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June 22, 2016

Mr. Ming-Tai Chao
NC DEQ Division of Waste Management
1646 Mail Service Center
Raleigh, North Carolina 27699

Re: Comments on the Revised Permit Amendment Application for Continued Operations
Tuscarora Long-Term Regional Landfill- IRL,
Phases 1 through 3 Craven County, North Carolina
Permit No. 2509-MSWLF-1999, Document Identification Number (DIN) 26135

Dear Mr. Chao:

On behalf of the Coastal Regional Solid Waste Management Authority (CRSWMA), Joyce Engineering, Inc. (JOYCE) is submitting this response to your comments on the Permit Renewal Application in the email dated May 26, 2016, for the above-referenced project. For reference, your comments are repeated below in *italicized print*, with our responses provided in **bold print**.

Closure & Post-Closure Plan

1. *(Appendix VII-2, Closure Cost Estimates) The revised Closure Plan describes that the largest area to be closed is 29.6 acres; therefore, the cost unit price and/or quantity should be increased in the cost estimates accordingly in comparison with those stated in the previous submittal.*

i. *Cost Items including Drainage Pipe, Mobilization/demobilization, Survey, Closure Certification & Erosion and Sediment Control. Please explain why the closure area increasing from 19.7 acres to 29.6 acres but the drainage pipe lengths are not increased and the above-mentioned lump sum costs are not increased accordingly in the revised cost estimates. Please revise the quantity and provide the revise cost estimates.*

Slope drains for Phase 3 have been added to the 2015 closure cost estimate. Survey has been increased proportionally. Erosion and stormwater control did not change as the downslope drain pipes and vegetation are itemized in the cost estimate. Assuming closure will take place at one time, mobilization/demobilization and closure certification should not increase as they are not a function of the area closed.

ii. *Except for the costs of the synthetics membrane, why the unit costs for other cost items are decreasing from those in the 2015 submittal. The total costs per acre of close area ($161,469/acre) is less than that ($170,439/acre) in 2009 cost estimate. Please provide the latest cost data from reliable sources, such as RSMeans reference books, government agencies, and/or the similar project completed in 2015 to demonstrate that the deduction of the unit costs for the cost items are reasonable and acceptable. Please be advised that the costs of the landfill closure construction must be estimated based on the contracting the third party to complete the project. If the back-up reference(s) is not available, please revise the cost estimates without reducing unit costs submitted in 2015.*

Starting with the 2015 submittal, we have added the additional items described above in Comment 1.i., and applied the 2016 inflation factor (1.01) obtained from the DEQ's website, to the total closure cost.

2. (Section 2.0 Post Closure Activities) Please address the following concerns of the post-closure plan:

i. (Section 2.3 Post-Closure Maintenance) Please add the maintenance & repair of the monitoring network – groundwater wells and landfill gas wells, probes & vents to the post-closure care tasks.

The paragraph has been revised to address the comment.

ii. (Section 2.5.5 Leachate Management) Please address the following concerns:

a. According to the agreement appended to the Revised Permit Application, leachate will be directly discharged into the constructed sewer system in following years. The description of leach management in the last sentence of the first paragraph does not likely occur in the post-closure period.

The paragraph has been revised to address the comment.

b. Pursuant to Rule 15A NCAC 13B. 1627(d)(1)(B), this Section must describe the maintenance of the leachate collection & storage system, producing leachate generation records, leachate monitoring requirements, leachate disposal methods, contingency plan for the extreme conditions, and record keeping requirements.

The paragraph has been revised to address the comment.

records, leachate monitoring requirements, leachate disposal methods, contingency plan for the extreme conditions, and record keeping requirements.

The paragraph has been revised to address the comment.

3. (Appendix VII-6, Post- Closure Cost Estimates) Please explain why some unit costs for cost items (except the leachate removal costs) are decreasing from those in the previously submittals in 2009 & 2015. Please provide the latest cost data from reliable sources, such as RSMeans reference books, government agencies, and/or the similar project completed in 2015 to demonstrate that the deduction of the unit costs for the cost items are reasonable and acceptable. Please be advised that the costs of the landfill post-closure cares must be estimated based on the contracting the third party to complete the tasks. If the back-upreference(s) is not available, please revise the cost estimates without reducing unit costs submitted in 2015.

Starting with the 2015 submittal, we have added the additional items described above in Comment 1.i., and applied the 2016 inflation factor obtained from the DEQ's website, to the total closure cost.

Sincerely,
JOYCE ENGINEERING, INC.

Amy Davis, P.E.
Technical Consultant

Attachments:

Revised Closure and Post Closure Plan
Revised Closure Cost Estimates
Revised Post Closure Cost Estimates

Cc: Bobby Darden, Executive Director, CRSWMA
Ray Williams, NC DEQ
Christine Ritter, NC DEQ
Andrew Hammonds, NC DEQ

JOYCE ENGINEERING

PREPARED FOR:

COASTAL REGIONAL SOLID WASTE AUTHORITY
TUSCARORA LONG-TERM REGIONAL LANDFILL
7400 OLD HIGHWAY 70 WEST
TUSCARORA, NC 28523

PERMIT No. 25-09

TUSCARORA LANDFILL
PHASE 3 EXPANSION

VOLUME 2, SECTION VII
CLOSURE & POST CLOSURE PLAN

NOVEMBER 2009
REVISED APRIL 2016
REVISED JUNE 2016

PREPARED BY:

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VOLUME 2, SECTION VII
CLOSURE AND POST CLOSURE PLAN

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APPENDICES

1.0 CLOSURE ACTIVITIES

Pursuant to the North Carolina Solid Waste Management Rules (15A NCAC 13B .1617), this Closure and Post-Closure Plan is submitted as part of the Permit to Operate (PTO) renewal the Tuscarora Landfill.

Within this Closure and Post-Closure Plan, references are made to information and drawings found in the Facility, Operations, and Engineering Plans to reduce redundancy in this report. Grading plans, cap sections, and other aspects related to closure, including phased development, stormwater management, and erosion and sediment control, are discussed in the Engineering and Operation Plans of this report, and are illustrated on the drawings. The Construction Quality Assurance (CQA) Plan provided in this application describes methods and procedures to be used in monitoring construction of the closure cap. Detailed drawings, specifications, and other documents will be prepared prior to closure for bidding and construction purposes.

The facility will be closed in accordance with the requirements of EPA's Subtitle D regulations (40 CFR 258.60) and Rule .1627 of the North Carolina Solid Waste Management Rules (15A NCAC 13 B). Given the proposed development plan for the facility, the waste disposal areas will be capped and closed in phases as described in the following paragraphs.

1.1 Closure of Disposal Units

1.1.1 Cap Design

Proposed final/intermediate grading contours for the facility are provided on Drawing No. FP-04 of the Facility Plan. Final contours have been designed with post-settlement surface slopes of at least five percent on top of the cell. Cross-sectional details of the proposed closure cap design, are provided on Drawing No. EP-10. The following components (bottom to top) are proposed as shown on the details:

a. Intermediate Cover and Leveling Course - Local soil will be placed over the daily cover soil to provide at least 12 inches of intermediate cover and a uniform base for construction of the cap.

b. Gas Migration Layer – A geonet composite will be installed between the intermediate cover and the overlying infiltration layer. The geonet composite will provide a pathway for accumulated gas to move laterally to the vents.

c. Composite Cap: GCL Component - The infiltration layer is proposed to consist of a geosynthetic clay liner. This layer will be constructed over the geonet composite that will serve as the gas migration layer. Installation and testing requirements for the cap are provided in the Specifications (Appendix IV-6) and the CQA Plan.

d. Composite Cap: Geomembrane Component - The geomembrane component of the infiltration layer will consist of a textured 40 mil flexible geomembrane. The

membrane will be in direct contact with the underlying layer. The testing program and quality assurance requirements for the geomembrane are described in the CQA Plan.

e. Drainage Layer - A drainage layer consisting of a geonet and geotextile composite will be placed over the geomembrane to promote drainage.

f. Protective Layer - A layer consisting of at least 18 inches of local soil will be placed above the drainage layer to provide a protective cover for the underlying cap components.

g. Vegetative Layer - A layer of topsoil material or organically amended local soil will be placed above the protective layer. This soil layer will be at least 6 inches in thickness. The material will be lightly compacted so that a good stand of vegetation can be established. Soil tests will be conducted prior to seeding to determine if soil additives are needed to establish and maintain the vegetation.

1.1.2 Area to Be Capped

The IRL (20.2 acres), Phase 1 (20.5 acres) and west slope of Phase 2 (7.3 acres) have been capped. Phase 2 permitted waste footprint of 17.2 acres has approximately 9.9 acres subject to closure. All of Phase 3 permitted waste footprint of 19.7 acres remains to be closed. Therefore, the largest area of the landfill subject for closure during the permit cycle should be 29.6 acres. A cost estimate for closure of this area is provided as Appendix VII-2.

1.1.3 Cap Settlement and Stability

Non-uniform settlement can be expected over the entire area that will receive a closure cap. The primary mechanism of settlement is waste consolidation due to decomposition of the landfilled material. According to Daniel, et al, long-term settlement is typically 5 to 15 percent over 20 to 30 years; however, settlement of about 5 percent can be expected in the first few months following waste placement. A significant amount of waste consolidation will likely have occurred by the time each portion of the landfill is closed.

The stability of the proposed cap design under static conditions has been evaluated and is included in the Engineering Plan. The proposed design was found to be stable at a slope of 3H:1V.

After capped portions are completed, monthly inspections of the final cover will be conducted to look for areas of the cap that might have experienced displacement. Should these inspections indicate problem areas, (ponding, exposure of the geomembrane, deep cracks, etc.), repairs will be initiated as soon as practical.

1.1.4 Drainage and Erosion

A combination of drainage ditches, diversion berms, vegetative cover, and sediment traps and basins will control drainage and erosion. Construction and design of sediment and erosion control features will be in accordance with applicable sections of the "North Carolina Erosion and Sediment Control Planning and Design Manual." Drainage will be directed to proposed ditches along the perimeter. These ditches will receive runoff from the cap, conveying the flow to on-site sediment basins. For a detailed discussion regarding stormwater management and erosion and sediment control, please refer to the Erosion and Sediment Control Plan submitted under separate cover.

1.1.5 Freeze/Thaw Effects

Based on a published map of frost depths throughout the United States (EPA, November 1993: A530-R-93-017), the anticipated maximum depth of freeze/thaw effects on the site is less than or equal to 18 inches. Since the upper 18 inches of final cover soil is not the low-permeability component of the cap, the effects of freeze/thaw cycles on the closure cap should not be detrimental to its function.

1.2 Waste Volume

A summary of the total airspace available by phase was made in the Facility Plan and has been included in Appendix VII-1. The available airspace was calculated based on a comparison of the base grade and final grade surfaces.

1.3 Closure Plan Schedule

The landfill is designed so that it can be closed incrementally as final contours are reached in various areas. Prior to beginning closure of any portion of the facility, CRSWMA will notify the Division that a notice of intent to close the facility has been placed in the operating record. An itemized list of closure milestones and a proposed schedule follow. Closure activities are proposed to begin within 30 days of final receipt of waste in the area to be closed. Construction of the closure cap is to be completed within 180 days following the initiation of closure activities. The total length of the proposed closure period is 210 days following the final receipt of waste.

The approximate closure milestones shown in Table 1 below are proposed for use in tracking the progress of closure activities. A detailed schedule will be established prior to construction.

Table 1
Proposed Closure Milestones and Schedule

Milestone	Proposed Schedule from the Date of Final Receipt of Waste
Testing of borrow sources	Within 6 months prior to closure
Grading of intermediate cover	Within 30 to 60 days
Placement of soil cap	30 to 150 days
Final inspection of cap by P.E.	150 to 180 days
Construction of stormwater controls	90 to 180 days
Seeding and mulching	150 to 180 days
Preparation of survey plat	180 to 210 days
Submittal of closure certification	180 to 210 days

1.4 Posting and Baiting

At least one sign will remain posted at the entrance to the facility notifying persons of the facility closing. Also, a notice prohibiting further receipt of waste materials will remain posted at the entrance. The site will be secured through the use of gates equipped with locks, fencing, and/or natural barriers. The site will be baited for rodent and vector control before final closure is initiated.

1.5 Notification

Once closure is complete, a survey plat will be prepared by a registered land surveyor showing the locations and dimensions of the landfill disposal areas, the locations of groundwater monitoring wells and gas probes, and the restrictions on future disturbance of the site. A notation will be recorded on the property deed stating that the land has been used to dispose solid waste and that its use is restricted under the Closure Plan as required by Rule .1627(c)(8). Copies of the deed notations as recorded will be placed in the Operating Record and forwarded to the Division.

1.6 Certification

Upon completion of closure, a licensed professional engineer acting on behalf of the owner will submit a Certification of Closure to the Division. This Certification will state that the site was closed in accordance with the Closure Plan and applicable solid waste regulations and laws as required by Rule .1627(c)(7).

The owner must record a notation on the deed to the landfill facility property at the Craven County Registrar of Deeds office, or some other instrument that is normally examined during title search, and notify the Division that the notation has been recorded and a copy has been placed in the operating record. The notation shall in perpetuity notify any potential purchaser of the property that the land has been used as a MSW facility and its use is restricted under the closure plan approved by the Division.

1.7 Closure Cost Estimate

An estimate of closure costs is provided in Appendix VII-2. All costs are given in 2015 dollars.

2.0 POST-CLOSURE ACTIVITIES

Post-closure activities will be conducted at the landfill in accordance with Rule .1627 for a period of 30 years following closure of the landfill. The length of the period can be increased or decreased in accordance with Division directives.

2.1 Contact

All correspondence and questions concerning the post-closure care of the unit should be directed to:

Mr. Bobby Darden
Executive Director
Coastal Regional Solid Waste Management Authority
PO Box 128
Cove City, North Carolina, 28523
252-633-1564

2.2 Security

Access to the site will be controlled by the use of barriers and gates at roadway entrances. These control devices will be maintained throughout the post-closure care period, and inspected as part of the monthly inspection program. All barriers and gates will be clearly marked with signs stating the name and nature of the facility and the person to contact in case of emergency or breach of security.

2.3 Post-Closure Maintenance

Post-closure maintenance and monitoring will be conducted at the Tuscarora Landfill for a period of 30 years after final closure. The Division may decrease the length of the post-closure period if the owner or operator demonstrates that the reduced period is sufficient to protect human health and the environment, and the Division approves this demonstration. The period might be increased by the Division if the Division determines that the lengthened period is necessary to protect human health and the environment.

Monitoring will include semiannual sampling of groundwater and surface water, quarterly gas monitoring and monthly inspection of the final cover and monitoring and control systems.

Routine maintenance and repairs may include upkeep of fencing, gates, & signage, access roads toward monitoring locations, stormwater, erosion, and sedimentation control facilities, potential leachate seeps, integrity of the final cap system, groundwater wells, landfill gas wells, and landfill gas monitoring probes.

Maintenance needs identified through the monitoring program will be initiated no later than 60 days after the discovery, and within 24 hours if a danger or eminent threat to human health or the environment is indicated. Minor cap maintenance may be deferred until there is a sufficient amount of work to justify the mobilization of equipment and personnel. Unusual or extreme maintenance needs due to calamities or vandalism might require the implementation of emergency contract service procedures established by CRSWMA.

2.4 Inspection Plan

Routine inspections will be conducted throughout the post-closure care period. These inspections will be carried out monthly unless problems are detected which indicate more frequent visits. Potential impacts to the public and environment will be considered in determining the inspection frequency. Items to be included in the monthly inspection will be as follows:

- Access and security control
- Leachate management and storage systems
- Stormwater management
- Erosion and sediment control
- Gas management
- Groundwater and landfill gas monitoring systems
- Integrity of site benchmarks
- Vector control.

Inspection forms have been prepared for use during each inspection (see Appendix VII-3). Completed copies of the inspection forms will be kept by the owner, and copies will be forwarded to the Division for its records.

2.5 Monitoring Plan

2.5.1 Groundwater Monitoring

Groundwater monitoring will occur semiannually throughout the post-closure care period. The monitoring schedule will continue as established during the active life of the facility. The applicable procedures outlined in Rules .1633 through .1637 will be followed through post-closure as required by site findings. Refer to the Water Quality Monitoring Plan in the Design Hydrogeologic Report, Volume III of this submittal.

The post-closure care period for the site is 30 years unless modified by the Division. If the statistical analysis of the groundwater monitoring data does not indicate degradation to the quality of the groundwater after the 30-year post-closure care period, a request will be made to terminate the groundwater monitoring program. All groundwater-monitoring wells will be maintained so that future monitoring can be resumed if desired. A blank groundwater monitoring well maintenance record form is provided in Appendix VII-4.

2.5.2 Surface Water Monitoring

Surface water will be monitored according to the Water Quality Monitoring Plan.

2.5.3 Landfill Gas Monitoring

Monitoring of explosive gas hazards will be performed as described in the Operations Plan.

The active landfill gas collection and control system will continue to operate according to the Title V Air Permit (Appendix VI-3).

At the end of the useful life of the gas collection and control system, and after operation is no longer required according to the Title V Air Permit, the gas extraction wellheads will be removed to allow any remaining gas to vent to the atmosphere. All buried gas system components will be left in place. The blower/flare and processing equipment will be decommissioned and may be removed from the facility. The facility will continue explosive gasses monitoring beyond the decommissioning of the active gas collection period in accordance with the Post-Closure criteria by Rule .1627 (d).

2.5.4 Stormwater, Erosion, and Sedimentation Control Facilities

Stormwater management features proposed in the Erosion and Sediment Control Plan are designed to function throughout the post-closure care period. Drainage ditches and sediment ponds will be inspected and maintained as needed to control surface water runoff and erosion.

2.5.5 Leachate Management

Leachate management will continue at the facility during the post-closure period as long as leachate continues to be generated. The leachate will be collected to the facility's leachate storage ponds and pumped via sewer line to the local wastewater treatment plant for disposal. The collection system will be evaluated periodically and maintained to prevent clogging.

The facility Operations Plan Section 9.0 Leachate Management Plan covers maintenance of leachate collection system, leachate generation records, leachate monitoring, leachate disposal and contingency plan for extreme conditions.

When leachate collection ceases, the following closure activities will be completed within 180 days. Leachate collection pipes will be securely plugged, and liquid and solid waste, and associated piping will be removed from the leachate storage facilities. Contaminated subsoils, structures, and equipment will also be removed. Material that is removed will be disposed in accordance with applicable requirements.

2.6 Training

Personnel responsible for conducting monitoring activities, site inspections and maintenance will be competent individuals trained in the skills needed for their job. Personnel will continue to receive training as new programs become available.

Groundwater and surface water monitoring will be performed by a qualified firm, and laboratory analysis will be conducted by a certified environmental laboratory.

2.7 Post-Closure Land Use

The primary land use for the site after closure of the landfill will be open dormant green space. Limited passive recreational uses may be proposed at a later time.

2.8 Post-Closure Cost Estimate

An estimate of post-closure care costs is provided in Appendix VII-6. All costs are given in 2015 dollars.

(End)

GROUNDWATER MONITORING WELL MAINTENANCE RECORD

FACILITY: _____ WELL #:

LOCATION: _____ DATE:

INSPECTOR: _____ COMPANY:

1. Is surface water diverted away from the wellhead?

2. Is the concrete pad still intact and free of cracks?

3. Has surface water runoff undercut the concrete pad

4. Is the outer casing still secure and locked?

5. Is the well identification tag present and is it legible?

   5a. Does the well identification tag provide the following information:

   - The well identification number?
   - Drilling contractor name and registration number?
   - Total depth of well?
   - Depth to screen?
   - A warning that the well is not for water supply and that the ground water may contain hazardous materials.

6. Is the grout between the inner and outer well casings all the way to the ground surface?

7. Is the inner casing firmly grouted in place?

8. Are the inner and outer casings upright and unobstructed?

9. Is water collecting in the outer casing? Does a weep hole need to be bored in the outer casing to provide drainage?

10. Is the monitoring well accessible by a four-wheel drive vehicle?

11. Have brush and weeds been trimmed so that the well is easy to locate and access?

12. Does the inner well casing have a vented cap?

13. Is the monitoring well visible and adequately protected from moving equipment?

POST-CLOSURE INSPECTION RECORD

FACILITY: _____ WELL #:

LOCATION: _____ DATE:

INSPECTOR: _____ COMPANY:

1. Access and Security Control

   - Is a notice prohibiting the further disposal of waste materials clearly visible at the entrance to the facility?
   - Is the site adequately secured by means of gates, chains, berms, fences or other security measures to prevent unauthorized entry?
   - Are the access roads to and within the site maintained to provide access to the closed disposal area and to all monitoring points?

2. Erosion and Sediment Control

   - Is the vegetation adequate to stabilize the site and prevent erosion?
   - Are the erosion control measures adequate to prevent silt from leaving the site and to prevent excessive on-site erosion?
   - Do the sediment basins require cleaning out, as indicted by the level of sediment buildup?

3. Drainage Control Requirements

   - Are all areas adequately sloped to promote surface water runoff in a controlled manner?
   - Are there areas of observed settlement, subsidence, and/or displacement of the closure cap?
   - Are all drainage channels free of accumulated sediment?

4. Uncontrolled Escape of Leachate or Landfill Gas

   - Are there any leachate seeps observed?
   - Are there any signs of uncontrolled releases of landfill gas?

5. Environmental Monitoring Systems

   - Are all monitoring wells (gas and groundwater) properly maintained? (Note: Complete the Groundwater Monitoring Well Maintenance Record during semiannual sampling events.)

6. Miscellaneous

   - Are all site benchmarks marked and evident?
   - Do vector control measures appear adequate?

METHANE MONITORING TEST REPORT

Facility:
Location:

Date of Test:

Weather Condition:

Temperature:_____ Barometric Pressure:
Sampling Personnel:

Monitoring Point	Description/Location	Time	Methane Concentration (% of LEL)

Opinion of Cost for Closure (Phases 2 and 3; 29.6 acres)

Facility Name: Tuscarora Landfill
Permit No.: 25-09
Facility Address: PO Box 128
Cove City, NC 28523
Facility Owner: Coastal Regional Solid Waste Management Authority

Date: 09/11/15
Calculated By: HMK
Reviewed By: LB
Revision No.: 3 6/9/2016
Project No.: 618.1601.11
Task No.: 05

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CLOSURE COSTS:

Native Soil for Slope and Fill-Intermediate Cover (Site Preparation)			Notes & Guidance Values	
a.	Area to be capped	29.6	acres x 4840 yd2/acre =	143,264 yd^2
b.	Depth of native soil for slope and fill	12	inches x 1yd/ 36 inches =	0.33 yd
c.	Quantity of native soil needed		(a x b)	47,755 yd^3
d.	Percentage of soil from off-site		100	100%
e.	Excavation unit cost (on-site material)		$1.79	$1.79 /$yd^3$
f.	Purchase unit cost (off-site material)		$3.58	$3.58 /$yd^3$
g.	Delivery Cost (off-site material)		$8.80/yd3 for 5 mil RT	$8.80 /$yd^3$
h.	Placement/Spreading unit cost		$1.65	$1.65 /$yd^3$
i.	Compaction unit cost		$0.41	$0.41 /$yd^3$
j.	Total on-site native soil unit cost		(e + h + i)	$3.85 /$yd^3$
k.	Total off-site native soil unit cost		(f + g + h + i)	$14.43 /$yd^3$
l.	Total on-site native soil cost		[j x (1-d) x c]	$0
m.	Total off-site native soil cost		(c x d x k)	$689,195
n.	Percent compaction		20	20%
o.	*Total native soil cost*		(l + m) * (1 + n)	***$827,034***

Topsoil (Vegetative Layer)				
a.	Area to be capped	29.6	acres x 4840 yd2/acre =	143,264 yd^2
b.	Depth of topsoil needed	6	inches x 1yd/ 36 inches =	0.17 yd
c.	Quantity of topsoil needed		(a x b)	23,877 yd^3
d.	Percentage of soil from off-site		100	100%
e.	Excavation unit cost (on-site material)		$1.79	$1.79 /$yd^3$
f.	Purchase unit cost (off-site material)		$5.50	$5.50 /$yd^3$
g.	Delivery Cost (off-site material)		$8.80/yd3 for 5 mil RT	$8.80 /$yd^3$
h.	Placement/Spreading unit cost		$1.65	$1.65 /$yd^3$
i.	Compaction unit cost		$0.41	$0.41 /$yd^3$
j.	Total on-site topsoil unit cost		(e + h + i)	$3.85 /$yd^3$
k.	Total off-site topsoil unit cost		(f + g + h + i)	$16.36 /$yd^3$
l.	Total on-site topsoil cost		[j x (1-d) x c]	$0
m.	Total off-site topsoil cost		(c x d x k)	$390,562
n.	Percent compaction		10	10%
o.	*Total topsoil cost*		(l + m) * (1 + n)	***$429,618***

Drainage Pipe			
a.	Length of pipe needed (15")	1537	1537 LF
b.	Pipe unit cost (15")	$21.73	$21.73 /LF
c.	Length of pipe needed (12")	1830	1830 LF
d.	Pipe unit cost (12")	$16.50	$16.50 /LF
e.	Trenching and backfilling cost	$13.20	$13.20 /LF
f.	Total drainage pipe unit cost (15")	(b + e)	$34.93 /LF
g.	Total drainage pipe unit cost (12")	(d + e)	$29.70 /LF
h.	*Total drainage pipe cost*	[(a x f) + (c x g)]	***$108,031***

Synthetic Membrane				
a.	Area to be capped with FML	29.6	acres x 43560 ft2/acre =	1,289,376 ft^2
b.	Purchase unit cost		$0.29	$0.29 /$ft^2$
c.	Delivery unit cost		$0.00	$0.00 /$ft^2$
d.	Installation unit cost		$0.11	$0.11 /$ft^2$
e.	Total synthetic membrane unit cost		(b + c + d)	$0.40 /$ft^2$
f.	*Total synthetic membrane cost*		(a x e)	***$510,593***

Geonet Composite (Drainage and Gas Migration)			Notes & Guidance Values	
a.	Quantity of Geonet Composite needed	29.6	acres x 43560 ft2/acre =	1,289,376 ft^2
b.	Purchase unit cost		$0.39	$0.39 /$ft^2$
c.	Delivery unit cost		$0.00	$0.00 /$ft^2$
d.	Installation unit cost		$0.07	$0.07 /$ft^2$
e.	Total geocomposite unit cost		(b + c + d)	$0.45 /$ft^2$
f.	*Total geocomposite cost*		(a x e)	***$581,509***

Geosynthetic Clay Liner				
a.	Quantity of GCL needed	29.6	acres x 43560 ft2/acre =	1,289,376 ft^2
b.	Purchase unit cost		$0.34	$0.34 /$ft^2$
c.	Delivery unit cost		$0.00	$0.00 /$ft^2$
d.	Installation unit cost		$0.10	$0.10 /$ft^2$
e.	Total GCL unit cost		(b + c + d)	$0.44 /$ft^2$
f.	*Total GCL cost*		(a x e)	***$567,325***

Protective Soil Cover				
a.	Area to be capped	29.6	acres x 4840 yd2/acre =	143,264 yd^2
b.	Depth of soil needed	18	inches x 1yd/ 36 inches =	0.50 yd
c.	Quantity of soil needed		(a x b)	71,632 yd^3
d.	Percentage of soil from off-site		25	25%
e.	Excavation unit cost (on-site material)		$1.79	$1.79 /$yd^3$
f.	Purchase unit cost (off-site material)		$3.58	$3.58 /$yd^3$
g.	Delivery Cost (off-site material)		$8.80/yd3 for 5 mil RT	$8.80 /$yd^3$
h.	Placement/Spreading unit cost		$1.65	$1.65 /$yd^3$
i.	Compaction unit cost		$0.41	$0.41 /$yd^3$
j.	Total on-site soil unit cost		(e + h + i)	$3.85 /$yd^3$
k.	Total off-site soil unit cost		(f + g + h + i)	$14.43 /$yd^3$
l.	Total on-site soil cost		[j x (1-d) x c]	$206,837
m.	Total off-site soil cost		(c x d x k)	$258,448
n.	Percent compaction		20	20%
o.	*Total protective soil cover cost*		(l + m) * (1 + n)	***$558,343***

Soil Testing			
a.	Number of acres to be capped	29.6	29.6 acres
b.	Testing unit cost (Includes density & permeability tests and technician)	$2,508	$2,508 /acre
c.	*Total Soil Testing Cost*	(a x b)	***$74,236.80***

Seeding			
a.	Number of acres to be vegetated	29.6	29.6 acres
b.	Unit cost for prep, seed, and fert.	$1,925	$1,925 /acre
c.	*Total Seeding Cost*	(a x b)	***$56,980***

Landfill Gas (LFG) Management System				
a.	Number of acres of landfill to be closed		29.6	
c.	Number of LFG wells		19	
e.	Average cost per LFG well		$3,850	
g.	Total cost for LFG wells		(c x e)	$73,150 total
Landfill Gas Appurtenances				
h.	Header Pipe (12")	ft.	2500	
i.	12" Pipe Unit Cost (including installation)		$39	$96,250.00 total
j.	Header Pipe (10")	ft.	200	
k.	10" Pipe Unit Cost (including installation)		$33	$6,600.00 total
l.	Lateral Pipe (8")	ft.	1830	
m.	6" Pipe Unit Cost (including installation)		$22	$40,260.00 total
n.	Isolation Valve		0	
o.	Isolation Valve Cost (including installation)		$1,320	$0.00 total
p.	Condensate Traps		2	
q.	Condensate Trap Unit Cost (including installation)		$2,750	$5,500.00 total
w.	*Total gas management system cost*			***$221,760***

Mobilization/demobilization	***$27,500***
Survey and deed notation	***$19,832***
Closure Certification	***$27,500***
Erosion and Stormwater Control	**$110,000**

Notes:
Inflation factor 1.01 was applied to the 2015 Financial Assurance unit costs.
In the 2015 Financial Assurance, guidance values were attained from recently completed JOYCE projects, and suppliers' price quotes.
Material Costs for Geosynthetics include Delivery.

Total Construction Closure Costs	
Total Unadjusted Closure Costs	***$4,120,261***
Contingency (10%)	$412,026
Engineering Fees	
Construction Documents	$82,500
Construction Quality Assurance	$330,000
Total Closure Cost 2016 (Phase 2 and 3)	**$4,944,787**
2015 TOTAL POST-CLOSURE COST ESTIMATE x 1.01 (2016 inflation factor) =	**$4,994,235.35**
Total Area to be capped	29.6 acres
Approximate closure cost per acre	**$168,724** /acre

Material Cost List

	2009 Prices		2015 Prices (10% Inflation)	
	Material (per ft^2)	Installation (per ft^2)	Material (per ft^2)	Installation (per ft^2)
Synthetic Membrane				
60 mil HDPE	$0.38	$0.10	$0.42	$0.11
40 mil LLDPE	$0.26	$0.10	$0.29	$0.11
40 mil PVC	$0.28	$0.10	$0.31	$0.11
Geonet Composite				
6 oz	$0.35	$0.06	$0.39	$0.07
8 oz	$0.39	$0.06	$0.43	$0.07
Triplanar	$0.60	$0.08	$0.66	$0.09
Geosynthetic Clay Liner				
Type I (Regular)	$0.27	$0.09	$0.30	$0.10
Type II (Reinforced)	$0.31	$0.09	$0.34	$0.10

Opinion of Cost for Post Closure Care

JOYCE ENGINEERING
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Facility Name:	Tuscarora Long-Term Regional Landfill	*Date:*	09/11/15
		Calculated By:	HMK
Permit No.:	25-09	*Reviewed By:*	LB
Facility Address:	PO Box 128	*Revision No.:*	3 6/9/2016
	Cove City, NC 28523	*Project No.:*	618.1601.11
Facility Owner:	Coastal Regional Solid Waste Management Authori	*Task No.:*	05

POST CLOSURE COSTS:

Ground & Surface Water Monitoring		Notes & Guidance Values		
a.	Total number of monitoring wells	42	42	wells
b.	Number of sampling events per year	2 sampling events per year	2	events
c.	Monitoring costs per sample	$1,650	$1,650	/sample
d.	Miscellaneous Engineering Fees	$11,000 or as required	$10,700	/year
e.	*Total annual monitoring costs*	[(a x b x c) + d]	**$149,300**	**/year**
f.	Total number of surface water monitoing points	4	4	
g.	Number of sampling events per year	2 sampling events per year	2	events
h.	Monitoring costs per sample	$165	$165	/sample
i.	*Total annual monitoring costs*	(f x g x h)	**$1,320**	**/year**
j.	Post-closure period	30	30	years
k.	*Total cost for post-closure period*	(e + i x j)	***$4,518,600.00***	

Landfill Gas Monitoring System Maintenance				
a.	Monthly wellfield monitoring	(12 events per year)	12	events/year
b.	Unit cost for 'a'	$1,650.00	$1,650	/event
c.	Quarterly Surface Emissions & Explosive Gases	(4 events per year)	4	events/year
d.	Unit cost for 'c'	$1,650.00	$1,650	/event
e.	Annual Reporting (Title V Permit Compliance)	$11,000 per year	$11,000	
f.	Maintenance and Response to Shutdowns	$11,000 per year	$11,000	
g.	Post-closure period	20	20	years
h.	*Total annual cost for post-closure period*	[(a x b) + (c x d) + e + f]	**$48,400**	
i.	*Total cost for post-closure period*	(g x h)	***$968,000***	

Decommisioning of Landfill Gas Collection and Control System				
a.	Total number of wellheads	59	59	wells
b.	Estimated cost per well head	110	*$110*	/well
c.	Estimated cost of wellhead removal	(a x b)	*$6,490*	
d.	Decommissioning of blower/flare	$1,100.00	*$1,100*	
e.	Decommissioning of processing equipment	$27,500.00	*$27,500*	
f.	Total cost for decommissioning LFGCC system	(c + d + e)	***$35,090***	

Explosive Gas Monitoring Period 20 to 30 Years				
	Quarterly Surface Emissions & Explosive Gases	(4 events per year)	4	events/year
	Unit cost for 'c'	$1,650.00	$1,650	/event
	Post-closure period (years 20 to 30)	10	10	years
	Total annual cost for post-closure period		**$66,000**	

Leachate Management				
a.	Private disposal unit cost	$0.00	$0.00	/gal
b.	POTW disposal unit cost	$0.00	$0.00	/gal
c.	Direct discharge to a POTW unit cost (2015 rate)	$0.009	$0.009	/gal
d.	Amount of leachate generated (HELP Model)	0.3 gal/acre/day	8,497	gal/yr
e.	Load/unload unit cost	$0	$0.00	/truck
f.	Capacity of truck	0	0	gallons
g.	Number of trucks required per year	(d ÷ f)	0	trucks/year
h.	Distance over 5 miles of hauling (one way)	0	0	miles
i.	Cost of hauling per mile	$0.00	$0.00	/mile
j.	Total cost for loading / unloading and hauling	[(e x g) + (h x i)]	$0.00	/year
k.	Total annual cost for Private Disposal	(a x d)	$0.00	/year
l.	Total annual cost for POTW Disposal (delivered)	[(b x d) + j]	$0.00	/year
m.	Total annual cost for POTW Disposal (direct)	(c x d)	**$78**	/year
n.	Number of sampling events per year	2 sampling events per year	2	events
o.	Monitoring costs per sample	$165	$165	/sample
p.	*Total annual monitoring costs*	(n x o)	**$330**	**/year**
q.	*Total leachate management cost*	(m + p)	***$408***	***/year***
r.	Post-closure period	30	30	years
s.	*Total cost for post-closure period*	(n x o)	***$12,252.87***	

Routine Maintenance and Repairs				
a.	Mowing frequency	2	2	visits/year
b.	Area to be maintained (acres)	77.6	77.6	acres
c.	Mowing unit cost per visit	$87	$87	/acre/visit
d.	Total mowing cost per year	(a x b x c)	$13,486.88	/year
e.	Fertilizer unit cost	$318	$318	/acre
f.	Total fertilizer cost per year	(b x e)	$24,669.04	/year
g.	Number of years to reseed (max 3 years)	3	3	years
h.	Area to reseed (acres)	77.6	77.6	acres
i.	Reseeding unit cost	$1,980	$1,980	/acre
j.	Total reseeding cost	(g x h x i)	***$460,944***	
k.	Mobilization/demobilization cost per year	$116	$116	/year
l.	*Total maintenance and repairs cost per year*	(d + f + k)	***$38,271***	***/year***
m.	Post-closure period	30	30	years
n.	*Total cost for post-closure period*	[(m x l) +j]	***$1,609,086.60***	

Vector and Rodent Control				
a.	*Total vector and rodent control costs per year*	$2,200 or as required	$2,140	/year
b.	Post-closure period	30	30	years
c.	*Total cost for post-closure period*	(a x b)	***$64,200***	

Total Post-Closure Costs

Total Unadjusted Post-Closure Costs	$7,273,229
Contingency (10%)	$727,323
Total Post-Closure Cost-Estimate	**$8,000,552**

Overall Total Costs

2015 TOTAL POST-CLOSURE COST ESTIMATE x 1.01 (2016 inflation factor) =	**$8,080,558**
Total Closure Cost-Estimate (From previous page)	**$4,994,235**
Potential Assessment and Corrective Action (PACA), NCGS 130A-295.2(h)	**$2,000,000**
TOTAL CLOSURE & POST-CLOSURE COST ESTIMATE =	**$15,074,793**