exiting the site.

or

- A discharge pipe outfitted with a flow meter/data logging system capable of measuring the flow of the stormwater exiting the site.

During Stage I, the DSWA will continue quarterly monitoring of the Northern Stormwater Management Basin, the Delaware River (R1 and R2), the Christina River (SW-5) and the stormwater outlet on 12th Street (SW-6) for the measurements and analytes listed in Tables 1 and 2 on pages 10 and 11 of this Plan. Additionally, semi-annual stormwater samples will be collected at LP-1, LP-2, LP-3 along the Christina River, LP-4, LP-8, SW-1 along the Delaware River, R-1 and R-2 along the Delaware River, and SW-6 on 12th Street. These samples shall be collected at least 90 days apart, be collected within 12-hours of the beginning of a significant precipitation event, and shall undergo analysis for the analytes listed in Table 3 on page 12 of this Plan. Figure 1 on page 9 of this Plan shows the location of the final monitoring points.

**Stage II (Transitional Stage)**

At this stage, the landfill has reached the top of the MSE berm and surface water runoff is being directed into one of the MSE berm stormwater discharge points (Drop Inlets 1, 1A, 2,3,4 and 5) shown on page 9, Figure 1 of this Plan. During this time, the LPs in the drainage area will be pressure grouted shut, and the FML sealed so that landfilling can take place in that area. As each LP in a drainage area is abandoned, it will be removed from the monitoring schedules, and the corresponding Drop Inlet will be added. Each of these new locations will be outfitted with flow monitoring instrumentation consistent with that listed for Stage I. Sampling at each new stormwater monitoring location will begin during the next scheduled stormwater sampling event.

**Stage III (Final Stage)**

At this stage, all of the stormwater runoff is being directed towards the six (6) Drop Inlets located along the perimeter of the MSE berm. During Stage III, six (6) stormwater discharge points and three surface water locations will be monitored. Page 9, Figure 1 of this Plan shows the location of the current and final monitoring points. Quarterly monitoring will continue at R1 and R2, SW-1, SW-5 and SW-6 for the measurements and analytes listed in Tables 1 and 2 on pages 10 and 11 of this Plan. Additionally, the semi-annual stormwater monitoring described under Stage I will continue. These samples shall be collected at least 90 days apart, and shall undergo analysis for the analytes listed in Table 3 on page 12 of this Plan.

It should be noted that stormwater sampling will only take place Monday through Friday due to security and access issues, health and safety issues, as well as holding times for some analytes.

I. <u>Monitoring Requirements</u>

Depending on the "Stage" of landfilling as listed above, surface water and stormwater samples shall be collected from the monitoring locations shown on page 9, Figure 1 of this Plan. These samples shall be analyzed in accordance with the schedules provided in Tables 1, 2, and 3 on pages 10 through 12 of this Plan. Sample collection, preservation, Chain-of-Custody, labeling, shipment, and equipment decontamination, shall follow the same procedures as outlined in this Plan.

II. <u>Analytical Methodology</u>

All samples shall be analyzed using the methods provided in the following publications:

A. SW-846 (Most Recent Edition) to be used first;
B. 40 CFR-136 (Most Recent Edition) to be used only if methods are not available in A above;
C. Standard Methods (Most Recent Edition) to be used only if methods are not available in A or B above;
D. Other methods as jointly approved by DSWA and DNREC to be used only if methods are not available in A, B, or C above.

III. <u>Control of Stormwater Runoff and Sedimentation</u>

As part of the CIL Stormwater Monitoring Plan, landfill operations staff will minimize suspended solids (i.e., sediment transport) from the stormwater runoff by constructing and maintaining berms and grading swales to direct stormwater running off the working surface along specific flow paths. Sediment basins and check dams will be used to reduce sediments in runoff reaching stormwater discharge points from CIL. In addition, areas that are not actively landfilled will be seeded and mulched.

IV. <u>System Maintenance</u>

The stormwater conveyance and discharge system (SCDS) shall be kept free of debris, waste, and sediment build-up. When discovered, ponding water on the landfill surface shall be diverted to the SCDS. The SCDS shall be visually inspected at a minimum frequency of once per month, and immediately after severe meteorological events such as hurricanes or floods. SCDS Inspection/Maintenance forms shall be completed on a monthly basis and included in the facility log. Inspections shall include the following:

- Berms and swales shall be inspected for erosion and sedimentation;
- Silt fences shall be inspected for holes, tears or separation from anchor posts;
- Culverts and pipes shall be inspected for siltation and blockage;
- Control structures shall be inspected for siltation, debris, and damage such as erosion.

All sediments, waste or debris removed from the SCDS shall be placed back on the operational portion of the landfill surface. Any needed repairs discovered during SCDS inspections shall be noted in the SCDS inspection/maintenance forms, and reported to the facility manager or designated DSWA representative. Any repairs or other remedial actions taken shall be scheduled by the facility manager and completed as necessary. Upon completion of repairs or remedial action, the facility manager or designated DSWA representative shall note the repairs on the original SCDS Inspection/Maintenance log along with the date of repairs or remedial action. A copy of the Inspection/Maintenance forms can be found on pages 13 through 15 of this Plan.

Swales designed to convey runoff to stormwater discharge points should be maintained to provide the necessary depth to hold stormwater within the confines of the taper and necessary fall to keep stormwater from backing up within the SCDS. To reduce erosion and filter out sediments, in areas that will not be impacted by landfilling activities for six months, DSWA personnel shall install an intermediate cover, seed and mulch.

## V. Meteorological Monitoring

DSWA shall maintain a meteorological weather station at CIL. Data from this weather station shall be maintained in an electronic database. Pertinent meteorological data shall accompany stormwater sample data upon submission to DNREC.

## VI. Field Preparation: Mobilization/Demobilization

The following outlines those procedures DSWA requires of its environmental monitoring contractors for preparation for the sampling of surface waters and stormwaters at the DSWA facilities:

A. Standard QA/QC required by the sampling contractor include:

1. External audits through certification programs.
2. External audits through acceptance of blind samples and round robin testing.
3. Internal audits through splitting samples and shipping samples to other local and regional laboratories.
4. Performance audits of all laboratory personnel and stations.

B. Many times, the bottles used by a contractor for sample collection, shipment, and storage are purchased pre-cleaned and (some with preservatives added) by an independent company. However, all sampling and field equipment is usually cleaned and maintained by the contractor. Therefore, as a part of standard quality checks, all bottle shipments should be tested by the contracted monitoring company on a routine basis for contamination. If the sampling company elects to clean their own bottles, quality checks should be standard protocol, and should be run on every lot washed. As a minimum, the following should be done prior to any bottles going into the field:

1. Fresh disposable Nitrile gloves should be worn whenever handling the glassware (prior to and after cleaning).
2. All labels should be affixed to the bottles prior to issuance to field teams.
3. All sample preservatives which can be placed in bottles prior to sample collection should be done so before the bottles are issued to the field teams. The type and amount of preservative should be placed on the label immediately prior to or after addition to the bottle.
4. Specific analytes and sample locations should be placed on the labels in indelible ink prior to the bottles leaving the laboratory. Note that all caps for volatile organic samples should be screwed down tightly prior to labeling to eliminate any airborne volatile contaminants from the label glues or ink from indelible markers, pens, or type.

C. Preparation of field equipment should include cleaning of all manual sampling equipment using the following procedures:

1. A general rinse with water to remove debris and solids.
2. An Alconox or Citrinox Wash.
3. Sterile rinses with deionized/distilled water.
4. Acid Wash.
5. Sterile rinses with deionized/distilled water.
6. Hexane Wash.
7. 3 sterile rinses with deionized/distilled water.

All acids and chemical rinses used should be GCMS grade or better. The field sampling team is required to carry the necessary chemicals and deionized/distilled water into the field in order to clean any materials that may become contaminated during sampling.

D. All pumps and field meters should be cleaned and calibrated prior to each sampling event using chemicals and standard procedures recommended by the manufacturer. The equipment should undergo the same protocols when it is returned to the lab.

E. Maintenance and parts replacement should be performed as required by the manufacturers suggested schedule.

F. The sampling company is required to retain records of maintenance and calibration certification. These records are periodically checked by the DSWA.

G. All field equipment should be inspected and tested for proper operation prior to being sent into the field.

H. The sampling team is required to carry duplicates of all major pieces of sampling equipment.

VII. Surface Water Samples

All surfacewater samples shown on Page 9, Figure 1 of this Plan shall be collected using methodology described in this Plan. These samples shall undergo the analysis provided in Tables 1 and 2 on pages 10 and 11 of this Plan.

VIII. Stormwater Flow Monitoring

During Stage III monitoring, DSWA shall maintain automated stormwater monitoring systems designed to measure the flow of stormwater during precipitation events. Either direct data transfer or remote logging capabilities shall be the basis for data collection.

IX. Stormwater Sample Collection

A. Monitoring of discharges from the CIL stormwater control system shall take place on a semi-annual basis. Stormwater samples shall be tested for those analytes listed in Table 3 on page 12 of this Plan. Stormwater samples shall be bulk samples. Scow float or precipitation actuated auto samplers shall be placed at the stormwater discharge boxes a maximum of 24 hours prior to an expected meteorological event that will exceed 1" of precipitation over a 24-hour period.

B. Calibration for scow float actuated samplers shall be set so that the auto samplers activate when discharge reaches approximately 50 gpm. Calibration can be to a set point estimated by simulating elevation of discharge over a V-notch or square weir.

C. Activation of a precipitation actuated auto sampler shall be tested for functionality by simulation of a 0.10" precipitation event.

D. The auto samplers shall be programmed to begin collection of a bulk sample at the calibrated actuation point. Bulk samples shall be the quantity necessary to perform testing for the analytes listed below.

E. Bulk samples shall be picked up and transported to an independent contracted laboratory within 18 hours of collection. Upon completion of sample collection, the auto samples shall be cleaned, inspected for damage, repaired as necessary, and placed in storage until the next sampling event. Sampling events shall be at least 60 days apart. No sampling event shall take place until after 72 hours of dry weather has occurred.

X. Sampling Protocols - General

A. All monitoring events shall be overseen by an individual with a minimum of three years field experience in the collection, preparation, and shipping of stormwater samples.

B. A minimum of one pair of Nitrile gloves (two are recommended) are to be used while handling equipment during all phases of the collection, preparation, and shipment of samples. Gloves are changed between sampling locations. (e.g. gloves are changed prior to sample collections and after equipment decontamination.) This insures minimal opportunity for contamination through handling of samples and equipment by operators.

XI. Health and Safety

A. During stormwater and surface water monitoring events at DSWA facilities, field sampling teams are required to follow the OSHA regulations governing personal health and safety. Personal protection shall be maintained at Level D requirements. Hard hats (when overhead danger exists), safety glasses, safety shoes with steel toes, and protective gloves are the only safety equipment required at the present time. However, should samples show any indication of being hazardous, the sampling team would be required to move to more stringent health and safety protocols before going further in the sampling event.

B. Field teams shall carry a basic first aid kit and a cell phone at all times to facilitate communications when needed. Any injuries sustained during sampling activities shall immediately be reported to the facility manager or authorized DSWA representative. An accident/incident report shall be filled out immediately upon reporting an accident or incident at a DSWA facility.

C. Field teams shall sign in at the appropriate location when entering the facility, and sign out immediately prior to leaving the site. At least one member of the sampling team collecting stormwater samples at DSWA facilities must carry the following valid certifications:

1. 40 hour OSHA Emergency Response Program
2. First Aid and CPR.

XII. Sample Collection Methodology – Surface Waters

A. Surface water samples shall be collected using grab methods.

B. Grabs may be collected using direct immersion of the sample bottles, prepackaged disposable ewers or dippers, or reusable ewers or dippers that have undergone decontamination as per Section VI.C. above.

C. Samples will be collected in a manner as to minimize solids and turbidity.

D. Due to the fluidic conditions of the surfacial soils on the bottom of the Christina River, no samples will be collected from SW-5 until tidal conditions allow sample collection from the shore line.

E. Field measurements and observations shall include those listed in Tables 1 and 2 (pages 10 and 11) of this Plan.

XIII. Sample Collection Methodology - Stormwaters

A. When retrieved from the auto sampler, the sampling team shall move the bulk storage sample vessel(s) to a working surface away from any airborne emissions. The field team shall then gently swirl the bulk storage sample vessel (s)containing the stormwater sample and then extract 1 liter into a clean sterile vessel for collection of field measurements. Field measurements and observations shall include those listed in Tables 1 and 2 (pages 10 and 11) of this Plan.

B. These measurements and observations shall be entered into a bound field log along with the time and date of sample collection. This field log book shall be carried by the field team whenever they are on site.

C. Upon completion of field measurements, the sampling team shall separate out the remaining sample into pre-sterilized, pre-labeled bottles. Each bottle shall contain the necessary preservative required for the specified analysis. The field team shall fill in all pertinent information as necessary to fully identify the sample. As a minimum, the label on each bottle shall identify the following:

1. Contracting Lab or Sampling Contractor
2. DSWA
3. Name of Person Collecting the Samples
4. Sample Location
5. Time and Date of Sample Collection
6. The preservatives present in the bottle

After samples have been collected, all pertinent data regarding the samples shall be transcribed onto the proper Chain of Custody. Samples will then be placed in coolers along with ice, dry ice, or cold packs, and chilled to 4° C for transportation to the laboratory.

D. If samples are to be shipped by a separate shipping company, all coolers shall be sealed with a custody seal to insure tampering has not occurred between the time the samples left the site and the time they are received at the contracted laboratory. Each time the samples change hands, the receiver shall inspect the condition of the shipping containers and sign off on the Chain of Custody to acknowledge receipt of the samples. Any aberrations in the custody seal or shipping container shall be noted on the Chain of Custody by the receiver of the samples.

XIV. Quality Control/Quality Assurance Samples

A. In addition to the stormwater/surface water samples, the field team will prepare two QC/QA samples per monitoring event. These samples will be submitted to the contracted laboratory for the same analysis that is required for the stormwater/surface water samples. The QC/QA samples shall include:

1. Laboratory prepared trip blank/monitoring event. The trip blank will accompany the stormwater/surface water sample bottles from preparation at the laboratory through the sampling process. This sample will be analyzed to evaluate if contamination was introduced during bottle preparation, sample handling or analytical procedures.

2. Equipment blank sample per monitoring event. The equipment blank will be prepared by pumping laboratory supplied deionized water through the same decontaminated sampling apparatus used during the collection of actual stormwater/surface water samples. This sample will be analyzed to evaluate the effectiveness of the decontamination process.

B. QA/QC samples will be analyzed for the same suite of analytes as the surface water and/or stormwater samples.

XV. Additional Samples

During each stormwater monitoring event, the sampling team shall grab one upstream and one downstream sample from the Delaware River. The upstream sample shall be collected at the Northernmost property boundary just below the City of Wilmington wastewater treatment plant outfall. The downstream sample shall be collected at the confluence of the Delaware and Christina Rivers. These samples shall be tested for the same analytes as the stormwater samples.

XVI. Supply Disposal

Non-hazardous expendable supplies and equipment used in the collection of samples can be disposed of at the small load collection station prior to the sampling team leaving the site. Unused or excess sample that has not contacted sample preservatives can be disposed of at the sample location. Disposal of hazardous expendable supplies such as excess preservatives are to be taken back to the laboratory by the sampling team for proper disposal.

XVII. Reporting

Stormwater sample results must be received by DSWA and DSWA's environmental monitoring contractor within 30 days of the completion of the stormwater sampling event. Results of analysis and discussion of the stormwater and surface water monitoring activities shall be included and discussed in the first quarterly groundwater and surface water monitoring report generated following reception of the stormwater monitoring data. The CIL historical surface water monitoring database will be transferred to DNREC by way of electronic media or direct file transfer on a quarterly basis.

As a final note, the environmental monitoring contractor and contracted laboratory providing analysis of samples is/are required to retain all field and laboratory records in hard copy format for a minimum of five years, with magnetic media storage for thirty years.

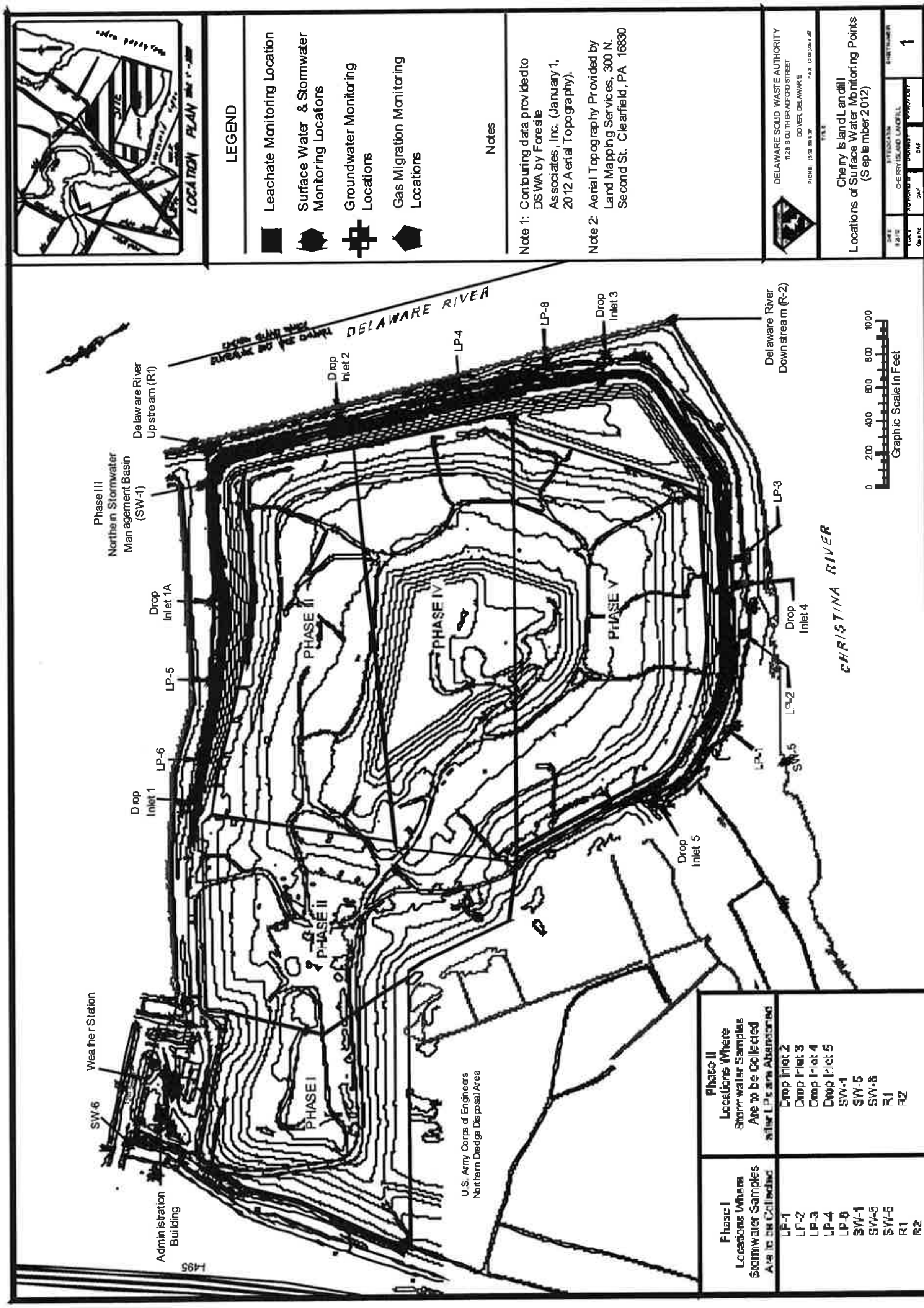

LOCATION PLAN
LEGEND
Leachate Monitoring Location
Surface Water & Stormwater Monitoring Locations
Groundwater Monitoring Locations
Gas Migration Monitoring Locations
Notes
Note 1: Contouring data provided to DSWA by Foresite Associates, Inc. (January 1, 2012 Aerial Topography).
Note 2: Aerial Topography Provided by Land Mapping Services, 300 N. Second St. Clearfield, PA 16830
DELAWARE SOLID WASTE AUTHORITY
1128 SOUTH BRADFORD STREET
DOVER, DELAWARE
Cherry Island Landfill
Locations of Surface Water Monitoring Points
(September 2012)
1
DELAWARE RIVER
CHRISTINA RIVER
Delaware River Upstream (R1)
Delaware River Downstream (R-2)
Phase III Northern Stormwater Management Basin (SW-1)
Drop Inlet 1A
Drop Inlet 1
Drop Inlet 2
Drop Inlet 3
Drop Inlet 4
Drop Inlet 5
LP-1
LP-2
LP-3
LP-4
LP-5
LP-6
LP-8
SW-5
SW-6
PHASE I
PHASE II
PHASE III
PHASE IV
PHASE V
Weather Station
Administration Building
I-495
U.S. Army Corps of Engineers Northern Dredge Disposal Area
0 200 400 600 800 1000
Graphic Scale In Feet
Phase I Locations Where Stormwater Samples Are to be Collected
LP-1
LP-2
LP-3
LP-4
LP-8
SW-1
SW-5
SW-6
R1
R2
Phase II Locations Where Stormwater Samples Are to be Collected after LPs are Abandoned
Drop Inlet 2
Drop Inlet 3
Drop Inlet 4
Drop Inlet 5
SW-1
SW-5
SW-6
R1
R2

Figure 1

**Table 1: CIL Monitoring Requirments For Surface waters Under Permit SW-06/01**

January and July

| Analyte | Northern Stormweater Management Basin | Delaware River Upstream (Low Tide) See Note 1 | Delaware River Downstream (Low Tide) See Note 1 | Delaware River Upstream (High Tide) See Note 2 | Delaware River Downstream (High Tide) See Note 2 | Christina River (SW-5) | 12th Street (SW-6) | Phase V Sedimentation Basin (LP-8) |
|---|---|---|---|---|---|---|---|---|
| River Elevation/Flow over Wier | X | X | X | | | X | X | X |
| Temperature (Field) | X | X | X | | | X | X | X |
| pH (Field) | X | X | X | | | X | X | X |
| Specific Cond. (Field) | X | X | X | | | X | X | X |
| REDOX (Field) | X | X | X | | | X | X | X |
| D. O. (Field) | X | X | X | | | X | X | X |
| Turbidity | X | X | X | | | X | X | X |
| pH (Lab) | X | X | X | | | X | X | X |
| Specific Cond. (Lab) | X | X | X | | | X | X | X |
| Alkalinity (Total) | X | X | X | | | X | X | X |
| Alkalinity (Phenolphth.) | X | X | X | | | X | X | X |
| Total Hardness | X | X | X | | | X | X | X |
| Ammonia-N | X | X | X | | | X | X | X |
| Total Organic-N | X | X | X | | | X | X | X |
| Total Kjehdahl-N | X | X | X | | | X | X | X |
| B.O.D. | X | X | X | | | X | X | X |
| C.O.D. | X | X | X | | | X | X | X |
| T.O.C. | X | X | X | | | X | X | X |
| Chlorides | X | X | X | | | X | X | X |
| Nitrate-N | X | X | X | | | X | X | X |
| Orthophosphate | X | X | X | | | X | X | X |
| Total Phosphorus | X | X | X | | | X | X | X |
| Dissolved Silica | X | X | X | | | X | X | X |
| Sulfate | X | X | X | | | X | X | X |
| T.D.S. | X | X | X | | | X | X | X |
| T.S.S. | X | X | X | | | X | X | X |
| Arsenic | X | X | X | | | X | X | X |
| Cadmium | X | X | X | | | X | X | X |
| Calcium | X | X | X | | | X | X | X |
| Chromium | X | X | X | | | X | X | X |
| Chromium (Hexovalent) | X | X | X | | | X | X | X |
| Copper | X | X | X | | | X | X | X |
| Iron | X | X | X | | | X | X | X |
| Lead | X | X | X | | | X | X | X |
| Magnesium | X | X | X | | | X | X | X |
| Manganese | X | X | X | | | X | X | X |
| Mercury | X | X | X | | | X | X | X |
| Nickel | X | X | X | | | X | X | X |
| Potassium | X | X | X | | | X | X | X |
| Sodium | X | X | X | | | X | X | X |
| Tin | X | X | X | | | X | X | X |
| Zinc | X | X | X | | | X | X | X |
| Aroclor-1016 | X | X | X | | | X | X | X |
| Aroclor-1221 | X | X | X | | | X | X | X |
| Aroclor-1232 | X | X | X | | | X | X | X |
| Aroclor-1242 | X | X | X | | | X | X | X |
| Aroclor-1248 | X | X | X | | | X | X | X |
| Aroclor-1254 | X | X | X | | | X | X | X |
| Aroclor-1260 | X | X | X | | | X | X | X |
| Oil and Grease (Hexane Extractable) | X | X | X | | | X | X | X |
| Oil and Grease (Silica Gel Treated) | X | X | X | | | X | X | X |
| BTEX | X | X | X | | | X | X | X |
| Diesel Range Organics | X | X | X | | | X | X | X |
| alpha Terpineol | X | X | X | | | X | X | X |
| Benzoic Acid | X | X | X | | | X | X | X |
| m/p Cresol | X | X | X | | | X | X | X |
| Total Phenolics | X | X | X | | | X | X | X |

Note 1: Contractor shall use the USGS Staff Gauge on the Delaware & Christina Rivers for this measurement. River samples shall be collected at low tide.

Note 2: Contractor shall use the USGS Staff Gauge on the Delaware & Christina Rivers for this measurement. River samples shall be collected at High tide.

**Table 2: CIL Monitoring Requirments For Surface waters Under Permit SW-06/01 (Continued)**

**April and October**

| Analyte | Northern Stormweater Management Basin | Delaware River Upstream (Low Tide) See Note 1 | Delaware River Downstream (Low Tide) See Note 1 | Delaware River Upstream (High Tide) See Note 2 | Delaware River Downstream (High Tide) See Note 2 | Christina River (SW-5) | 12th Street (SW-6) | Phase V Sedimentation Basin (LP-8) |
|---|---|---|---|---|---|---|---|---|
| River Elevation/Flow over Wier | X | X | X | X | X | X | X | X |
| Temperature (Field) | X | X | X | X | X | X | X | X |
| pH (Field) | X | X | X | X | X | X | X | X |
| Specific Cond. (Field) | X | X | X | X | X | X | X | X |
| REDOX (Field) | X | X | X | X | X | X | X | X |
| D. O. (Field) | X | X | X | X | X | X | X | X |
| Turbidity | X | X | X | X | X | X | X | X |
| pH (Lab) | X | X | X | X | X | X | X | X |
| Specific Cond. (Lab) | X | X | X | X | X | X | X | X |
| Alkalinity (Total) | X | X | X | X | X | X | X | X |
| Alkalinity (Phenolphth.) | X | X | X | X | X | X | X | X |
| Total Hardness | X | X | X | X | X | X | X | X |
| Ammonia-N | X | X | X | X | X | X | X | X |
| Total Organic-N | X | X | X | X | X | X | X | X |
| Total Kjehdahl-N | X | X | X | X | X | X | X | X |
| B.O.D. | X | X | X | X | X | X | X | X |
| C.O.D. | X | X | X | X | X | X | X | X |
| T.O.C. | X | X | X | X | X | X | X | X |
| Chlorides | X | X | X | X | X | X | X | X |
| Nitrate-N | X | X | X | X | X | X | X | X |
| Orthophosphate | X | X | X | X | X | X | X | X |
| Total Phosphorus | X | X | X | X | X | X | X | X |
| Dissolved Silica | X | X | X | X | X | X | X | X |
| Sulfate | X | X | X | X | X | X | X | X |
| T.D.S. | X | X | X | X | X | X | X | X |
| T.S.S. | X | X | X | X | X | X | X | X |
| Arsenic | X | X | X | X | X | X | X | X |
| Cadmium | X | X | X | X | X | X | X | X |
| Calcium | X | X | X | X | X | X | X | X |
| Chromium | X | X | X | X | X | X | X | X |
| Chromium (Hexovalent) | X | X | X | X | X | X | X | X |
| Copper | X | X | X | X | X | X | X | X |
| Iron | X | X | X | X | X | X | X | X |
| Lead | X | X | X | X | X | X | X | X |
| Magnesium | X | X | X | X | X | X | X | X |
| Manganese | X | X | X | X | X | X | X | X |
| Mercury | X | X | X | X | X | X | X | X |
| Nickel | X | X | X | X | X | X | X | X |
| Potassium | X | X | X | X | X | X | X | X |
| Sodium | X | X | X | X | X | X | X | X |
| Tin | X | X | X | X | X | X | X | X |
| Zinc | X | X | X | X | X | X | X | X |
| Aroclor-1016 | X | X | X | X | X | X | X | X |
| Aroclor-1221 | X | X | X | X | X | X | X | X |
| Aroclor-1232 | X | X | X | X | X | X | X | X |
| Aroclor-1242 | X | X | X | X | X | X | X | X |
| Aroclor-1248 | X | X | X | X | X | X | X | X |
| Aroclor-1254 | X | X | X | X | X | X | X | X |
| Aroclor-1260 | X | X | X | X | X | X | X | X |
| Oil and Grease (Hexane Extractable) | X | X | X | X | X | X | X | X |
| Oil and Grease (Silica Gel Treated) | X | X | X | X | X | X | X | X |
| BTEX | X | X | X | X | X | X | X | X |
| Diesel Range Organics | X | X | X | X | X | X | X | X |
| alpha Terpineol | X | X | X | X | X | X | X | X |
| Benzoic Acid | X | X | X | X | X | X | X | X |
| m/p Cresol | X | X | X | X | X | X | X | X |
| Total Phenolics | X | X | X | X | X | X | X | X |

**Note 1: Contractor shall use the USGS Staff Gauge on the Delaware & Christina Rivers for this measurement. River samples shall be collected at low tide.**

**Note 2: Contractor shall use the USGS Staff Gauge on the Delaware & Christina Rivers for this measurement. River samples shall be collected at High tide.**

### Table 3: CIL Monitoring Requirments For Surfacewaters and Storm waters Under Permit SW-06/01

| Location → | LP-1 Southwest of Phase V (Note 1) | LP-2 South of Phase V (Note 1) | LP-3 South of Phase V (Note 1) | LP-4 East of Phase IV (Note 1) | LP-8 East of Phase V (Note 1) | Drop Inlet 2 East of Phase III (Note 2) | Drop Inlet 3 East of Phase V (Note 2) | Drop Inlet 4 South of Phase V (Note 2) | Drop Inlet 5 West of Phase V (Note 2) | Northern Stormwater Management Basin (SW-1) | Confluence of the USACE Area and Phase V (SW-5) | 12th Street behind Gas Plant (SW-6) | Delaware River Upstream (R-1) | Delaware River Downstream (R-2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Phase I | Phase I | Phase I | Phase I | Phase I | Phase II | Phase II | Phase II | Phase II | Phase I &II | Phase I &II | Phase I &II | Phase I &II | Phase I &II |
| **Measurement or Analyte** | Frequency | | | | | | | | | | | | | |
| River Elevation/Flow over Wier | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Temperature (Field) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| pH (Field) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Specific Cond. (Field) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| REDOX (Field) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| D. O. (Field) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Turbidity | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Inches Below Wier | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Color and Clarity of Sample | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Odor of Sample | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Condition of Sampling Point | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Presence/Absence of Debris | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| pH (Lab) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Specific Cond. (Lab) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Alkalinity (Total) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Alkalinity (Phenolphth.) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Total Hardness | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Ammonia-N | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Total Organic-N | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Total Kjehdahl-N | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| B.O.D. | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| C.O.D. | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| T.O.C. | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Chlorides | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Nitrate-N | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Orthophosphate | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Total Phosphorus | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Dissolved Silica | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Sulfate | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| T.D.S. | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| T.S.S. | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Arsenic | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Cadmium | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Calcium | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Chromium | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Chromium (Hexovalent) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Copper | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Iron | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Lead | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Magnesium | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Manganese | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Mercury | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Nickel | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Potassium | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Sodium | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Tin | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Zinc | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Aroclor-1016 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Aroclor-1221 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Aroclor-1232 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Aroclor-1242 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Aroclor-1248 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Aroclor-1254 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Aroclor-1260 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Oil and Grease (Hexane Extractable) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Oil and Grease (Silica Gel Treated) | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| BTEX | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Diesel Range Organics | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| alpha Terpineol | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Benzoic Acid | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| m/p Cresol | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Total Phenolics | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |

Note 1: Phase I Monitoring - Locations to be monitored until landfilling reaches the top of the MSE wall. To be abandoned once waste reaches the top of MSE wall.

Note 2:Phase II Monitoring - Locations to be monitored once landfilling reaches the top of the MSE wall.

# STORMWATER CONVEYANCE and DISCHARGE SYSTEM INSPECTION FORM

Date: ____________ Time: ____________

Is this inspection an emergency inspection following a significant meteorological event ? Yes _____ No _____

Duration of Event: ______ Hours
Total Precipitation: ______ Inches

Meteorological Data at Time of Inspection

24 Hour Precipitation (Inches): ______
Temperature (°C): ______
Relative Humidity (%): ______
Barometric Pressure (Inches of Hg): ______
Solar Radiation (Watts/m²): ______
Wind Speed (mph): ______
Wind Gust (mph): ______
Wind Direction (°True): ______

Berms and Swales free of erosion, sedimentation and debris?
Yes _____ No _____

Silt fences free of damage, accumulated debris, and firmly anchored?
Yes _____ No _____

Culverts and pipes free of siltation, blockage, and debris?
Yes _____ No _____

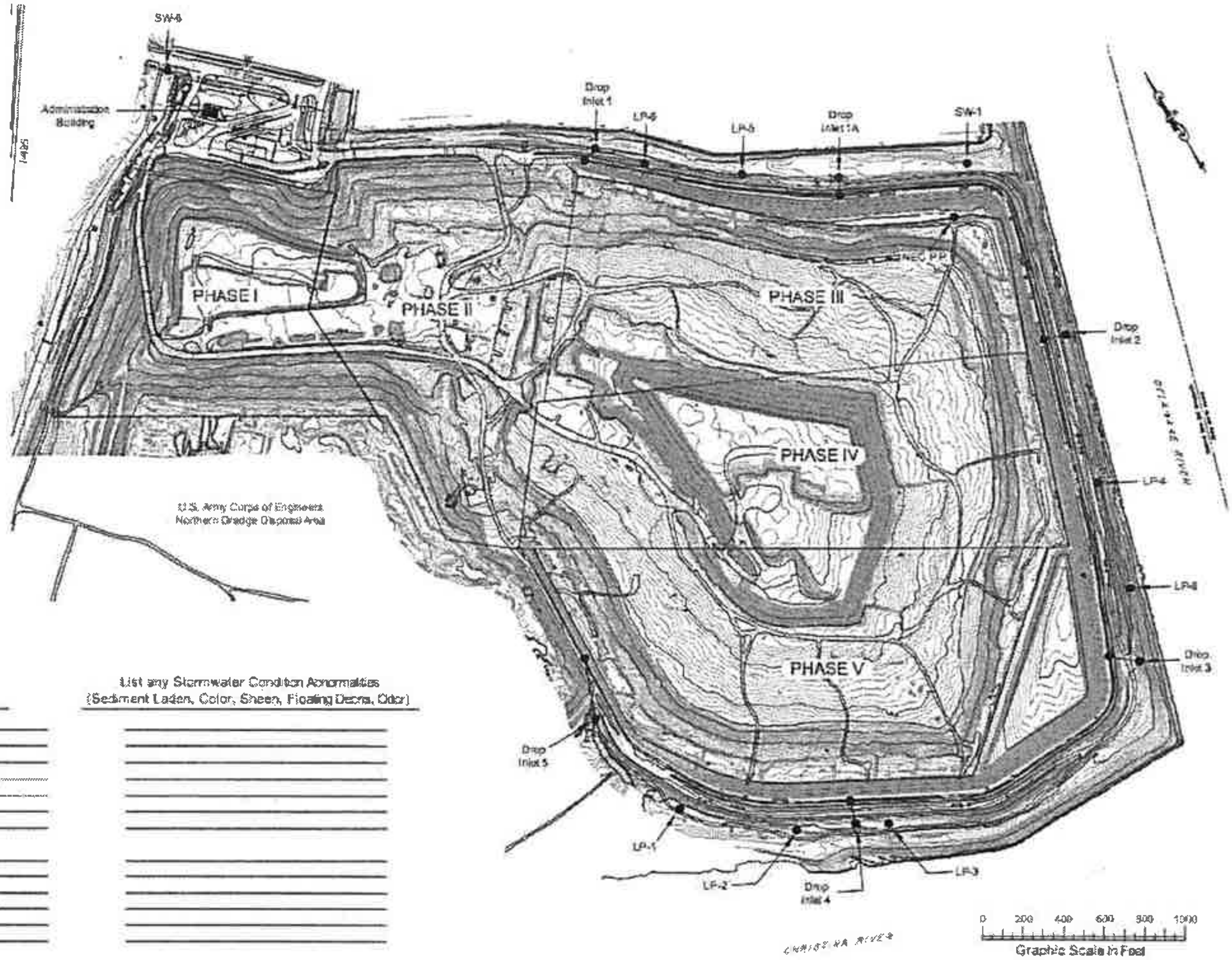
Control structures, including drop inlets, free of siltation, debris, and damage?
Yes _____ No _____

Mark the location of maintenance and repairs needed.
Type of repair required: ____________

Action taken: ____________

Date Completed: ____________

Control structures, including drop inlets, free of siltation, debris, and damage?
Yes _____ No _____




| | ✓ If OKay | | List Any Repairs Needed | List any Stormwater Condition Abnormalities (Sediment Laden, Color, Sheen, Floating Debris, Odor) |
|---|---|---|---|---|
| LP-1 | ___ Inlet | ___ Outlet | | |
| LP-2 | ___ Inlet | ___ Outlet | | |
| LP-3 | ___ Inlet | ___ Outlet | | |
| LP-4 | ___ Inlet | ___ Outlet | | |
| LP-5 | ___ Inlet | ___ Outlet | | |
| LP-6 | ___ Inlet | ___ Outlet | | |
| LP-8 | ___ Inlet | ___ Outlet | | |
| DI-1 | ___ Inlet | ___ Outlet | | |
| DI-1A | ___ Inlet | ___ Outlet | | |
| DI-2 | ___ Inlet | ___ Outlet | | |
| DI-3 | ___ Inlet | ___ Outlet | | |
| DI-4 | ___ Inlet | ___ Outlet | | |
| DI-5 | ___ Inlet | ___ Outlet | | |
| NEC P.P. | ______ | | | |
| SW-1 | ______ | | | |
| SW-6 | ______ | | | |

Inspected By: ____________
Company: ____________
Date: ____________

Confirmation Of Repairs By: ____________
DSWA Representative
Date: ____________

**ENVIRONMENTAL MONITORING PROGRAM**
**FOR THE**
**NORTHERN SOLID WASTE MANAGEMENT CENTER AT CHERRY ISLAND**
**(Revision 1 - October 10, 2012)**

## ATTACHMENT B: Leachate Monitoring Plan for the Cherry Island Landfill

Background: Permits and Compliance

Monitoring of the Cherry Island Master Pump Station (CI-MPS) falls under two permits and undergoes 18 monitoring events per year. City of Wilmington Permit W-88-02 (Rev.7), requires a minimum of 14 days to pass between the first and second monitoring events for all months that require two monitoring events. Two monitoring events are required in February, April, June, August, October and December. DNREC Permit SW-06/01 requires one monthly monitoring event comprised of CIL leachate and wastewater only.

With the exception of cyanide, all samples collected during these events are 24-hour flow-weighted composite samples collected from the CI-MPS. It should be noted that the CI-MPS receives wastewater from all sewage systems at CIL in addition to leachate generated by the landfill. Also, CIL receives leachate shipments from DSWA's Central and Southern Solid Waste Management Centers (CSWMC & SSWMC). Leachate received from these sites is off-loaded by way of a discharge port into the main vault of the CI-MPS. The CI-MPS discharges these wastewaters and leachates to the City's wastewater treatment plant by way of one of the New Castle County's 72" force mains located 10 feet west of CIL's western boundary.

I. Monitoring Requirements

Leachate samples shall be collected from the Cherry Island Master Pump Station (CI-MPS) as shown in Figure 1 on page 8 of this Plan. All samples shall be collected and analyzed in accordance with the schedules provided in Tables 1, 2, 3 and 4 on pages 9 through 11 of this Plan. In April and October, leachate shall be undergo analysis for "Table 5 - *DNREC's Supplemental Listing for Semi Annual Analysis of Leachates*" found on page 12 of this Plan. Sample collection, preservation, Chain-of-Custody, labeling, shipment, and equipment decontamination, shall follow the same procedures as outlined in this Plan.

II. Analytical Methodology

All samples shall be analyzed using the methods provided in the following publications:

A. SW-846 (Most Recent Edition) to be used first;
B. 40 CFR-136 (Most Recent Edition) to be used only if methods are not available in A above;
C. Standard Methods (Most Recent Edition) to be used only if methods are not available in A or B above;
D. Other methods as jointly approved by DSWA and DNREC to be used only if methods are not available in A, B, or C above.

III. System Leachate System Maintenance and Operation

A. Leachate System Operation

1. DSWA shall monitor all collection systems, wet-wells, pumps, flow meters, controls and recording devices each operating day to insure proper operation. DSWA shall inspect all connections to valves, pipes, and flow meters at riser houses and pump stations for leaks. The results of monitoring and inspections shall be recorded in the facility log.

2. DSWA shall measure and record the quantities of leachate pumped to the City of Wilmington's wastewater treatment plant on a weekly basis. DSWA shall also record the quantity of all leachates being transferred from the CSWMC and SSWMC to CIL for disposal. These records shall include the date of the event, the origin of the leachate, quantity of leachate, and the destination of the leachate.

B. System Maintenance

1. Annually, all accessible leachate collection pipes shall be cleaned with a self propelled, high pressure jetting system. DSWA shall identify and assess any blockages or areas that are inaccessible during the annual cleanings.

2. At least once every four years, DSWA shall have all accessible leachate collection systems video inspected to assess their condition. Upon completion, DSWA shall generate a report discussing the condition of the leachate collection pipes including the condition of the pipes, clogging of the pipe perforations, locations and cause of blockages, and any effects the blockages had on operation of the system.

C. Spill Contingency

1. DSWA shall immediately notify DNREC regarding any incident of a leachate release.
2. DSWA shall immediately cleanup any and all areas impacted by the leachate release.
3. Should the spill be of a quantity or in an area that poses a potential release from site, the DSWA shall:

   a. Estimate the quantity of the release;
   b. Provide a map showing the location of the release;
   c. Sample free liquids in the impacted area and the closest surfacewater to the release;
   d. Test the samples for the analytes and measurements listed in Table 6 on Page 13 of this Plan;
   e. Report the results of analysis to the Solid and Hazardous Waste Section of the Department of Natural Resources and Environmental Control within 45 days of the release.

IV. Meteorological Monitoring

DSWA shall maintain a meteorological weather station at CIL. Data from this weather station shall be maintained in an electronic database. Pertinent meteorological data shall accompany stormwater sample data upon submission to DNREC.

V. Field Preparation: Mobilization/Demobilization

The following outlines those procedures DSWA requires of its environmental monitoring contractors for preparation for the sampling of leachates from Cherry Island:

A. Standard QA/QC required by the sampling contractor include:

1. External audits through certification programs.
2. External audits through acceptance of blind samples and round robin testing.
3. Internal audits through splitting samples and shipping samples to other local and regional laboratories.
4. Performance audits of all laboratory personnel and stations.

B. Many times, the bottles used by a contractor for sample collection, shipment, and storage are purchased pre-cleaned and (some with preservatives added) by an independent company. However, all sampling and field equipment is usually cleaned and maintained by the contractor. Therefore, as a part of standard quality checks, all bottle shipments should be tested by the contracted monitoring company on a routine basis for contamination. If the sampling company elects to clean their own bottles, quality checks should be standard protocol, and should be run on every lot washed. As a minimum, the following should be done prior to any bottles going into the field:

1. Fresh disposable Nitrile gloves should be worn whenever handling the glassware (prior to and after cleaning).
2. All labels should be affixed to the bottles prior to issuance to field teams.
3. All sample preservatives which can be placed in bottles prior to sample collection should be done so before the bottles are issued to the field teams. The type and amount of preservative should be placed on the label immediately prior to or after addition to the bottle.
4. Specific analytes and sample locations should be placed on the labels in indelible ink prior to the bottles leaving the laboratory. Note that all caps for volatile organic samples should be screwed down tightly prior to labeling to eliminate any airborne volatile contaminants from the label glues or ink from indelible markers, pens, or type.

C. Preparation of field equipment should include cleaning of all manual sampling equipment using the following procedures:

1. A general rinse with water to remove debris and solids.
2. An Alconox or Citrinox Wash.
3. Sterile rinses with deionized/distilled water.
4. Acid Wash.
5. Sterile rinses with deionized/distilled water.
6. Hexane Wash.
7. 3 sterile rinses with deionized/distilled water.

All acids and chemical rinses used should be GCMS grade or better. The field sampling team is required to carry the necessary chemicals and deionized/distilled water into the field in order to clean any materials that may become contaminated during sampling.

D. All pumps and field meters should be cleaned and calibrated prior to each sampling event using chemicals and standard procedures recommended by the manufacturer. The equipment should undergo the same protocols when it is returned to the lab.

E. Maintenance and parts replacement should be performed as required by the manufacturers suggested schedule.

F. The sampling company is required to retain records of maintenance and calibration certification. These records are periodically checked by the DSWA.

G. All field equipment should be inspected and tested for proper operation prior to being sent into the field.

H. The sampling team is required to carry duplicates of all major pieces of sampling equipment.

VI. <u>Sampling Protocols - General</u>

A. All monitoring events shall be overseen by an individual with a minimum of three years field experience in the collection, preparation, and shipping of environmental samples.

B. A minimum of one pair of Nitrile gloves (two are recommended) are to be used while handling equipment and during all phases of the collection, preparation, and shipment of samples. Gloves are changed between sampling locations. (e.g. gloves are changed prior to sample collections and after equipment decontamination.) This insures minimal opportunity for contamination through handling of samples and equipment by operators.

VII. Health and Safety

A. During leachate monitoring events at DSWA facilities, field sampling teams are required to follow the OSHA regulations governing personal health and safety. Personal protection shall be maintained at Level D requirements. Hard hats (when overhead danger exists), safety glasses, safety shoes with steel toes, and protective gloves are the only safety equipment required at the present time. However, should samples show any indication of being hazardous, the sampling team would be required to move to more stringent health and safety protocols before going further in the monitoring event.

B. Field teams shall carry a basic first aid kit and a cell phone at all times to facilitate communications when needed. Any injuries sustained during sampling activities shall immediately be reported to the facility manager or authorized DSWA representative. An accident/incident report shall be filled out immediately upon reporting an accident or incident at a DSWA facility.

C. Field teams shall sign in at the appropriate location when entering the facility, and sign out immediately prior to leaving the site. At least one member of the sampling team collecting leachate samples at DSWA facilities must carry the following valid certifications:

1. 40 hour OSHA Emergency Response Program
2. First Aid and CPR.

VIII. Sample Collection Methodology - Leachate

A. With the exception of cyanide (which is a grab sample), the sampling team will collect 24-hour composite leachate samples from the CI-MPS using an ISCO™ 3700 automatic sampler (or equal) equipped with 24 collection vessels.

B. Prior to initiating the ISCO's 24-hour computer program, the sample team will purge the Teflon tubing coming from the sample port. Purging is done to remove unwanted solids that have collected in the sample tube since the previous sampling event. The sample crew will purge the tube until visible solids are no longer present in the sample stream (~ 2 gallons). All purged liquids will be returned to the CI-MPS after set up of the auto-sampler has been prepared to collect the 24-hour composite.

C. Each auto-sampler will be outfitted with 24 separate 1-liter bottles that are mounted to an automated carriage. During sampling events where PCB congeners are to be collected, each sample vessel will be lined with Teflon inserts. The auto-samplers will be connected to Teflon sampling tubes and programmed to deliver a specified volume of sample to a separate bottle each hour, and then shut down automatically after all 24 samples have been collected.

The Auto-samplers will also be used to collect additional aliquots of sample for cyanide analysis, and taking the field measurements listed in Tables 1, 2, and 3 on pages 8 through 10 of this Plan. The aliquots used for field measurements will be returned to the CI-MPS once the sampling team has completed taking the sampling measurements and entering the measurements on the sampling data sheets.

D. Once the sample has been collected, the sampling team will use the auto-sampler to collect an additional aliquot of leachate for cyanide analysis. The sampling team will then create a composite sample for the remaining laboratory analytes or measurements by mixing aliquots of leachate from each of the 24 sample bottles collected over the previous 24 hours in a large decontaminated glass mixing jar.

E. Upon completion of field measurements, the sampling team shall separate out the composited sample into pre-sterilized, pre-labeled bottles. Each bottle shall contain the necessary preservative required for the specified analysis. The field team shall fill in all pertinent information as necessary to fully identify the sample. As a minimum, the label on each bottle shall identify the following:

1. Contracting Lab or Sampling Contractor
2. DSWA
3. Name of Person Collecting the Samples
4. Sample Location
5. Time and Date of Sample Collection
6. The preservatives present in the bottle

After samples have been collected, all pertinent data regarding the samples shall be transcribed onto the proper Chain of Custody. Samples will then be placed in coolers along with ice, dry ice, or cold packs, and chilled to 4° C for transportation to the laboratory.

E. If samples are to be shipped by a separate shipping company, all coolers shall be sealed with a custody seal to insure tampering has not occurred between the time the samples left the site and the time they are received at the contracted laboratory. Each time the samples change hands, the receiver shall inspect the condition of the shipping containers and sign off on the Chain of Custody to acknowledge receipt of the samples. Any aberrations in the custody seal or shipping container shall be noted on the Chain of Custody by the receiver of the samples.

IX. Quality Control/Quality Assurance Samples (QC/QA)

A. In addition to the leachate samples, the field team will prepare two QC/QA samples per monitoring event. These samples will be submitted to the contracted laboratory for the same analysis that is required for the leachate samples. The QC/QA samples shall include:

1. Laboratory prepared trip blank/monitoring event. The trip blank will accompany the leachate sample bottles from preparation at the laboratory through the sampling process. This sample will be analyzed to evaluate if contamination was introduced during bottle preparation, sample handling or analytical procedures.

2. Equipment blank sample per monitoring event. The equipment blank will be prepared by pumping laboratory supplied deionized water through the same decontaminated sampling apparatus used during the collection of actual leachate samples. This sample will be analyzed to evaluate the effectiveness of the decontamination process.

B. QA/QC samples will be analyzed for the same suite of analytes as the leachate samples.

X. Supply Disposal

Non-hazardous expendable supplies and equipment used in the collection of samples can be disposed of at the small load collection station prior to the sampling team leaving the site. Unused or excess sample that has not contacted sample preservatives can be disposed of at the sample location. Disposal of hazardous expendable supplies such as excess preservatives are to be taken back to the laboratory by the sampling team for proper disposal.

XI. Reporting

Results of analysis and discussion of the leachate monitoring activities shall be included and discussed in the first quarterly leachate monitoring report generated following reception of the leachate monitoring data. The CIL historical leachate monitoring database will be transferred to DNREC by way of electronic media or direct file transfer on a quarterly basis.

As a final note, the environmental monitoring contractor and contracted laboratory providing analysis of samples is/are required to retain all field and laboratory records in hard copy format for a minimum of five years, with magnetic media storage for thirty years.

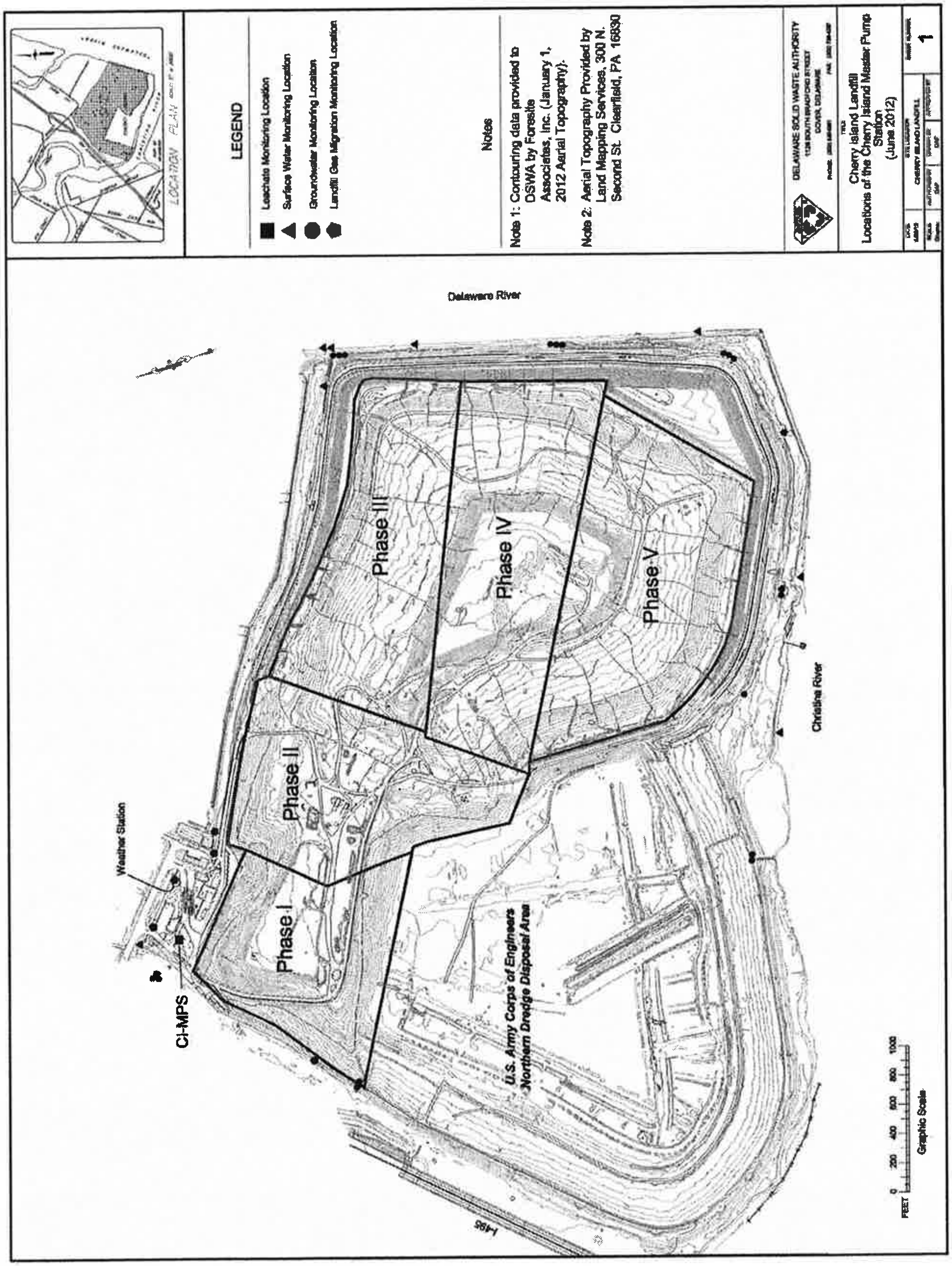

LEGEND
Leachate Monitoring Location
Surface Water Monitoring Location
Groundwater Monitoring Location
Landfill Gas Migration Monitoring Location
Notes
Note 1: Contouring data provided to DSWA by Foresite Associates, Inc. (January 1, 2012 Aerial Topography).
Note 2: Aerial Topography Provided by Land Mapping Services, 300 N. Second St. Clearfield, PA 16830
DELAWARE SOLID WASTE AUTHORITY
Cherry Island Landfill
Locations of the Cherry Island Master Pump Station
(June 2012)
1
Delaware River
Christina River
Weather Station
CI-MPS
Phase I
Phase II
Phase III
Phase IV
Phase V
U.S. Army Corps of Engineers
Northern Dredge Disposal Area
I-495
Graphic Scale
FEET

Figure 1

**Table 1: CIL Monitoring Requirments for Leachates Under Permits SW-06/01 and W-88-02 (Rev 7)**

**January and July**

| Measurement/Analyte | Location I.D. Units | CI-MPS **Mixed w/ CSWMC & SSWMC** (24 Hr. Comp.) | CI-MPS **Unmixed** (24 Hr. Comp.) |
|---|---|---|---|
| Temperature (Field) | (Centigrade) | | X |
| pH (Field) | (SU) | | X |
| Specific Cond. (Field) | (umhos/cm) | | X |
| REDOX (Field) | (mV) | | X |
| pH (Lab) | (SU) | | X |
| Specific Cond. (Lab) | (umhos/cm) | | X |
| Alkalinity (Total) | (mg/L) | | X |
| Alkalinity (Phenolphth.) | (mg/L) | | X |
| BOD-5 | (mg/L) | | X |
| Chloride | (mg/L) | | X |
| C.O.D. | (mg/L) | | X |
| Cyanide | (mg/L) | | X |
| Nitrogen (Ammonia) | (mg/L) | | X |
| Nitrogen (Nitrate) | (mg/L) | | X |
| Nitrogen (Organic) | (mg/L) | | X |
| Nitrogen (Kjeldahl) | (mg/L) | | X |
| Phenols (Total) | (mg/L) | | X |
| Phosphate (Ortho) | (mg/L) | | X |
| Phosphorus (Poly Hydro) | (mg/L) | | X |
| Phosphorus (Soluble) | (mg/L) | | X |
| Phosphorus (Total) | (mg/L) | | X |
| Silica (Dissolved) | (mg/L) | | X |
| Sulfate | (mg/L) | | X |
| Sulfide | (mg/L) | | X |
| Total Organic Carbon | (mg/L) | | X |
| Total Dissolved Solids | (mg/L) | | X |
| Total Suspended Solids | (mg/L) | | X |
| Acetic Acid | (mg/L) | | X |
| Propionic Acid | (mg/L) | | X |
| Isobutyric Acid | (mg/L) | | X |
| Butyric Acid | (mg/L) | | X |
| Isovaleric Acid | (mg/L) | | X |
| Valeric Acid | (mg/L) | | X |
| Arsenic | (mg/L) | | X |
| Calcium | (mg/L) | | X |
| Chromium | (mg/L) | | X |
| Copper | (mg/L) | | X |
| Iron | (mg/L) | | X |
| Lead | (mg/L) | | X |
| Magnesium | (mg/L) | | X |
| Manganese | (mg/L) | | X |
| Nickel | (mg/L) | | X |
| Potassium | (mg/L) | | X |
| Sodium | (mg/L) | | X |
| Zinc | (mg/L) | | X |
| Perimeter Cell Seep Inspecion | None | | X |

**Table 2: CIL Monitoring Requirments for Leachates Under Permits SW-06/01 and W-88-02 (Rev 7)**

**March, May, September, November**

| Measurement/Analyte | Location I.D.<br>Units | CI-MPS<br>**Mixed w/ CSWMC & SSWMC**<br>(24 Hr. Comp.) | CI-MPS<br>**Unmixed**<br>(24 Hr. Comp.) |
|---|---|---|---|
| Temperature (Field) | (Centigrade) | | X |
| pH (Field) | (SU) | | X |
| Specific Cond. (Field) | (umhos/cm) | | X |
| REDOX (Field) | (mV) | | X |
| pH (Lab) | (SU) | | X |
| Specific Cond. (Lab) | (umhos/cm) | | X |
| Alkalinity (Total) | (mg/L) | | X |
| Alkalinity (Phenolphth.) | (mg/L) | | X |
| BOD-5 | (mg/L) | | X |
| Chloride | (mg/L) | | X |
| C.O.D. | (mg/L) | | X |
| Cyanide | (mg/L) | | X |
| Nitrogen (Ammonia) | (mg/L) | | X |
| Nitrogen (Nitrate) | (mg/L) | | X |
| Nitrogen (Organic) | (mg/L) | | X |
| Nitrogen (Kjeldahl) | (mg/L) | | X |
| Phenols (Total) | (mg/L) | | X |
| Silica (Dissolved) | (mg/L) | | X |
| Sulfate | (mg/L) | | X |
| Sulfide | (mg/L) | | X |
| Total Organic Carbon | (mg/L) | | X |
| Total Dissolved Solids | (mg/L) | | X |
| Total Suspended Solids | (mg/L) | | X |
| Arsenic | (mg/L) | | X |
| Calcium | (mg/L) | | X |
| Chromium | (mg/L) | | X |
| Copper | (mg/L) | | X |
| Iron | (mg/L) | | X |
| Lead | (mg/L) | | X |
| Magnesium | (mg/L) | | X |
| Manganese | (mg/L) | | X |
| Nickel | (mg/L) | | X |
| Potassium | (mg/L) | | X |
| Sodium | (mg/L) | | X |
| Zinc | (mg/L) | | X |
| Perimeter Cell Seep Inspecion | None | | X |

**Table 3: CIL Monitoring Requirments for Leachates Under Permits SW-06/01 and W-88-02 (Rev 7) - Continued**

**February, June, August, December**

| Measurement/Analyte | Location I.D. Units | CI-MPS **Mixed w/ CSWMC & SSWMC** (24 Hr. Comp.) | CI-MPS **Unmixed** (24 Hr. Comp.) |
|---|---|---|---|
| Temperature (Field) | (Centigrade) | X | X |
| pH (Field) | (SU) | X | X |
| Specific Cond. (Field) | (umhos/cm) | X | X |
| REDOX (Field) | (mV) | X | X |
| pH (Lab) | (SU) | X | X |
| Specific Cond. (Lab) | (umhos/cm) | X | X |
| Alkalinity (Total) | (mg/L) | | X |
| Alkalinity (Phenolphth.) | (mg/L) | | X |
| BOD-5 | (mg/L) | X | X |
| Chloride | (mg/L) | | X |
| C.O.D. | (mg/L) | | X |
| Cyanide | (mg/L) | X | X |
| Nitrogen (Ammonia) | (mg/L) | X | X |
| Nitrogen (Nitrate) | (mg/L) | | X |
| Nitrogen (Organic) | (mg/L) | | X |
| Nitrogen (Kjeldahl) | (mg/L) | | X |
| Phenols (Total) | (mg/L) | X | X |
| Silica (Dissolved) | (mg/L) | | X |
| Sulfate | (mg/L) | | X |
| Total Organic Carbon | (mg/L) | | X |
| Total Dissolved Solids | (mg/L) | | X |
| Total Suspended Solids | (mg/L) | X | X |
| Arsenic | (mg/L) | X | X |
| Calcium | (mg/L) | | X |
| Chromium | (mg/L) | X | X |
| Copper | (mg/L) | X | X |
| Iron | (mg/L) | | X |
| Lead | (mg/L) | X | X |
| Magnesium | (mg/L) | | X |
| Manganese | (mg/L) | | X |
| Nickel | (mg/L) | X | X |
| Potassium | (mg/L) | | X |
| Sodium | (mg/L) | | X |
| Zinc | (mg/L) | X | X |
| Perimeter Cell Seep Inspecion | None | | X |

### Table 4: CIL Monitoring Requirments for Leachates Under Permits SW-06/01 and W-88-02 (Rev 7) - Continued

**April and October**

| Measurement/Analyte | Location I.D. Units | CI-MPS **Mixed w/ CSWMC & SSWMC** (24 Hr. Comp.) | CI-MPS **Unmixed** (24 Hr. Comp.) |
|---|---|---|---|
| Temperature (Field) | (Centigrade) | X | X |
| pH (Field) | (SU) | X | X |
| Specific Cond. (Field) | (umhos/cm) | X | X |
| REDOX (Field) | (mV) | X | X |
| pH (Lab) | (SU) | X | X |
| Specific Cond. (Lab) | (umhos/cm) | X | X |
| Alkalinity (Total) | (mg/L) | | X |
| Alkalinity (Phenolphth.) | (mg/L) | | X |
| BOD-5 | (mg/L) | X | X |
| Chloride | (mg/L) | | X |
| C.O.D. | (mg/L) | | X |
| Cyanide | (mg/L) | X | X |
| Nitrogen (Ammonia) | (mg/L) | X | X |
| Nitrogen (Nitrate) | (mg/L) | | X |
| Nitrogen (Organic) | (mg/L) | | X |
| Nitrogen (Kjeldahl) | (mg/L) | | X |
| Phenols (Total) | (mg/L) | X | X |
| Phosphate (Ortho) | (mg/L) | | X |
| Phosphorus (Poly Hydro) | (mg/L) | | X |
| Phosphorus (Soluble) | (mg/L) | | X |
| Phosphorus (Total) | (mg/L) | | X |
| Silica (Dissolved) | (mg/L) | | X |
| Sulfate | (mg/L) | | X |
| Sulfide | (mg/L) | | X |
| Total Organic Carbon | (mg/L) | | X |
| Total Dissolved Solids | (mg/L) | | X |
| Total Suspended Solids | (mg/L) | X | X |
| Acetic Acid | (mg/L) | | X |
| Propionic Acid | (mg/L) | | X |
| Isobutyric Acid | (mg/L) | | X |
| Butyric Acid | (mg/L) | | X |
| Isovaleric Acid | (mg/L) | | X |
| Valeric Acid | (mg/L) | | X |
| Fluoride | (mg/L) | | X |
| Aluminum | (mg/L) | | X |
| Arsenic | (mg/L) | X | X |
| Boron | (mg/L) | | X |
| Calcium | (mg/L) | | X |
| Chromium | (mg/L) | X | X |
| Copper | (mg/L) | X | X |
| Iron | (mg/L) | | X |
| Lead | (mg/L) | X | X |
| Lithiun | (mg/L) | | X |
| Magnesium | (mg/L) | | X |
| Manganese | (mg/L) | | X |
| Nickel | (mg/L) | X | X |
| Potassium | (mg/L) | | X |
| Sodium | (mg/L) | | X |
| Zinc | (mg/L) | X | X |
| DNREC Supplimental Analysis for Leachates/TTO Do Not Duplicate Metals Listed Above | Anayte Dependent | X | X |
| 209 PCB Congeners | ng/L | | X |

**Table 5: DNREC Supplemental Listing for Semi Annual Analysis of Leachates** — Modified June 2011

| VOLATILE ORGANICS | DIOXIN SCREEN | | WET CHEMISRTY |
|---|---|---|---|
| 1) Acetone | 55) 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) | | 157) Cyanide (Total) |
| 2) Acrolein | SEMIVOLATILES | | 158) Sulfides |
| 3) Acrylonitrile | 56) Acenaphthene | 108) Nitrobenzene | **METALS** |
| 4) Benzene | 57) Acenaphthylene | 109) 2-Nitrophenol | 159) Antimony |
| 5) Bromochloromethane | 58) Acetophenone | 110) 4-Nitrophenol | 160) Arsenic |
| 6) Dichlorobromomethane (Bromodichloromethane) | 59) Anthracene | 111) N-Nitrosodimethylamine | 161) Barium |
| 7) .Bromoform | 60) Benzidine | 112) N-Nitrosodi-n-propylamine | 162) Beryllium |
| 8) Bromomethane | 61) Benzo (a) anthracene | 113) N-Nitrosodiphenylamine | 163) Cadmium |
| 9) 2-Butanone | 62) Benzo (a) pyrene | 114) Pentachlorophenol | 164) Chromium (Total) |
| 10) Carbon disulfide | 63) Benzo (b) fluoranthene | 115) Phenanthrene | 165) Cobalt |
| 11) Carbon tetrachloride | 64) Benzo (g,h,i) perylene | 116) Phenol | 166) Copper |
| 12) Chlorobenzene | 65) Benzo (k) fluoranthene | 117) Phenols (Total) | 167) Lead, Total |
| 13) Dibromochloromethane (Chlorodibromomethane) | 66) Benzyl Alcohol | 118) Pyrene | 168) Magnesium |
| 14) Chloroethane | 67) 4-Bromophenyl phenyl ether | 119) Pyridine | 169) Mercury |
| 15) 2-Chloroethyl vinyl ether | 68) Butylbenzyl Phthalate | 120) 1,2,4-Trichlorobenzene | 170) Molybdenum |
| 16) Chloroform | 69) 4-Chloro-3-methylphenol | 121) 2,4,5 Trichlorophenol | 171) Nickel |
| 17) Methyl chloride (Chloromethane) | 70) Bis (2-chloroethoxy) methane | 122) 2,4,6-Trichlorophenol (2,4,6 T) | 172) Selenium |
| 18) 1,2-Dibromo-3-chloropropane | 71) Bis (2-chloroethyl) ether | **PCBs** | 173) Silver |
| 19) 1,2-Dibromoethane | 72) Bis (2-chloroisopropyl) ether | 123) PCB-1016 | 174) Thallium |
| 20) Methylene bromide (Dibromomethane) | 73) 2-Chloronaphthalene | 124) PCB-1221 | 175) Tin |
| 21) trans-1,4-Dichloro-2-butene | 74) 2-Chlorophenol | 125) PCB-1232 | 176) Vanadium |
| 22) 1,1-Dichloroethane | 75) 4-Chlorophenyl Phenyl Ether | 126) PCB-1242 | 177) Zinc |
| 23) 1,2-Dichloroethane | 76) Chrysene | 127) PCB-1248 | |
| 24) 1,1-Dichloroethene | 77) 3/4 Methylphenol (m/p-Cresol) | 128) PCB-1254 | |
| 25) 1,2-Dichloroethene | 78) 2-Methylphenol (o-Cresol) | 129) PCB-1260 | |
| 26) cis-1,2-Dichloroethene | 79) Di-n-Butylphthalate | 130) Total Polychlorinated Biphenyl | |
| 27) trans-1,2-Dichloroethene | 80) Di-n-octyl Phthalate | PESTICIDES | |
| 28) 1,3-Dichloropropane | 81) Dibenz (a,h) anthracene | 131) Aldrin | |
| 29) 1,2-Dichloropropane | 82) 1,2-Dichlorobenzene (ortho) | 132) alpha-BHC | |
| 30) cis-1,3-Dichloropropene | 83) 1,3-Dichlorobenzene (meta) | 133) beta-BHC | |
| 31) trans-1,3-Dichloropropene | 84) 1,4-Dichlorobenzene (para) | 134) delta BHC | |
| 32) 1,3-Dichloropropene (Total) | 85) 3,3'-Dichlorobenzidene | 135) gamma BHC (Lindane) | |
| 33) Diethyl Ether | 86) 2,4-Dichlorophenol | 136) alpha-Chlordane | |
| 34) Ethylbenzene | 87) Diethylphthalate | 137) gamma-Chlordane | |
| 35) 2-Hexanone (Methyl butyl ketone) | 88) Dimethoate | 138) p,p'-DDD | |
| 36) Methyl Iodide (Iodomethane) | 89) 2,4-Dimethylphenol | 139) 4,4'-DDE | |
| 37) 4-methyl-2-pentanone | 90) Dimethylphthalate | 140) 4,4'-DDT | |
| 38) Methylene chloride (Dichloromethane) | 91) 2,4-Dinitrophenol | 141) Dieldrin | |
| 39) Styrene | 92) 2,4-Dinitrotoluene | 142) alpha Endosulfan | |
| 40) 1,1,1,2-Tetrachloroethane | 93) 2,6-Dinitrotoluene | 143) beta Endosulfan | |
| 41) 1,1,2,2-Tetrachloroethane | 94) 1,2-Diphenylhydrazine | 144) Endosulfan Sulfate | |
| 42) Tetrachloroethene | 95) Bis(2-ethylhexyl)phthalate | 145) Endrin | |
| 43) Tetrahydrofuran | 96) Fluoranthene | 146) Endrin Aldehyde | |
| 44) Toluene | 97) Fluorene | 147) Endrin Ketone | |
| 45) Tot. Xylenes | 98) Hexachlorobenzene | 148) Heptachlor | |
| 46) 1,1,1-Trichloroethane | 99) Hexachlorobutadiene | 149) Heptachlor epoxide | |
| 47) 1,1,2-Trichloroethane | 100) Hexachlorocyclopentadiene | 150) Methoxychlor | |
| 48) Trichloroethene | 101) Hexachloroethane | 151) Toxaphene | |
| 49) Trichlorofluoromethane | 102) Ideno (1,2,3-cd) pyrene | **HERBICIDES** | |
| 50) 1,2,3-Trichloropropane | 103) Isophorone | 152) 2,4-D | |
| 51) Vinyl Acetate | 104) 2-Methyl-4,6-Dinitrophenol | 153) Dicamba | |
| 52) Vinyl chloride | 105) 2-Methylnaphthalene | 154) Dichloroprop | |
| 53) o-xylene | 106) 2-Naphthylamine | 155) 2,4,5-T | |
| 54) mp-xylene | 107) Naphthalene | 156) 2,4,5-TP (Silvex) | |

Table 6: Analysis For Spills

| |
|---|
| Temperature (Field) |
| pH (Field) |
| Specific Cond. (Field) |
| REDOX (Field) |
| D. O. (Field) |
| Turbidity |
| pH (Lab) |
| Specific Cond. (Lab) |
| Alkalinity (Total) |
| Alkalinity (Phenolphthalien) |
| Total Hardness |
| Ammonia-N |
| Total Organic-N |
| Total Kiehdahl-N |
| B.O.D. |
| C.O.D. |
| T.O.C. |
| Chlorides |
| Nitrate-N |
| Orthophosphate |
| Total Phosphorus |
| Dissolved Silica |
| Sulfate |
| T.D.S. |
| T.S.S. |
| Arsenic |
| Cadmium |
| Calcium |
| Chromium |
| Chromium (Hexovalent) |
| Copper |
| Iron |
| Lead |
| Magnesium |
| Manganese |
| Mercury |
| Nickel |
| Potassium |
| Sodium |
| Tin |
| Zinc |
| Aroclor-1016 |
| Aroclor-1221 |
| Aroclor-1232 |
| Aroclor-1242 |
| Aroclor-1248 |
| Aroclor-1254 |
| Aroclor-1260 |
| Oil and Grease (Hexane Extractable) |
| Oil and Grease (Silica Gel Treated) |
| BTEX |
| Diesel Range Organics |
| alpha Terpineol |
| Benzoic Acid |
| m/p Cresol |
| Total Phenolics |

**ENVIRONMENTAL MONITORING PROGRAM**
**FOR THE**
**NORTHERN SOLID WASTE MANAGEMENT CENTER AT CHERRY ISLAND**
**(Revision 1 – October 10, 2012)**

**ATTACHMENT C: Groundwater Monitoring Plan for the Cherry Island Landfill**

| | |
|---|---|
| Background | Implementation of the Slow Purge Method |
| Section I | Monitoring |
| Section II | Analytical Methodology |
| Section III | Well Head Protection/Security |
| Section IV | Well Construction |
| Section V | Well Locations |
| Section VI | Well Modifications for Current Sampling Protocols |
| Section VII | Sample Collection Procedures |
| Section VIII | Groundwater Sample Collection |
| Section IX | Groundwater Monitoring Well Sampling |
| Section X | Quality Assurance/Quality Control |
| Section XI | Supply Disposal |
| Section XII | Reporting |

## Background: Implementation of Slow Purge Method

In October of 1991, the United States Environmental Protection Agency (USEPA) promulgated new regulations under RCRA called the "Solid Waste Disposal Facility Criteria - 40 CFR-258". These regulations present the minimum criteria that owners and operators of municipal solid waste landfill units must meet for protection of the surrounding environment. Some of the criteria covered in this document includes:

1. Design
2. Operation
3. Closure
4. Post closure care
5. Monitoring
6. Record keeping
7. Financial Assurance

Although this document explains what criteria owners and operators have to meet to be in compliance with these regulations, the document does not present details concerning the selection and implementation of methodologies to meet compliance.

In 1992, a draft of the "Technical Manual for Solid Waste Disposal Facility Criteria - 40 CFR-258" was released to the State Governments for comment. This DRAFT technical manual discusses methods for selection of sites, materials, testing requirements, acceptance testing, sampling protocols, and monitoring requirements.

Review of this DRAFT technical manual, by the Delaware Department of Natural Resources and Environmental Control (DNREC) and the Delaware Solid Waste Authority (DSWA), raised questions concerning the benefits of implementing certain sampling protocols put forth within the document. Both Agencies felt that upgrading the current groundwater monitoring systems with dedicated equipment necessary to comply with these protocols would:

1. Add excessive and unnecessary costs to the current Environmental Monitoring Program.
2. Increase the time necessary for sample collection.
3. Not yield fully representative samples.

Due to the presence of fine sands, silts, and clays in the aquifers being monitored at all Delaware Solid Waste Authority solid waste management centers, DSWA has Implemented a "Common Sense" approach for the collection and preparation of groundwater samples for analysis. Using guidance provided by DNREC, in 1993, DSWA began using slow-purge or micro-purge techniques to collect groundwater samples. These techniques or sampling protocols were implemented to accomplish the following:

1. Reduce the heavy pieces of field equipment, purge pumps, steam cleaners, and generators needed to purge wells and decontaminate equipment;
2. Reduce the number of wells being sampled;
3. Eliminate hand bailing;
4. Significantly reduce time spent purging wells;
5. Reduce or eliminate field filtering as required by 40 CFR-258;

Both the DNREC and the DSWA understand that these methods may vary significantly from many of the currently accepted methods. However, the hydrogeologic conditions that exist on the Delmarva Peninsula (and many other locations where the primary aquifers were formed by weathering and tidal deposition) make certain requirements of 40 CFR-258 difficult to meet without modification.

I. Monitoring

Groundwater samples shall be collected from the groundwater monitoring locations shown in Figure 1 on page 11 of this plan. These samples shall be analyzed in accordance with the schedules provided in Table 1 on page 14 of this plan. Sample collection, preservation, Chain-of-Custody, labeling, shipment, and equipment decontamination, shall follow the same procedures as outlined in this Plan.

II. Analytical Methodology

All samples shall be collected and analyzed using the methods provided in the following publications:

1. SW-846 (Most Recent Edition) to be used first;
2. 40 CFR-136 (Most Recent Edition) to be used only if methods are not available in A above;
3. Standard Methods (Most Recent Edition) to be used only if methods are not available in A or B above;
4. Other methods as jointly approved by DSWA and DNREC to be used only if methods are not available in A, B, or C above.

III. Well Head Protection/Security

Well heads at all DSWA facilities meet or exceed the standards set forth in *DNREC's Delaware Regulations Governing the Construction and Use of Wells*. All monitoring wells are constructed of PVC or stainless steel with protective outer steel casings and locking caps. Additionally, most DSWA wells have additional outer protective casings made of concrete or steel, or concrete pads enclosed by bollards as shown in Figure 2 on Page 12 of this Plan. All protective steel casings have been outfitted with a locking cap, are kept locked using tamper resistant, hardened steel or brass locks. All locks at the major landfill facilities are keyed alike.

IV. Well Construction

All DSWA wells have been constructed and installed in a manner consistent with the existing specifications required by DNREC at the time of construction.

V. Well Locations

The inner well casings of all GMW's being monitored at DSWA facilities have been surveyed by a land surveyor licensed in the State of Delaware. All groundwater monitoring wells have been tied in to the National Geodetic Vertical Datum and Delaware State Coordinate plane using standard land surveying practices. At the time of this plan the coordinate systems being used are the 1927 Delaware State Plane coordinate system and 1929 National Geodetic Vertical Datum.

VI. Well Modifications for Current Sampling Protocols

A. No modifications have been made to groundwater monitoring wells with average DTWs greater than 25 feet.

B. All wells with an average DTW of 25 feet or less have been modified through the installation of a 3/16" Teflon™ tube extending the entire length of the casing and screen. The tube is plugged at the lower end to prevent uptake of solids during sampling, and is solid except for a liberally perforated 2-3 foot section located at mid screen of the well casing. The tube is secured to the outer steel casing by way of nylon cord and straps as shown in Figure 3 on Page 13 of this Plan.

VII. Sample Collection Procedures

The following presents the methods by which DSWA collects or has it's Environmental monitoring contractors collect groundwater samples from DSWA solid waste management centers. It is believed that these methods allow for uniform sampling of the aquifers without drawing in fine sediments from the surrounding aquifer, or disturbing sediments present in the well casings.

A. Field Preparation: Mobilization/Demobilization

The following outlines those procedures DSWA requires of it's environmental monitoring contractors for preparation for the sampling of groundwaters at the DSWA facilities:

1. Standard QA/QC required by the monitoring contractor include:

   a. External audits through certification programs;
   b. External audits through acceptance of blind samples and round robin testing;
   c. Internal audits through splitting samples and shipping samples to other local and regional laboratories;
   d. Performance audits of all laboratory personnel and stations.

2. Many times, the bottles used by a contractor for sample collection, shipment, and storage are purchased pre-cleaned and (some with preservatives added) by an independent company. However, all sampling and field equipment is usually cleaned and maintained by the contractor. Therefore, as a part of standard quality checks, all bottle shipments should be tested by the contracted monitoring company on a routine basis for contamination. If the monitoring company elects to clean their own bottles, quality checks should be standard protocol, and should be run on every lot washed. As a minimum, the following should be done prior to any bottles going into the field:

   a. Fresh disposable Nitrile gloves should be worn whenever handling the glassware (prior to and after cleaning);
   b. All labels should be affixed to the bottles prior to issuance to field crews;
   c. All sample preservatives that can be placed in bottles prior to sample collection should be done so before the bottles are issued to the field crews. The type and amount of preservative should be placed on the label immediately prior to or after addition to the bottle;

   d. Specific analytes and sample locations should be placed on the labels in indelible ink prior to the bottles leaving the laboratory. Note that all caps for volatile organic samples should be screwed down tightly prior to labeling to eliminate any airborne volatile contaminants from the label glues or ink from indelible markers, pens, or type.

3. Preparation of field equipment should include the following:

   a. Cleaning of all manual sampling equipment should include the following procedures:

      1. A general rinse with water to remove debris and solids.
      2. An Alconox Wash.
      3. Sterile rinses with deionized/distilled water.
      4. Acid Wash.
      5. Sterile rinses with Deionized/distilled water.
      6. Hexane Wash.
      7. 3 sterile rinses with deionized/distilled water.

All acids and chemical rinses used should be GCMS grade or better. The field sampling crew is required to carry the necessary chemicals and deionized/distilled water into the field in order to clean any materials that may become contaminated during sampling.

b. All pumps and field meters should be cleaned and calibrated prior to each monitoring event using chemicals and standard procedures recommended by the manufacturer. The equipment should undergo the same protocols when it is returned to the lab.

c. Maintenance and parts replacement should be performed as required by the manufacturers suggested schedule.

d. The monitoring company is required to retain records of maintenance and calibration certification. These records are periodically checked by the DSWA.

e. All field equipment should be inspected and tested for proper operation prior to being sent into the field.

f. The sampling crew is required to carry duplicates of all major pieces of sampling equipment.

VIII. <u>Groundwater Sample Collection</u>

A. <u>General</u>

During all phases of groundwater monitoring at DSWA facilities, field sampling crews are required to:

1. Follow the OSHA regulations governing personal health and safety. (Since there have been no indication of hazardous constituents present in any of the groundwater samples collected at the DSWA Facilities, personal protection has been maintained at Level D requirements. Hard hats, safety glasses, safety shoes with steel toes, and protective gloves are the only safety equipment required at the present time. However, should samples show any indication of being hazardous, the sampling crew is required to move to a more stringent health and safety program before going further in the monitoring event.)

   Generally, **<u>a minimum of</u>** one pair of Nitrile gloves (two are recommended) are to be used while handling equipment and all phases of the collection, preparation, and shipment of samples. Gloves are changed between monitoring locations. (e.g. gloves are changed prior to sample collections and after equipment decontamination.) This insures minimal opportunity for contamination through handling of samples and equipment by operators.

2. At least one member of the sampling crew collecting samples at DSWA facilities shall carry the following valid certifications:

   a. 40 hour OSHA Emergency Response Program
   b. First Aid and CPR.

3. All monitoring events must be overseen by an individual with a minimum of three years field experience in the collection, preparation, and shipping of groundwater samples.

4. The monitoring company shall conduct annual audits of the procedures and equipment being used by their field crews.

5. DSWA shall conduct random inspections of the field crews sampling protocols during each monitoring event.

B. Gauging

Prior to the collection of any groundwater samples from a DSWA facility, the field sampling crew is required to measure the static groundwater levels to 1/100 of a foot in all groundwater monitoring wells on site. The contractor is required to use an electronic water level indicator dedicated specifically for this purpose. The inner well casings of all groundwater monitoring wells being monitored at DSWA facilities have been surveyed by a land surveyor licensed in the State of Delaware. Each is marked with a reference point that is tied into the National Geodetic Vertical Datum (NGVD). All depth to water readings are to be measured from these reference points.

The following procedures are used by environmental monitoring contractor's field sampling crews for gauging the groundwater monitoring wells prior to collection of samples from DSWA facilities:

1. The following protocols are to be used by the field sampling crew whenever groundwater elevations are taken:

    a. All measurements at a DSWA site are to be taken on the same day.
    b. All GMWs are to be inspected externally and internally for damage, and notations of physical well inspection entered in the field log prior to and after opening the well casing.
    c. Well casings are to be re-locked after measurements have been completed on the well.
    d. Measurements are to be taken from a reference point marked on the inner casing.
    e. A minimum of three measurements are to taken from each well. The location of the well, and the three measurements are to be recorded in a field log along with the time and date. These readings are to be averaged. The average of these measurements will be used for:

        1. Mapping the potentiometric head elevations of each aquifer.
        2. Tracking groundwater elevation fluctuations in the aquifers.
        3. Calculating the flow directions and hydraulic gradients of the aquifers.
        4. Entry into a data base for engineering applications as well as possible fate-transport modeling.

2. Between each well being sampled, the field sampling crew is required to rinse the electronic water level indicator thoroughly with deionized-distilled water. If any procedural or well contamination is suspected, the field sampling crew is required to use the following protocols to decontaminate the water level indicator:

    a. A general rinse with water to remove debris and solids.
    b. An Alconox Wash.
    c. Sterile rinses with deionized/distilled water.
    d. Acid Wash.
    e. Sterile rinses with deionized/distilled water.
    f. Hexane Wash.
    g. 3 sterile rinses with deionized/distilled water.

C. Purging

After all wells have been gauged, the field sampling crew is to use the following procedures to collect the groundwater samples:

1. For wells with depth to water measurements (DTWs) equal to or less than 25 feet:

    The field sampling crew attaches a sterile piece of silicone tubing to the Teflon™ tube installed in the well. The sample crew attaches a fresh piece of dedicated Teflon™ tubing between the outflow of the peristaltic pump and a decontaminated flow-through sample chamber. The sample chamber contains the following probes and meters:

a. pH
b. Dissolved Oxygen
c. Temperature
d. Specific Conductance
e. Oxidation/Reduction Potential
f. Turbidity (measured initially at the outflow from the sample cell.)

2. For wells with DTWs greater than 25 feet:

The field sampling crew lowers the pump head of an adjustable speed low flow pump down to the middle of the GMW screen and ties off, clips off, or sets the brake on the hose spool to maintain the preferred depth. The sample crew affixes a piece of Teflon™ tubing between the outlet of the pump and a decontaminated flow-through sample chamber. The sample chamber contains the following probes and meters:

a. pH
b. Dissolved Oxygen
c. Temperature
d. Specific Conductance
e. Oxidation/Reduction Potential
f. Turbidity is also measured initially at the outflow from the sample cell.

3. The field sampling crew begins the purge by recording the following:

a. Date
b. Start Time
c. Location
d. Location Description:

   1. Well Diameter
   2. Casing Type
   3. Top of Casing
   4. Depth of Well
   5. Depth to Water
   6. Standing Water in Casing
   7. Land Surface Elevation (if necessary)
   8. Sample Methods (Grab, Bailer, Pump, etc...)

4. The field sampling crew starts the purge at a flow rate of 1L/Min or less, and records the following in the field log:

a. The flow rate setting of the peristaltic pump.
b. Initial pH
c. Initial Dissolved Oxygen
d. Initial Temperature
e. Initial Specific Conductance
f. Initial Oxidation/Reduction Potential
g. Initial Turbidity

Stabilization of these indicator analytes (except Turbidity) is indicative of uniform water being drawn in from the aquifer. Therefore, the well is considered purged after stabilization has occurred. The field sampling crew is required to purge at least 5 minutes, and no longer than 10 minutes at each sampling point.

5. After purging is complete, the field sampling crew records the following in the field log.

   a. Final pH
   b. Final Dissolved Oxygen
   c. Final Temperature
   d. Final Specific Conductance
   e. Final Oxidation/Reduction Potential
   f. Final Turbidity
   g. Stop time of purge
   h. Total amount of water purged (Gallons), and the number of well volumes removed
   i. Any problems encountered during purging including:

      1. Mechanical problems/calibration problems.
      2. Any strange color, clarity, or odor problems with the samples.
      3. Any notes on problems with the wells such as the presence of roots, or gravel pack in the wells, or damage to the well and casing.

D. Well Closeout

1. Upon completion of sampling, the field crew is to rinse off the well plug or expansion cap prior to replacement in the inner casing, replace or close the outer protective well lid, and re-lock the well.
2. The field crew shall use decontamination procedures recommended by the equipment manufacturer.

3. Readings from all equipment are verified 3X before final acceptance. If readings cannot be verified, re-calibration is required. If re-calibration does not result in verification, the monitoring company is required to switch to the back-up meter. Although they are generally done more frequently, calibration checks are required every three samples for most field meters.

*Note: If the monitoring event only requires field analytes, instruments, sample cells, and sample tubes may be decontaminated between GMWs by flushing thoroughly with deionized-distilled water. All pump heads, and hosing of the variable speed pump must be thoroughly rinsed with deionized-distilled water between monitoring points.*

IX. Groundwater Monitoring Well Sampling

If the monitoring event requires indicators or indicators/DNREC Supplemental Analysis for Groundwater Samples to be collected, the sample crew is required to use fresh or decontaminated/dedicated sample tubing in the peristaltic pump. Low flow variable speed pumps must undergo decontamination procedures recommended by the manufacturer. All sample cells are to be decontaminated using the procedures described in VII.A.3.a. above.

The following procedures are to be used by the field sampling crew to collect samples from DSWA GMW wells during a monitoring event that requires indicators or indicator/DNREC Supplemental Analysis for Groundwater Samples analysis to be run on GMW samples:

A. After purging is completed, the field sampling crew shall collect Volatile and Semi-Volatile Organic samples using the peristaltic pump or variable speed pump at a flow rate of 100 mL/Min or less. This is done to insure that:

   1. Volatile Organic Compounds (VOCs) are not stripped from the samples.
   2. Light silts, flocculants, and fine precipitates are not drawn into the sample.

B. Samples can be collected directly into the bottles, however no contact is allowed between sample bottle or tubing from the pump. VOC vials are to be checked for air entrainment. If air entrainment occurs, the sample shall be retaken. After the VOC and Semi-Volatile Organic samples have been collected, the field crew can increase the flow rate of the pump to expedite the sampling of the remaining sample types which could include:

   1. Heavy Metals and Indicator Metals
   2. Cyanide
   3. Sulfate and Chloride
   4. Nitrate and Ammonia
   5. Radionuclides
   6. All other analytes of interest

   The Metals fraction of the samples is to be collected after the Volatile and Semi volatile samples have been collected. Metals samples are the only type of sample that will be considered for filtration. Filtration of Metal samples is to be used as a last resort, and will only be allowed under the following conditions:

   1. The turbidity of the sample is >10 NTU's.
   2. Reduction in flow rates fail to decrease the Turbidity below 10 NTU's.

   If filtration is necessary, the field crew are required to filter the samples through a 0.45 micron mesh cellulose or glass fiber filter.

C. After the sample is collected, the field crew is to record the flow rate of the peristaltic pump in the field logs.

D. After collection of each type of sample is completed, the field crew is required to add any preservatives not added during the bottle prep.

E. Labels affixed to any extra bottles that were not prepared in the laboratory, shall be filled out in indelible ink. Each label is to include the following information:

   1. Customer Name or Identification
   2. Facility Location
   3. Sample Collection Location
   4. Time
   5. Date
   6. Analysis Required
   7. Preservatives Used
   8. Flow rates used for sample collection.
   9. Name of Person that collected the sample.
   10. Analytes being analyzed for.

F. After the labels are completed, all samples are to be wrapped in bubble wrap, and placed in shipping boxes containing ice, dry ice, or freezer packs, and preserved at 4° C for shipment.

G. Chain of Custody forms (COC's) are to be filled out with the same information listed above. Each time the sample is transferred, the sample must have a signature of the individual who releases the sample, and one for the individual who receives the sample.

H. The field sampling crew then packages the samples and hand delivers, or ships by overnight express to the contracted analytical laboratory for testing.

I. As the samples arrive at the laboratory, they are to be logged into a laboratory information system where:

   1. They are given sample identification numbers (This number is to be noted on the COC).
   2. Their pH and Specific conductance is measured and noted on the COC.
   3. They are stored or dispersed to the various laboratory stations for analysis.

J. After the samples are logged in, copies of all completed Field Data Sheets and Field logs are to be e-mailed to the DSWA via internet in upon completion of the monitoring event.

X. Quality Assurance/Quality Control

As a minimum, during each monitoring event, the following QA/QC samples are collected, or prepared and analyzed for the analytes required by State Permits/Regulatory Requirements and Federal Requirements under 40 CFR-258.

- Trip Blanks: One per sampling day per facility
- Field Blanks: One per sampling day per facility
- Laboratory Duplicates: One per 10 samples analyzed
- Surrogate Standards: One per sample set
- Surrogate Spike: One per 20 samples
- Lab Method Blanks: One per sample set

This analysis is done to insure:

1. Procedures or equipment being used in the sampling, preparation, and shipment train do not cause degradation of the samples.
2. Procedures or equipment being used in the analysis train do not cause degradation of the samples.
3. Samples are not contaminated through outside sources.
4. Methods being used for analysis are conducive to the sample matrix.

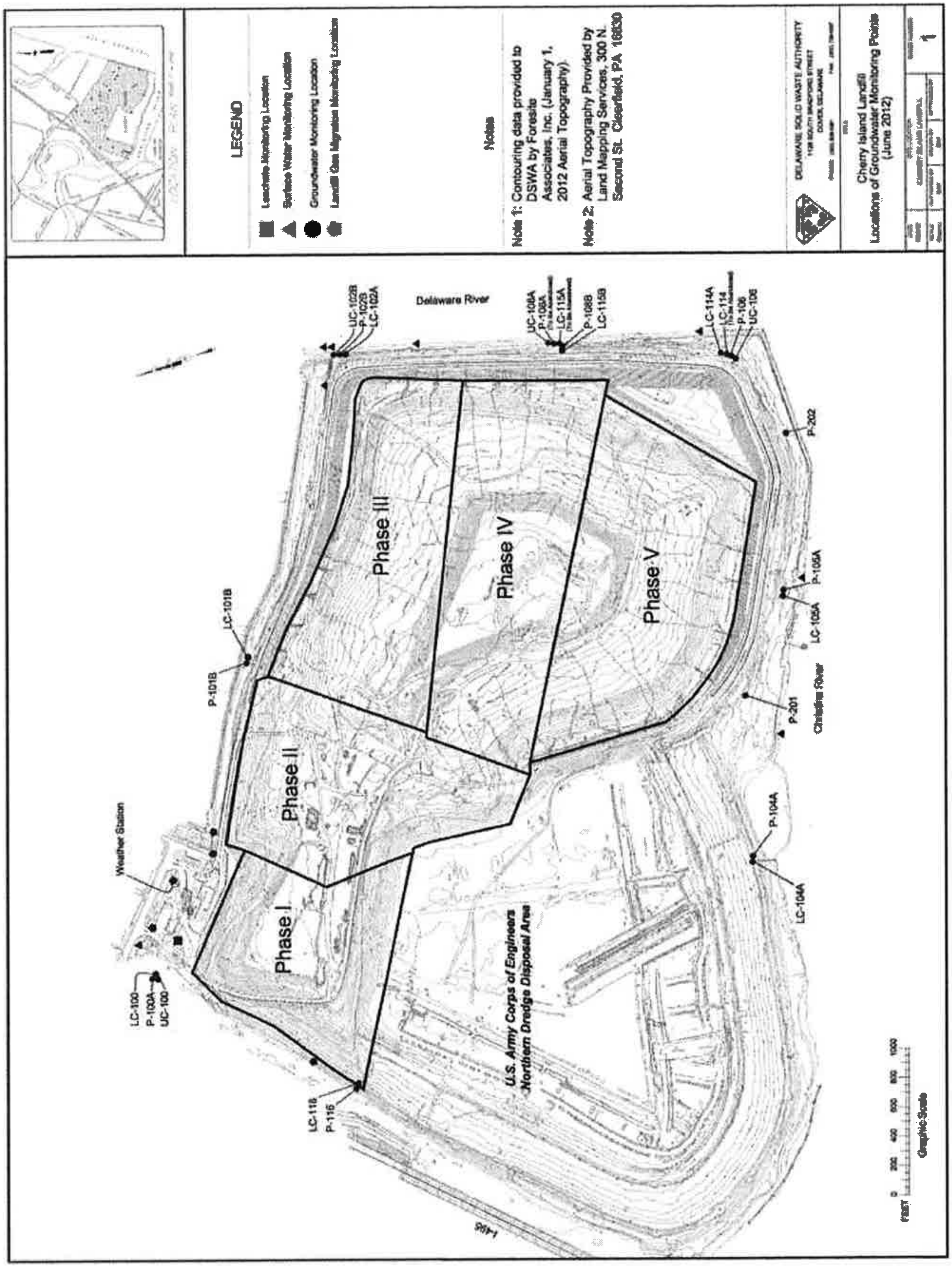
XI. Supply Disposal

Non-hazardous expendable supplies and equipment used in the collection of samples can be disposed of at the small load collection station prior to the sampling team leaving the site. Unused or excess sample that has not contacted sample preservatives can be disposed of at the sample location. Disposal of hazardous expendable supplies such as excess preservatives are to be taken back to the laboratory by the sampling team for proper disposal.

XII. Reporting

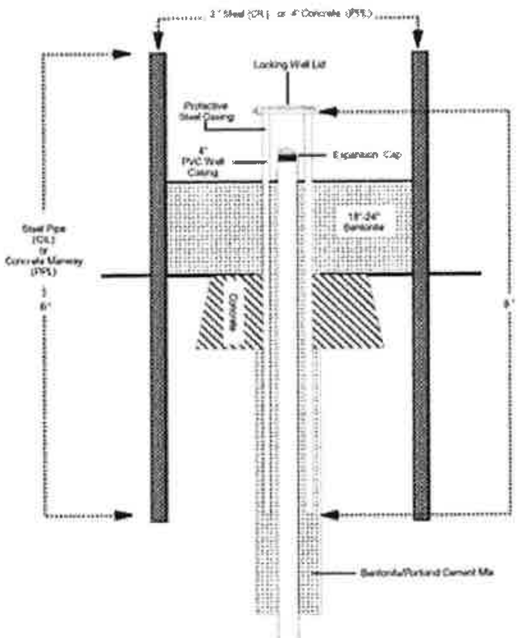
Results of analysis and discussion of the groundwater monitoring activities shall be included and discussed in the first quarterly groundwater monitoring report generated following reception of the groundwater monitoring data. The CIL historical groundwater monitoring database will be transferred to the Solid and Hazardous Waste Section of the Delaware Department of Natural Resources and Environmental Control by way of electronic media or direct file transfer on a quarterly basis.

As a final note, the environmental monitoring contractor and contracted laboratory providing analysis of samples is/are required to retain all field and laboratory records in hard copy format for a minimum of five years, with magnetic media storage for thirty years.

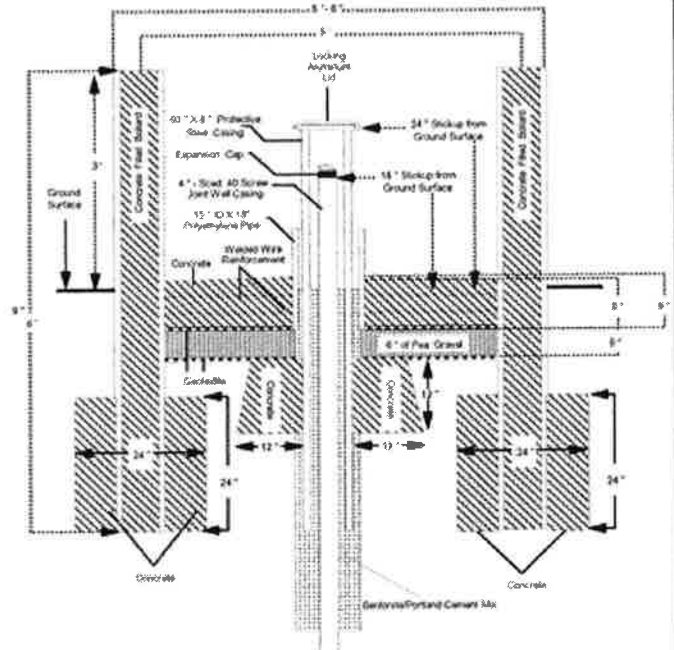


LEGEND
Leachate Monitoring Location
Surface Water Monitoring Location
Groundwater Monitoring Location
Landfill Gas Migration Monitoring Location
Notes
Note 1: Contouring data provided to DSWA by Foresite Associates, Inc. (January 1, 2012 Aerial Topography).
Note 2: Aerial Topography Provided by Land Mapping Services, 300 N. Second St. Clearfield, PA 16830
DELAWARE SOLID WASTE AUTHORITY
Cherry Island Landfill
Locations of Groundwater Monitoring Points
(June 2012)
Phase I
Phase II
Phase III
Phase IV
Phase V
Delaware River
Christina River
U.S. Army Corps of Engineers
Northern Dredge Disposal Area
Weather Station
LC-100
P-100A
UC-100
LC-116
P-116
P-101B
LC-101B
UC-102B
P-102B
LC-102A
UC-108A
P-108A
LC-115A
P-108B
LC-115B
LC-114A
LC-114
P-106
UC-106
P-202
P-105A
LC-105A
P-201
P-104A
LC-104A
Graphic Scale

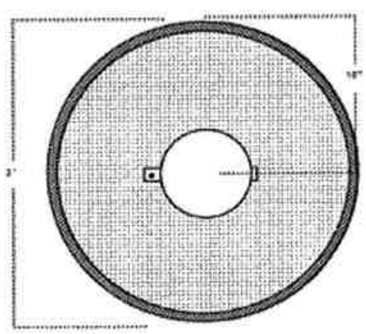

**Figure 1**



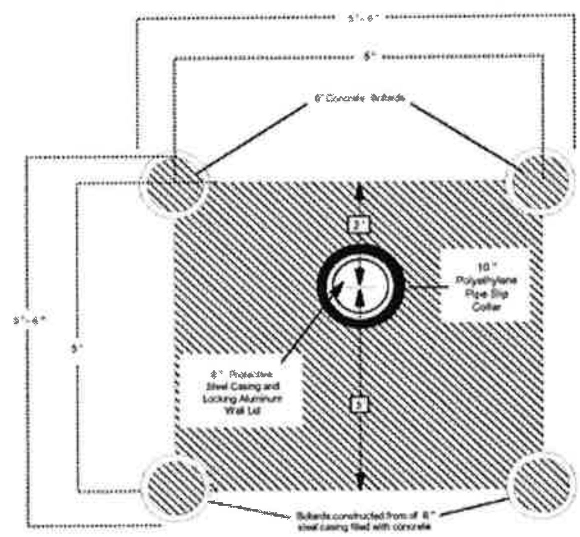
***Frontal /Cross-Section View of Older Style Well Terminus - Typical at CIL and PPL only***



***Frontal /Cross-Section View of Graded Protective Working Pad Common to All New Well Construction***



***Plan View of Older Monitoring Well (Typical of CIL and PPL only)***




***Plan View of Graded Protective Working Pad***

Note: Concrete has a minimum 28 day compressive strength of 3,000 psi. The concrete pad is be sloped at least 1/4" per foot away from the well to shed rainwater.

Note: Working pad may have slighty different bollard/concrete set-up depending on surrounding topography and land-use.

Figure 2

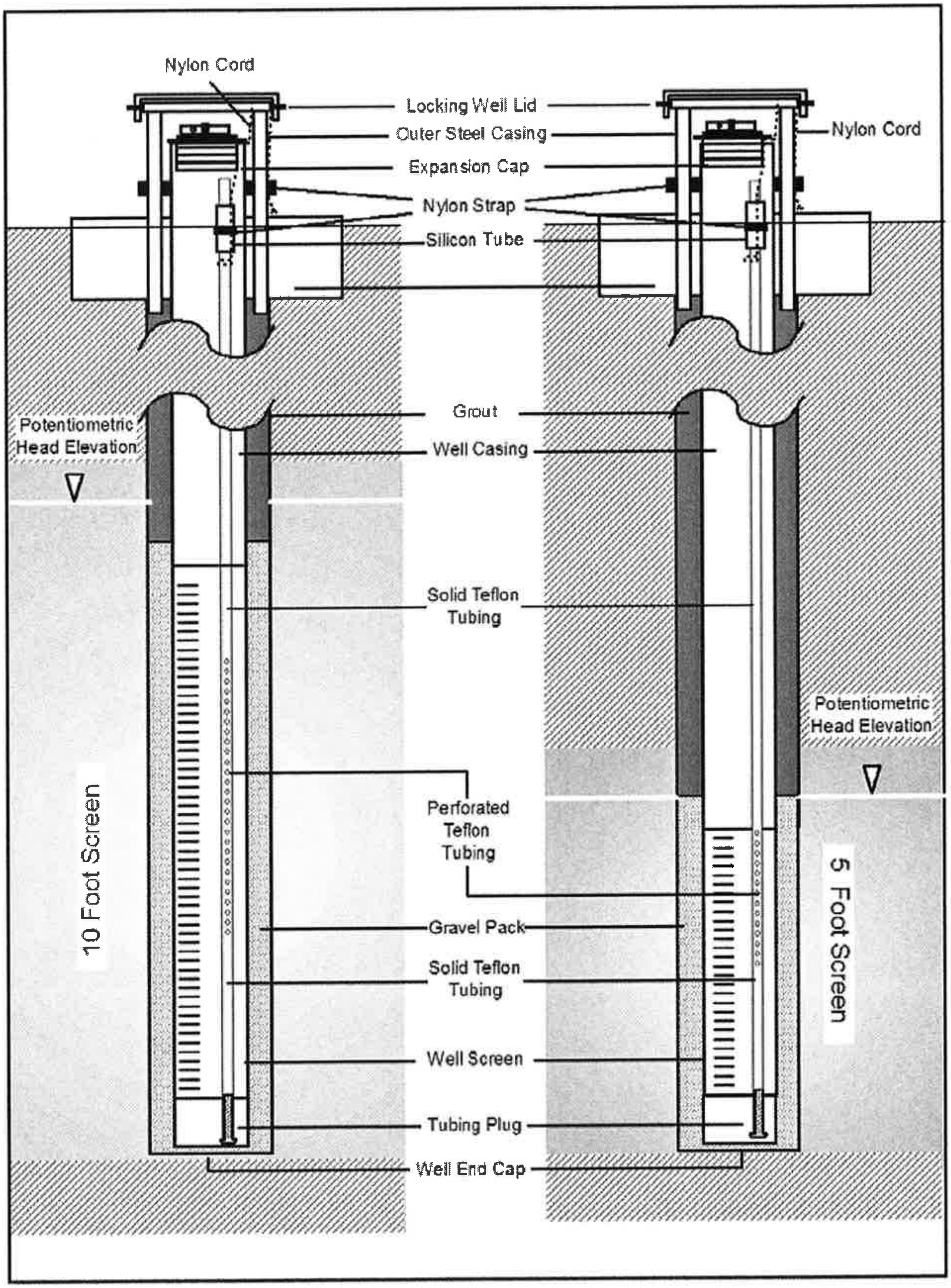

Nylon Cord
Locking Well Lid
Outer Steel Casing
Nylon Cord
Expansion Cap
Nylon Strap
Silicon Tube
Potentiometric
Head Elevation
Grout
Well Casing
Solid Teflon
Tubing
Potentiometric
Head Elevation
10 Foot Screen
Perforated
Teflon
Tubing
5 Foot Screen
Gravel Pack
Solid Teflon
Tubing
Well Screen
Tubing Plug
Well End Cap

Figure 3

**Table 1: CIL Monitoring Requirments For Groundwaters Under Permit SW-06/01**

**January, July, October**

| Measurement or Analyte | **Sounding of Wells (January only)** | DTW/Elevation | Temperature (Field) | pH (Field) | Specific Cond. (Field) | REDOX (Field) | D. O. (Field) | Turbidity | pH (Lab) | Specific Cond. (Lab) | Dissolved Methane | Alkalinity (Total) | Alkalinity (Phenolphth.) | Ammonia-N | Bicarbonate | Carbonate | C.O.D. | Chlorides | Nitrate-N | Dissolved Silica | Sulfate | T.D.S. | T.O.C. | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | (0.01 Ft) | (0.01 Ft NGVD) | (Centigrade) | (SU) | (umhos/cm) | (mV) | (mg/L) | (NTU's) | (SU) | (umhos/cm) | (ug/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Well I.D. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UC-100 | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LC-100 | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| LC-101B | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| UC-102B | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| LC-102A | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| LC-104A | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| LC-105A | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| UC-106 | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| UC-108A | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| **LC-114A** | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| **LC-115B** | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| LC-116 | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | |
| P-100A | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| P-101B | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| P-102B | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| P-104A | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| **P-105B** | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| P-106 | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| **P-108B** | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| P-116 | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| P-201 | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| P-202 | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |

**April**

| Measurement or Analyte | DTW/Elevation | Temperature (Field) | pH (Field) | Specific Cond. (Field) | REDOX (Field) | D. O. (Field) | Turbidity | pH (Lab) | Specific Cond. (Lab) | Dissolved Methane | Alkalinity (Total) | Alkalinity (Phenolphth.) | Ammonia-N | Bicarbonate | Carbonate | C.O.D. | Chlorides | Nitrate-N | Dissolved Silica | Sulfate | T.D.S. | T.O.C. | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | (0.01 Ft NGVD) | (Centigrade) | (SU) | (umhos/cm) | (mV) | (mg/L) | (NTU's) | (SU) | (umhos/cm) | (ug/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Well I.D. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UC-100 | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LC-100 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| LC-101B | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| UC-102B | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| LC-102A | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| LC-104A | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| LC-105A | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| UC-106 | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| UC-108A | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **LC-114A** | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **LC-115B** | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| LC-116 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| P-100A | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| P-101B | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

**ENVIRONMENTAL MONITORING PROGRAM**
**FOR THE**
**NORTHERN SOLID WASTE MANAGEMENT CENTER AT CHERRY ISLAND**
**(Revision 1 – October 10 2012)**

## ATTACHMENT D: May 23, 2000 Memorandum on Future Cherry Island Monitoring Requirements

# MEMORANDUM DELAWARE SOLID WASTE AUTHORITY

May 23, 2000

**TO:** Richard P. Watson, P.E., DEE
Chief of Engineering

**FROM:** Daniel A. Fluman
Supervisor of Environmental Monitoring and Testing

**SUBJECT:** Future Cherry Island Monitoring Requirements

I have completed an extensive evaluation of all historical Organics, Pesticides, Cyanide and Metals data for all groundwater samples collected between the October 1983 site investigation and April 2000. The evaluation included filtering out all detects in the historical files, and then verifying these values against the hardcopies retained in our library. The results of this evaluation lead me to conclude that Table 2 analysis of groundwaters is unnecessary for CIL and that we should petition DNREC to remove this analysis from the groundwater monitoring program.

**Applicable Regulatory Criteria**

Since there are no potable water sources below Cherry Island, and use of any water is limited to industrial withdraw from the Potomac, this review was based on the possible effects of contaminated groundwater discharging to surrounding surfacewaters (i.e. the Christina and Delaware Rivers). DNREC has established surface water criteria in their regulations *State of Delaware Surface Water Quality Standards (amended 8/11/99)* ( SWQS). The criteria presented in the SWQS are based on the chronic and acute effects certain organic compounds and metals have on freshwater and marine organisms. In the case of VOCs, SVOC's and BNAs, no discharge limits have been established for any of the organic compounds detected in groundwaters below the CIL. When considering metals, the levels for chronic freshwater criterion was chosen as a basis for data comparison as these levels are lower than many of the marine criterion.

**Organics Review**

The organics analysis run on groundwater samples over the past 18 years included the USEPA Priority Pollutants listing (prior to 1996) and DNREC Table 2 analytes (1996 – present). Due to the lack of freshwater discharge limits, low percentage of organics which have been detected over the past 18 years, and the low levels at which these have been detected, evaluation of the data was based solely on presence or absence of the organic compound in the sample and it's concentration. The following summarizes the data review for organics analysis

- Of the 9,230 organics tests run on groundwater samples from 25 existing or now abandoned wells. 9,174 (99.4%) were non-detect.
- 18 organic compounds were detected a total of 56 times of which 6 detects (10.7%) were at their mdl.
- With the exception of two locations (new wells C-113 & C-155) which show rapidly declining trends, there is no consistency to the location or concentration of the organics detected around the site.
- Twenty (20) of the detections (36%) were of common laboratory/field contaminants - Acetone, Methylene chloride and Bis(2-ethylhexyl)phthalate.

- Eight (8) of the detections (14%) probably resulted from weathering of fuels or degreasing agents, (Tetrachloroethylene, Ethylbenzene, Benzene and Toluene).
- Sixteen (16) of the detections (24%) were in locations upgradient to landfill, in areas far away from where landfilling activities were taking place, or were detected too early to be caused by filling activities.
- In only four cases (9%) did the concentration of an analyte exceed 0.1 mg/L. All such detects were common laboratory contaminants.
- 91% of detected analytes were less than 0.05 mg/L.
- 48% of the analytes detected were at or below 0.01 mg/L.

**Metals and Cyanide Review**

When evaluating metals detected over the past 18 years, the following technique was used to filter and evaluate metals data collected for samples taken from CIL wells:

1. Metals analyses were separated into "Common Metals" and "Criteria Metals" having an established Freshwater Chronic Criterion (FCC) level.

2. Common metals are those which normally show up in soils throughout Delaware. These metals include Ba, Ca, Co, Fe, Mg, Mn, K, and Na. Common metals accounted for 1,973 (32.7%) of the 6,027metals analysis run on groundwater samples from CIL. These were filtered from the data and not considered for this evaluation.

3. Criteria metals included, As. Cd. Cr. Cu. Pb. Hg. Ni. Se, Ag, Zn. Additional metals reviewed and listed as "other metals" below, but which have no limits were Sb. Be. and Mo. Tl and V. Limits given for As. Cr. Cyanide, Hg, and Se were established values. Limits for Cd. Cr. Cu. Pb, Ni, Ag. and Zn were based on equations for each analyte listed in Table 1. The equations are based on the effects of Hardness on the criterion metal. In most cases, the average Hardness was used. In cases where

Hardness data was not available or could not be calculated. Total Alkalinity (as $CaCO_3$) was substituted for Hardness. (comparisons indicate that the averages for Hardness and Total Alkalinity in the nominal range of 4.5 to 8.5 are very close). The following describes the results of the data review:

- After removal of the common metals from the data reviewed, 4,054 Criteria or "other" metals remained for review.
- Review of the Criteria and "other metals" indicated the results for 3,628 (89.5%) were non-detects.
- Of the 428 (10.5%) samples which resulted in detections, only 94 (22%) have concentrations of metals exceeding their FCC.
- Of the 94 values which exceeded their FCC, only 10 values (10.1%) did not have "pre-existing" levels of the metals. Pre-existing means:

  1. metals were detected during the initial site investigation;
  2. metals were detected in wells upgradient from landfilling activities;
  3. metals were detected in wells too far away at the time of detection to be caused by landfilling activities.

- Of the 428 detections, only 10 values (2.3% of the total detections) did not meet the pre-existing criteria above, and exceeded their FCC.
- Of the 4,054 Criteria Metals tests run over 18 years, only 0.25% tests did not meet the pre-existing criteria and resulted in exceedences of the FCC.
- Be and Mo were never detected in any samples tested.
- Sb was only detected once in the 323 times it was tested for.

- Pre-existing detections of Criteria Metals can be found in data for the Potomac, Columbia Aquifers, and dredge spoils.
- Criteria metals having a FCC have been detected only 11 times in the past five years.
- Historically, seventy-seven (77) CIL groundwater samples have been tested for Cyanide. To date it has been detected 4 times (5%), and has exceeded it's FCC of 0.0052 twice (0.006 and 0.009 mg/L).
- Except for recently installed wells, the background levels of Criteria Metals present in groundwater samples was considerably higher than levels of detects in recent years.

**Conclusions**

When considering this information, it is unlikely that landfilling activities at CIL are the source of organics detected in groundwater samples taken from Cherry Island. The data indicates that the organics were present prior to the site being used for the disposal of MSW, and are most likely coming from the dredge materials. Metals detected in the wells are most likely coming from the dredge spoils as well. The fine grained sediments making up the dredge spoils are primarily composed of silts, sands, and direct discharge of waste from industries and POTWs which have been established along the Delaware and Christina Rivers over the past several hundred years. Up until the 1970s very few regulations existed to keep industries from directly discharging waste into the rivers.

**Other considerations for elimination of DNREC Table 2 analytes include:**

1. One of the reasons Cherry Island was selected for establishing a landfill was the groundwater was of poor quality and not potable.
2. The weight of the landfill is compressing dredge water from the spoil materials and forcing it up into the leachate collection systems of the cells. From there, the dredge water is transported to the Wilmington Wastewater Treatment Plant. Therefore, CIL is actually intercepting and removing potential contaminants from the spoils before they can reach the Delaware and Christina Rivers.
3. This compaction of the underlying spoils by the landfill is establishing the natural liner.
4. Due to the neutral to higher pH and availability of anions in established landfills, the landfill itself acts as a sink for most metals. Therefore, given some retention time, most of the heavy metals which can form salts will become permanently locked up within the landfill mass.
5. Eventually, sometime after landfilling at Cherry Island has been completed, the upward gradient caused by landfilling activities should reverse. The water from the spoils will begin to move downward towards the Columbia and Potomac aquifers again. With the natural liner established, the leachate will continue to be pumped to the City of Wilmington's wastewater treatment plant for disposal.

**TABLE I**

**WATER QUALITY CRITERIA FOR PROTECTION OF AQUATIC LIFE**
**(All Values Are Listed or Calculated in Micrograms Per Liter)**

| [illegible] | [illegible] Acute Criterion | [illegible] Chronic Criterion | [illegible] Acute Criterion | [illegible] Chronic Criterion |
|---|---|---|---|---|
| Aldrin | 3.0 | -- | 1.3 | -- |
| Aluminum | 750. | 87. | -- | -- |
| Arsenic (III) | 360. | 190. | 69. | 36 |
| Cadmium | $e^{(1.128[\ln(Hd)]-3.828)}$ | $e^{(0.7852[\ln(Hd)]-3.490)}$ | 43. | 9.3 |
| Chlordane | 2.4 | 0.0043 | 0.09 | 0.004 |
| Chlorine | 19 | 11. | 13 | 7.5 |
| Chlorpyrifos | 0.083 | 0.041 | 0.011 | 0.0056 |
| Chromium (III) | $e^{(0.8190[\ln(Hd)]+3.688)}$ | $e^{(0.8190[\ln(Hd)]+1.561)}$ | — | -- |
| Chromium (VI) | 16. | 11. | 1,100 | 50 |
| Copper | $e^{(0.9422[\ln(Hd)]-1.464)}$ | $e^{(0.8545[\ln(Hd)]-1.465)}$ | 2.9 | -- |
| Cyanide[1] | 22. | 5.2 | 1.0 | -- |

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Salt Acute Criterion | Salt Chronic Criterion |
|---|---|---|---|---|
| DDT and Metabolites | 1.1 | 0.0010 | 0.13 | 0.0010 |
| Demeton | -- | 0.10 | -- | 0.10 |
| Dieldrin | 2.5 | 0.0019 | 0.71 | 0.0019 |
| Endosulfan | 0.22 | 0.056 | 0.034 | 0.0087 |
| Endrin | 0.18 | 0.0023 | 0.037 | 0.0023 |
| Guthion | -- | 0.01 | -- | 0.01 |
| Heptachlor | 0.52 | 0.0038 | 0.053 | 0.0036 |
| Hexachlorocyclohex | 2.0 | 0.08 | 0.16 | -- |
| Iron | -- | 1000. | -- | -- |
| Lead | $e^{(1.273[\ln(Hd)]-1.460)}$ | $e^{(1.273[\ln(Hd)]-4.705)}$ | 140. | 5.6 |
| Malathion | -- | 0.1 | -- | 0.1 |
| Mercury (II) | 2.4 | 0.012 | 2.1 | 0.025 |
| Methoxychlor | -- | 0.03 | -- | 0.03 |
| Mirex | -- | 0.001 | -- | 0.001 |

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| Nickel | $e^{(0.8460[\ln(Hd)]+3.3612)}$ | $e^{(0.8460[\ln(Hd)]+1.1645)}$ | 75. | 8.3 |
| Total PCBs | 2.0 | 0.014 | 10 | 0.03 |
| Parathion | 0.065 | 0.013 | -- | – |
| Pentachlorophenol | $e^{[1.005(pH)-4.830]}$ | $e^{[1.005(pH)-5.290]}$ | 13 | 7.9 |
| Selenium | 20 | 5.0 | 300. | 71 |
| Silver | $e^{(1.72[\ln(Hd)]-6.52)}$ | 0.12 | 2.3 | – |
| Toxaphene | 0.78 | 0.0002 | 0.21 | 0.0002 |
| Zinc | $e^{(0.8473[\ln(Hd)]+0.8604)}$ | $e^{(0.8473[\ln(Hd)]+0.7614)}$ | 95. | 86. |

Notes

Cyanide measured as free cyanide at the lowest pH occurring in the receiving water, or cyanide amenable to chlorination

Specific numerical acute criteria as presented in this table are applied as one-hour average concentrations not to be exceeded more than once in any three-year period. Specific numerical chronic criteria as presented in this table are applied as four-day average concentrations not to be exceeded more than once in any three-year period.

ln = natural log base e

e=2.71828

Hd= hardness is expressed as mg/L as $CaCO_3$

pH is expressed as Standard Units

Example calculation: Fresh acute criterion for silver at hardness of 50 mg/L. Criterion in ug/L = e raised to the [1.72 ln(50) - 6.52] power. This is equal to e to the 0.21 power, or 1.23 ug/L