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REMEDIAL ACTION WORK PLAN

Remedial Activities for Lagoon Area

Prepared for

BASF CORPORATION
Rensselaer, New York

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1.0 INTRODUCTION

Remedial Engineering, P.C. (Remedial Engineering) and Roux Associates, Inc. (Roux Associates), on behalf of the BASF Corporation (BASF), have prepared this Remedial Action Work Plan (RAWP) to describe the capping of the Lagoon Area located at the BASF Rensselaer Facility, Rensselaer, New York (Figure 1).

The capping design for the Lagoon Area consists of an alternative cover with multiple fill layers that will be vegetated with indigenous plant species in a configuration that will meet the requirements for a low permeable cap as specified in the Record of Decision for the BASF Manufacturing Plant Site Operable Unit No. 1 (OU-1 ROD), dated September 2003. In accordance with the OU-1 ROD, the objectives of the Lagoon Area alternative cover are as follows:

- Eliminate the threat to human health associated with potential exposure to Lagoon Area soil; and
- Mitigate or eliminate infiltration into Lagoon Area soil.

1.1 Previous and Ongoing Remedial Activities

Remedial activities completed in the Lagoon Area include:

- Excavation of 7,300 tons (5,600 cubic yards) of arsenic-impacted soil (Areas 4A and 4C groundwater source areas) described in the report titled "Interim Remedial Measure Remedial Action Completion Report" (Roux Associates, December 16, 2005);
- Removal of standing water and sludge from the north and south lagoons as summarized in the "North and South Lagoon Remedial Action Completion Report" (Roux Associates, October 27, 2005), which included:
  - Draining standing water from the north and south lagoons;
  - Dredging of sludge from each lagoon;
  - Physical/chemical processing (pre-treatment) and offsite disposal of the dredged sludge;
  - Mechanical separation and offsite disposal of sludge from riprap rock that lined the lagoon sidewalls;
  - Emplacement of cleaned riprap rock into the north lagoon for use as fill; and
  - Process piping removal.

- Two rounds of *in situ* treatment of arsenic-impacted groundwater with Metals Remediation Compound (MRC™), as summarized in the report titled "Remedial Action Report and Remedial Action Work Plan for Lagoon Area Groundwater" (Roux Associates, August 22, 2007).

In addition to the above-completed remedial actions, an additional round of MRC™ injection is planned for Lagoon Area groundwater, as described in the "Revised Work Plan for Supplemental Treatment of Arsenic in Lagoon Area Groundwater" (Roux Associates, February 25, 2008 letter to the NYSDEC). The additional injection will be performed in Spring 2008.

The previous remedial actions performed in the lagoon area and the capping will ensure that public health and environment are protected and portions of the lagoon area will be available for redevelopment.

2.0 PROPOSED REMEDIAL DESIGN FOR LAGOON AREA COVER

The proposed alternative cover for the Lagoon Area will consist of multiple fill layers with a minimum total thickness of 30 inches. The cover layers will be placed directly on top of the re-graded existing site soil surface.

The cover layers will provide a stable environment for vegetation growth while providing an adequately sloped surface to promote runoff and reduce infiltration. The Lagoon Area will be vegetated with a variety of native grasses, trees, and shrubs as outlined in Table 1. The proposed Lagoon Area cover will meet the substantive requirements for a low permeability cap as specified in the OU-1 ROD via the following mechanisms:

- The soil cover and biota barrier will eliminate human health and wildlife exposure to constituents in the underlying Lagoon Area soil; and
- The combination of grading improvements, evapotranspiration mechanisms, and water storage in the soil will eliminate or mitigate recharge/infiltration in the Lagoon Area, thereby minimize groundwater flow through the Lagoon Area to the adjacent Hudson River.

The following sections provide a summary of each component of the Lagoon Area alternative cover. The plan view of the proposed alternative cover is provided on Plate 1. Profile views of the cover are provided on Plate 2.

2.1 Grading Plan

Prior to installation of the cover layers, the Lagoon Area surface will be graded to slope generally from Riverside Avenue toward the Hudson River to prevent ponding and promote surface drainage. The western banks of the north and south Lagoons will be cut and used as fill in the lagoons as illustrated on Plates 1 and 2. Additional fill material required to meet the overall slope (between 2 and 12 percent) will be obtained from an approved offsite source. The overall slope of the Lagoon Area surface will promote stormwater runoff and reduce infiltration.

A lined (40-mil high density polyethylene (HDPE)) detention basin for stormwater control will be integrated into the grading plan over the South Lagoon as shown on Plate 1. The detention basin will be designed to retain stormwater runoff from the Site, up to a 10-year 24-hour storm event.

2.2 Cover Layers

Following grading of the Lagoon Area surface, the remaining cover layers will be installed. The proposed alternative cover for the Lagoon Area will consist of the following fill layers (minimum 30-inch total thickness):

- 6-inch biota barrier (coarse aggregate or stone);
- 18-inch common fill layer; and
- 6-inch topsoil layer.

All imported fill will be certified clean from an approved offsite source.

The biota barrier for the Lagoon Area will be composed of a 6-inch layer of 1 to 2-inch coarse aggregate (e.g., recycled concrete aggregate or equivalent), which is consistent with the construction of the biota barrier installed during closure of the Landfill. The biota barrier will be installed to prevent burrowing animals from contacting underlying Lagoon Area soil. The biota barrier will not be placed within the footprints of the former North and South Lagoons, as the lagoon void spaces will contain approximately 10 feet of clean fill to meet the topographic elevations illustrated on Plates 1 and 2 and the overall slope (between 2 and 12 percent) for positive drainage. Beneath the detention basin, where there is less fill thickness, the 40-mil HDPE liner will serve as the biota barrier.

Approximately 18-inches of common fill will be installed over the biota barrier. The common fill layer will be compacted and proof rolled as necessary. As noted above, the thickness of the common fill will be up to 10-feet thick within the former North and South Lagoon volumes to bring the lagoon voids up to the proposed topographic elevations.

Approximately six inches of loam-type topsoil will be placed over the common fill to provide a rooting medium for mechanical support and anchoring of the specified cover vegetation. The topsoil layer is also designed to provide sufficient temporary water storage during storm events to prevent infiltration. Water stored within the surface soil layers (both the topsoil and the common fill) will be removed via evapotranspiration mechanisms, as discussed in further detail in the water balance Section 3.2.

2.3 Planting Plan

The Lagoon Area will be vegetated with a diversity of native species with high ecological value, similar to the Landfill alternative cover. A conceptual planting plan is provided in Table 1. Species to be planted include a diversity of riparian enhancement species designed to provide stabilization of the re-graded Hudson River shoreline, ecological enhancement to the river habitat, while providing hydraulic control of infiltrating precipitation via evapotranspiration losses. The vegetation selected has a medium to high wildlife habitat value by either providing food (e.g., berry production) or shelter (e.g., large leaf canopy).

The planting plan provides complete detail on the vegetation species (common name and scientific name), planting densities and quantities for each of the selected species (Table 1). Immediate erosion control will be achieved through the use of native grass seed for understory cover (Table 2). The understory seed mix will provide immediate soil stabilization as the shrubs and trees become established. Incorporation of the understory seeding will additionally limit the potential for colonization by invasive plant species, yet still allow for introduction of the plants specified in the planting plan.

2.4 Drainage and Erosion Control

The proposed Lagoon Area cover will be sloped generally from east to west during grading to promote positive drainage, reduce infiltration and minimize erosion. The cover design includes a dense vegetative cover to provide protection from wind and water erosion. Erosion control in the interim period while the vegetative species are being established will be achieved by applying straw with tackifier, or hydromulch with tackifier if the soil will be exposed for three weeks or more prior to planting. If planting occurs within three weeks after earth work is done, mulch will be placed between the plants.

A significant advantage of the alternative cover design over a conventional impermeable cap (asphalt or clay) is reduction in stormwater runoff and improvement in stormwater quality. The cover has been designed to reduce stormwater runoff volumes and mitigate the erosive properties of significant storm events via the incorporation of mild slopes, dense vegetation cover, and an integrated stormwater detention basin sized to accommodate a 10-year, 24-hour storm event.

Under the mean monthly precipitation scenario, there is no potential for infiltration of precipitation into the underlying Lagoon Area soil (as discussed in Section 3.2).

2.5 Long-Term Maintenance

In contrast to the performance of asphalt, compacted clay or geomembrane caps, which can deteriorate with time due to differential settling, freeze-thaw cracking, desiccation cracking, and plasticizer leaching, the performance of the proposed alternative cover is expected to improve with time due to root and plant development and increased water holding capacity as the soil horizons develop and incorporate natural organic matter into the soil. Therefore, long-term maintenance requirements of the alternative cover are expected to decrease with time, as opposed to increased maintenance requirements with time for conventional caps.

3.0 ROD CAP EQUIVALENCY ANALYSIS

The ROD specifies a low permeable cap, utilizing asphalt and existing concrete, to be installed over Site areas with residual soil contamination that are not currently covered by asphalt or concrete. The cap would have the two-fold purpose of preventing direct contact with underlying soil, and mitigating or eliminating infiltration of precipitation into impacted soil, which could mobilize constituents into groundwater. An equivalency analysis was performed to demonstrate that the ROD capping objectives will be met with the alternative cover design for the Lagoon Area.

Unlike conventional covers, alternative covers are not dependent on a layer having a low saturated hydraulic conductivity to minimize infiltration. Rather, alternative covers use a combination of soil water storage and evapotranspiration to reduce infiltrating precipitation from migrating into impacted soil. Alternative covers achieve equivalent performance to conventional impermeable covers through an action that has been described as 'sponge and pump': the soil and plants absorb moisture from precipitation, store it in the plant and soil structure, and later release much of that moisture back to the atmosphere through evaporation directly from the soil, or through transpiration from the plants.

Alternative cover designs are increasingly being tested, approved and installed at a variety of facilities. These alternative covers are being installed in place of the conventional low permeable caps based on their proven success for long term protection, stability and sustainability. The NYSDEC approvals of both the General Electric (GE) Main Plant agronomic cover design in Rotterdam, New York and the Alternative Landfill Cover Design for the BASF Rensselaer Landfill have set precedents for the future implementation of alternative cover designs in New York State.

Citations supporting the use of alternative covers for this purpose include:

- ***The Alternative Covers Assessment Program (ACAP).*** The Alternative Cover Assessment Program was established by the USEPA to provide a comparison between alternative covers and conventional low permeability covers. A series of test facilities were constructed across the country to collect performance data on site-specific designs. The sites included a variety of climatic conditions, with varying rainfall, temperature, altitude and growing season; and

- ***Green Remediaiton.*** USEPA is committed to developing and promoting innovative cleanup strategies that restore contaminated sites to productive use, reduce costs, and promote environmental stewardship, while ensuring that cleanups are protective of human health and the environment. USEPA strives for cleanup programs that use natural resources and energy efficiently, reduce negative impacts on the environment, minimize pollution at its source, and reduce waste to the greatest extent possible. The USEPA supports the adoption of green remediation as the practice of considering all environmental effects of cleanup actions and incorporating strategies to maximize the net environmental benefit, including the application of alternative covers.

- ***NYSDEC Approval of an agronomic cover system for closure of the former East and West Landfills at the General Electric Main Plant in Rotterdam, New York (NYSDEC, 2004).*** The selected cover is an integrated plant and soil system that has a deep soil profile with abundant vegetative cover and an adequate water holding capacity so that precipitation and surface percolation is removed by evaporative losses from the soil surface and transpiration by the vegetation. The agronomic cover consists of a bi-modal plant community: plants that remove large amounts of water (i.e., willows and poplars) and plants selected for their ecological restoration value.

- ***NYSDEC Approval of an alternative cover system for closure of the former Landfill at the Site.*** The selected cover is an integrated plant and soil system that has a deep soil profile, with abundant vegetative cover and an adequate water holding capacity, so that precipitation and surface percolation is removed by evaporative losses from the soil surface and transpiration by the vegetation. The agronomic cover consists of a bi-modal plant community: plants that remove large amounts of water (i.e., willows and poplars) and plants selected for their ecological restoration value.

The proposed alternative cover design for the Lagoon Area is consistent with the design of the Alternative Landfill Cover in that the proposed Lagoon alternative cover replaces the need for a low permeable cap with a combination of multiple fill layers and vegetation to prevent infiltration. Provided in the following sections is a summary of how the proposed alternative cover will meet or exceed the ROD requirements for the Lagoon Area cap.

3.1 Protect Human Health and the Environment

The ROD specifies that a low permeable cap utilizing asphalt and existing concrete be installed across the Site areas with residual soil contamination to prevent human exposure. Alternative covers are one of the most efficient and beneficial methods to manage the human and ecological risks associated with contaminated soils. This will be accomplished with the alternative cover design for the Lagoon Area via the following:

- A minimum 30-inch thick fill layer with an integrated biota barrier; and

- Slope stabilization and erosion control via the use of a dense vegetative cover.

These design elements will provide a long-lasting, low-maintenance physical barrier to prevent direct contact with underlying soil.

3.2 Minimize Infiltration

The ROD specifies that a low permeable cap be installed over areas with residual soil contamination to eliminate or mitigate infiltration. To demonstrate equivalency with this ROD requirement, a water balance[1] evaluation was conducted based upon mean monthly climatology.

The proposed Lagoon Area cover design will greatly decrease the infiltration into the underlying soils via soil storage and evapotranspiration through a combination of a multiple fill layers and vegetative plantings. As described in the following sections, the projected water balance for the proposed alternative cover design demonstrates equivalency with the ROD design objective of preventing infiltration.

Water Balance

A water balance has served as the basis for several studies to design, test, and evaluate a variety of cover alternatives (Nyhan et al., 1990; Hakonson et al., 1992; Hakonson et al., 1993; Lane 1984; Lane and Nyhan 1984). Water balances are used to evaluate the role of vegetation in removing soil moisture via evapotranspiration, the use of subsurface barriers to intercept and divert percolating water, and surface management practices to control runoff and erosion.

Due to the numerous environmental factors affecting a water balance, local climatologic data (air temperature, relative humidity, precipitation, wind speed, and wind direction) collected from the Albany International Airport weather station were used to quantify potential water use and infiltration from the proposed alternative cover according to the following equation.

[1] The water balance was developed to demonstrate ROD equivalent water balance for areas of the Lagoon Area where unsaturated soil directly overlies groundwater, and does not include the former North and South Lagoons or the proposed stormwater detention basin. These areas are either lined with low permeable clay (North and South Lagoon) or a 40-mil HDPE liner (stormwater detention basin) and, therefore, already meet the ROD requirements.

Net Water Balance = Precipitation – Stormwater Runoff – Soil Storage – Evapotranspiration

As local climatology varies seasonally, the detailed water balance for the proposed Lagoon Area design was calculated on a monthly basis to verify seasonal equivalency (Table 3).

Precipitation/Stormwater Runoff

Mean annual precipitation for the Albany region was estimated to be 38.6 inches (Table 3). Based upon the findings of the TR-55 modeling analysis previously completed for the Landfill portion of the facility, monthly stormwater runoff from the Lagoon Area surface was estimated to be 10 percent during the growing season (April through November). During the winter months (December, January, and February), runoff was assumed to be 100 percent due to frozen soil conditions. During the spring thaw (March), runoff was assumed to be approximately 75 percent due to partial frozen soil conditions.

Soil Moisture Storage

Soil moisture storage refers to the amount of water held in the soil at any particular time. The amount of water in the soil depends on soil properties (i.e., soil texture and organic matter content). When the alternative cover is installed, the surficial soil layers of the lagoon cover will consist of at least of 24 inches common fill and topsoil. The field capacity (the maximum volume of water the soil can hold) of the common (sandy) fill is 0.062 (on a volume per volume basis [vol/vol]), while the topsoil's (silt loam) field capacity is 0.284 (vol/vol). Thus, approximately 18 inches of common fill and 6 inches of topsoil will provide 2.82 inches of water storage capacity to temporarily store precipitation until it is subsequently removed by the cover vegetation via evapotranspiration mechanisms. Infiltration will only occur when the soil moisture content exceeds 2.82 inches. As will be discussed below, the water balance demonstrates that this is unlikely to occur under annual weather conditions based on historical climate records.

Potential Evapotranspiration

Potential evapotranspiration (PET) values for a standard grass crop were estimated using the modified Penman-Monteith method (Allen et al., 1998):

$$ET = \frac{\Delta(R_n - G) + \rho_a c_p \dfrac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \dfrac{r_s}{r_a}\right)}$$

where R_n is the net radiation, G is the soil heat flux, $(e_s - e_a)$ represents the vapor pressure deficit of the air, ρ_a is the mean air density at constant pressure, c_p is the specific heat of the air, Δ represents the slope of the saturation vapor pressure temperature relationship, γ is the psychrometric constant, and r_s and r_a are the (bulk) surface and aerodynamic resistances.

To estimate PET from the proposed alternative cover design, the calculated grass evapotranspiration is multiplied by leaf area index and crop coefficient values reported for the proposed plantings (Allen et al., 1998; Snyder et al., 2004). The leaf area index and crop coefficient values for the species selected will result in greater evapotranspiration rates than a standard grass crop. Evapotranspiration rates for the proposed vegetation range from zero inches in the non-growing season (December to February) to over five inches in July (Table 3).

Net Water Balance

An average of 63 percent of the annual precipitation falls during the April through October period, leaving 37 percent to fall from November through March when PET is estimated to be zero. During winter months, moisture in the soil is assumed to be frozen; therefore, water will not infiltrate and all stormwater will runoff the soil surface. In the spring, as the soil thaws, precipitation recharges the soil moisture until field capacity is reached (March to April). However, as demonstrated in Table 3, soil moisture (maximum soil water storage capacity reached = 2.64 inches in April) never exceeds field capacity (2.82 inches) and, thus, infiltration is prevented. As spring progresses, vegetation leafs out and begins to transpire the stored water in the surface soil, thereby reducing soil moisture content (2.05 inches in May) and providing more soil water storage capacity to further prevent infiltration.

As the growing season continues and temperatures increase, the cover vegetation on the Lagoon Area is capable of transpiring more water than is stored in the cover soil matrix, resulting in a soil moisture deficit (July through October; Table 3). In the fall, as the cover vegetation across the Lagoon Area begins to senesce, precipitation begins to exceed potential evapotranspiration

and water begins to recharge the soil moisture (2.06 inches in November; Table 3). Due to the frozen surface soil conditions in winter, soil moisture never fully recharges to maximum field capacity of 2.82 inches, thereby maintaining 0.76 inches of available storage.

In conclusion, the water balance demonstrates that the Lagoon Area cover will provide hydraulic control even during dormancy periods, with the cover soil material providing additional storage capacity for occasional high capacity rain events.

4.0 HASP AND CAMP

A Site-specific Health and Safety Plan (HASP) will be prepared prior to performing Work at the Site. The HASP will be consistent with the requirements of OSHA (29 CFR 1910 and 1926), federal, state, and local authorities.

All personnel working at the Site must be OSHA HAZWOPER-certified and have obtained medical clearance to perform the Work at the Site.

A Fugitive Dust Suppression and Particulate Monitoring Program consistent with the NYSDEC Technical Administrative Guidance Memorandum 4031 will be implemented during earth moving work. Dust suppression will be achieved, at a minimum, through the use of a dedicated onsite water truck equipped with a water cannon to enable the spray of water into off-road areas, including excavations and stockpiles.

A Community Air Monitoring Program (CAMP) will be implemented to adhere to any personal protective equipment upgrades, additional dust suppression requirements and/or work stoppages that may be required based upon the results of the CAMP monitoring.

5.0 SUMMARY AND CONCLUSIONS

Alternative cover designs are increasingly being installed in place of the conventional low permeable caps due to their proven success for long term protection, stability, and sustainability. The NYSDEC approval of both the GE agronomic cover design in Rotterdam, New York and the Alternative Landfill Cover Design for the Site have set precedent for the future implementation of alternative cover designs in New York State.

The proposed alternative cover for the Lagoon Area is consistent with the NYSDEC-approved BASF Landfill Cover in that the Lagoon Area cover is a multi-layer cover that uses vegetation and the water storage capacity of soil to minimize infiltration and prevent direct contact. The risks to human health and the environment associated with the Lagoon Area soil will be mitigated or eliminated through the following key design elements:

- The soil cover and biota barrier will eliminate direct human health and wildlife exposure to underlying soil;
- The combination of soil water storage and enhanced evapotranspiration will result in the reduction of infiltration that would lead to groundwater recharge;
- The planted vegetation will provide erosion protection for the Lagoon Area soils through root zone stabilization mechanisms;
- Positive grading toward the Hudson River will help reduce infiltration;
- Stormwater quality improvement will occur via filtration through the cover vegetation; and
- Stormwater conveyance to an integrated detention basin will manage significant storm event runoff.

As demonstrated through the detailed evaluation above, the proposed Lagoon Area alternative cover will meet the substantive requirements for an impermeable cap as specified in the ROD for OU-1 through the combination of the multiple fill layers, positive grading, and vegetative cove and integrated detention basin, together with the previous remedial actions (soil source area excavation and *in situ* groundwater remediation).

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Table 1. Proposed Groundcover for Ecological Enhancement of Lagoon Area
BASF Corporation, Rensselaer Facility

Common Name	Scientific Name	Rooting Depth (inches)	Bloom Period	Wildlife Value	Bloom Color	Light Preference	Moisture Preference	Height (feet)	Notes
Trees									
Pincherry	*Prunus pensylvanica*	20	mid-spring	high	white	Sun	Moist-Dry	30	Fruit provides food for birds and large and small mammals. Buds are also eaten by some bird species. Foliage and twigs are browsed by deer.
Eastern Red Cedar	*Juniperus virginiana*	20	May	very high	green	Sun	moist	40-50	Provides food and cover for numerous birds and mammals. Winter food and protection is particularly important for pheasant, mule deer and whitetail deer.
Flowering Dogwood	*Cornus florida*	18	April-June	very high	white	Sun-shade	moist	10-30	Fruit provides fall and winter food for numerous birds and small mammals. The leaves and twigs are choice food for the white-tailed deer.
Quaking Aspen	*Populus tremuloides*	32	mid-spring	high	blue	Sun-shade	Moist-dry	40	Young quaking aspen provides food and habitat for a variety of wildlife including birds and small and large mammals.
American Basswood	*Tilia americana*	30	late-spring	high	yellow	Sun-shade	moist	60	Basswood is good browse and buds are important for birds and deer in winter. Fruits are eaten by birds and small mammals. The wood decays easily and produces many cavities, which are used by cavity-nesting animals).
Shrubs									
Highbush Cranberry	*Viburnum opulus*	14	May-June	high	white	Sun-shade	Moist-Dry	12	Twigs and fruit provide food for small mammals and birds. Shrubs provide cover small mammals and birds.
Northern Bayberry	*Myrica pensylvanica*	20	May-July	high	yellow	Sun	Moist-Dry	10	Berries provide food for birds, and are key to migrating swallows. These fruit are retained on the plant well into winter above any accumulated snow. Provides year-round shelter for birds and mammals.
Purple Flowering Raspberry	*Rubus odoratus*	16	late spring	high	purple	Sun-shade	Moist-Dry	5	Very commonly used by songbirds, game birds, and large and small mammals.
Red-Oiser Dogwood	*Cornus sericea*	16	late spring	medium	white	Sun-shade	Moist-Dry	5	Very commonly used by waterfowl, marshbirds and shorebirds as well as large and small mammals. Deer browse on dogwood year-round.
Fragrant Sumac	*Rhus aromatica*		April-June	high	yellow	Sun-shade	Moist-dry	5-12	Berries provide winter food for large and small mammals and birds. Thickets provide cover for many species of birds and small mammals

Table 2. Proposed Groundcover for Lagoon Area Alternative Cover

BASF Corporation, Rensselaer Facility

Northeast Upland Wildflower/Restoration Erosion Mix		
Scientific Name	**Common Name**	**Percent**
Grass Portion		
Agrostis alba	Redtop	60.8%
Festuca rubra	Red Fescue	27.5%
Lolium multiflorum	Annual Ryegrass	11.7%
Legume Portion		
Lotus corniculatus	Birds-Foot Trefoil	100.0%
Wildflower Portion		
Achillea millefolium	Common Yarrow	41.9%
Rudbeckia hirta	Black-eyed Susan	24.1%
Chrysanthemum leucanthem	Ox-Eye Daisy	9.8%
Aster novae-angliae	New England Aster	8.6%
Hesperis matronalis	Dame's Ricket	6.5%
Daucus carota	Queen Anne's Lace	5.8%
Polygonum pensylvanicum	Pennsylvania Smartweed	3.3%

Source : Southern Tier Consulting

Table 3. Monthly Water Balance summary for Lagoon Area Alternative Cover
BASF Corporation, Rensselaer Facility

	Precipitation [1]	Stormwater Runoff [2]	Soil Moisture Content [3]	Soil Water Storage Capacity [3]	Potential ET [4]	Water Balance [5]
	inches	inches	inches	inches	inches	inches
JAN	2.71	-2.71	2.06	0.76	0.00	0.00
FEB	2.27	-2.27	2.06	0.76	0.00	0.00
MAR	3.17	-2.38	2.19	0.63	-0.67	0.00
APR	3.25	-0.33	2.64	0.18	-2.47	0.00
MAY	3.67	-0.37	2.05	0.77	-3.89	0.00
JUN	3.74	-0.37	0.95	1.87	-4.46	0.00
JUL	3.50	-0.35	0.00	2.82	-5.05	-0.94
AUG	3.68	-0.37	0.00	2.82	-4.85	-1.54
SEPT	3.31	-0.33	0.00	2.82	-3.98	-1.00
OCT	3.23	-0.32	0.00	2.82	-3.20	-0.29
NOV	3.31	-0.33	2.06	0.76	-0.92	0.00
DEC	2.76	-2.76	2.06	0.76	0.00	0.00
NET	38.60	-12.89	16.07	17.77	-29.49	-3.78

Notes:

[1] Precipitation based upon 30 year mean precipitation recorded at Albany International Airport.

[2] Stormwater runoff estimated as follows:

a. During winter months (December through February) when ground is frozen, runoff is estimated to be 100%.

b. In late winter/early Spring (March) when ground starts to thaw, runoff is estimated to be 75%.

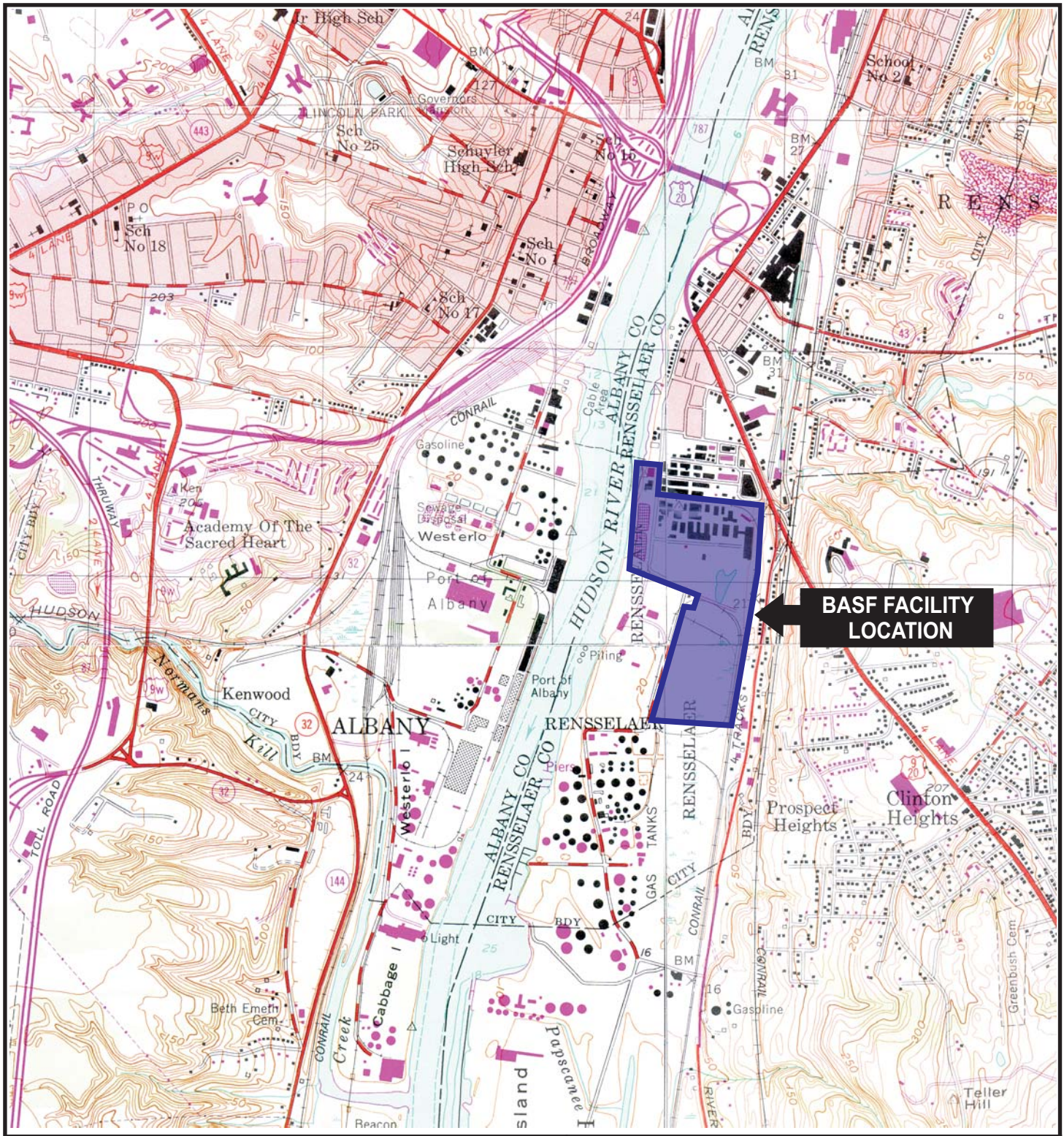
c. During spring, summer and fall months (April through November), monthly average runoff is estimated to be 10% of the monthly average rainfall based on the results of the Soil Conservation District's TR-55 runoff simulation

[3] Soil moisture content/capacity = 2.82 inches; [(6 inches of silt loam amendment x 0.284 field capacity)+(18 inches of sandy fill x 0.062 field capacity)]

[4] Potential evapotranspiration calculated from data recorded at the Albany International Airport using the modified Penman-Monteith method (Allen et al., 1998).

[5] Water balance calculated based upon following equation:

Water Balance = Precipitation + Stormwater Runoff - Soil Water Storage Capacity + Potential Evapotranspiration



QUADRANGLE LOCATION

N

0 2000'

SOURCE:
USGS; 1980. Albany, New York;
USGS; 1980. Troy South, New York
USGS; 1980. Delmar, New York
USGS; 1980. East Greenbush, New York
7.5 Minute Topographic Quadrangles

Title:

SITE LOCATION MAP

BASF RENSSELAER LAGOON AREA
REMEDIAL ACTION WORK PLAN

Prepared for:
BASF CORPORATION
FLORHAM PARK, NEW JERSEY

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: O.R.		Date: 11JUN08	FIGURE
Prepared by: B.H.C.		Scale: AS SHOWN	
Project Mgr.: O.R.		Office: NY	1
File No.: BF1150103.CDR		Project No.: 25111Y31	

N:\PROJECTS\BF251Y\BF11Y\501\BF1150103.CDR

HUDSON RIVER

N

20' TEMPORARY EMERGENCY SPILLWAY INSTALL TOPSOIL 6" LOWER IN THIS AREA

EDGE OF WATER

EXISTING VEGETATION TO BE REMOVED. ALL MATURE DECIDUOUS TREES LARGER THAN 6 INCHES IN DIAMETER ALONG THE RIVER BANK AREA, WHERE THERE IS NO BULKHEAD, SHALL BE PROTECTED AND REMAIN

EXISTING VEGETATION TO BE REMOVED

CONCRETE DEADMAN ARE LOCATED APPROXIMATELY 55' FROM EXISTING BULKHEAD SYSTEM (TYP.) TIE-RODS ARE SPACED AT 12' MIN O.C. (ELEVATION VARIES)

A

A'

B

B'

TOP OF RETENTION BASIN BERM (16.5')

SEWER LINE EASEMENT NOT TO BE DISTURBED

PROPOSED LINED RETENTION BASIN

EXISTING LAGOON BOTTOM ELEV. = 4'0"

NORTH LAGOON
EXISTING LAGOON BOTTOM ELEV. = 4'0"

LIMIT OF LINER (ANCHOR TRENCH TO EXTEND OUTSIDE THIS LINE)

EXISTING ELECTRICAL JUNCTION/PULLBOX

EXISTING BURIED ELECTRICAL LINE

LIMIT OF LAGOON CAP (SEE NOTE 8)

6' CHAIN LINK FENCE

CURB

WATER LINE EASEMENT NOT TO BE DISTURBED

APPROX. LOCATION OF WATER LINE FROM RECORD PLANS 15' EASEMENT

RIVERSIDE AVENUE

EXISTING VEGETATION TO BE REMOVED

EXISTING GCS TRENCH WITH ASSOCIATED STRUCTURES NOT TO BE DISTURBED

MAP REFERENCES:

1. ALTA/ACSM LAND TITLE SURVEY LANDS NOW OR FORMERLY OF BASF WYANDOTTE, CORPORATION PREPARED FOR BESICORP-EMPIRE DEVELOPMENT, LLC, CITY OF RENSSELAER, RENSSELAER COUNTY, NEW YORK, PREPARED BY C.T. MALE ASSOCIATES DATED JANUARY 31, 2001, DWG. NO. 01-114R.
2. TOPOGRAPHIC SURVEY LANDS NOW OR FORMERLY OF BASF WYANDOTTE, CORPORATION, PREPARED FOR BESICORP-EMPIRE DEVELOPMENT, LLC, CITY OF RENSSELAER, RENSSELAER COUNTY, NEW YORK, PREPARED BY C.T. MALE ASSOCIATES DATED JANUARY 28, 2001, DWG. NO. 01-109.
3. RECORD SURVEY OF GCS AREAS 2, 3, 4, 5, 6 AND 7 PREPARED FOR OBRIEN AND GERE ENGINEERS, INC., PREPARED BY C.T. MALE ASSOCIATES P.C., DATED JULY 2, 2003, DWG NO. 03-450. MODIFICATIONS TO GCS AREA 3 IN 2004 ARE BASED ON FIELD MEASUREMENTS PROVIDED BY O'BRIEN AND GERE OF NORTH AMERICA, INC. IN FEBRUARY 2005.

NOTES:

1. SURVEY INFORMATION PROVIDED BY C.T. MALE ASSOCIATES, P.C. 50 CENTURY HILL DRIVE, LATHAM, NY 12110.
2. NORTH ORIENTATION AND BEARING BASED ON MAP REFERENCE NO. 1.
3. ELEVATIONS ARE IN FEET RELATIVE TO THE NATIONAL GEODETIC VERTICAL DATUM, 1929 (NGVD 29), HEREINAFTER REFERRED TO AS MEAN SEA LEVEL. ALL HORIZONTAL LOCATIONS ARE IN FEET RELATIVE TO THE NEW YORK STATE PLANE COORDINATE SYSTEM, NYE 3101, NORTH AMERICAN DATUM, 1927.
4. BULKHEAD SYSTEM COMPONENTS (I.E. DEADMAN, TIE-BACKS, ETC.) ARE LOCATED BETWEEN THE LAGOONS AND THE HUDSON RIVER. PRIOR TO CONSTRUCTION, CONTRACTOR MUST LOCATE THEM TO PREVENT DISTURBANCE.
5. EXISTING SURVEY TOPOGRAPHY REFLECTS THE WATER SURFACE OF THE LAGOONS. BOTTOM ELEVATIONS WERE DETERMINED BY LOOKING AT LAGOON DESIGN DRAWINGS. SLOPE OF LAGOON SIDES ARE UNIFORM TO THE BOTTOM.
6. THE LIMIT OF WORK INCLUDING CLEARING OF VEGETATION AND GRADING OF THE LAGOON AREA SHALL NOT EXTEND BELOW THE EXISTING 10 FT ELEVATION CONTOUR IN THE AREA WHERE THE BULKHEAD IS NOT PRESENT.
7. FUTURE STORM SEWER CONNECTION TO RETENTION BASIN WILL BE PART OF A SEPARATE CONTRACT.
8. LIMIT OF LAGOON CAP SHALL BE THE PROPERTY LINE ON THE SOUTH AND EAST, THE 10' CONTOUR AND/OR BULKHEAD ON THE WEST, AND THE LINE AS SHOWN ON THE NORTH.

LEGEND

- PROPERTY LINE
- EDGE OF WATER
- UTILITY EASEMENT
- TOP OF RETENTION BASIN BERM
- EXISTING BULKHEAD
- 18 EXISTING CONTOURS
- ST EXISTING STORMWATER LINE
- WL EXISTING WATERLINE
- SAN EXISTING SANITARY LINE
- 18 PROPOSED FINAL MINOR CONTOURS
- 15 PROPOSED FINAL MAJOR CONTOURS
- PROPOSED SILT FENCE
- PROPOSED HAY BALES
- LIMIT OF LINER
- EXISTING GCS TRENCHES AND ASSOCIATED STRUCTURES
- STABILIZED CONSTRUCTION ENTRANCE

30' 0 30'

NO.	DATE	REVISION DESCRIPTION	INT.

UNAUTHORIZED ALTERATION OR ADDITION TO THIS DOCUMENT IS A VIOLATION OF STATE LAW.

THESE DOCUMENTS (OR COPIES OF ANY THEREOF) PREPARED BY OR BEARING THE SEAL OF THE ENGINEER, SHALL NOT BE REUSED FOR ANY EXTENSIONS OF THE PROJECT OR ANY OTHER PROJECT WITHOUT THE WRITTEN CONSENT OF THE ENGINEER.

PROJECT ENGINEER: K.T.
DESIGNED BY: K.T.
DRAWN BY: G.M.
CHECKED BY: C.J.M.

PROJECT NO. 25111Y31
FILE NO. BF1150101
SCALE: AS SHOWN
DATE: JUNE 2008

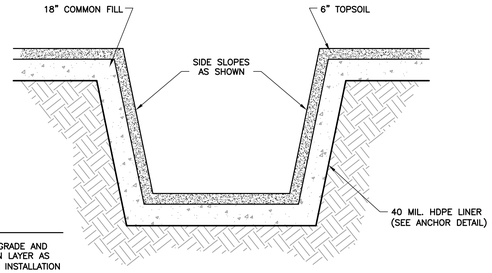
REMEDIAL ENGINEERING, P.C.
209 Shafter Street
Islandia, New York 11749 (631) 232-2600

PROJECT NAME:
BASF RENSSELAER LAGOON AREA
REMEDIAL ACTION WORK PLAN
PROJECT FOR:
BASF CORPORATION
FLORHAM PARK, N.J.

TITLE:
FINAL GRADING PLAN

DRAWING NO.
C1
DRAWING 1 OF 2

Plot Scale: 1:1
Date: 06JUN08
File Name: N:\PROJECTS\BF2511Y\SG1\BF1150101.DWG

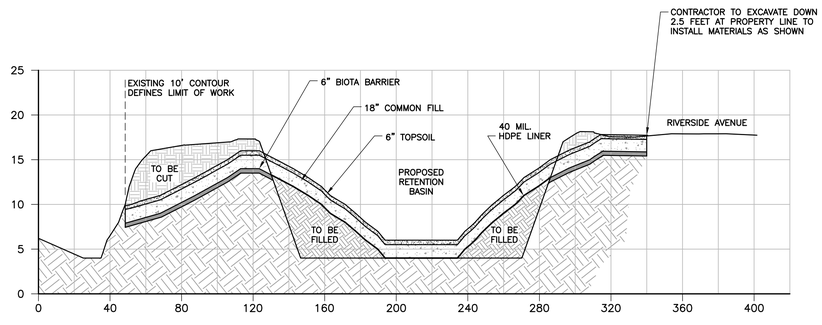


NOTE

LINER CONTRACTOR TO INSPECT SUBGRADE AND PROVIDE SAND OR SUITABLE CUSHION LAYER AS REQUIRED TO MEET MANUFACTURER'S INSTALLATION REQUIREMENTS.

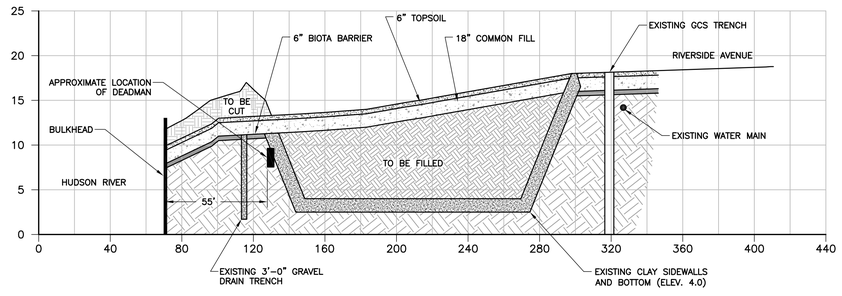
RETENTION BASIN LINER DETAIL

SCALE: NOT TO SCALE



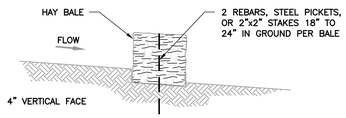
SECTION A–A'

SCALE: 1" = 40'

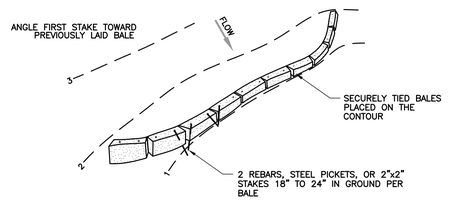


SECTION B–B'

SCALE: 1" = 40'



EMBEDDING DETAIL

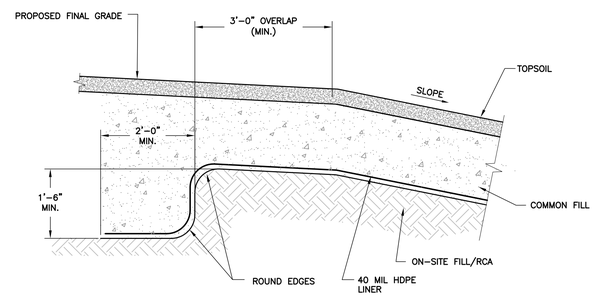


NOTES

1. WHERE HAY BALES AND SILT FENCES ARE REQUIRED TOGETHER, THE HAY BALES SHALL BE LOCATED UPGRADIENT OF SILT FENCE.
2. REBAR OR STAKES SHALL BE EMBEDDED 2'–0" IN GROUND, TWO PLACES IN EACH HAY BALE.
3. WHERE STAKING OR EMBEDDING (FOR PAVED SURFACES) IS NOT PRACTICAL AND IN PAVED AREAS, HAY BALES SHALL BE TIED TOGETHER TO PREVENT MOVEMENT OR OPENINGS IN THE BARRIER.

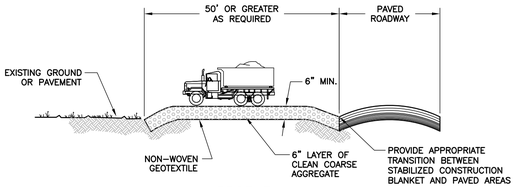
HAY BALE SEDIMENT BARRIER PLACEMENT AND ANCHORING DETAIL

SCALE: NOT TO SCALE

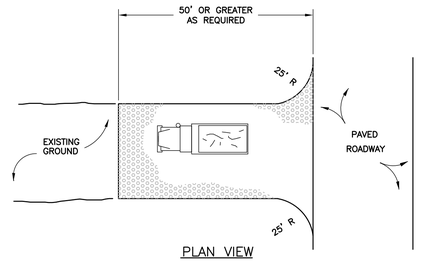


PROPOSED ANCHOR TRENCH FOR HDPE LINER (TYP.)

SCALE: NOT TO SCALE



PROFILE



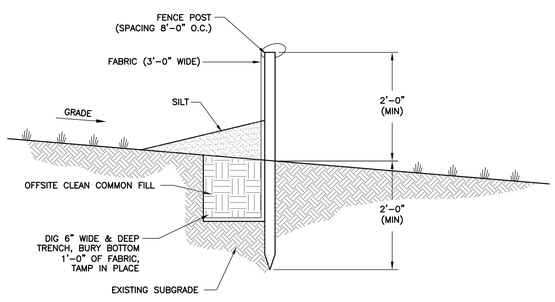
PLAN VIEW

STABILIZED CONSTRUCTION BLANKET

SCALE: NOT TO SCALE

NOTES

1. CONTRACTOR SHALL INSTALL STABILIZED CONSTRUCTION ENTRANCE AT EACH VEHICLE ACCESS POINT TO THE SITE, AS SHOWN ON THE DRAWING, OR NECESSARY FOR THE WORK.
2. STONE SIZE SHALL BE COURSE AGGREGATE (STONE SIZE 2" TO 3").
3. NON–WOVEN GEOTEXTILE – PLACE OVER ENTIRE AREA PRIOR TO PLACING OF STONE.
4. MAINTENANCE – THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SOIL ONTO PUBLIC RIGHTS–OF–WAY. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SOIL. ALL SOIL SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS–OF–WAY MUST BE REMOVED IMMEDIATELY.
5. WASHING – WHEELS SHALL BE CLEANED TO REMOVE SOIL PRIOR TO ENTRANCE ONTO PUBLIC RIGHTS–OF–WAY. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH STONE.
6. PERIODIC INSPECTION AND NEEDED MAINTENANCE SHALL BE PROVIDED AFTER EACH RAIN.



TYPICAL SILT FENCE DETAIL

SCALE: NOT TO SCALE

Plot Scale: 1:1
Date: 15MAR05

NO.	DATE	REVISION DESCRIPTION	INT.

PROJECT ENGINEER: A.L.
DESIGNED BY: K.T.
DRAWN BY: G.M.
CHECKED BY: C.M.

PROJECT NO. 0251.0011Y31
FILE NO. BF1150102
SCALE: AS SHOWN
DATE: APR. 2008

REMEDIAL ENGINEERING, P.C.
209 Shafter Street
Islandia, New York 11749 (631) 232–2600

PROJECT NAME: BASF RENSSELAER LAGOON AREA REMEDIAL ACTION WORK PLAN
PROJECT FOR: BASF CORPORATION FLORHAM PARK, N.J.

TITLE: PROFILES AND DETAILS

DRAWING NO. **C2**
DRAWING 2 OF 2