Residuals Guidance Document No. 90 - 1

Guidelines for Hydrogeologic Evaluations

The project proponent should submit a hydrogeological survey report, prepared by a qualified hydrogeologist, for Department approval. The purpose of the study is to determine the following:

(1) Define the geology beneath the site area,

(2) Identify groundwater flow paths and rates,

(3) Determine design characteristics of the landfill liner based upon maximum observed or expected groundwater conditions, and

(4) Determine the location of all proposed groundwater protection and monitoring systems.

The report shall include a determination of groundwater flow and velocities prior to and subsequent to landfill construction, groundwater elevations, and potential effect of leachate migration on the surrounding area including public and private water supplies, streams, ponds, wetlands, and coastal waters. The report shall also recommend a ground water monitoring network including upgradient and downgradient monitoring wells, their location and number, method of construction and sampling, and screen depth and intervals.

The hydrogeologic report shall include, as a minimum the following items:

* a determination of the nature of the soils and subsurface geology, thickness and porosity of the unsaturated zone, aquifer saturated thickness, and hydraulic conductivity and porosity of the aquifer and confining layers;

* recommendation of the appropriate location and construction of monitoring wells based on a thorough understanding of the site's subsurface stratigraphy, depth to ground water, groundwater fluctuations, ground water flow direction and mounding potential due to proposed storm water detention basins;

* an evaluation of the potential impacts on current and potential downgradient receptors based on full characterization of subsurface conditions, location of public and private wells, location of hydraulically connected surface waters, hydraulic conductivity,

saturated thickness and porosity, and ground water velocities and flow directions;

* a determination of ambient water quality including ground water sample collection from monitoring wells and samples from adjacent surface water bodies;

* a determination of required liner elevations to maintain a vertical separation of four (4) feet between the bottom of the secondary liner and maximum observed or anticipated ground water elevations; and

* a summary of all soil boring and geotechnical evaluations and a plan indicating the location of all subsurface testing.

A general outline for the scope of work to be conducted for hydrogeologic evaluations is as follows:

I. Background Information.

A. Site Description.

1. Owner of the site,
2. Location of the site,
3. Acreage of the site and of the proposed landfill footprint,
4. Description of the surrounding environment and potential environmental resources affected,
5. Identification of abutting property owners and land uses.

B. Reason for the Investigation.

II. Project Schedule.

A. Order or procession of Investigations.

1. Timetable for investigations.
2. Timetable for deliverables.

III. Technical Approach.

Phase 1 - Preliminary Assessment.

A. Historical Review / Literature Search.

1. Provide historical research on the site.
2. Provide a base map and locus map of appropriate scale.
3. Review, evaluation, and summary of existing data from the site.

    a. Previous subsurface investigations.

        (1) soil and water quality data,
        (2) soils information from deep observation hole tests, soil borings, or monitoring wells,
        (3) observed water levels,
        (4) water table fluctuation information,
        (5) seasonal and tidal influences on water table fluctuations,
        (6) provide relevant U.S.G.S. data,

4. Provide available quality data for all materials proposed to be disposed in the residuals landfill.

B. Regional Survey.

1. Determine the location and use of existing and potential public groundwater supply wells within 1 mile of the proposed facility.

    a. Wells - historical and anticipated pumping rates, pumped volumes, and pumping durations for existing and proposed public supply wells.

    b. Zone of contribution (Zone II) information generated for public supply wells or interim wellhead protection area (½ mile radius).

    c. well construction, depth, and related soils information.

    d. provide information on areas within a 1 mile radius under investigation for water supply purposes.

e. provide all historical water quality data.

2. Determine the location and use of surface water supply areas within a 1 mile radius of the facility.

   a. contributing watershed areas.
   b. supply existing volumes and pumping system information.
   c. anticipated future use.
   d. surface water areas under investigation as a potential drinking water supply source.
   e. historical water quality data.

3. Determine the location of private wells within ½ mile of the facility.

   a. bedrock and overburden wells.
   b. well depth and screened intervals.
   c. potential areas of development near the facility which could utilize private wells for a source of water supply.

4. Provide background geologic data for the area from the following sources:

   a. U.S.G.S. topographic map, locus map, and site plan.
   b. U.S.G.S. surficial geologic map.
   c. U.S.G.S. bedrock map.
   d. U.S.G.S. hydrologic atlas.

5. Develop a conceptual groundwater transport model.

6. Preliminary mapping - Provide an up-to-date base map. The scale of the map must be between 1" = 40' and 1" = 100'. The following features must be shown:

   a. Site topography,
   b. Property boundaries, including landfill boundary and proposed waste deposition areas.

c. Location of all existing monitoring wells, test pits, borings, surface water, and soil sampling locations,

d. On or within 1 mile of the site, identify:

(1) Public water supplies (surface and groundwater),
(2) Existing Zone II delineations,
(3) Interim Wellhead Protection Areas - (a ½ mile radius around public wells),
(4) Watersheds and their drainage patterns,
(5) Aquifer protection zones,
(6) other areas of environmental concern.

e. On or within ½ mile of the site, identify:

(1) Private water supplies,
(2) Surface water bodies, wetlands, 100 year floodplains,
(3) Areas of critical environmental concern,
(4) Existing buildings and/or man-made structures, monitoring devices, utilities, etc.

f. Submit a copy of the U.S.G.S. surficial geology map locating the site.

g. Submit a copy of the U.S.G.S. bedrock geology map locating the site.

7. Develop a preliminary report which summarizes the previous information including but not limited to a description of the regional and site specific surficial geology, bedrock geology, hydrogeology, potentially affected receptors, and potential environmental resources affected. In addition, the preliminary report must provide recommendations for additional subsurface work to be accomplished and the reasons the work is necessary.

Phase 2 - Comprehensive Assessment

1. Provide a brief summary of prior data on the site, and any analyses of that data used to develop the scope of work for phase 2 activities.

2. Phase 2 activities should include the following:

   A. Preliminary field work

      (1) Revisions to site plan based upon field observations,
      (2) Revisions to preliminary mapping of wetlands, surface water bodies, existing monitoring devices, man-made features, etc.
      (3) Geologic mapping,
      (4) Sampling of existing monitoring devices (if applicable),
      (5) Identification and installation of necessary soil borings, test pits, piezometers, and / or monitoring wells,
      (6) Identification and conductance of necessary geophysical surveys,
      (7) Obtaining static water measurements.

   B. Preliminary compilation, interpretation, and presentation of data.

      (1) Determine ground and surface water quality,
      (2) Construct water table and potentiometric surface contour maps,
      (3) Construct vertical equipotential sections,
      (4) Construct vertical and horizontal flow nets,
      (5) Determine possible ground and surface water flow paths,
      (6) Perform a water balance to determine potential volumes of leachate and surface runoff,
      (7) Determine overburden thickness and saturated thickness,
      (8) Determine if a bedrock investigation is necessary,

(9) Compile all soil boring, piezometer, and monitoring well data,
(10) Construct geologic cross-sections,
(11) Refine conceptual model,
(12) Prepare a draft report that includes an amended scope of work and a QA/QC plan for additional phase 3 work (if necessary).

Drilling Program Guidance

1. Submit a plan for a drilling program which includes:

(1) The rational for the choice of location, depth, and number of boreholes, monitoring wells, piezometers installed and environmental samples collected,
(2) Locus map indicating the proposed locations listed above,
(3) Drilling method(s) and field procedures,
(4) Copy of a standard boring log to be utilized,
(5) Soil sampling procedures to be utilized,
(6) Soil classification system,
(7) Bore hole abandonment procedures,
(8) Drilling QA/QC plan which includes:

a. Well logs, both drillers and consultants,
b. As built monitoring well, piezometer designs,
c. Equipment decontaminant procedures,

Subsurface Work Required

1. Determine a sufficient number of monitoring wells, screened intervals and multilevel wells clusters (bedrock, deep, and water table) to:

(1) determine groundwater flow direction,
(2) determine vertical and horizontal hydraulic groundwater gradients,
(3) determine the over burden/bedrock hydraulic relationships,

(4) determine the groundwater quality in bedrock, at depth in the aquifer, and at the water table interface,

(5) determine the permeabilities of the above through the use of in-situ down hole permeability testing and sieve analysis of lithologic units encountered,

(6) generation of potential contaminant contour maps (if necessary),

(7) estimate groundwater flow rates based on hydraulic gradients and permeabilities as encountered,

(8) determine competency of bedrock through coring and RQD's. Bedrock wells should be screened from 10-20 feet into rock, rock type should also be determined,

(9) estimate flow path of a potential plume based on the hydrogeologic data gathered during the investigation,

(10) wells must be constructed according to DEP monitoring well guidelines,

(11) fracture trace analysis or similar technique should be utilized for determining rock fracture and joint patterns,

(12) Determine the hydraulic conductivity (reference the method used to do so and include all data generated.

2. Soil Borings and Soil Sampling

(1) Soil samples must be collected from the deepest well (bedrock) at each well cluster,

(2) Soil samples should be collected with a split spoon sampler utilizing ASTM guidelines for sample retrieval and determination of compactedness,

(3) Soil samples must be collected at five (5) foot intervals, changes in stratigraphy, and at the water table, unless continuous sampling is warranted,

(4) Split spoon samplers must be de-contaminated with methanol, scrubbed, and rinsed with clean water after each use,

(5) All drilling tools and associated machinery should be steam cleaned prior to starting the installation of each new individual well,

(6) Soil samples undergoing laboratory analysis for organic compounds must be collected in appropriate jars and vials; a field organic vapor detector (HNU, photo vac, OVA, AID, etc.) should be used to screen the head space in soil jars,

(7) Samples of wash water used during drilling operations should be analyzed for the same constituents as the groundwater samples.

Phase 3 - Additional Field Work/ Refinement of Data

Phase 3 activities should include the following:

1. Additional field work.

   a. refine phase 2 site characterization with additional field work,
   b. perform bedrock investigation if necessary and required.

2. Refine all preliminary data compilations, interpretations, and presentations.

3. Refine conceptual model.

4. Design an environmental monitoring system.

   a. Determine depth and location of all well screens.
   b. Confirm location and depths with the Department.
   c. Install monitoring wells after approved by the Department.

5. Design sampling and analysis program.

6. Initiate at least one round of sampling.

7. Prepare final report.

Design of the Sampling and Analysis Plan

1. Prepare a sampling and analysis plan to establish background groundwater, surface water, and soil quality. If prior analysis has not been conducted of the products to be disposed in the landfill, then the plan should include methods for obtaining such data.

   a. Groundwater Samples.

      (1) First round sampling should include analysis for those parameters identified in DWPC Guidance Document No. 89-2, Closure/Post Closure Requirements for Residuals Landfills. For metals the initial analysis should be conducted for total metals. If the results indicate the presence of metals above Maximum Contaminant drinking Water Levels (MCL), re-sampling should be conducted for dissolved metals.

      (2) Quarterly samples should be collected from each monitoring well and analyzed by EPA approved methods. Analysis must be conducted by a laboratory certified by the State.

      (3) Samples should be collected at extreme ground water elevations for each season. This sampling program should be continued for at least one year at which time it may be amended based on the results obtained.

      (4) Samples should not be taken within 48 hours after a precipitation event.

      (5) The location of all sampling points must be shown on the base map.

      (6) Water quality parameters anticipated for analysis should be included in the scope of work. The parameters should be based on current drinking water standards and guidelines as well as those parameters found to be present

in the material proposed to be landfilled. TCLP analysis must also be conducted on the waste material proposed to be landfilled.

(7) Wells must be properly developed and purged prior to sample acquisition.

(8) Monitoring well sampling must be conducted according to accepted sanitary groundwater sampling protocol. Acceptable sampling techniques vary for differing parameters. For example, VOA samples must not be aerated during pumping, collection, and bottling.

(9) Chain of custody protocols must be complied with.

2. Prepare a field QA / QC sampling plan to include:

(1) Sample collection method,
(2) Containers used,
(3) Sample preservation techniques,
(4) Equipment decontamination procedures,
(5) Trip blanks,
(6) Field blanks,
(7) Equipment blanks,
(8) Duplicates,
(9) Chain of custody procedures,
(10) Field log book.

3. Prepare a lab QA / QC plan (or obtain from the lab) to include:

(1) Lab blanks,
(2) Duplicates,
(3) Sample preservation techniques,
(4) Spiked samples,
(5) Chain of custody procedures.

* Laboratory data sheets must be submitted as part of the assessment report for all samples analyzed. These data sheets must include: date(s) of sample collection, arrival at the lab, analysis, and extraction, (if applicable). The data sheets must

also include minimum detection limits, analytical methods employed, signature of the person who performed the analysis and reason for deviation from approved procedures, if necessary.

* Data sheets for all blanks and duplicates conducted must also be submitted.

Final Report Submittal

Upon completion of the above tasks, prepare a final report summarizing the results of the hydrogeological evaluation. The report should include the following information:

1. **Discussion and inclusion of all items listed in the previous phases as approved by the Department.**

2. Data compilations, interpretations, and presentations.

   a. Evaluation of ground and surface quality on-site,
   b. Evaluation of site hydrogeology with respect to local geology,
   c. Presentation of data on potential human and environmental receptors which may be effected by potential contamination from the site.
   d. Compilation of piezometric data on a site map contoured to indicate equipotential and flow lines for both horizontal and vertical flow for seasonal high and seasonal low groundwater elevations,
   e. Identification of possible surface water paths before and after design of the landfill,
   f. Calculation of water balance to determine potential volumes of leachate and surface water runoff,
   g. Compilation of all soil boring, piezometer, and monitoring well data,
   h. Construction of geologic cross-sections,
   i. Monitoring well construction details,
   j. Survey data with respect to mean sea level (MSL),
   k. Interpretation of trends observed in piezometric and analytical data,

l. Recommendations for additional assessment work as may be necessary,
m. Recommendations for minimum liner elevations based on observed or potential groundwater fluctuations,
n. Recommendations for surface and/or groundwater control structures to control erosion and protect the landfill integrity and surrounding environment.

3. Maps, Plans, and Figures.

a. Locus map,
b. Site plan; scale between 1" = 40' and 1" = 100'
c. Bedrock topography map,
d. Surficial geologic map,
e. Potentiometric surface contour maps;

(1) Seasonal high with date of observation,
(2) Seasonal low with date of observation,
(3) Design elevation(s) (i.e. maximum anticipated)

f. Vertical equipotential sections,
g. Geological cross-sections (minimum of two at right angles),
h. Contaminant concentration maps for key chemical parameters of concern.

4. Summaries, Tables, and Forms.

a. Geologic logs of all boring and test pits,
b. Summary and table of all analytical and field screening data,
c. As built monitoring well design schematics for all wells,
d. Summary of all geophysical results,
e. Table of ground water level measurements,
f. Table of hydraulic conductivity test results.

5. Recommendations.

6. Proposed monitoring plans.