**RICHARDSON SMITH GARDNER & ASSOCIATES**
Engineering and Geological Services

| Fac/Perm/Co ID # | Date | Doc ID# |
|---|---|---|
| 24-02 | 02/13/09 | DIN 8769 |

February 13, 2009

North Carolina – DENR
Division of Waste Management
Attn: Edward Mussler, PE
401 Oberlin Road Suite 150
Raleigh, NC 27699-1646

RECEIVED
FEB 13 2009
SOLID WASTE SECTION

RE: Certification of Final Closure
International Paper Rieglewood
Industrial Landfill Permit 2402

Dear Mr. Mussler;

This letter certifies that the final closure of the referenced landfill has been completed in accordance with the March 2003 Closure and Post-Closure Plan previously approved. The attached report reviews the closure work performed and identifies all exceptions to the approved plan. Additionally, the attached report summaries the ongoing post-closure operations that are designed to provide improvements to the post-closure grades.

Reflecting completion of final closure, the revised financial assurance requirements for the landfill are attached.

Cordially,
**Richardson Smith Gardner & Associates**

Gregory N. Richardson Ph.D., P.E.
Senior Engineer

NORTH CAROLINA PROFESSIONAL SEAL 8895 ENGINEER GREGORY N. RICHARDSON 2-13-09

Gregory Mills, P.E.
Senior Engineer

NORTH CAROLINA PROFESSIONAL SEAL 024935 ENGINEER GREGORY G. MILLS 2-13-09

INTERNATIONAL PAPER - RIEGELWOOD, N.C.

## Closure Costs - Unlined Landfill

| Description | | | 2009 Year End Adjusted Values (based on Oct-08 CPI of 3.7%) |
|---|---|---|---|
| Topsoil | | $300,000 | $311,100 |
| HDPE Pipe | | $0 | $0 |
| Sumps and Culvert Entrances | | $0 | $0 |
| Perimeter Channel | | $0 | $0 |
| Rock Check Dams | | $0 | $0 |
| Turf Reinforcement Mat (TRM) | | $0 | $0 |
| Revegetation | | $108,000 | $111,996 |
| | TOTAL | **$408,000** | **$423,096** |

## Post-Closure Costs - Unlined Landfill

| Annual Costs | | | | |
|---|---|---|---|---|
| 1) Yearly inspection and report to DENR (covered in Cell 1) | | | $0 | $0 |
| 2) Monitoring (GW collection and lab covered in Cell 1) | | | $0 | $0 |
| 3) Maintenance - Unlined Landfill | | | | |
| | groundwater wells | | $1,000 | $1,037 |
| | final cover, dikes ditches and roads | 55.6 AC @ $500/AC | $27,800 | $28,829 |
| | Maintenance Grading Phase 1 Area | 35200 CY on ~11 AC | $29,333 | $30,419 |
| | Maintenance Grading Phase 2 Area | 52800 CY on ~11 AC | $44,000 | $45,628 |
| | Maintenance Grading Phase 3 Area | 32000 CY on ~5 AC | $26,667 | $27,653 |
| | Revegation | ~30 AC @ $2500/AC | $25,000 | $25,925 |
| 4) Regulatory Fees | | | | |
| | License (Covered in Cell 1) | | $0 | $0 |
| | Inspection (Covered in Cell 1) | | $0 | $0 |
| 5) Misc. repairs (piping, fencing, etc.) | | | $2,000 | $2,074 |
| | | YEARS 1 -3 ANNUAL COSTS | **$155,800** | $161,565 |
| | | YEARS 4-30 ANNUAL COST | **$30,800** | $31,940 |
| | | TOTAL COSTS FOR 30-YEARS | **$1,049,000** | $1,087,813 |

# CLOSURE CERTIFICATION and POST-CLOSURE MAINTENANCE PLAN
INDUSTRIAL LANDFILL PERMIT 2402
INTERNATIONAL PAPER
RIEGELWOOD MILL FACILITY
RIEGELWOOD, NORTH CAROLINA

Prepared for:

International Paper – Riegelwood Mill
865 John L. Riegel Road
Riegelwood, North Carolina 28456

For Submittal to:

North Carolina Department of Environmental and Natural Resources
NCDENR of Waste Management
Solid Waste Section
Raleigh, North Carolina

Prepared by:

Richardson Smith Gardner & Associates, Inc.
Raleigh, North Carolina

February, 2009

CLOSURE CERTIFICATION and POST-CLOSURE MAINTENANCE PLAN
INDUSTRIAL LANDFILL PERMIT 2402

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**PHOTOGRAPHS**



**ATTACHMENT**

# 1.0 INTRODUCTION

The Riegelwood industrial landfill has been operated since 1951 to manage paper-making process residuals generated by the adjacent paper mill. This waste has historically included wastewater treatment plant solids, process residuals (grits, dregs, paper cores, paper slabs, packaging lumber), small quantities of putrescible wastes from the on-site food service, wood waste, boiler ash, and construction demolition debris generated by facility updates. This landfill was permitted by NC-DENR Solid Waste Section in 1981 under permit 2402. In response to regulation changes, this landfill ceased accepting wastes on December 31, 2002. Currently, all industrial wastes that have no beneficial reuse value are placed in a double lined landfill immediately adjacent to the northern boundary of the existing landfill. Most putrescible waste is now hauled to a commercial lined MSW landfill.

As previously detailed in the March 2003 Closure and Post-Closure Plan submitted to DENR, the majority of residuals historically placed in the unlined landfill were wastewater treatment plant sludges. These sludges pass EPA's paint filter test for solids, but may contain 80% or more water by weight. Such sludges are thixotropic, i.e. experience a temporary but significant reduction in shear strength during handling. Substantial earthen perimeter berms were required to contain the low-strength sludges as they were landfilled. These perimeter earthen berms form the steeper side slopes of the landfill and are not included in the actual area of the landfill requiring a final closure cover. However, the earthen berms were vegetated early in 2003 with winter rye and then re-vegetated that spring with long term vegetation.

Three distinct surface conditions having unique closure schedules were identified in the March 2003 Closure Plan for the final cover. These surface conditions are shown on the aerial photograph shown on Photo 1 and include the following:

Stable Surface Zone – thirty acres of perimeter earthen berms and approximately 12.9-acres of the landfill top were stable and closed during the summer of 2003. These zones were vegetated with limited amendments.

Slide Zone – On January 5, 2003, approximately 3.5 acres in the southern limits of the closed landfill sluffed into the South Pond of the wastewater treatment system. 8.4-acres were impacted by the slide and require stabilization before placement of an earthen cover. Stabilization was completed by the summer of 2003 and the zone was vegetated by the winter of 2004.

Secondary Waste Surface Zones – In 2003, two large surface areas of recently deposited secondary sludges existed on the north and north-west limits of the top of the landfill. These two areas had approximately 13.6-acres of surface area that was too weak to be traversed.

Out of a total footprint of 55.1-acres, approximately 31.2-acres were closed and vegetated in 2003, and 10.3 acres were closed and vegetated in 2004. The closure of the 13.6-acres of exposed and weak secondary sludge required more time using a "corduroy roads" construction technique common in swampy areas near the coast. Final closure of the secondary sludge zones was not completed until winter of 2007. Post-closure work to enhance the final contours has been ongoing since completion of the 2003 final closure plan.

The primary goals of the March 2003 closure design was to limit exposure of the waste sludges to the environment and to provide for control of surface waters. The closure design was developed based on the assumption that it would be difficult to obtain final contours over much of the top greater than the minimal 2% requirement and with the realization that localized seeps would have to be mitigated as encountered. Closure work performed over the past 5 years has shown that minimum slopes approaching 4% can be obtained over the entire final closure and that such slopes minimize long term settlement related slope reversals with the resultant ponding of surface waters, and eliminate the development of seeps on the flatter top. This certification report documents the completion of the final cover constructed in accordance with the March, 2003 Closure Plan and presents the final cover upgrade goals of the ongoing post-closure activities.

## 2.0 COMPLETION OF MARCH 2003 FINAL COVER SYSTEM

Under NC Solid Waste Management Rule 0505(3)(c), the final cover for an industrial landfill should include at least 24 inches of compacted earthen material that must be placed within 180-days of closure. No permeability or other material properties are specified for the earthen material. As detailed in the March 2003 Closure Plan, the 24 inches of compacted earthen material consists of both clean borrow soils and beneficial reuse mill material including the following:

Woodyard waste ($\gamma$ = 27 pcf, soil and bark);
Ash ($\gamma$ = 34 pcf, sand from fly ash separation and wood fired boiler bottom ash);
Grits and Dregs ($\gamma$ = 60 pcf, calcium and lime residuals).

The beneficial reuse mill materials are trackable and provide moisture to support vegetative growth. A 6-inch layer blend of ash and dregs and secondary sludge is now being placed for the final vegetative surface. This blend of ash and secondary sludge was observed to support a rapid development of a healthy healthy vegetative layer in Cell 1, see Photos 18 and 19. An agronomic evaluation of this blend of ash and secondary sludge is provided in Attachment 1 to support its use as the topsoil layer in ongoing maintenance regrading.

Where possible, contours were developed to the minimum 2% grade specified in the 2003 closure plan. At the time the 2003 Closure Plan was developed, there was concern that many areas within the Slide Zone and the two Secondary Sludge Zones would not be able to achieve even this minimum slope due to the low strength of wastes encountered in those zones. In the five years since submittal of the Closure Plan, we have determined that final slopes in excess of 2% can be achieved and that there is significant benefits in increasing the minimum final slope angle to limit future ponding and vertical seeps.

### 2.1 Stable Surface Zones

As described above, the stable surface zones include the perimeter berm side slopes and approximately 9-acres of the north-east landfill top. The perimeter berms were at final grade and received no additional earthen cover. The 9-acres of the top was regraded and covered with 24 inches of compacted earthen material to achieve the 2% slopes. Elevation contours of the Stable Zone taken in November 26, 2003 after closure are presented on Figure 1 and show that contours having a minimum 2% slope were obtained. Photo's 10 an 11 show that the developed vegetation has been marginal despite extensive seeding. When this area was covered, the blend of ash and secondary sludge that has proven to be very supportive of grasses was not understood. Additionally, a portion of this zone has been disturbed this year to provide a working area for conditioning beneficial reuse materials being used to close other zones of the final cover, see Photo 9.

### 2.2 Slide Zone

The slide zone on the southern limits of the landfill required stabilization and establishment of final contours prior to placement of the 24-inch final cover layer. After the January 5, 2003 slide, a perimeter berm was established to prevent further movement of the landfill using suitable soils that were part of the slide debris and 4,500 cyd of additional soil fill brought from one of the unused perimeter dikes atop the landfill. This berm was equipped with a drainage layer on its waste face and solid pipe drains that discharge to the adjacent NDPES permitted wastewater treatment system.

The irregular slide contours were corrected by placing lightweight beneficial reuse materials. No wastewater sludges were used as fill in the remedial construction. Late in 2003 an access road was constructed across the face of the slide that is located essentially at the pre-slide limits of waste, see Photo 2. North of this road, the majority of waste did not slide but was experiencing significant drainage from cracking of the in-place waste. South of the road, all waste was slide deposited and the contours were flatter. The roadway provided access to the interior of the slide, reduced the flow length of surface water, and acted as an intercept to seeps draining to the south.

Significant seeps developed at the southern limits of both halves of the slide zone. Each seep was excavated and filled with drainage stone and perforated pipe to route the drainage directly to surface water drainage ditches at the southern limits of each slide zone, see Photo 6. Stable contours were established by 2005 and are shown on Figure 1. Photos 2 through 6 show the two Slide Zone halves as they currently appear. Seeps have become rare and the entire zone is trackable with low ground pressure equipment.

### 2.3 Secondary Waste Surface Zones

The 13.6-acres of very weak secondary sludges had initial slopes of less than 1% and provide little support for overlying materials. Therefore, use of a conventional cover was not feasible without the benefit of significant time to allow for these sludges to consolidate and gain strength. The 2003 Closure Plan proposed an alternative closure procedure that relied on a moderately high strength geotextile and lightweight fill to allow construction of a working platform over the weak secondary sludges.

As frequently happens when an experienced contractor tackles a difficult field operation, the facility contractor implementing closure demonstrated that by using means historically employed to construct corduroy roads in swamps, it was possible to place fill over the secondary sludge portions of the closure. The corduroy road technique simply involved placement of a layer of logs and wood debris over the secondary sludge to support the fill by both buoyancy and load distribution mechanisms. Using this technique, the two Secondary Sludge Zones requiring closure were brought to proposed grades in 2004. Figure 1 shows the contours established using the corduroy road technique.

## 3.0 EROSION AND SEDIMENT CONTROL

The unlined landfill is esentially surrounded by wastewater treatment ponds to the east and south, the wastewater treatment system canal carrying clarified wastewater to the ponds on the west side, and the lined Cell 1 to the north of the landfill, see Photo 1. Surface waters are discharged to all of these except Cell 1 to the north of the unlined landfill. The IP Riegelwood wastewater treatment system has handled over 100 million gallons of flow in a single day (recorded during hurricane Floyd). As a comparison, the total runoff expected from a 100-year, 24-hour storm event is about 12 million gallons, or about 30% of the normal flow to the treatment system. Runoff volume from the landfill after closure is no different than during its operation.

Storm water control features at the landfill were sized in 2003 using a 25-year storm event for the unvegetated condition, and verified to be adequate for a 100-year storm event after the landfill is vegetated. As shown on Photo 1, storm water runoff is routed off the landfill with soil diversion berms, HDPE downpipes and concrete culverts. Runoff from the perimeter berm sheet flows directly into the treatment ponds. This storm water control network is essentially as designed in the March 2003 Closure Plan.

## 3.1 Erosion Observations

The perimeter containment dikes have exterior slopes of 3H:1V and do not appear to have flattened since 2003. Having a maximum slope length of 189-feet, these slopes have not experienced any visible erosion. This was predicted in the 2003 Closure Plan and has been confirmed from observation. Large portions of the landfill cap top deck are very gently sloping, and have minimal erosion potential even with poor vegetative cover. Recent close visual inspection of the final cover has not observed any zones of surface erosion on the final closure cap.

## 3.2 Deviation from 2003 Stormwater Control Plan

As presented in the 2003 Closure Plan, grass-lined perimeter drainage channels direct runoff form the top of the landfill toward down pipes that prevent runoff from the cap of the landfill from flowing down the slopes. This general surface water control strategy was implemented essentially as outlined in the 2003 Closure Plan with the following exceptions:

As previously described in Section 2.2, the Slide Zone was divided by an access road placed approximately at the edge-of-waste limits before the slide, see Photo 2. A drainage ditch north of the roadway direct runoff from the Slide Zone north of the road to an 18-inch corrugated plastic pipe (CPP) that drains to the southwest into the South Pond, see Photos 3 and 4. Proposed surface water precast concrete drainage sumps serving the Secondary Sludge Zones were replaced with a 18-inch vertical perforated pipe to better tolerate fines accumulation that occurs prior to establishing vegetation, see Photos 13,14, and 16. Two emergency storm water spillways or chutes were added to the Secondary Sludge Zones to handle potential historic peak hurricane related surface water flows. These are located on Photo 12 and shown on Photo 17.

All surface water drainage from the implemented final cover discharge into the waste water treatment system for the mill at the perimeter of this landfill

## 4.0 POST-CLOSURE MAINTENANCE PLAN

Closure work performed over the past five years has established the ability of blends of beneficial reuse materials and soil to provide both suitable fills and a very effective vegetative growth media. Additionally, the difficult closures over the Secondary Sludge Zones have been so successful that concern has moved from closure to enhancing the ability of the final cover system to resist the impact of an even larger design precipitation. Therefore the post-closure maintenance is planned with the following supplemental goals:

- Achieve a minimum slope over the top deck of approximately 4% as compared to the 2003 goal of a minimal 2% slope. The ability to achieve the greater minimum slope reduces the potential for ponding due to differential settlement and increases the rate at which surface water is removed from the final cover.
- Incorporation of secondary sludge into the topsoil blend that has proven very successful in promoting rapid and a healthy development of grass.

More traditional maintenance items including maintenance of surface and storm water features are also discussed in this section.

### 4.1 Post-Closure Maintenance Stable Surface Zone

As shown on Figure 1, the Stable Surface Zone was the first zone to be completed under the 2003 Closure Plan. A minimum 2% slope was obtained with much of the zone having a 3% slope. Photos 7 to 11 show the following current conditions of this zone:

- Surface vegetation is thin indicating a lack of nutrients in the sandy soil/beneficial reuse material vegetative layer, and
- Much of the eastern half of the Stable Surface Zone is currently being used as a staging area for conditioning of soil/beneficial reuse cover and the ash/secondary sludge vegetative topsoil being used in other zones of the final cover

Upon completion of the closure upgrades to the Slide and Secondary Sludge Zones, the contours of the Stable Surface Zone will be restored to a minimum 4% grade, receive a 6-inch layer of the ash/secondary sludge vegetative topsoil, and be completely reseeded.

### 4.2 Post-Closure Maintenance Slide Zone

The access road constructed across this zone divides the Slide Zone produces the two distinct zones previously discussed in Section 2.2. Northeast of the access road, the Slide Zone has steeper slopes (up to 20%) and has experience some surface erosion. South west of the access road, the Slide Zone has flatter slopes that been the site of seeps that have been remediated with gravel/pipe intercept trenches stabilizing the surface. Vegetation in both zones ranges from lush to minimal and the surface water drainage ditch immediately north of the access road does not properly drain.

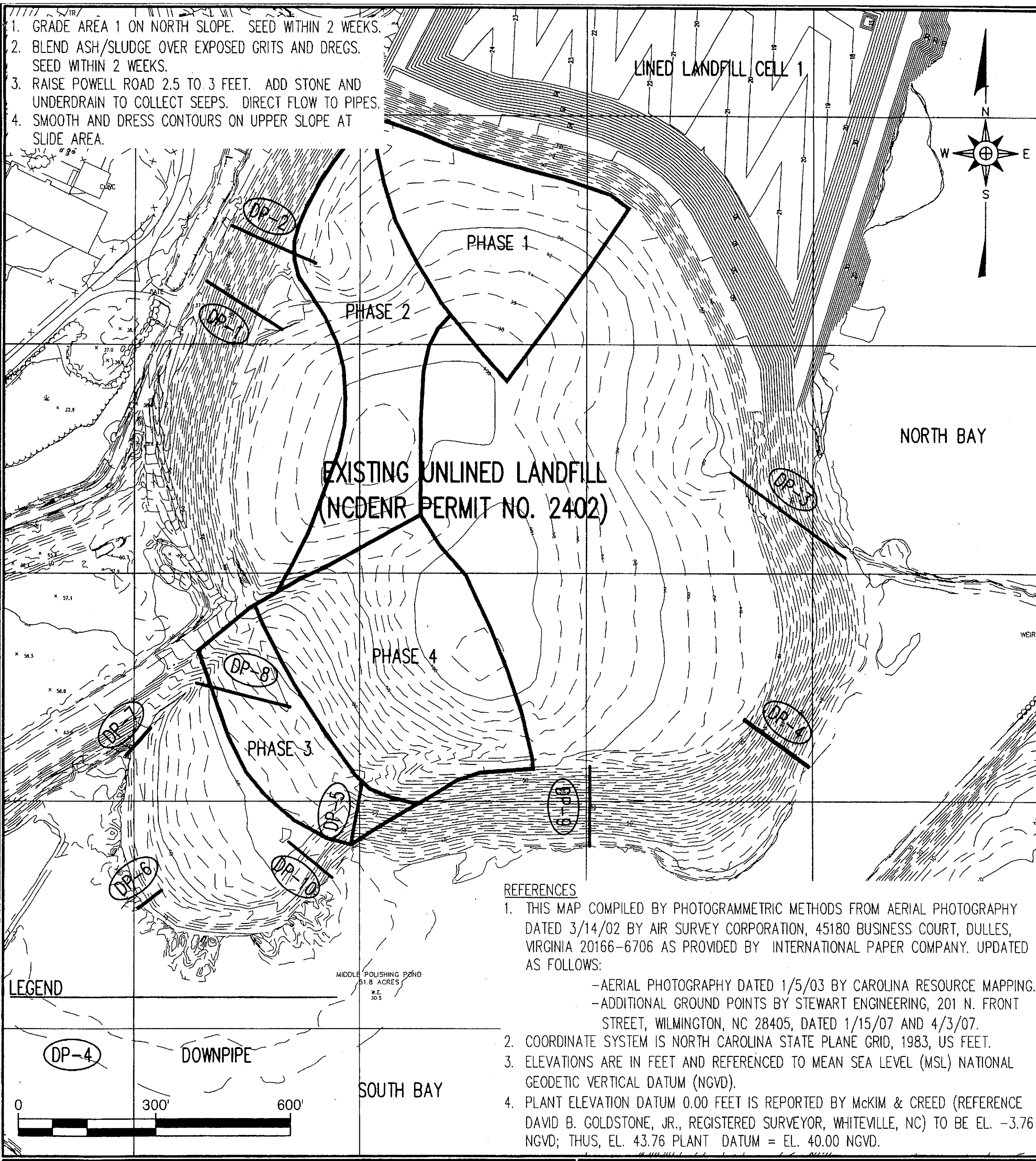
Post-closure maintenance activities northeast of the access road will include raising the access road 2-ft in elevation to allow correction of flow in the access road drainage ditch and a moderate reduction of the slope grades north of the road. This will be followed by placement of the ash/secondary sludge vegetative topsoil and the zone will be reseeded.

Post-closure maintenance activities southwest of the access road will include placement of additional soil/beneficial reuse fill to eliminate differential settlement of the slide debris and to cover the seep drainage features. This will be followed by placement of the ash/secondary sludge vegetative topsoil and the zone will be reseeded.

### 4.3 Post-Closure Maintenance Secondary Sludge Zones

During the regarding of the smaller Secondary Sludge Zones to correct for localized differential settlements, it was possible to achieve a minimum slope of 4% to provide better drainage and reduce the potential for future ponding. Additionally, the grading was extended north to tie in the grades between the two Secondary Sludge Zones. Photo 16 shows the smaller Secondary Sludge Zone where the maintenance regarding has been completed including placement of the ash/secondary sludge vegetative topsoil. Maintenance regrading of the larger Secondary Sludge Zone will be completed as needed after completion of the maintenance regrading of the Slide Zone.

1. GRADE AREA 1 ON NORTH SLOPE. SEED WITHIN 2 WEEKS.
2. BLEND ASH/SLUDGE OVER EXPOSED GRITS AND DREGS. SEED WITHIN 2 WEEKS.
3. RAISE POWELL ROAD 2.5 TO 3 FEET. ADD STONE AND UNDERDRAIN TO COLLECT SEEPS. DIRECT FLOW TO PIPES.
4. SMOOTH AND DRESS CONTOURS ON UPPER SLOPE AT SLIDE AREA.




REFERENCES

1. THIS MAP COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 3/14/02 BY AIR SURVEY CORPORATION, 45180 BUSINESS COURT, DULLES, VIRGINIA 20166-6706 AS PROVIDED BY INTERNATIONAL PAPER COMPANY. UPDATED AS FOLLOWS:
   - AERIAL PHOTOGRAPHY DATED 1/5/03 BY CAROLINA RESOURCE MAPPING.
   - ADDITIONAL GROUND POINTS BY STEWART ENGINEERING, 201 N. FRONT STREET, WILMINGTON, NC 28405, DATED 1/15/07 AND 4/3/07.
2. COORDINATE SYSTEM IS NORTH CAROLINA STATE PLANE GRID, 1983, US FEET.
3. ELEVATIONS ARE IN FEET AND REFERENCED TO MEAN SEA LEVEL (MSL) NATIONAL GEODETIC VERTICAL DATUM (NGVD).
4. PLANT ELEVATION DATUM 0.00 FEET IS REPORTED BY McKIM & CREED (REFERENCE DAVID B. GOLDSTONE, JR., REGISTERED SURVEYOR, WHITEVILLE, NC) TO BE EL. −3.76 NGVD; THUS, EL. 43.76 PLANT DATUM = EL. 40.00 NGVD.

# INTERNATIONAL PAPER
# RIEGELWOOD, NC
# LANDFILL CLOSURE AREAS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| SCALE: | DRAWN BY: | CHECKED BY: | DATE: | PROJECT NO. | FIGURE NO. | FILE NAME |
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# PHOTOS


**Photo 1 Aerial of Final Cover and Wastewater Treatment System**

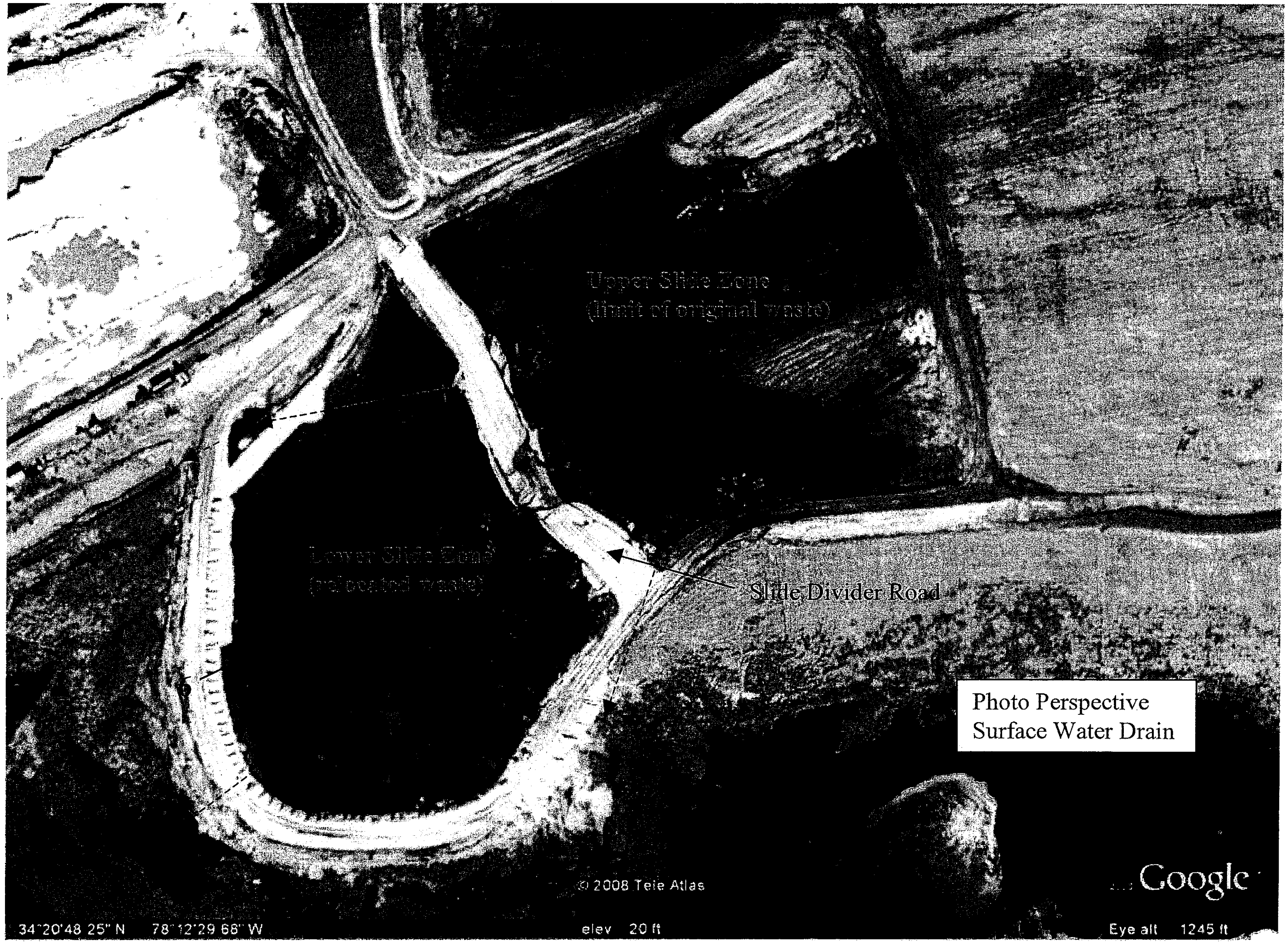


**Photo 2 Aerial of Slide Zone**

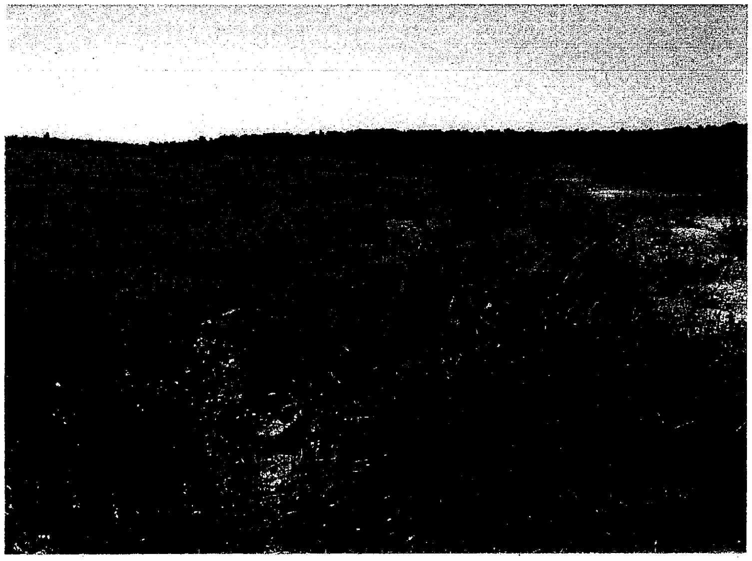

Photo 3  Surface Water Channel @ Slide Zone

Photo 4 Upper Slide Surface Water Drain


Photo 5  Vegetation on Upper Slide Zone

Photo 6 Slide Zone Ponding/Seep Drain


**Photo 7 Aerial Stable Zone and Surface Water Features**

Photo 8  Stable Zone Surface Water Inlet

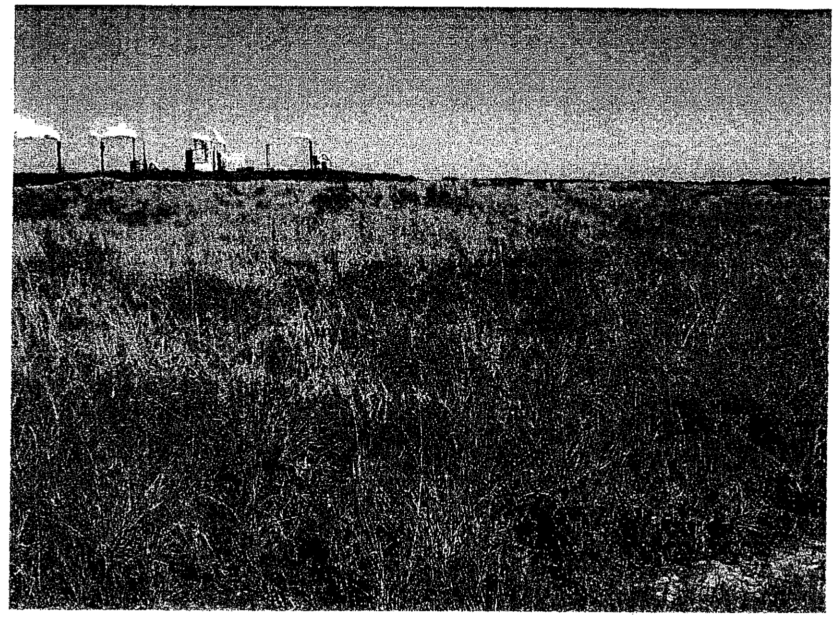

Photo 10  Stable Zone Vegetation

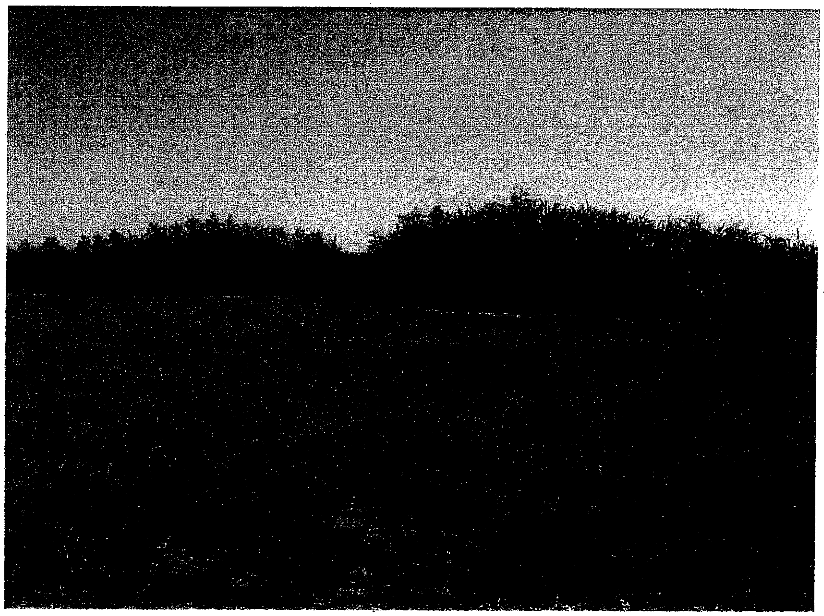

Photo 9  Stable Zone Beneficial Reuse Conditioning

Photo 11 Stable Zone Localized Vegetation


**Photo 12 Aerial Secondary Sludge Zones**

Photo 13  Secondary Sludge Zone Storm Water Drain Basin

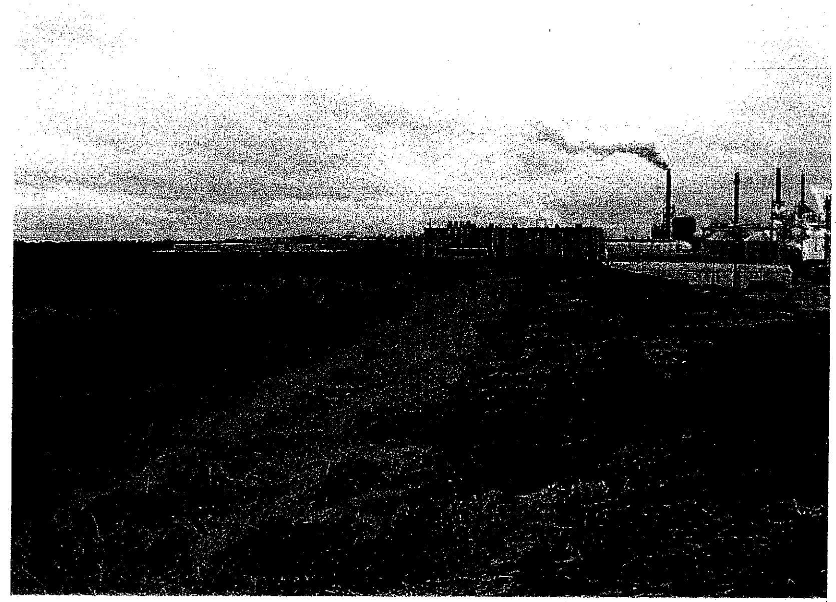

Photo 15  Secondary Sludge Zone Storm Water Ditch

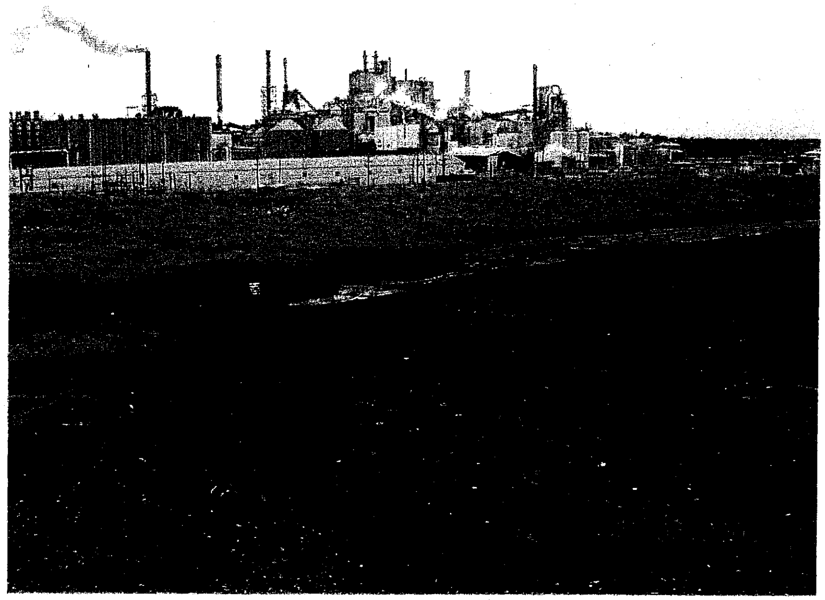

Photo 14  Secondary Sludge Zone Storm Water Drain Basin

Photo 16  Secondary Sludge Zone Storm Water Drain Basin

Photo 17  Emergency Overflow Chute

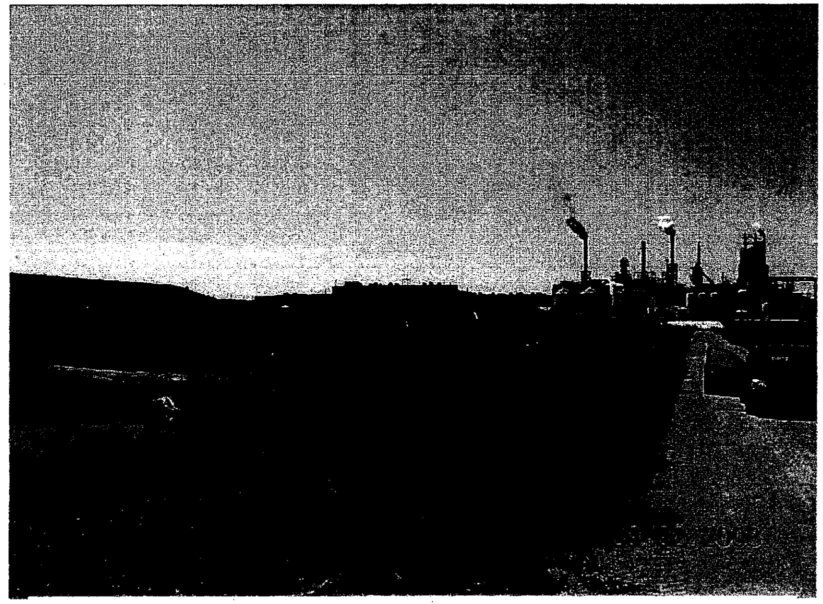

Photo 19  Cell One Voluntary Vegetation

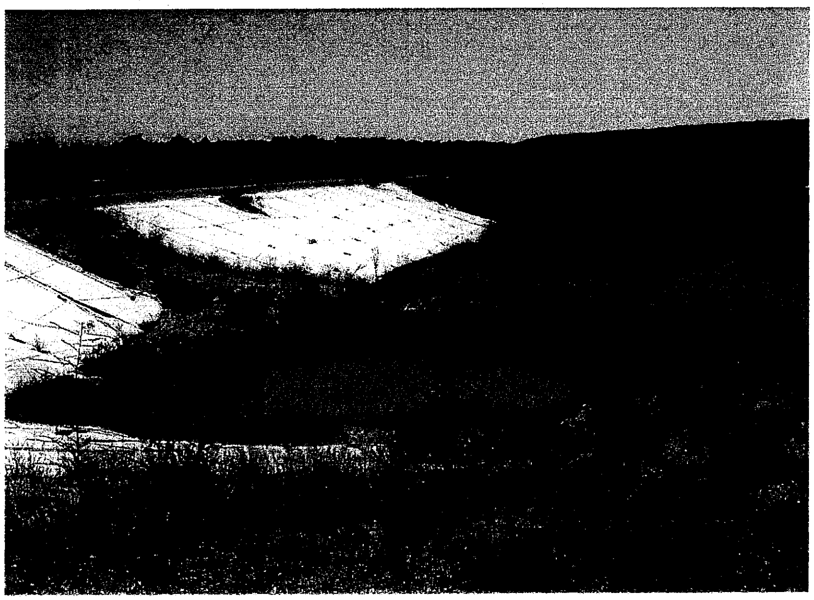

Photo 18  Cell One  Voluntary Vegetation

# Attachment

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue Tel: 919-828-0577
Raleigh, NC 27603 Fax: 919-828-3899

SHEET:
JOB #: IP-6
DATE: 7/28/2006
BY: G. Mills
CHKD BY:

International Paper, Riegelwood Mill
Agricultural Benefit of Sludge & Ash

Purpose: Determine the appropriate application of available material to promote vegetative growth on the final cover, based no agricultural analysis.

PART 1. AVAILABLE NUTRIENTS

| | | Nitrogen | Phosphate ($P_2O_5$) | Potash ($K_2O$) | pH | Ca | Mg | K | Na |
|---|---|---|---|---|---|---|---|---|---|
| SAMPLE | Dry Matter % | lbs/ 1000 gal | lbs/ 1000 gal | lbs/ 1000 gal | | ppm | ppm | ppm | ppm |
| IPASH-1 | 66.50% | 1.8 | 13.2 | 20.3 | 8.36 | 23747 | 2017 | 2541 | 2033 |
| IPASH-2 | 66.83% | 0 | 9.9 | 16.3 | 9.06 | 18399 | 1642 | 2039 | 1564 |
| IPSS-3 | 45.13% | 3 | 9.3 | 3.7 | 7.66 | 49155 | 887 | 809 | 1141 |
| IPSS-4 | 36.79% | 4.7 | 15.9 | 5 | 8.00 | 63040 | 1329 | 618 | 1622 |
| Avg. Ash | 66.67% | 0.9 | 11.55 | 18.3 | 8.71 | 21,073.0 | 1,829.5 | 2,290.0 | 1,798.5 |
| Avg Secondary | 40.96% | 3.85 | 12.6 | 4.35 | 7.83 | 56,097.5 | 1,108.0 | 713.5 | 1,381.5 |

PART 2. BLENDED TO CREATE SYNTHETIC SOIL

| | |
|---|---|
| PARTS ASH | 1 |
| PARTS SECONDARY SLUDGE | 3 |

| Property | Desired Range | Expected Result | Comment |
|---|---|---|---|
| Calcium | 60 - 70% | 92.4% | high |
| Magnesium | 10 - 20% | 2.5% | low |
| Potassium | 2 - 5% | 2.2% | low |
| Sodium | 0.5 - 3 % | 2.9% | OK |
| pH | 5.5-6.0 | 8.1 | high |

PART 3. USE AS A SOIL AMENDMENT

| | | | CY / ACRE |
|---|---|---|---|
| 1000's gals of Ash | | 0 | 0 |
| 1000's gals of Secondary | | 15.6 | 77 |
| Requirements: | | lbs/acre | |
| Nutrient | Min. | Max. | |
| Lime | 0 | 0 | 0 |
| Nitrogen | 40 | 60 | 60 |
| Phosphate ($P_2O_5$) | 110 | 130 | 196 |
| Potash ($K_2O$) | 0 | 20 | 68 |
| pH | | | 7.8 |

PART 4. PROBLEMS

1. Blend has too much Potash, which can cause the plants to take up too much water. Shouldn't be as big a problem with the secondary sludge, since it has so much water.
2. To much Phosphate prevents iron and magnesium uptake by the plant roots. Can cause leaves to turn yellow.
3. pH is too alkaline. Nutrients will become bound in the soil and unavailable for the plants. pH can be adjusted by adding Sulfur at approximately 1750 lb/acre, or adding Aluminum Sulfate at approximately 5.2 tons/acre.

PART 5. CONCLUSIONS

The ash-sludge mixture has been shown to be highly beneficial in promoting vegetative growth, based on a) field studies in containers, b) large-scale examples in the landfill and c) unplanned, volunteer growth on exposed ash-sludge mixtures in the operating landfill. Of the problems identified in Part 4, the only significant issue is the potential for the soil to become too alkaline, leaving nutrients bound in the soil and unavailable for plant growth. The alternative to using the ash-sludge mixture is to grow vegetation in the available sands on-site. In general, untended plots of land in the area evolve into pine forests, which would not be tolerated or sustainable on the landfill. The best available option is to monitor vegetative growth and soil pH, and apply sulfur or Aluminum Sulfate as necessary to maintain a pH balance that promotes vegetative growth.

BASED ON THE ANALYSIS, A 3 PARTS SLUDGE TO 1 PART ASH IS AN APPROPRIATE BLEND FOR DEVELOPING A BASE SOIL.
THE BASE SOIL BLEND SHOULD BE TOPPED WITH SLUDGE TO PROMOTE BALANCED pH AND VEGETATIVE GROWTH.

Nutritional requirements are for the soil sample labeled "IPBRM" taken from the Wright Chemical site, with the analysis dated May 7, 2002, for a crop of "Roadside Grass."
Nutritional analysis was don by the North Carolina Department of Agriculture (NCDA) in May 2002.
The soil and grass analyzed are similar to those expected to be similar to that grown on the capped landfill.
Analysis of Ash and Secondary Sludge done by NCDA in July 2006.

NCDA&CS Agronomic Division | 1040 Mail Service Center, Raleigh NC 27699-1040 | (919) 733-2655 | www.ncagr.com/agronomi/

# Understanding the Waste Analysis Report

www.ncagr.com/agronomi/pwshome.htm

Steve Troxler, Commissioner of Agriculture

**Waste products can provide essential plant nutrients to growing crops. They can also improve soil physical properties, such as (1) cation exchange capacity and (2) water drainage, infiltration and holding capacity. Waste products must be applied at agronomic rates and in ways that protect the environment.**

**Sample Info:** Sample identification number, waste code and description as supplied by grower on *Waste Sample Information* sheet

**Laboratory Results:** Concentrations (ppm) of essential nutrients (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B), Na, Cl (if requested), Mo (if requested), C (for composed wastes or those to be composted), heavy metals (Cd, Ni, Pb—for municipal or industrial by-products; Al, Li, Se—by special request only); pH (for composted, noncomposted and animal lagoon wastes); SS (electrical conductivity in units of $10^{-5}$ siemens/cm for composted and noncomposted waste); DM% (for litter, sludge, and other wastes that are dried before processing); CCE% and ALE (for wastes that may have neutralizing value)

**Recommendations:**

1) *Nutrients Available for First Crop* are based on estimates of mineralization rate and nutrient loss and depend on application method. Estimates are reported in lb/ton for solid waste and lb/1000 gal for liquid waste; T = a trace quantity (< 0.005 lb/unit).

Since 50–75% of the nutrients available for first crop become available within a month after application, apply wastes to crops near the time of planting to maximize uptake and reduce environmental impact. Remaining nutrients gradually become available over the next three months.

Nutrients not available for the first crop are mineralized to available forms over time, usually years. Nutrients like Zn and Cu may accumulate in the soil in significant quantities. If waste is routinely applied, monitor nutrient accumulation with soil tests *at least* once every two years. Some cropping systems and metal levels may necessitate annual soil samples.

ALE indicates the amount of the waste product required to equal one ton of good quality agricultural lime (CCE%=90). If waste materials have significant neutralizing value, apply them at rates necessary to optimize pH.

For flexibility, the information sheet allows two choices for application method. Predictions of available nutrients are based on the type of waste and the method of application. If you decide to change the application method after the analysis is complete, contact the Agronomic Division for a revised recommendation.

2) *Other Elements* include those that may have an impact on the environment (Na, Ni, Cd, Pb, Al, Se, Li) and indicate the likelihood of harmful buildup in the soil. As with nutrients, these measurements are reported in lb/ton or lb/1000 gal., as appropriate.

3) *Agronomic Comments* (when present) provide general information on the waste product and alert the user if plant nutrients or heavy metals are high enough to warrant special precautions when applying the waste. For diagnostic samples, site-specific recommendations are provided based on information sheet data. The more thoroughly the problem and its unique conditions are described on the information sheet, the more pertinent and site specific the recommendations will be.

**Key to abbreviations**

| | |
|---|---|
| Al | Aluminum |
| ALE | Ag lime equivalent |
| B | Boron |
| C | Carbon |
| C:N | Carbon-nitrogen ratio |
| Ca | Calcium |
| CCE% | $CaCO_3$ equivalence |
| Cd | Cadmium |
| Cl | Chloride |
| Cu | Copper |
| DM% | Percent dry matter |
| Fe | Iron |
| IN-N | Inorganic nitrogen |
| K | Potassium |
| $K_2O$ | Potash |
| Li | Lithium |
| Mg | Magnesium |
| Mn | Manganese |
| Mo | Molybdenum |
| N | Nitrogen |
| Na | Sodium |
| $NH_4$ | Ammonium nitrogen |
| Ni | Nickel |
| $NO_3$ | Nitrate nitrogen |
| OR-N | Organic nitrogen |
| P | Phosphorus |
| $P_2O_5$ | Phosphate |
| Pb | Lead |
| pH | Scale of acidity,alkalinity |
| ppm | parts per million |
| S | Sulfur |
| Se | Selenium |
| SS | Soluble salts |
| T | Trace quantity |
| Zn | Zinc |

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# Waste Analysis Report

7/21/2006

Grower: **Mills, Greg**
14 N Boylan Ave
Raleigh, NC 27603

Copies To:

Farm:

**Columbus County**

**Sample Information** — Sample ID: IPASHI; Waste Code: SAR; Description: Indust.-Stack Ash

**Laboratory Results (parts per million unless otherwise noted)**

| N | | P | K | Ca | Mg | S | Fe | Mn | Zn | Cu | B | Mo | Cl | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 426 | 987 | 2541 | 23747 | 2017 | 2279 | 2432 | 272 | 60.9 | 54.7 | 14.7 | | | |
| IN-N | | | | | | | | | | | | | | |
| -NH4 | | | | | | | | | | | | | | |

| N | | Na | Ni | Cd | Pb | Al | Se | Li | pH | SS | C:N | DM% | CCE% | ALE(Kgal) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -NO3 | | | | | | | | | | | | | | |
| OR-N | | 2033 | 13.3 | 0.39 | 7.60 | | | | 8.36 | | | 66.50 | 7.00 | 3.10 |
| Urea | | | | | | | | | | | | | | |

**Recommendations:**

| Application Method | N | P2O5 | K2O | Ca | Mg | S | Fe | Mn | Zn | Cu | B | Mo | Cl | Na | Ni | Cd | Pb | Al | Se | Li |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nutrients Available for First Crop | | | | | | | | | | | | lbs/1000 gallons | Other Elements | | | | | | lbs/1000 gallons |
| Broadcast | 1.8 | 13.2 | 20.3 | 138.6 | 11.8 | 13.3 | 14.2 | 1.6 | 0.36 | 0.32 | 0.09 | | | 17.0 | 0.11 | T | 0.06 | | | |
| Soil Incorp | 2.1 | 15.1 | 22.9 | 158.4 | 13.5 | 15.2 | 16.2 | 1.8 | 0.41 | 0.36 | 0.10 | | | 17.0 | 0.11 | T | 0.06 | | | |

Neutralizing value is very low. The waste product cannot be economically used as a liming material. Application rates should be based on crop nutrient requirement.

**Sample Information** — Sample ID: IPASH2; Waste Code: SAR; Description: Indust.-Stack Ash

**Laboratory Results (parts per million unless otherwise noted)**

| N | | P | K | Ca | Mg | S | Fe | Mn | Zn | Cu | B | Mo | Cl | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 0.00 | 738 | 2039 | 18399 | 1642 | 1582 | 2150 | 216 | 48.4 | 40.8 | 14.2 | | | |
| IN-N | | | | | | | | | | | | | | |
| -NH4 | | | | | | | | | | | | | | |

| N | | Na | Ni | Cd | Pb | Al | Se | Li | pH | SS | C:N | DM% | CCE% | ALE(Kgal) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -NO3 | | | | | | | | | | | | | | |
| OR-N | | 1564 | 10.3 | 0.32 | 8.05 | | | | 9.06 | | | 66.83 | 11.25 | 1.90 |
| Urea | | | | | | | | | | | | | | |

**Recommendations:**

| Application Method | N | P2O5 | K2O | Ca | Mg | S | Fe | Mn | Zn | Cu | B | Mo | Cl | Na | Ni | Cd | Pb | Al | Se | Li |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nutrients Available for First Crop | | | | | | | | | | | | lbs/1000 gallons | Other Elements | | | | | | lbs/1000 gallons |
| Broadcast | 0.00 | 9.9 | 16.3 | 107.4 | 9.6 | 9.2 | 12.6 | 1.3 | 0.28 | 0.24 | 0.08 | | | 13.0 | 0.09 | T | 0.07 | | | |
| Soil Incorp | 0.00 | 11.3 | 18.4 | 122.8 | 11.0 | 10.6 | 14.4 | 1.4 | 0.32 | 0.27 | 0.09 | | | 13.0 | 0.09 | T | 0.07 | | | |

Neutralizing value is very low. The waste product cannot be economically used as a liming material. Application rates should be based on crop nutrient requirement.

| Sample Information | Laboratory Results (parts per million unless otherwise noted) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sample ID:* | | *N* | *P* | *K* | *Ca* | *Mg* | *S* | *Fe* | *Mn* | *Zn* | *Cu* | *B* | *Mo* | *Cl* | *C* |
| IPSS3 | *Total* | 1211 | 809 | 460 | 49155 | 887 | 2268 | 1289 | 219 | 185 | 22.0 | 0.10 | | | |
| | *IN-N* | | | | | | | | | | | | | | |
| *Waste Code:* | *-NH4* | | | | | | | | | | | | | | |
| 100 | *-NO3* | | *Na* | *Ni* | *Cd* | *Pb* | *Al* | *Se* | *Li* | *pH* | *SS* | *C:N* | *DM%* | *CCE%* | ALE (Kgal) |
| *Description:* | *OR-N* | | 1141 | 16.8 | 0.64 | 7.16 | | | | 7.66 | | | 45.13 | 27.50 | 0.80 |
| Indust.-Other | *Urea* | | | | | | | | | | | | | | |

| Recommendations: | Nutrients Available for First Crop | | | | | | | | | | lbs/1000 gallons | | | Other Elements | | | | | lbs/1000 gallons | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Application Method* | *N* | *P2O5* | *K2O* | *Ca* | *Mg* | *S* | *Fe* | *Mn* | *Zn* | *Cu* | *B* | *Mo* | *Cl* | *Na* | *Ni* | *Cd* | *Pb* | *Al* | *Se* | *Li* |
| Broadcast | 3.0 | 9.3 | 3.7 | 246.0 | 4.4 | 11.4 | 6.5 | 1.1 | 0.92 | 0.11 | T | | | 9.5 | 0.14 | 0.01 | 0.06 | | | |
| Soil Incorp | 4.0 | 11.6 | 4.1 | 307.5 | 5.6 | 14.2 | 8.1 | 1.4 | 1.2 | 0.14 | T | | | 9.5 | 0.14 | 0.01 | 0.06 | | | |

The waste product contains large amounts of phosphorus, and zinc. The waste should be applied at rates needed to meet crop nitrogen requirement unless one of the other elements are more restrictive. When soil test P is very high and the site is vulnerable to phosphorus movement to nearby surface water, limit application of P to estimated crop removal of this element. Limit zinc application as necessary to avoid excess accumulation of this element in the soil.

The waste product contains a large amount of sodium. This element can accumulate in soils where it replaces calcium and contributes to excess soluble salts. Sodium may also damage the foliage of sensitive plants where the waste is a liquid and applied in overhead irrigation systems. Monitor sodium accumulation in the soil where the waste is routinely applied.

Nickel concentration is near the EPA ceiling concentration for municipal sludge applied on agricultural land. Consult state and local authorities concerning proper disposal of the waste product.

| Sample Information | Laboratory Results (parts per million unless otherwise noted) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sample ID:* | | *N* | *P* | *K* | *Ca* | *Mg* | *S* | *Fe* | *Mn* | *Zn* | *Cu* | *B* | *Mo* | *Cl* | *C* |
| IPSS4 | *Total* | 1860 | 1388 | 618 | 63040 | 1329 | 3744 | 1922 | 345 | 258 | 29.3 | 0.00 | | | |
| | *IN-N* | | | | | | | | | | | | | | |
| *Waste Code:* | *-NH4* | | | | | | | | | | | | | | |
| 100 | *-NO3* | | *Na* | *Ni* | *Cd* | *Pb* | *Al* | *Se* | *Li* | *pH* | *SS* | *C:N* | *DM%* | *CCE%* | ALE (Kgal) |
| *Description:* | *OR-N* | | 1622 | 30.4 | 1.00 | 10.7 | | | | 8 | | | 36.79 | 31.25 | 0.70 |
| Indust.-Other | *Urea* | | | | | | | | | | | | | | |

| Recommendations: | Nutrients Available for First Crop | | | | | | | | | | lbs/1000 gallons | | | Other Elements | | | | | lbs/1000 gallons | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Application Method* | *N* | *P2O5* | *K2O* | *Ca* | *Mg* | *S* | *Fe* | *Mn* | *Zn* | *Cu* | *B* | *Mo* | *Cl* | *Na* | *Ni* | *Cd* | *Pb* | *Al* | *Se* | *Li* |
| Broadcast | 4.7 | 15.9 | 5.0 | 315.5 | 6.7 | 18.7 | 9.6 | 1.7 | 1.3 | 0.15 | 0.00 | | | 13.5 | 0.25 | 0.01 | 0.09 | | | |
| Soil Incorp | 6.2 | 19.9 | 5.6 | 394.3 | 8.3 | 23.4 | 12.0 | 2.2 | 1.6 | 0.18 | 0.00 | | | 13.5 | 0.25 | 0.01 | 0.09 | | | |

The waste product contains large amounts of nitrogen, phosphorus, zinc, and copper. The waste should be applied at rates needed to meet crop nitrogen requirement unless one of the other elements are more restrictive. When soil test P is very high and the site is vulnerable to phosphorus movement to nearby surface water, limit application of P to estimated crop removal of this element. Limit applications of zinc and copper as necessary to avoid excess accumulation of these elements in the soil.

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