APPENDIX E

SUPPLEMENTAL DEC DATA

Comparison Tables

Habitat Fragmentation Technical Memorandum

Leachate Generation Technical Memorandum

Landfill Gas Emissions Technical Memorandum

Table E-1:
2011 Analysis Year, Yukon Avenue Corridor: 40-foot vs. 60-foot Road Embankment

Description of Work	On-mound construction of embankment to accommodate future roads		Difference	Comments
	40-foot embankment	60-foot embankment		
Gas Collection system	Landfill gas header pipe is relocated to avoid road alignment, 4 landfill gas well laterals are reconnected to the new header.	Landfill gas header pipe is relocated to avoid road alignment, 4 landfill gas well laterals are reconnected to the new header.	There are no differences in the landfill gas system modifications between the 40-foot-wide and 60-foot-wide embankments.	The gas system will continue to operate within the permit parameters throughout construction and post-construction.
Leachate Collection System and Slurry Wall	The Final Cover Design Report, Addendum 1does not require any modifications to the leachate collection or slurry wall system.	The Final Cover Design Report, Addendum 1does not require any modifications to the leachate collection or slurry wall system.	No modification to leachate collection system or slurry wall required in either scenario and negligible differences in loading.	No impacts—the leachate collection system will continue to operate in accordance with the approved parameters throughout construction and post-construction.
Excavation (cut and fill quantities)	43,468 cubic yards of cut and 56,000 cubic yards of fill, within the landfill solid waste management unit boundary and including geomembrane subgrade preparation.	83,113 cubic yards of cut and 64,124 cubic yards of fill, within the solid waste management unit boundary and including geomembrane subgrade preparation.	The 40-foot-wide embankment scenario has the potential to reduce the cut volume by approximately 48 percent (i.e., cut volume of 43,486 for 40-foot embankment vs. 83,113 for 60-foot embankment) and decrease the fill volume by 13 percent (i.e., reduction of approximately 8,124 cubic yards of fill).	Moderate differences in grading volumes; the excess cut volumes will be used as fill in other areas of landfill Section 6/7 where fill would otherwise need to be imported to achieve the design grade; construction practices in place to avoid impacts.
Landfill Stability	The vertical profile of the 4-lane road is created to achieve the required geometry for roadway design. The geometry results predominately in cut to create an approximately 6 percent maximum grade. The final grade is stable.	The vertical profile of the 4-lane road is created to achieve the required geometry for roadway design. The geometry results predominately in cut to create an approximately 6 percent maximum grade. The final grade is stable.	The 2-lane and 4-lane options utilize the same vertical profile; therefore, there is no difference between the two options with regard to landfill stability.	The landfill is stable under both options.
Hydrology (Conveyance and collection systems) and water quality	Interim landfill service road and grass final cover.	Interim landfill service road and grass final cover.	No difference.	No impact on hydrology or water quality with the proposed design (see also the FSEIS for the water quality analysis with the modified interim road).
Wetlands and aquatic resources (filling)	None	None	N/A	All work on Landfill Section 6/7—no wetlands or natural resources affected.
Wetlands and aquatic resources (total shading and filling)	None	None	N/A	All work on Landfill Section 6/7—no wetlands or natural resources affected.

Table E-2:
2011 Analysis Year, Forest Hill Road Corridor: 40-foot vs. 60-foot Road Embankment

Description of Work	On-mound construction of embankment to accommodate future roads		Difference	Comments
	40-foot embankment	60-foot embankment		
Gas Collection system	Gas Extraction Wells W-62, W-69, and W-74 to be relocated.	Gas Extraction Wells W-62, W-69, W-74 and W-78 to be relocated.	The 40-foot embankment scenario has the potential to impact one less gas extraction well (W-78). In general, impacts to other gas system components, such as headers and laterals, is controlled by horizontal and vertical alignment, which are similar for both scenarios.	The gas system will continue to operate within the permit parameters throughout construction and post-construction.
Leachate Collection System and Slurry Wall	The Final Cover Design Report, Addendum 1 does not require any modifications to the leachate collection or slurry wall system.	The Final Cover Design Report, Addendum 1 does not require any modifications to the leachate collection or slurry wall system.	No modification to leachate collection system or slurry wall required in either scenario and negligible differences in loading.	No impacts—the leachate collection system will continue to operate in accordance with the approved parameters throughout construction and post-construction.
Excavation (cut and fill quantities)	98,770 cubic yards of cut and 56,751 cubic yards of fill, within the landfill solid waste management unit boundary and including geomembrane subgrade preparation.	115,770 cubic yards of cut and 65,391 cubic yards of fill within the landfill solid waste management unit boundary and including geomembrane subgrade preparation.	The 40-foot embankment scenario has the potential to reduce the cut volume by 17,000 cubic yards (19 percent) and decrease the fill volume by 8,640 cubic yards (13 percent)	Minor differences in grading volumes; the excess cut volumes will be used as fill in other areas of landfill Section 6/7 where fill would otherwise need to be imported to achieve the design grade; construction practices in place to avoid impacts.
Landfill Stability	Smaller embankment area than 60-foot embankment, but also no impact on stability.	The 60-foot embankment is stable under static and traffic loading. Surcharge soil stockpile placement is found to be stable. The maximum loading is due to the surcharge stockpile with a 20-foot-high stockpile.	The embankment fill heights are based on vertical profile, not width. Because the 2-lane and 4-lane scenario alignments are similar in vertical profile, there would be no significant change in the embankment fill height between 2-lane and 4-lane scenarios.	Negligible difference in loading, the landfill is stable under both options.
Hydrology (conveyance and collection systems) and water quality	Interim landfill service road and grass final cover.	Interim landfill service road and grass final cover.	No difference	No impact on hydrology or water quality with the proposed design (see also the FSEIS for the water quality analysis with the modified interim road).
Wetlands and aquatic resources (filling)	None	None	N/A	All work on Landfill Section 6/7—no wetlands or natural resources affected.
Wetlands and aquatic resources (total shading and filling)	None	None	N/A	All work on Landfill Section 6/7—no wetlands or natural resources affected.

Table E-3:
2036 Analysis Year, Yukon Avenue Connection: 2-Lane vs. 4-Lane Road

Description of Work	40-foot wide (2-lane) Road	60-foot-wide (4-lane) Road	Difference	Comments
Gas Collection system	No modifications (addressed by Final Cover Design Report, Addendum 1)	No modifications (addressed by Final Cover Design Report, Addendum 1)	None	N/A
Leachate Collection System and Slurry Wall	The road alignment will cross the slurry wall and leachate collection system. Rigid concrete structures will be designed for protection of the slurry wall. Deformations will be maintained below the limits agreed upon limits established between DSEC and DSNY.	The road alignment will cross the slurry wall and leachate collection system. Rigid concrete structures will be designed for protection of the slurry wall. Deformations will be maintained below the limits agreed upon limits established between DSEC and DSNY.	None	N/A
Fill quantities (Landfill Section 6/7)	11,900 cubic yards of fill (for fill above the top of final cover elevation, as established during the 2011 build year, Final Cover Design Report, Addendum 1 design).	16,425 cubic yards of fill (for fill above the top of final cover elevation, as established during the 2011 build year, Final Cover Design Report, Addendum 1 design).	A reduction of 4,525 cubic yards of fill with the 2-lane road.	Limited reduction in fill materials for road surfaces, No impact in either scenario with impact avoidance and mitigation measures during construction.
Cut/fill quantities (off mound)	3,345 cubic yards of cut, 2,040 cubic yards of fill (a net of -1,305 cubic yards), for areas outside of Landfill Section 6/7 solid waste management unit boundary.	3,785 cubic yards of cut, 5,685 cubic yards of fill (a net of +1,900 cubic yards), for areas outside of Landfill Section 6/7 solid waste management unit boundary.	Minors reductions in cut (440 cubic yards) and fill (3,645 cubic yards) with the 2-lane road.	Limited reduction in grading with 2-lane road, No environmental impacts in either scenario with impact avoidance and mitigation measures during construction.
Landfill Stability	No Impacts	No Impacts	No differences in landfill stability and no impacts with either a 2-lane or 4-lane road.	Although the 2-lane scenario would have less possible vehicle loading with a narrower width, because the 4-lane scenario is stable for a conservative loading analysis, the 2-lane provides no added benefit in terms of stability.
Hydrology (conveyance and collection systems) and water quality	2.46 acres of paved road	3.69 acres of paved road	Neither scenario will overburden hydraulic capacity of the landfill stormwater management system or adversely impact quality.	The 2-lane scenario would have less road surface (less impervious coverage) runoff than the 4-lane wide road, but neither would result in impacts to stormwater conveyance systems or the receiving basins. The smaller impervious area would result in less pollutant loading but neither would have a water quality impact.
Wetlands and aquatic resources (filling, e.g., culvert base, supports)	No filling necessary	Filling of 0.01 acres	Filling of 0.01 acres with 4-lane road	Potential wetlands impacts are minor for 4-lane road and can be mitigated.
Wetlands and aquatic resources (total shading and filling)	No filling or shading impacts	Filling of 0.01 acres (no shading impacts).	Filling of 0.01 acres with 4-lane road	Potential wetlands impacts are minor for 4-lane road and can be mitigated.

Table E-4:
2036 Forest Hill Road Connection: 2-Lane vs. 4-Lane Road

Description of Work	40-foot-wide (2-lane) Road	60-foot-wide (4-lane) Road	Difference	Comments
Gas Collection system	A new detail for crossing of the landfill gas vent trench will need to be created and approved.	A new detail for crossing of the landfill gas vent trench will need to be created and approved.	None	Gas venting system will operate properly in both scenarios. No impacts created under either scenario.
Leachate Collection System and Slurry Wall	The road alignment will cross the slurry wall and leachate collection system. Rigid concrete structures will be designed for protection of the slurry wall. Deformations will be maintained below the limits agreed upon limits established between DSEC and DSNY.	The road alignment will cross the slurry wall and leachate collection system. Rigid concrete structures will be designed for protection of the slurry wall. Deformations will be maintained below the limits agreed upon limits established between DSEC and DSNY.	No difference	Negligible difference in loading—no impact on leachate collections and slurry wall.
Fill quantities (Landfill Section 6/7)	8,500 cubic yards of fill, (for fill above the top of final cover elevation, as established during the 2011 build year, Final Cover Design Report, Addendum 1 design).	12,500 cubic yards of fill, (for fill above the top of final cover elevation, as established during the 2011 build year, Final Cover Design Report, Addendum 1 design).	A reduction of 4,000 cubic yards of fill with the 2-lane road.	Limited reduction in fill materials for road surfaces. No impact in either scenario with impact avoidance and mitigation measures during construction.
Cut/fill quantities (off mound)	970 cubic yards of cut, 25,175 cubic yards of fill (a net of ±24,205 cubic yards) for areas outside the Landfill Section 6/7 solid waste management unit boundary.	1,195 cubic yards of cut, 33,365 cubic yards of fill (a net of +32,170 cubic yards) for areas outside the Landfill Section 6/7 solid waste management unit boundary.	Minors reductions in cut (220 cubic yards) and fill (8,190 cubic yards) with the 2-lane road.	Limited reduction in grading with 2 lane road, No environmental impacts in either scenario with impact avoidance and mitigation measures during construction.
Landfill Stability	Loading conditions with a 40-foot-wide (2-lane road) may be somewhat less than that with a 60-foot-wide (4-lane road), but in both cases there are no impacts on landfill stability.	No Impacts	Although the 2-lane scenario would have less possible vehicle loading with a narrower width, because the 4-lane scenario is stable for a conservative loading analysis, the 2-lane provides no added benefit in terms of stability.	No differences in landfill stability and no impacts.
Hydrology (conveyance and collection systems) and water quality	4.8 acres of paved road	7.2 acres of paved road	The 2-lane scenario would have less road surface (less impervious coverage) runoff than the 4-lane wide road, but neither would result in impacts to stormwater conveyance systems (e.g., channels C-26 and R-27) or the receiving basins. The smaller impervious area would result in less pollutant loading but neither would have a water quality impact.	Neither scenario will overburden hydraulic capacity of the landfill stormwater management system or adversely impact quality.
Wetlands and aquatic resources (filling, e.g., culvert base, supports)	Filling of 1.92 acres	Filling of 2.18 acres	A reduction of 0.26 acres of filling with the 2-lane road.	All wetland impacts can be mitigated in either scenario.
Wetlands and aquatic resources (total shading and filling)	2.16 acres (with 0.24 acres of shade impacts).	2.54 acres (with 0.36 acres of shade impacts).	A reduction of 0.38 acres of filling with the 2-lane road.	All wetland impacts can be mitigated in either scenario.

Table E-5:
2036 Analysis Year, Richmond Hill Road Connection: 2-Lane vs. 4-Lane Road

Description of Work	40-foot-wide (2-lane) Road	60-foot-wide (4-lane) Road	Difference	Comments
Gas Collection system	No modifications to the active landfill gas collection system are required, passive features, such as the landfill gas collection trench will be required to be reconstructed or modified. A new detail for crossing of the landfill gas vent trench will need to be created and approved.	No modifications to the active landfill gas collection system are required, passive features, such as the landfill gas collection trench will be required to be reconstructed or modified. A new detail for crossing of the landfill gas vent trench will need to be created and approved.	No differences between the options.	No impacts to active system, (all work off Landfill Section 6/7) with impact avoidance measures to be implemented for passive systems. Details to be determined during design phases.
Leachate Collection System and Slurry Wall	The road alignment will cross the slurry wall and leachate collection system. Rigid concrete structures will be designed for protection of the slurry wall. Deformations will be maintained below the limits agreed upon limits established between DSEC and DSNY.	The road alignment will cross the slurry wall and leachate collection system. Rigid concrete structures will be designed for protection of the slurry wall. Deformations will be maintained below the limits agreed upon limits established between DSEC and DSNY.	N/A	No Impacts (all work off Landfill Section 6/7)
Fill quantities (Landfill Section 6/7)	N/A	N/A	N/A	N/A
Cut/fill quantities (off mound)	16,239 cubic yards of cut, 70, 550 cubic yards of fill (a net of +54,230 cubic yards) for areas outside the Landfill Section 6/7 solid waste management unit boundary.	21,365 cubic yards of cut, 87,404 cubic yards of fill (a net of +66,039 cubic yards) for areas outside the Landfill Section 6/7 solid waste management unit boundary.	A reduction of 11,910 cubic yards of fill with the 2 lane road.	Limited reduction in truck traffic and construction related to filling with the 2-lane road. No impacts in either scenario with impact avoidance and mitigation measures in place.
Landfill Stability	N/A	N/A	N/A	N/A
Hydrology (conveyance and collection systems) and water quality	4.58 acres of paved road	6.87 acres of paved road	The 2-lane scenario would have less road surface (less impervious coverage) runoff than the 4-lane road, but neither would result in impacts to stormwater conveyance systems or the receiving basins. The smaller impervious area would result in less pollutant loading but neither would have a water quality impact.	Neither scenario will overburden hydraulic capacity of the landfill stormwater management system or adversely impact quality.
Wetlands and aquatic resources (filling ,e.g., culvert base, supports)	Filling of 2.49 acres	Filling of 3.09 acres	A reduction of 0.6 acres of filling with the 2-lane road.	All wetland impacts can be mitigated.
Wetlands and aquatic resources (total shading and filling)	Filling of 2.49 acres (no additional shading impacts).	Filling of 3.09 acres (no additional shading impacts).	A reduction of 0.6 acres of total wetland impact with the 2-lane road.	All wetlands impacts can be mitigated.

Technical Memorandum

To:	Steve Zahn, New York State Department of Environmental Conservation
From:	Terry Doss (Biohabitats), Robert White (AKRF), Sandy Collins (AKRF), Andrew Bernick (AKRF), and Michael Quinn (HDR)
Date:	September 28, 2009
Re:	Assessment of Measures to Minimize East Park Habitat Impacts from the Yukon Avenue Connections
cc:	Michael Marrella, Freshkills Park Project

1.0 Introduction

Upon review of the East Park Roads Draft Supplemental Environmental Impact Statement (DSEIS) prepared with the New York City Department of Parks & Recreation (DPR) as lead agency, the New York State Department of Environmental Conservation (DEC) provided the following comment with respect to the Yukon Road crossing:

"The portion of the Yukon Connection crossing between stormwater basins B1 and B2 entails extending the length of the existing 5-foot diameter culvert. While this may maintain a hydrologic connection, it does not appear that it would provide an adequate, suitable wildlife passage area. If species such as turtles and frogs do not find the culvert usable, they will be more likely to cross the road to migrate from basin to basin, which is likely to result in a significant increase in mortality to these species. The SEIS must evaluate the suitability of the expanded culvert as a wildlife conduit and explore design alternatives to avoid these impacts (e.g. wider culvert(s) or viaduct). "

The purpose of this technical memorandum is to present a detailed discussion of the measures that will be implemented to minimize the potential for adverse impacts to wildlife associated with the proposed Yukon Avenue Connection segment of the East Park Road project. This technical memorandum has been prepared as part of the East Park Roads Final Supplemental Environmental Impact Statement (FSEIS), and serves as a follow-up to the March 2009 memorandum presenting AKRF's Fresh Kills Park: Wildlife Avoidance Response Analysis.

2.0 Potential for Habitat Impacts and General Mitigation Strategies

The Fresh Kills Park GEIS (March 2009) and the East Park Roads SEIS (June 2009) provide a detailed assessment of the potential impacts to habitat and wildlife for the East Park roads. As stated in these documents, the proposed park road corridors have the potential to result in long-term adverse impacts to wildlife populations and habitat due to:

- Habitat and population fragmentation;
- Degradation and loss of quality habitat and wildlife avoidance response;
- Interruption of natural hydrologic features;
- Decreased wildlife biodiversity;
- Direct loss of wildlife individuals due to impact with vehicles; and
- Decreased access to habitat vital to the life cycle of certain wildlife species.

The general impact avoidance measures envisioned by the park plan (see the DSEIS Chapter 23 "Impact Avoidance and Mitigation") include measures to maintain wildlife corridors and connectivity between habitats, such as the following:

- Incorporating measures to mitigate potential impairments to wildlife movement in the areas identified above by incorporating wildlife underpass features into culverts constructed under the park roads to maintain stormwater drainage and flow patterns, or separate wildlife underpass features where feasible;
- Using viaducts or bottomless arch structures where feasible to minimize impairment of wildlife movement under roadways;
- Incorporating wildlife crossing warnings into roadway signage;
- Monitoring wildlife/vehicle collisions to identify the need for additional measures (e.g., speed reduction) to minimize wildlife losses and adverse effects to motorist safety due to collisions;
- Using vegetation that does not attract wildlife in roadside landscaping and keeping vegetation adjacent to the road low to provide wildlife with unobstructed view of oncoming traffic; and
- Establishing vegetation screens along roadway to reduce traffic noise in certain landscape enhancement areas.

3.0 Proposed Road Crossing at Yukon Avenue

The proposed Yukon Avenue Connection in the road segment between Landfill Section 6/7 and Richmond Avenue would pass between stormwater drainage basins B1 and B2 (see Figure E-1). Currently, these basins are hydrologically connected by a 60-inch standard culvert. With the proposed project, the Yukon Avenue Connection would be installed as either a 2 lane (40-foot-wide) or 4 lane (60-foot-wide) park road. The proposed road would have little direct (filling) impact on the wetlands (estimated at 0.1 acres due to side slope grading with a four-lane-wide road). The limited impact is because this segment of the proposed road has been sited at an area that has already been developed as part of the Fresh Kills Landfill with a service road and the associated infrastructure (see Figure E-2). However, both of the basins, although structural in design, are hydraulically connected to adjoining wetlands and are part of the overall interconnected habitat system that exists east of Landfill Section 6/7, between the landfill and Richmond Avenue.

4.0 Baseline Ecological Conditions at Stormwater Basins B1 and B2

As described in the DSEIS, the National Wetlands Inventory (NWI) maps the stormwater management basins (Basins A, B1 and B2) on the east side of Landfill Section 6/7 as estuarine intertidal emergent and unconsolidated shore (E2EM5P and E2EM1P, and E2USN)). These wetlands have not been mapped as tidal or freshwater wetlands by the DEC, but activities in and around these wetlands would be regulated under Article 15, "Protection of Waters" on a case by case basis. Freshwater wetland investigations were conducted in September 2007 within the East Park by Geosyntec Consultants, Inc. (Geosyntec 2007) as part of the Fresh Kills Park Generic Environmental Impact Statement (GEIS). That investigation used the three parameter methodology (i.e., hydrology, vegetation and soils) of the USACE Wetlands Delineation Manual (1987). The Geosyntec Consultants, Inc. wetlands study identified a freshwater wetlands system on the east side of Landfill Section 6/7. The northern portion of this wetland system comprises two interconnected stormwater management basins (B1 and B2) that receive stormwater runoff from Landfill Section 6/7, and ultimately discharge to the area indicated on the NWI as estuarine emergent wetland that is located at the northeast side of Landfill Section 6/7. This area contains vegetation characteristic of a freshwater emergent/forested wetland and ultimately drains north to a tributary of Springville Creek through a culvert. Based on field observations, stormwater runoff from Richmond Avenue also drains into this area through existing storm drain pipes. Plant species associated with the emergent wetland areas include *Phragmites*, spike rush, switchgrass, and various sedge species. Plant species associate with the forested wetland areas include red maple, pin oak, sweet gum, black gum, gray birch, black willow, sassafras, arrowwood, marsh-elder, bayberry, groundselbush, jewelweed, greenbrier, and various sedge species (AKRF, 2007). These areas correspond to the areas previously misidentified as estuarine emergent wetlands on the NWI maps.

Other habitats in the vicinity of the Yukon Avenue Connection include the berms created by the New York City Department of Sanitation (DSNY) along the Richmond Avenue frontage for the purposes of screening the landfill. These berms were primarily landscaped with evergreen species, but are also populated by red oak, tulip poplar, black cherry, and an understory of multiflora rose, poison ivy, and Virginia creeper; less-frequently observed are *Phragmites*, grape, blueberry, black locust, and groundselbush (AKRF, 2007).

As presented in Chapter 10 of the DSEIS, the freshwater wetlands, including the open water and vegetated wetland habitats east of Landfill Section 6/7 formed by the two stormwater management basins and adjacent wetland areas, other open water areas west of Landfill Section 6/7, and smaller ponds throughout the project site, provide foraging and breeding habitat for mammal species, including muskrat, raccoon, Virginia opossum, and white-tailed deer. Four species of reptiles and amphibians were observed or heard at Fresh Kills and are known to be present within or near Basins B1 and B2.

Open water areas and emergent and forested wetlands within the vicinity of the Yukon Avenue Connection provide important foraging and breeding areas for reptiles, amphibians and mammals. White-tailed deer would be the largest species expected to be present within the roadway or basin area, and movement of reptiles (i.e., turtles) and amphibians (i.e., frogs) is likely to occur between the basins.

5.0 Proposed Impact Avoidance and Mitigation Strategies for the Yukon Avenue Connection

As presented in the March 2009 AKRF memorandum presenting AKRF's Fresh Kills Park: Wildlife Avoidance Response Analysis, it has been well established that road kills of reptiles and amphibians dispersing between habitats bisected by vehicular roadways is a significant source of mortality (Bissonette 2006). For road arrangements that are situated between breeding ponds and required upland habitats (e.g., the two stormwater management ponds, Basins B1 and B2), the lack of safe passage at the upland-wetland interface may result in increased mortality during seasonal movements. Reptile and amphibian mortality, and mortality of other wildlife may be reduced by (1) creating passageways under or around roadways to allow for safe movement; (2) closure of roadways during peak activity periods; and (3) avoidance of road arrangements that bisect breeding habitats for reptiles and amphibians. The following section describes the mitigation strategies proposed for the Yukon Avenue crossing.

Location, hydrology, light, openness ratio [cross-sectional area of a culvert divided by its length], and cover) are critical elements to consider in the design of successful wildlife passageways that function to direct the movements of wildlife around potential sources of mortality (MassHighway 2006; Forman et al. 2003). Tunnel-barrier structures, specifically hybrid systems that use guide fences and underpasses that guide organisms underneath roadways, appear to be successful in reducing wildlife mortality due to vehicular collision (Woltz et al. 2008).

Use of box culverts underneath a roadway and adjacent fencing has been shown to reduce mortality of amphibians (Breisch and Fitzsimmons 2001). If appropriate, an open top feature can allow for the flow of air, light, and moisture that can aid visibility and movement through a tunnel (Jackson 2003). Placement of natural surfaces, including soil or stone substrates, along areas of a culvert where dispersal is anticipated may further enhance its use as a passageway (Jackson 2003). As tall curb cuts and catch basins may entrain dispersing reptiles and amphibians and cause high mortality, it is also recommended that "Cape Cod" berms or some form of egress from catch basins are incorporated in roadway design where feasible (Jackson 2003).

By incorporating an existing landfill roadway as part of the Yukon Avenue crossing, DPR has reduced adverse impacts to wetlands, and aquatic and terrestrial biota associated with the placement of fill or structure that would be associated with the construction of the roadway. Other measures being considered at the Yukon Avenue Connection to further minimize the potential for adverse impacts to aquatic and terrestrial biota associated with habitat fragmentation and avoidance include:

- Replacement of the existing 60-inch standard culvert with an open bottom box culvert with footings provided at each wall, thereby allowing natural substrate beneath it. The box culvert will be sized to provide enhanced hydraulic conductivity between stormwater basins B1 and B2, and wildlife passage above the permanent pool elevation (see Figures E-3 and E-4).
- Planting of native vegetation along the fronting walls of the culvert will provide cover and foraging habitat for wildlife species expected to move between stormwater basins B1 and B2 Planting native woody vegetation (such as inkberry and shadbush) and grasses (such as little bluestem) would provide resources to attract dispersing wildlife to the culvert passageway and reduce the potential for vehicular collisions. It would be expected that other native species present in the vicinity of the Yukon Avenue Crossing (such as bayberry, groundsel bush and various herbaceous species) would also colonize this area and provide further resource value. Site maintenance would be performed to keep vegetation at an appropriate density to allow for wildlife movement.
- Wing fencing will be used to establish a barrier to wildlife between the culvert and the road, and to funnel wildlife towards the culvert passageway.

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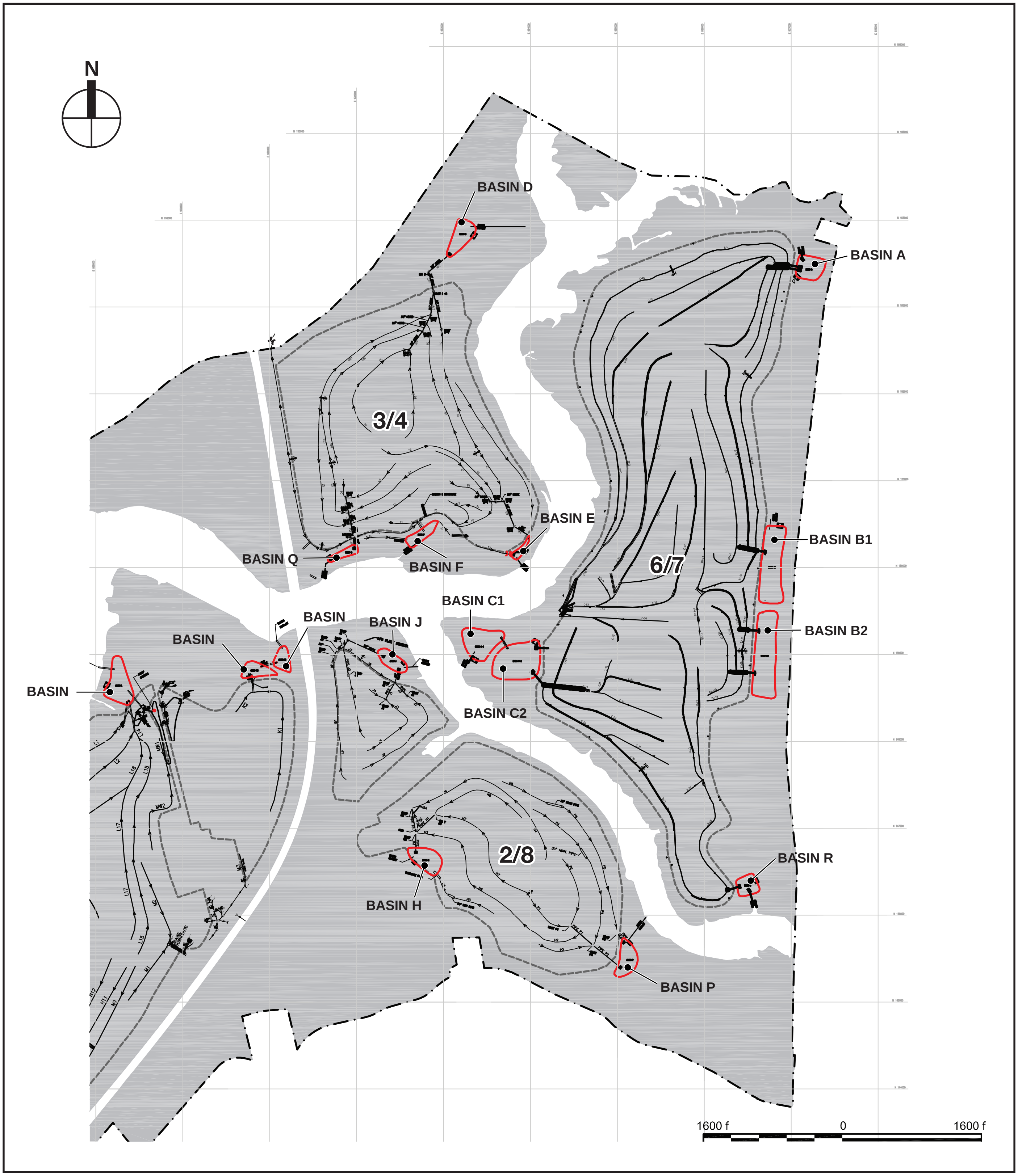
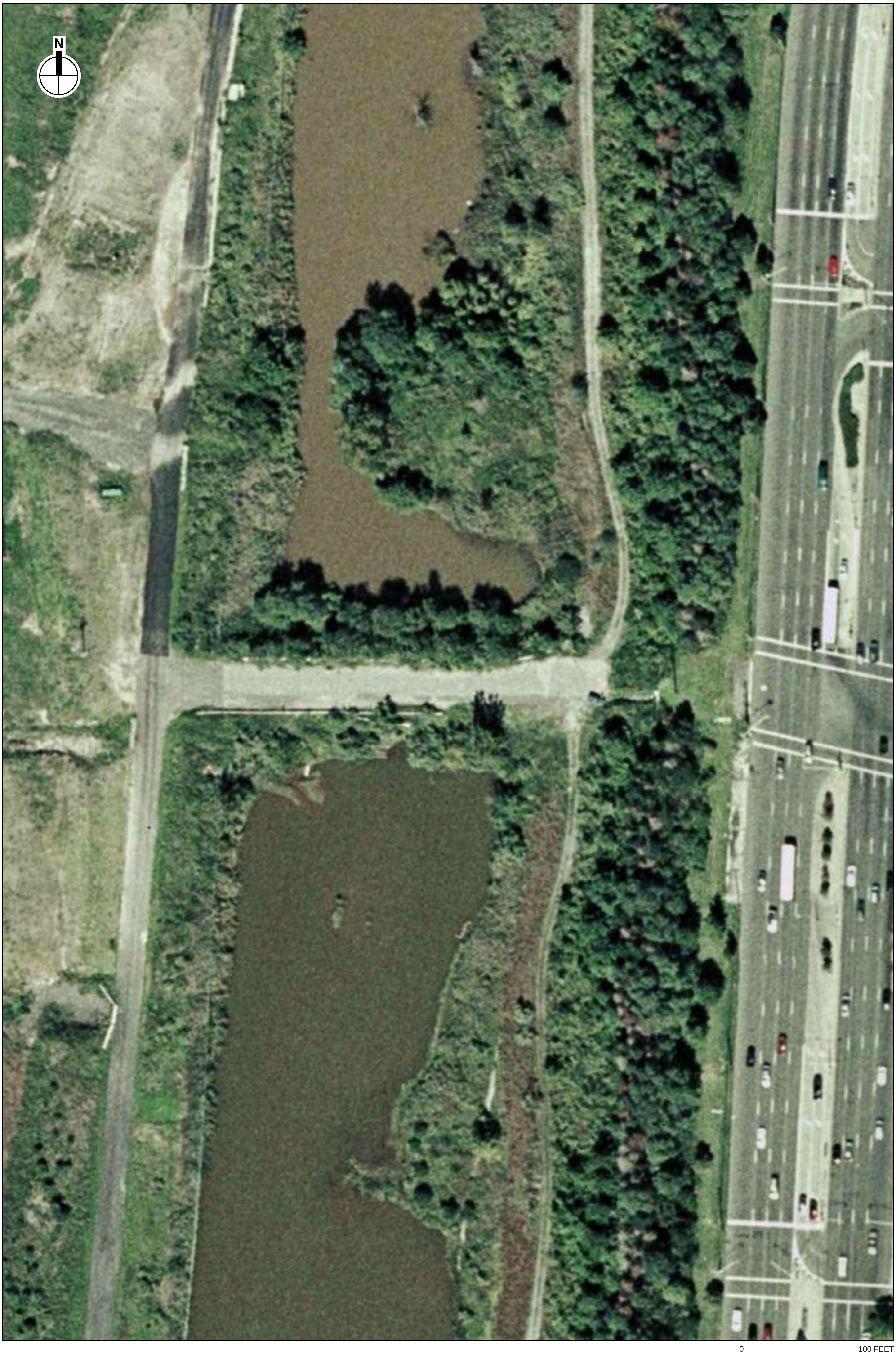


SOLID WASTE MANAGEMENT UNIT BOUNDARY
DRAINAGE SWALE
DOWNCHUTE
CULVERT
BASINS

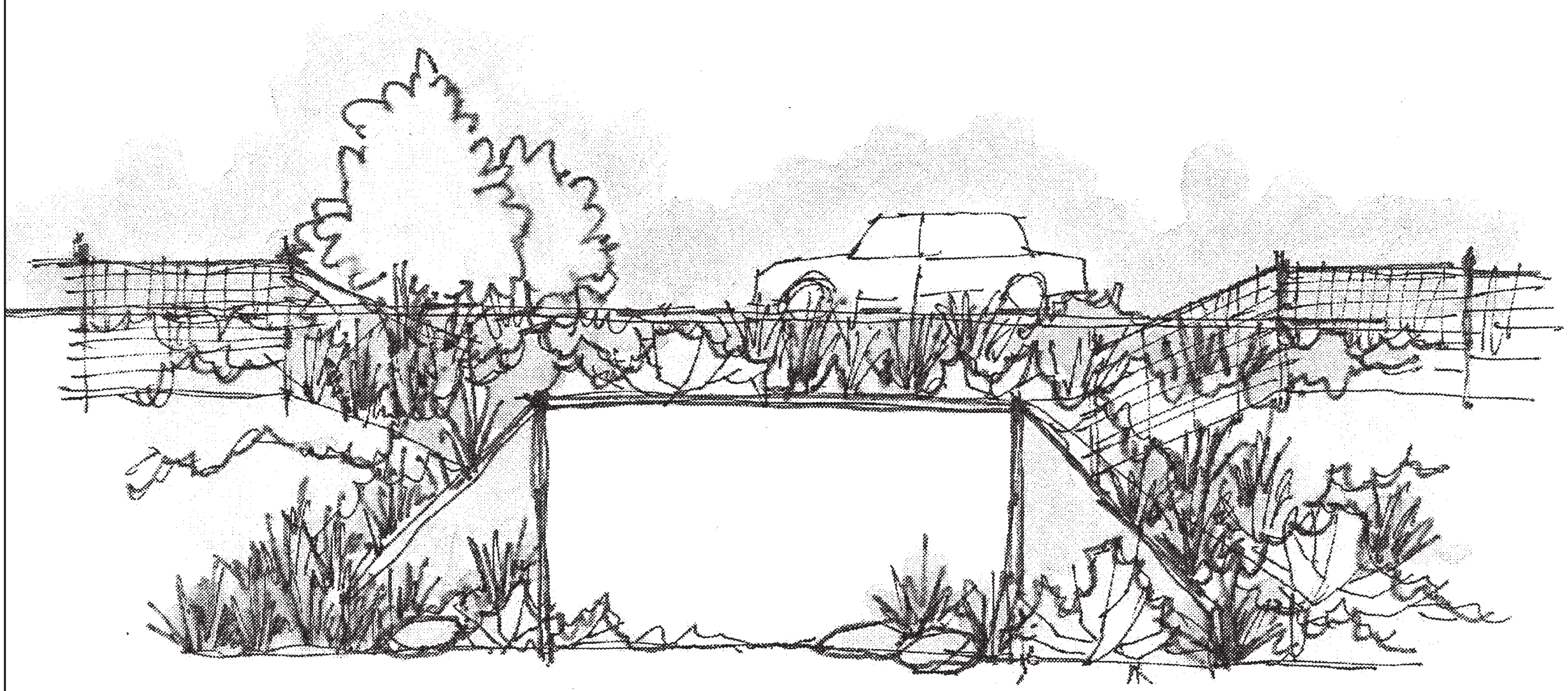
Existing Landfill Stormwater Management System

Figure E-1



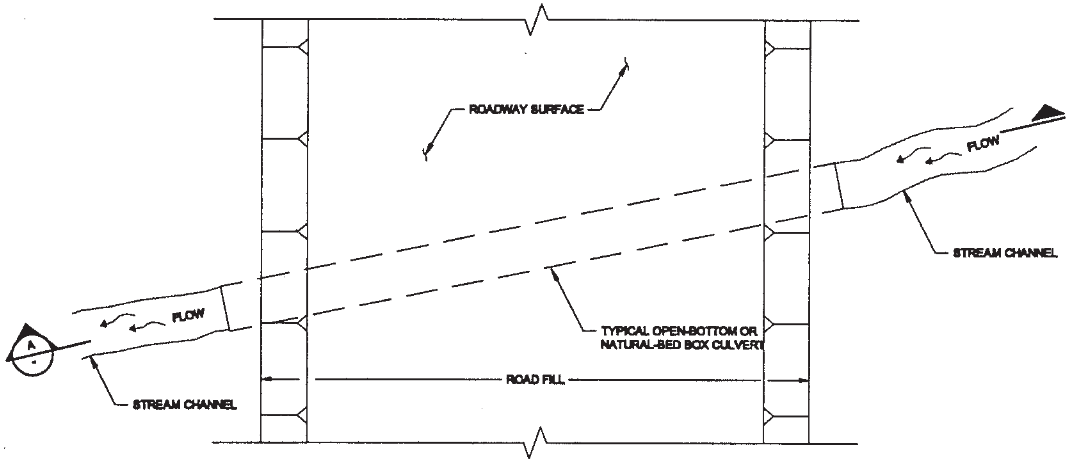
2007 AERIAL - Microsoft Virtual Earth

Aerial Photo, 2007
Figure E-2

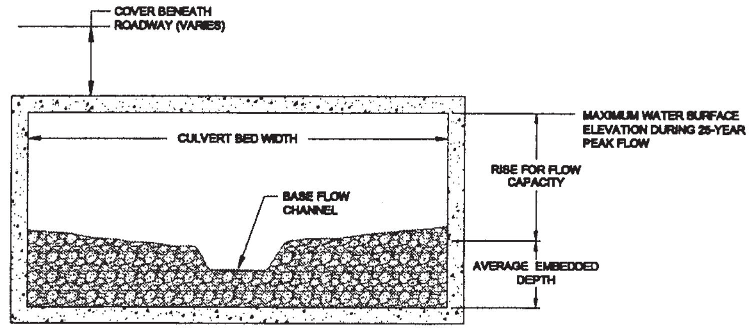


Box Culvert Conceptual Design

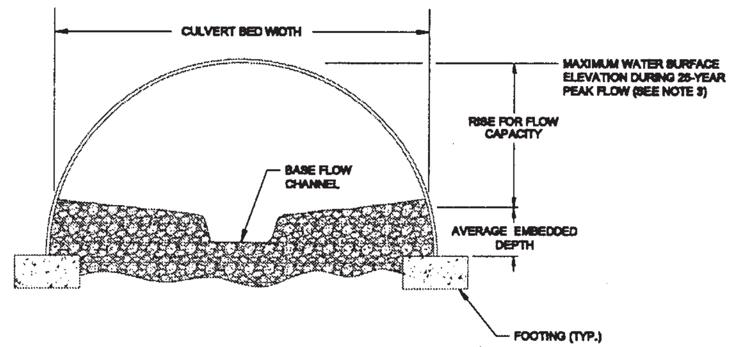
Figure E-3



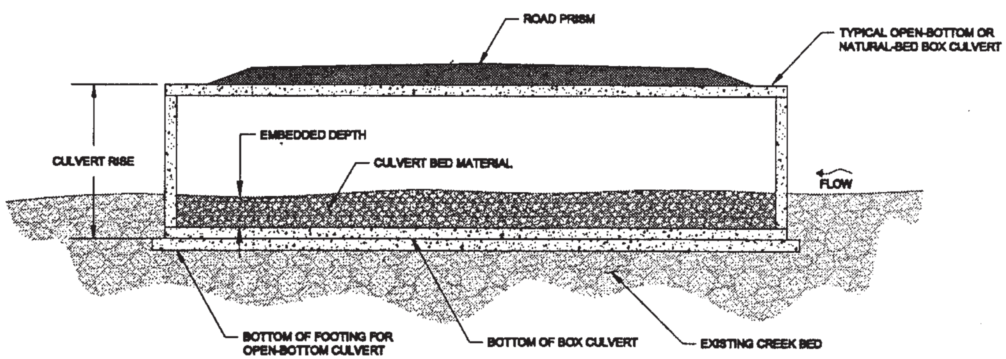
TYPICAL CULVERT ALIGNMENT PLAN
SCALE: NTS



TYPICAL NATURAL-BED BOX CULVERT
SCALE: NTS



TYPICAL OPEN-BOTTOM METAL ARCH CULVERT
SCALE: NTS



TYPICAL CULVERT PROFILE
SCALE: NTS

NOTES:

1. MINIMUM CULVERT BED WIDTH IS THAT OF THE ACTIVE CHANNEL
2. MINIMUM EMBEDDED DEPTH IS 12 INCHES OR 20% OF CULVERT RISE, WHICHEVER IS GREATER
3. DESIGN CULVERT RISE TO ALLOW FOR WOODY DEBRIS TRANSPORT IF APPROPRIATE
4. FOR HYDROLOGIC AND HYDRAULIC DESIGN OF CULVERTS, SEE CHAPTERS 6 AND 8 OF THE PORTLAND SEWER AND DRAINAGE FACILITY DESIGN MANUAL (BES 2006)
5. CULVERTS MUST MEET OREGON DEPARTMENT OF FISH AND WILDLIFE FISH PASSAGE REQUIREMENTS WHERE NATIVE MIGRATORY FISH ARE CURRENTLY OR WERE HISTORICALLY PRESENT
6. IF THE CULVERT IS NOT OVERSIZED TO CONVEY THE 100-YEAR PEAK FLOW, AN OVERFLOW ROUTE MUST BE ESTABLISHED TO SAFELY CONVEY FLOWS EXCEEDING THE 25-YEAR STORM WITHOUT DAMAGE TO PROPERTY, ENDANGERING HUMAN LIFE OR PUBLIC HEALTH, OR SIGNIFICANT ENVIRONMENTAL IMPACT.
7. FOR MORE INFORMATION AND DETAILS SEE CONCEPT DESIGNS AND TECHNICAL GUIDANCE: OPEN BOTTOM/ NATURAL-BED BOX CULVERTS.

HERRERA ENVIRONMENTAL CONSULTANTS

Natural Substrate
Culvert Schematic (Typical)

Figure E-4

Geosyntec consultants

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Memorandum

TO: Michael Marrella, AICP
Fresh Kills Park
Manager of Environmental Planning

FROM: William M. Steier, P.E.
Jennifer M. Padgett
Geosyntec Consultants

DATE: 10 September 2009

SUBJECT: Leachate Generation Estimate for One-Year Closure Delay
Fresh Kills Park East Park Roads
Draft Supplemental Environmental Impact Statement
(DSEIS) CEQR No. 06DPR002R

INTRODUCTION

Final closure construction began at Landfill Section 6/7 at the Fresh Kills Landfill in 2007 and was expected to be completed in the year 2010; however, to accommodate the preparation of an alternate final closure design plan and an accompanying SEIS associated with the Fresh Kills Park East Park Roads Project, a one-year delay in the final closure capping schedule will be required. Due to the delay, leachate generation due to seepage of precipitation through the intermediate soil cover, which would otherwise not enter the waste mound if the final closure capping were completed according to the original schedule, will occur. Consequently, the purpose of this memorandum is to present an estimate of the additional leachate generation at Section 6/7 during the alternative capping schedule period.

METHODOLOGY

In preparation of the leachate generation estimate, Geosyntec reviewed the following: (i) site specific hydrogeologic report; (ii) published literature pertaining to leachate generation under various capping scenarios; (iii) original and delayed Section 6/7 closure schedule; and (iv) information regarding on-going leachate control system operations, as provided by the

Department of Sanitation. The specific documents used as the basis of the leachate generation estimate presented in this memorandum are listed below.

- *Final Leachate Mitigation Report (FLMR)*, International Technology Corporation, 7 March 1994.
- Construction Sequence Plan (Sheet 3) of the drawing set, *Initial Working Drawings, Final Cover at Fresh Kill Landfill Section 6/7*, GZA Environmental, 19 December 2006 (Original Closure Schedule).
- *Critical Evaluation of Factors Required to Terminate the Postclosure Monitoring Period At Solid Waste landfills*, Barlaz, Rooker, Kjeldsen, Gabr, and Borden, Environmental Science and Technology, American Chemical Society, Vol. 36, No 16, 2002.
- Section 6/7 leachate collection records 2005 through 2008, Department of Sanitation records.

The calculation of the estimated leachate generation is presented in Table 1. To obtain the additional leachate generation as a result of the alternative capping schedule, the year-by-year leachate generation from the initial schedule are subtracted from the corresponding leachate generation during the alternative schedule. The total additional leachate generation due to the one-year delay is reported as the sum of the year-by-year differences. An explanation of the step-by-step process used to create Table 1 and the calculated estimate of additional leachate generation is described below.

Step 1 (Column A) — Review estimated vertical flux rate into the landfill Section 6/7 refuse unit as presented in the FLMR, which was prepared using multiple modeling techniques and a sensitivity analysis. It should also be noted that the influx rates presented in the FLMR were based on a daily soil cover condition present at the time of report preparation. Consequently, the FLMR estimate is conservative (i.e., higher) when compared to the influx infiltration rate that is expected to result from the existing intermediate cover condition, as well as the ongoing progressive landfill closure. The FLMR estimated influx rate of 308,000 gallons per day (gpd) is entered into Column A. See Figure 1 for reference.

Step 2 (Column B) — To appropriately estimate the future leachate generation rate and volume, the leachate collection rates recorded by DSNY for 2005 through 2008 were reviewed and entered into Column B. For years 2005 and 2006 the entire landfill was in a intermediate cover condition and the average recorded leachate

	collection rate at Section 6/7 ranged from 111,000 gpd to 125,000 gpd.
Step 3 (Column C)	The FLMR includes flux analysis with regard to both vertical and horizontal flow in/out of the Landfill Section 6/7 refuse unit. These flux rates, presented on Figure 1, reveal that the vertical flux of leachate away from the refuse unit is estimated to be approximately 0.46% of the total precipitation-based flux into the refuse unit. Consequently, the recorded leachate flow rates provided by DSNY, which represent only the horizontal component of flux leaving the refuse unit, are used to back-calculate the total estimated flux into the refuse unit from precipitation, which is presented in Column C.
Step 4 (Column D_i and D_{alt})	The area, in acres and as a percentage of the completed final landfill closure capping in place at the end of each year, is entered into the appropriate row of Column D. The closure capping timeline and capped area for Column D_i are based on the initial estimated four-year closure schedule, while the capping timeline and capped area for Column D_{alt} is based on the estimated five-year closure schedule, which includes the one-year delay beyond the Original Closure Schedule. The estimated closure area by year for the alternative capping schedule is presented in Figure 2.
Step 5 (Column E_i and E_{alt})	To account for the differences between FLMR influx estimate and the current influx based on the intermediate cover conditions, the average ratio of the current influx (Column C) to the average modeled influx (Column A) for 2005 and 2006 (i.e., 38.5 percent) is applied to the intermediate cover areas according to the initial capping schedule presented in Column D_i. The adjusted, uncapped area FLMR model flux rate for the initial schedule is entered into Column E_i. The average ratio of the estimated current influx to the average modeled influx is also applied to the intermediate cover areas according to the alternate capping schedule presented in Column D_{alt}. The adjusted, uncapped area FLMR model flux rate for the alternative schedule is entered into Column E_{alt}.
Step 6 (Column F_i and F_{alt})	Placement of the final cover reduces the flux of precipitation into the refuse unit by creating a near-impermeable barrier to

infiltration. To account for the fact that there will be a reduced flux into the waste mass after capping is completed in an area, a reduction factor of 75 percent is applied to the adjusted uncapped flux rate for areas that are capped. The reduction factor is based on research conducted by Barlaz, et. Al. (2002). The adjusted capped area FLMR model flux rate is entered into Column F_i and F_{alt} for the initial and alternative capping schedule respectively.

Step 7 (column G_i and G_{alt})	The total adjusted FLMR model flux rate for the initial schedule, the sum of Columns E_i and F_i, is entered into Column G_i. The total adjusted FLMR model flux rate for the alternative schedule, the sum of Columns E_{alt} and F_{alt}, is entered into Column G_{alt}.
Step 8 (Column H)	The additional leachate generation is calculated by subtracting the leachate generation from the initial schedule (Column G_i) from the leachate generation from the alternative schedule (Column G_{alt}). This estimated rate of leachate generation is presented first in gallons per day and then converted to an annual volume for 2007 through 2011. Both values are presented in Column H.

To validate whether the leachate generation reduction factor of 75 percent as proposed by Barlaz et. Al. is reasonable for the Section 6/7 closure capping project, the flux rate from Column G_{alt} is compared to rates from Column C. The percent difference between the two values is calculated for 2007 and 2008, the two years for which flow data during a period of partial final cover placement, is available. The results of the comparison reveal a good correlation for the 2007 (i.e., 5.2 percent difference), but a less than accurate correlation for the 2008 (i.e., 24.9 percent difference). These data two points serve as estimates of the difference between the assumed reduction factor model and the reported values.

To account for the observed difference between the modeled flow rates using the reduction factor and recorded flow rates, as revealed by the analysis above, the future predicted leachate generation volumes are calculated by increasing the total flux rate presented in Column H by 24.9 percent. This value is the higher of the two percent differences calculated for the available data, and is intended to provide a conservative estimate of the additional leachate generation per year. The sum of the per-year additional leachate generation resulting from the one-year closure delay is calculated to be 18,328,027 gallons total volume.

DISCUSSION AND RESULTS

As shown in Table 1, a total volume of 18.3 million gallons of additional leachate (approximately 50,200 gallons per day) is estimated as the additional leachate generated at Section 6/7 because of the one-year delayed closure period. When comparing this additional volume of generated leachate to a total baseline generation, which would have been expected between 1990 and 2010 (i.e., the time period between the signing of the Order on Consent and completion of closure capping according to the original closure schedule), the calculated increase is approximately 1.2 percent.

In addition to presenting an estimate of the flux rate through the cover system soils, the FLMR also includes an analysis of the groundwater and leachate fluxes into and away from the (i) refuse unit; (ii) unconsolidated soil units; and (iii) bedrock units beneath the Landfill Section 6/7. The flux estimates for the refuse unit, as shown in Figure 1, include an estimated lateral flow rate of 306,615 gpd and an estimated vertical flow rate of 1,410 gpd. The leachate cutoff wall and leachate collection drain, which are the selected and approved leachate mitigation measures, are designed to control the estimated lateral leachate flux flowing away from landfill Section 6/7. To date, the leachate mitigation system has operated within the established design parameters and is expected to continue to operate within these parameters during the entire post-closure period of at least 30 years, including a possible added one-year for the delay in closure of Section 6/7.

Vertical flux of leachate away from the refuse, which is predominately controlled by an existing natural soil liner and not specifically managed by the approved leachate mitigation cutoff wall and collection drain, is estimated in the FLMR to be only 0.46 percent of the total influx. The vertical flux is not expected to change with the additional leachate generation estimate presented in this memo as this estimate is based on conservative assumptions and the progressive capping of the landfill will minimize any increase in the head of the leachate within the refuse unit. Consequently, applying the vertical flux of 0.46 percent to the estimated total leachate flow presented in Column H of Table 1, the estimated leachate discharge vertically away from the refuse unit due to the one-year delay in closure is approximately 84,308 gallons in total or an average of 231 gallons per day.

CLOSING

This memorandum presents an estimate of additional leachate generation that will be expected to occur from the Landfill Section 6/7 of the Fresh Kills Landfill under an alternate closure capping schedule, which will include a one-year delay beyond the original capping schedule. The analysis is based on the use of actual recently reported data from the Fresh Kills site and use of final capping leachate reduction factors as reported in the literature. The results indicate that the delay will cause an approximate 1.2 percent increase in the total volume of leachate generated above the baseline volume.

* * * * *

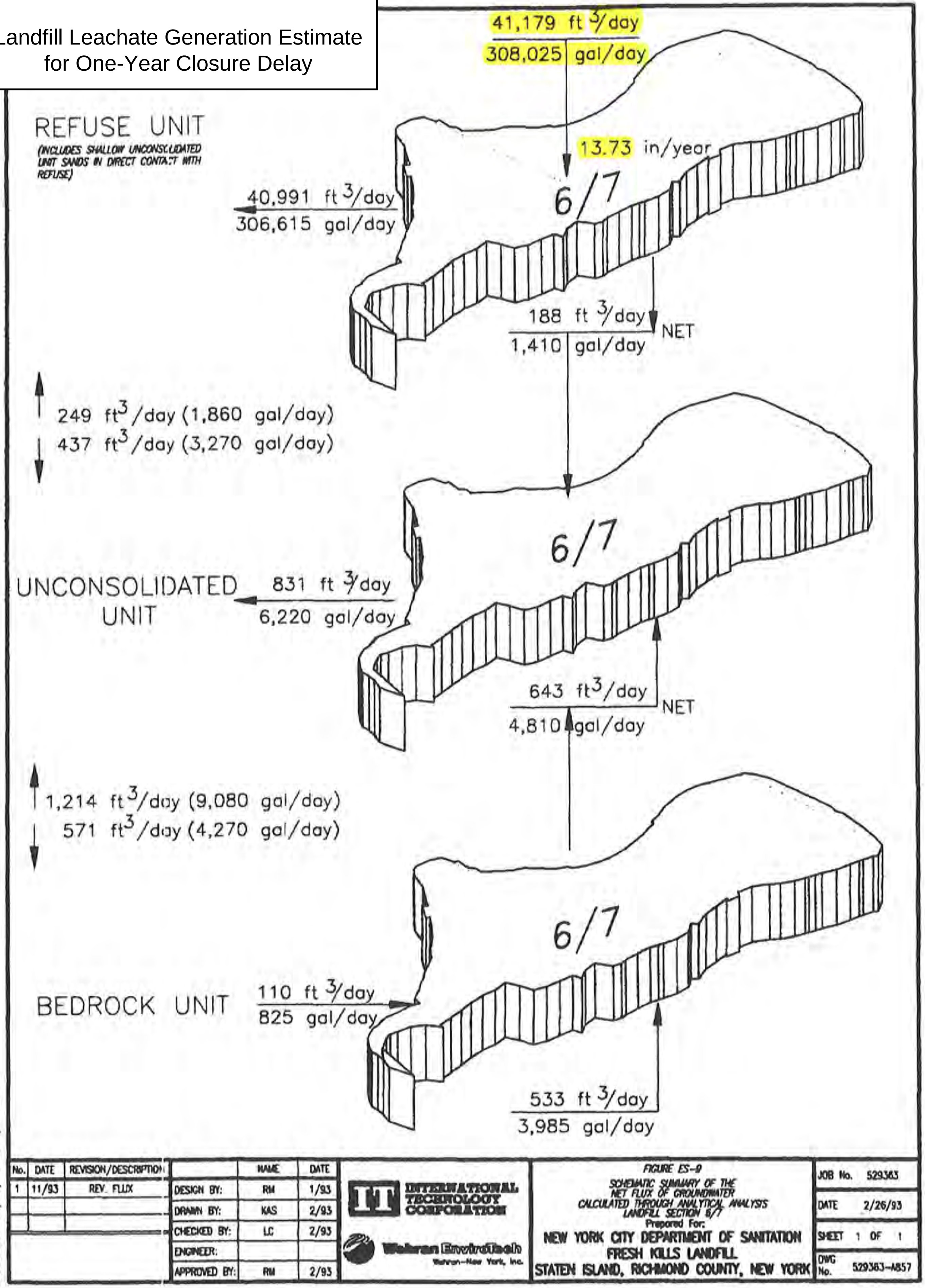
Table 1: Estimated Leachate Generation at Section 6/7 (2007-2011)

Year	FLMR Model Flux Rate	Recorded Leachate Flow Rate	Influx Based on Recorded Flow Rate	Final Cover in Place: Initial Schedule: area capped	Final Cover in Place: Initial Schedule: cumulative total	Final Cover in Place: Alternate Schedule: area capped	Final Cover in Place: Alternate Schedule: cumulative total	Initial Schedule: Adjusted FLMR Model Flux Rate, Uncapped Areas	Initial Schedule: Adjusted FLMR Model Flux Rate, Capped Areas	Initial Schedule: Total Adjusted FLMR Model Flux Rate (Capped + Uncapped)	Final Schedule: Adjusted FLMR Model Flux Rate, Uncapped Areas	Final Schedule: Adjusted FLMR Model Flux Rate, Capped Areas	Final Schedule: Total Adjusted FLMR Model Flux Rate (Capped + Uncapped)	Estimated Additional Leachate Generation	
units	(gpd)	(gpd)	(gpd)	(ac)	(%)	(ac)	(%)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gpd)	(gal/yr)
Notes	Note 1	Note 2	Note 3			Note 4		Note 5	Note 6		Note 5	Note 6			
Column	A	B	C	D_i		D_{alt}		E_i	F_i	G_i	E_{alt}	F_{alt}	G_{alt}	H	
2005	308,000	125,000	125,575	0	0	0	0%	118,543	0	118,543	118,543	0	118,543	0	0
2006	308,000	111,000	111,510	0	0	0	0%	118,543	0	118,543	118,543	0	118,543	0	0
2007	308,000	101,000	101,464	71.6	25%	71.6	25%	88,740	7,451	96,191	88,740	7,451	96,191	0	0
2008	308,000	100,000	100,460	81.5	54%	66.5	48%	54,818	15,931	70,749	61,061	14,370	75,431	4,683	1,709,149
2009	308,000	--	--	70.9	79%	35.0	61%	25,307	23,309	48,616	46,493	18,012	64,505	15,890	5,799,713
2010	308,000	--	--	60.8	100%	56.8	81%	0	29,636	29,636	22,851	23,923	46,774	17,138	6,255,486
2011	308,000	--	--	0	100%	54.9	100%	0	29,636	29,636	0	29,636	29,636	0	0
															13,764,348
															Note 7
															18,328,027

1. Model flow rate is based on surface flux estimate provided in the *Final Leachate Mitigation Report,* (FLMR) International Technology Corporation, March, 1994 (See Figure 1).
2. Recorded flow rate is obtained from the records provided by DSNY.
3. Flux rate in to the refuse unit back-calculated to account for vertical flux (i.e.,. 0.46 percent increase)
4. Alternate closure capping schedule is taken from Figure 2.
5. Adjusted model influx rate for uncapped areas is based on average ratio of recorded to modeled flow rate between 2005 and 2006 of 38.5 percent.
6. Adjusted model influx rate for capped areas is based on an estimated leachate generation reduction of 75 percent as recommended by Barlaz et. Al. 2002.
7. Estimated future flow based on application of a factor of 24.9%. The factor of 24.9% is based on the comparison of the 2008 model flux rate to recorded flux rate, Column G_{alt} divided by Column C

FIGURE 1

Landfill Leachate Generation Estimate for One-Year Closure Delay



NOTES:

1. BASE PLAN TOPOGRAPHIC/SURVEY PROVIDED BY LAYOUT, INC. LYNDHURST, NEW JERSEY. THE PLAN WAS DEVELOPED BASED ON AUGUST 2006 MAPPING. AREAS FOR PHASE LIMITS ARE AS FOLLOWS:
   - PHASE 1 71.6 ACRES
   - PHASE 2 81.5 ACRES
   - PHASE 3 70.9 ACRES
   - PHASE 4 60.8 ACRES

   284.8 ACRES TOTAL
2. FOR GENERAL NOTES, ABBREVIATIONS & LEGENDS SEE SHEET 2.
3. ACTUAL SEQUENCE OF CONSTRUCTION MAY VARY DEPENDING ON FIELD CONDITIONS AND SCHEDULE AND WILL BE ESTABLISHED BY THE ENGINEER.
4. COSTRUCTION SUBPHASE 1.1 HAS BEEN REMOVED AND THE ACERAGE DESTRIBUTED OVER SUBPHASES 1.2, 1.3, 1.4, 1.5, AND 1.6.

LEGEND:

PHASE DIVISION

SUB PHASE DIVISION

1.1 INDICATES SUBAREA DESIGNATION

8.8A INDICATES SUBAREA AREA IN ACRES

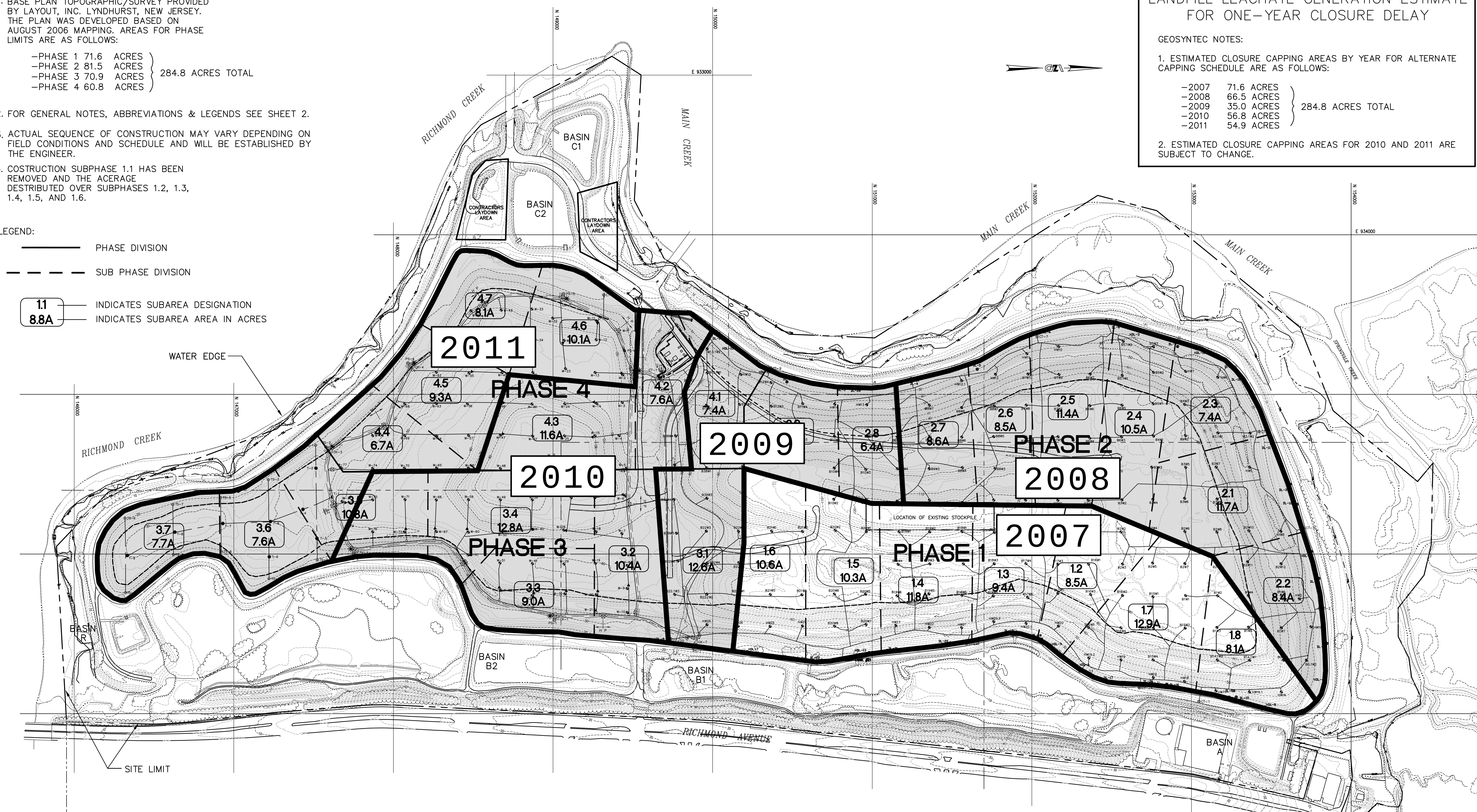
FIGURE 2

LANDFILL LEACHATE GENERATION ESTIMATE FOR ONE-YEAR CLOSURE DELAY

GEOSYNTEC NOTES:

1. ESTIMATED CLOSURE CAPPING AREAS BY YEAR FOR ALTERNATE CAPPING SCHEDULE ARE AS FOLLOWS:
   - 2007 71.6 ACRES
   - 2008 66.5 ACRES
   - 2009 35.0 ACRES
   - 2010 56.8 ACRES
   - 2011 54.9 ACRES

   284.8 ACRES TOTAL
2. ESTIMATED CLOSURE CAPPING AREAS FOR 2010 AND 2011 ARE SUBJECT TO CHANGE.



WARNING – IT IS A VIOLATION OF NEW YORK EDUCATION LAW, SECTION 7209.2, FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR, TO ALTER THIS DOCUMENT IN ANY WAY. IF ALTERED, THE ALTERING PERSON SHALL COMPLY WITH THE REQUIREMENTS OF NEW YORK LAW, SECTION 7209.2.

This drawing was prepared at the scale indicated in the title block. Inaccuracies in the stated scale may be introduced when drawings are reproduced by any means. Use the graphic scale bar in the title block to determine the actual scale of this drawing.

300 0 300 600
SCALE IN FEET

CONTRACT #: CT-82720060040940

In charge of E.R.H.
Designed by T.R.G
Checked by R.J.M
Drawn by C.R.B./P.J.S.

GZA GEOENVIRONMENTAL

TULLY CONSTRUCTION CO. INC.
127-50 NORTHERN BLVD. FLUSHING, NEW YORK 11368

NO.	DATE	REVISION	INIT.
2	12/19/06	UPDATE PHASE DIVISIONS	PJS
1	11/6/06	UPDATE TOPO/NOTES	PJS

NEW YORK CITY DEPARTMENT OF SANITATION
FRESH KILLS LANDFILL
STATEN ISLAND, RICHMOND COUNTY, NEW YORK

FINAL COVER AT FRESH KILLS LANDFILL SECTION 6/7

CONSTRUCTION SEQUENCE PLAN

FILE NO. 33133 | SHEET 3
DATE DEC. 19, 2006 | REV. 2

P:\cadd\fresh kills\Section 6.7 2-27-09\FRESHKILLS ME0530-02000\DRAWINGS\Figures\ME0529A-CapPhasing.dwg, Fig 2, 8/31/2009 3:43:02 PM, JWheeler

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Memorandum

TO: Michael Marrella, AICP
Fresh Kills Park
Manager of Environmental Planning

FROM: William M. Steier, P.E.
Jeremy W.F. Morris, Ph.D., P.E.
Geosyntec Consultants

DATE: 10 September 2009

SUBJECT: Landfill Gas Emissions Estimate for One-Year Closure Delay
Fresh Kills Park East Park Roads
Draft Supplemental Environmental Impact Statement
(DSEIS) CEQR No. 06DPR002R

INTRODUCTION

Final closure construction began at Landfill Section 6/7 at the Fresh Kills Landfill in 2007 and was expected to be completed in year 2010; however, to accommodate the preparation of an alternate final closure design plan, inclusive of a Supplemental Environmental Impact Statement, associated with the Fresh Kills Park East Park Roads Project, a one-year delay in the final closure capping schedule will be required. During that one year, fugitive landfill gas (LFG) emissions, which would otherwise not be emitted if the final closure capping were completed according to the original schedule, will occur. Consequently, the purpose of this memorandum is to present an estimate of the fugitive LFG emissions from Section 6/7 during the one-year delay period. The fugitive emissions estimates are reported in terms of methane and non-methane organic compounds (NMOC) in LFG, as they are the compounds of most concern with regard to regulatory compliance[i].

METHODOLOGY

In preparation of the fugitive emission estimate, Geosyntec reviewed the following: (i) regulatory air pollution emission factors for solid waste disposal facilities; (ii) site-specific air permit documents; (iii) published literature pertaining to LFG emissions; (iv) the original and delayed Section 6/7 closure schedules; and (v) information regarding on-going LFG system operations, as provided by the Department of Sanitation. The specific documents used as the basis of the emission estimate presented in this memorandum are listed below.

- *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition,* Office of Air Quality Planning and Standards, Office of Air and Radiation, United States Environmental Protection Agency, January 1995 (AP-42).
- *Landfill Gas Flares Air Permit Application, Fresh Kills Landfill, Staten Island New York,* Paullus, Sokolowski, and Sartor, April 1998 (PSS Report).
- *2008 Emission Statement, Fresh Kills Landfill, Staten Island New York*, DEC ID 2649900029, New York City Department of Sanitation, 14 April 20090 (2008 Emissions Statement).
- Construction Sequence Plan (Sheet 3) of the drawing set, *Initial Working Drawings, Final Cover at Fresh Kill Landfill Section 6/7,* GZA Environmental, 19 December 2006 (Original Closure Schedule).
- Scheutz, C. & Kjeldsen, P. (2002): Methane Oxidation and Degradation of Halocarbons in Landfill Soil Covers. In: 3rd International Symposium on Non-CO2 Greenhouse Gases (NCGG-3), Maastricht, the Netherlands, 21-13 January.
- “Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills", prepared for Solid Waste Industry for Climate Solutions (SWICS) by Pat Sullivan, Version 2.2, Revised January, 2009

The calculation of the estimated fugitive emissions is presented in Table 1. To obtain the additional fugitive emissions as a result of the alternative capping schedule, the year-by-year fugitive emissions from the initial schedule are subtracted from the corresponding fugitive emissions during the alternative schedule. The total additional fugitive emissions due to the one-year delay are reported as the sum of the year-by-year differences. An explanation of the step-by-step process used to create Table 1 and the calculated estimate of fugitive emissions is described below.

Step 1 (Column A) Review PSS Report estimates of LFG generation to establish a per-year estimate of the potential gas generation rate. The time period is selected to begin in 2007, which corresponds to the date when landfill closure construction began at Section 6/7. It is also recognized however, that the potential generation rates obtained from the PSS Report permit application are based on regulatory default parameters from AP-42, which result in conservative (i.e., larger) gas generation rates than those actually observed from site operating records, as described in Step 2. The rates from the PSS Report are presented in Column A.

Step 2 (Column B)

To appropriately estimate the fugitive emissions, the per-year gas generation rate based on the actual gas generation rates is needed. Accordingly, the reported gas collection rate from the 2008 Emission Statement (2,071 scfm) is compared with the estimated volume of controlled gas based on the 2008 PSS Report generation rate (i.e., 4,762, which is equal to 5,672 scfm (generated) minus 910 scfm (estimated to be uncontrolled)). The ratio between these generation rate values, 43.5 percent (i.e., 2,071/4,762), is used to pro-rate the PSS Report yearly gas generation rates. The results are presented in Column B.

Step 3 (Column C_i and C_{alt})

The area, in acres and as a percentage of the completed final landfill closure capping in place at the end of each year, is entered into the appropriate row of Column C. The closure capping timeline and capped area for Column C_i is based on the initial estimated four-year closure schedule, while the capping timeline and capped area for Column C_{alt} is based on the estimated five-year closure schedule, which includes the one-year delay beyond the Original Closure Schedule. The estimated closure area by year for the alternative capping schedule is presented in Figure 1.

Step 4 (Column D_i and D_{alt})

The uncontrolled LFG emissions under both capping schedules need to account for the fact that LFG collection by the active control system is influenced by cover conditions. Different gas system collection efficiencies are assigned according to the type of cover (i.e., intermediate soil cover or final cover) that is in place each year. The gas collection system efficiency is assumed to be 75% prior to installation of final cover and 95% thereafter, which is based on data reported by SWICS (2009). Using the prorated LFG generation rate from Column B and the cover condition (from the initial schedule) from Column C_i, the fraction of the total LFG generation rate estimated to be uncontrolled for the initial capping schedule is calculated and entered into Column D_i. The same calculation is repeated to obtain the uncontrolled LFG emissions under the alternative capping schedule and the result is entered into Column D_{alt}.

Step 5 (Column E_i and E_{alt}) To estimate the per-year rate of fugitive methane and NMOC emissions, under both capping schedules, the estimated rate of uncontrolled LFG emission presented in Column D_i and D_{alt} is partitioned according to the AP-42 default concentrations of 50% methane and 595 ppmv (i.e., 0.0595%) NMOC. To further account for the fact that oxidation of methane and degradation of NMOC will occur within the intermediate cover soils, a median state-of-the-practice oxidation rate of 35% for methane and degradation rate of 70% for NMOC are also applied to the estimated rate of uncontrolled LFG emissions presented in Column D_i and D_{alt}. The resulting uncontrolled methane and NMOC emission rate during each year between 2007 and 2011 is presented in Column E_i and E_{alt}.

Step 6 (Column F) The additional methane and NMOC emissions are calculated by subtracting the emissions from the initial schedule from the emissions from the alternative schedule. These estimated rates of methane and NMOC emissions are converted to an annual volume for 2007 through 2011 and presented in Column F.

DISCUSSION AND RESULTS

As accounted for in the calculated emissions presented in Table 1, it is important to note that while the final cover construction will be extended for one year, DSNY has required that the alternate design allow the gas collection system to be active throughout the entire construction period. In addition, intermediate soil covers either will remain in place or be used to cover excavation areas during construction, both of which will aid in the reduction of fugitive emissions.

As part of the evaluation, a sensitivity analysis using upper- and lower-bound gas system collection efficiencies and methane oxidation and NMOC degradation factors for landfill cover soils was also prepared. The results of the sensitivity analysis revealed that even with a very wide range of gas collection system efficiencies and oxidation/degradation factors, the range between the total emission estimates was small. Thus, the amount of additional emissions was not found to be particularly sensitive to these input conditions and the use of mean values, as presented in Table 1, is appropriate.

As shown in Table 1, a total volume of 33.7 mmcf of methane and 6.0 mcf of NMOC are estimated as the additional emissions from the site due to the one-year delayed closure period. When comparing these additional emissions to total baseline fugitive emissions, which would have been expected between 1990 and 2010 (i.e., the time period between the signing of the Order on Consent and completion of closure capping according to the original closure schedule), the calculated increase is approximately 1.0%.

CLOSING

This memorandum presents an estimate of fugitive gas emissions that will be expected to occur from the Landfill Section 6/7 of the Fresh Kills Landfill under an alternate closure capping schedule, which will create a one-year delay beyond the original capping schedule. The analysis is based on the use of recent actual reported data from the Fresh Kills site and use of state-of-the-practice LFG system collection efficiency factors, and methane oxidation and NMOC degradation factors for landfill cover soils. The results indicate that the delay will cause an approximate one percent increase in the total emissions above the baseline emissions.

* * * * *

[i] Carbon dioxide and methane are both greenhouse gases. However, it is usually assumed that they are produced in equimolar quantities in a landfill. Therefore, the amount of carbon dioxide produced by the delay in capping would be roughly the same amount as the methane. Carbon dioxide is not accounted for when doing landfill gas emission calculations because carbon dioxide emissions produced from a landfill are assumed to be part of the natural carbon cycle of decomposition(1). In other words, the organic components in a landfill (paper, food waste, yard waste, etc) which are the components that are degrading are of biogenic origin, meaning their source (trees or vegetable) used carbon dioxide from the atmosphere to produce the mass. If these components were not placed in a landfill they would have decomposed in the presence of oxygen and would have been converted back to carbon dioxide. When these components are placed in a landfill and there is no oxygen the components degrade and convert to methane and carbon dioxide. The methane is considered anthropogenic, but the carbon dioxide is considered biogenic. Methane emissions from a landfill are regulated (and carbon dioxide emissions are not) for their anthropogenic classification and because methane is 21 times more powerful at warming the atmosphere than carbon dioxide.

(1) *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.*

Table 1: Estimated Mean LFG Emissions from Section 6/7 (2007-2011)

Year	LFG Generation Rate (scfm)	LFG Generation Rate (scfm)	Final Cover in Place				Initial Capping Schedule			Alternative Capping Schedule			Additional Uncontrolled methane emission (scf/year)	Additional Uncontrolled NMOC emission (scf/year)
			Initial Schedule		Alternative Schedule									
			acres capped	cum. total (as %)	acres capped	cum. total (as %)	Uncontrolled LFG (scfm)	Uncontrolled methane emissions (scfm)	Uncontrolled NMOC emissions (scfm)	Uncontrolled LFG (cfm)	Uncontrolled methane emissions (scfm)	Uncontrolled NMOC emissions (scfm)		
	Note 1	Note 2	Note 3				Note 4	Notes 5 and 6	Notes 5 and 7	Note 4	Notes 5 and 6	Notes 5 and 7	Note 8	
Column	**A**	**B**	**C_i**		**C_{alt}**		**D_i**	**E_i**		**D_{alt}**	**E_{alt}**		**F**	
2007	5,896	2,564	71.6	25%	71.6	25%	512	166	0.030	512	166	0.030	0	0
2008	5,672	2,467	81.5	54%	66.5	48%	351	114	0.020	377	123	0.022	4,438,531	792
2009	5,461	2,375	70.9	79%	35.0	61%	220	72	0.013	305	99	0.018	14,500,585	2,588
2010	5,152	2,241	60.8	100%	56.8	81%	112	36	0.006	198	64	0.012	14,755,966	2,634
2011	4,990	2,170	0	100%	54.9	100%	109	35	0.006	109	35	0.006	0	0
Total													33,695,082	6,015

Notes:

1. LFG Generation is from Landfill Gas Flares Air Permit Application dated on April 1998. It is assumed that LFG comprises 50% methane, 50% CO_2 with NMOC concentration 595 ppmv (per AP-42 defaults).
2. Adjusted generation rate based on actual average flow rate to Section 6/7 flare during 2008 (from 2008 Emissions Statement, p9a), adjustment factor 43.5%.
3. Final cover alternate schedule is from Figure 1.
4. Gas system collection efficiency is assumed at 75% prior to installation of final cover and 95% thereafter, based on review of new data provided by SWICS (2009).
5. Flare destruction efficiency assumed at 100% for methane and 99.2% for NMOC, based on AP-42 default values (i.e., negligible emissions from the flare stack).
6. Cover soil methane oxidation rate assumed at 35% for uncontrolled portion of landfill gas generated (based on average oxidation rate reported by SWICS, 2009)
7. Cover soil NMOC degradation rate assumed at 70% for uncontrolled portion of landfill gas generated (based on weighted average rate reported by Scheutz & Kjeldsen, 2002).
8. Additional fugitive emissions are calculated as the difference between the per-year estimated emissions, summed over the entire alternate capping schedule.

NOTES:

1. BASE PLAN TOPOGRAPHIC/SURVEY PROVIDED BY LAYOUT, INC. LYNDHURST, NEW JERSEY. THE PLAN WAS DEVELOPED BASED ON AUGUST 2006 MAPPING. AREAS FOR PHASE LIMITS ARE AS FOLLOWS:
   - PHASE 1 71.6 ACRES
   - PHASE 2 81.5 ACRES
   - PHASE 3 70.9 ACRES
   - PHASE 4 60.8 ACRES

   284.8 ACRES TOTAL
2. FOR GENERAL NOTES, ABBREVIATIONS & LEGENDS SEE SHEET 2.
3. ACTUAL SEQUENCE OF CONSTRUCTION MAY VARY DEPENDING ON FIELD CONDITIONS AND SCHEDULE AND WILL BE ESTABLISHED BY THE ENGINEER.
4. COSTRUCTION SUBPHASE 1.1 HAS BEEN REMOVED AND THE ACERAGE DESTRIBUTED OVER SUBPHASES 1.2, 1.3, 1.4, 1.5, AND 1.6.

LEGEND:

PHASE DIVISION

SUB PHASE DIVISION

1.1 INDICATES SUBAREA DESIGNATION

8.8A INDICATES SUBAREA AREA IN ACRES

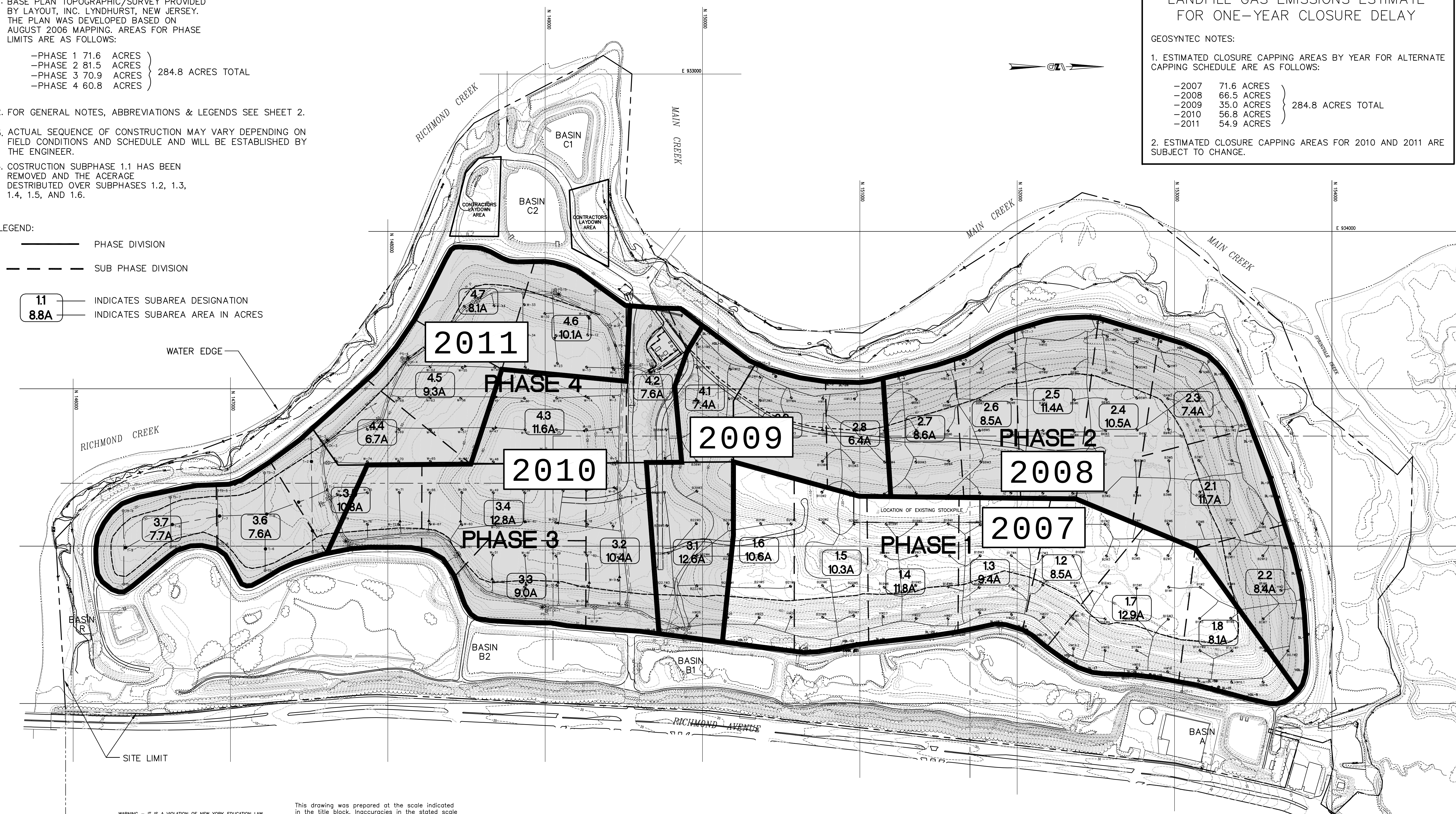
FIGURE 1

LANDFILL GAS EMISSIONS ESTIMATE FOR ONE-YEAR CLOSURE DELAY

GEOSYNTEC NOTES:

1. ESTIMATED CLOSURE CAPPING AREAS BY YEAR FOR ALTERNATE CAPPING SCHEDULE ARE AS FOLLOWS:
   - 2007 71.6 ACRES
   - 2008 66.5 ACRES
   - 2009 35.0 ACRES
   - 2010 56.8 ACRES
   - 2011 54.9 ACRES

   284.8 ACRES TOTAL
2. ESTIMATED CLOSURE CAPPING AREAS FOR 2010 AND 2011 ARE SUBJECT TO CHANGE.



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CONTRACT #: CT-82720060040940

In charge of E.R.H.
Designed by T.R.G
Checked by R.J.M
Drawn by C.R.B./P.J.S.

GZA GEOENVIRONMENTAL

TULLY CONSTRUCTION CO. INC.
127-50 NORTHERN BLVD. FLUSHING, NEW YORK 11368

NO.	DATE	REVISION	INIT.
2	12/19/06	UPDATE PHASE DIVISIONS	PJS
1	11/6/06	UPDATE TOPO/NOTES	PJS

NEW YORK CITY DEPARTMENT OF SANITATION
FRESH KILLS LANDFILL
STATEN ISLAND, RICHMOND COUNTY, NEW YORK

FINAL COVER AT FRESH KILLS LANDFILL SECTION 6/7

CONSTRUCTION SEQUENCE PLAN

FILE NO. 33133

SHEET 3

DATE DEC. 19, 2006

REV. 2