Permit No.	Date	Document ID No.
06-03	**September 29, 2008**	**5911**

Trout Stream Buffer Variance Request and 401/404 Nationwide Permit No. 39 Application

Avery County C&D Landfill Expansion Ingalls, North Carolina

Prepared For:

Avery County Solid Waste Department
175 Linville Street
Newland, North Carolina

September 2008

Prepared By:

CAROLINA ECOSYSTEMS, INC.

&

RICHARDSON SMITH GARDNER & ASSOCIATES
ENGINEERING & GEOLOGICAL SERVICES

PRINTED ON 100% RECYCLED PAPER

AVERY COUNTY LANDFILL EXPANSION

TROUT STREAM BUFFER VARIANCE REQUEST
& 404/401 NWP 39 PCN

ATTACHMENT LIST

Attachment

1	Copy of NCDENR Correspondence
2	PCN Form
3	Figures (see below)
4	Site Photographs
5	On-Site Mitigation Plan
6	Delineation Information
7	Protected Species and Archaeological Reports/Correspondence
8	Stormwater Management Plan (see below)

Figures (Attachment 3)

1	Site Location
2	Wetlands and Streams
3	Restoration Plan Overview
4	USGS Map
5	Soils Mapping
6	Stream Impact Area
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Stormwater Management Plan Appendix C: Engineering Drawings

S1	Existing Site Conditions
S2	Initial Grading Plan
S3	Stormwater Management Plan
S4	Restoration Plan
D1	Underdrain Details
EC1	Stormwater Management Plan Details (Sheet 1 of 3)
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EC3	Stormwater Management Plan Details (Sheet 3 of 3)
EC4	Cascade Details

CAROLINA
ECOSYSTEMS, INC.

8208 Brian Ct.; Garner, NC 27529
P:919-606-1065 – F:919-341-4474

September 19, 2008

Ms. Amanda Jones
Asheville Regulatory Field Office
U.S. Army Corps of Engineers
151 Patton Avenue
Room 208
Asheville, North Carolina 28801-5006

RE: Nationwide Permit 39 Pre-Construction Notification
Avery County Landfill Expansion
Newland, North Carolina

Dear Ms. Jones;

Avery County is proposing to expand its existing construction and demolition (C&D) landfill located near Newland, North Carolina. In support of this activity, Carolina Ecosystems, Inc. (CEI) and Richardson Smith Gardner and Associates, Inc. have prepared this Nationwide Permit (NWP) 39 Pre-Construction Notification (PCN) for the project, which will impact 408 linear feet of intermittent stream and 0.004 acres of headwater forest wetland. As previously discussed in our June 12, 2007 site meeting, the 300 foot limit of the NWP is being waved for this project due to the lack of significant aquatic function within the subject channel. Included in this submittal are a PCN form, vicinity and site maps, site photographs, engineering plans and details, and other pertinent supporting documentation. Additional information supplementing the PCN form is included in this cover letter.

Based on a meeting with the Gray Hauser of the NC Division of Land Resources (NCDLR) on July 24, 2008 and subsequent conversations with Ron Linville of the NC Wildlife Resource Commission, a trout buffer variance is being submitted concurrently with this Pre-Construction Notification, and a copy of the variance request is attached. All other materials in this application are also part of the variance request.

Site Background Information

The Avery County Landfill (Site) is located in the southwest portion of Avery County, North Carolina near the Mitchell County line. It is north of Brushy Creek Road as shown in Figure 1. The Site is within the French Broad River Basin, and contains an unnamed tributary to Brushy Creek, located just south of the facility. Brushy Creek and its tributaries are classified as Class C Trout waters by the North Carolina Department of Environment and Natural Resources

(NCDENR Index No 7-2-29). NC Wildlife Resource Commission surveys found no trout habitat on the site.

The landfill facility consists of a municipal solid waste transfer station, and open and closed cells of a construction and demolition landfill. The Site comprises approximately 78 acres, most of which is forested. The landfill is located in the southeastern portion of the property and is adjacent to two stream channels. The smaller of these channels (SA) is an intermittent and perennial unnamed tributary to Brushy Creek, and the landfill encompasses most of its watershed. The larger perennial stream (SB) to the west of the landfill almost bisects the property. Several smaller drainages and wetlands exist on the Site as shown in Figure 2. The topography of the Site is very steep, as is typical in this mountain region.

Streams and wetlands under the jurisdiction of the Clean Water Act are present on the site. As discussed with you during our site visit, the wetland delineation (submitted in May 2008) was limited to the landfill expansion project area. The remainder of the site was reviewed for jurisdictional resources, and the outer and upper extents of those wetlands and streams encountered were located using submeter GPS technology. This was done to allow the County to plan for future site development while avoiding the remaining jurisdictional areas. The delineation and approximate location of all jurisdictional areas are presented in Figure 2.

Within the project site, wetlands consist primarily of small riparian headwater forest areas that are saturated by base flow and groundwater table associated with the perennial and intermittent streams on the site. Some larger headwater forest and seep wetlands exist on other portions of the site not delineated (see Figure 2). The headwater forest wetland within the impact area is not typical of the other wetland types on site. This area is primarily formed by the inundation and backwater effect of the existing road crossing, and is primarily a disturbed alder (*Alnus serrulata*) thicket.

Several intermittent and perennial streams are present on the site, and there are two streams within the project area. The first is a larger perennial feature (SB) that originates from several seeps on the steeper slopes above the landfill. The smaller channel (SA) begins at a seasonal spring as an intermittent channel and becomes a perennial stream after the existing road crossing on site. The larger perennial stream is a typical mountain stream, with steep gradient, frequent grade control by rock outcrops, and severe side slopes dominated by Rhododendron thickets. The channel in between the landfill cells is not as typical. The upper, intermittent portion lacks strong bed and bank for much of its length, partly due to previous sedimentation. The perennial segment, below the stream crossing exhibits bed and bank and other common stream features. The sediment in the channel has affected the aquatic habitat significantly. Searches yielded a few macrobenthos in the less impacted areas, including stoneflies, mayflies, and dragonflies. A few salamanders were also found in the wetland areas.

Project Purpose, Need, and Alternatives

The purpose of the Avery County Landfill Expansion is threefold. First, the County is in need of additional capacity for disposal of construction and demolition waste materials generated in the area. Second, the previous landfill activities have encroached beyond their permitted limits

slightly, and removal of this waste is required to gain compliance with their solid waste permit. Finally, the expansion will be designed to provide increased erosion control measures and prevent downstream degradation of surface waters during larger storm events.

The County has evaluated its options regarding waste disposal and determined that continued disposal of C&D waste within its own landfill is preferred while capacity on the site still exists. The County ships its municipal solid waste (MSW) through the transfer station and to a permitted landfill in Bristol, Virginia. This was not deemed feasible for the C&D waste due to the cost of transportation, the potential for increased hauling costs in the future outside the control of the County, and the fact that construction of a C&D landfill is much less than that of a MSW landfill due to the relatively inert nature of C&D waste. Due to the lack of capacity, the County is currently transferring C&D waste on a temporary basis. The proposed expansion will provide 50 years of additional capacity. Off-site disposal alternatives are not feasible due to the lack of available County-owned lands of adequate size, and not already used for another purpose. Also, recent North Carolina solid waste regulations placing stringent siting requirements on new landfill sites that severely limit the potential for new sites to be developed.

The presence of waste outside the permitted footprint of the landfill has created additional capacity requirements for the re-interment of this material when it is removed. The current landfill is at capacity, and the existing waste stream combined with the removed material results in an increased need for additional landfill space. Due to the cost of transporting waste to other facilities, the County is planning on expanding the landfill rather than transferring the C&D waste on a permanent basis. The current transfer of C&D waste, mixed with MSW, is causing logistical issues related to the volume and cost of hauling the waste. The mixed waste is more difficult to compact and therefore increases costs by reducing the tonnage in each load.

The sedimentation that has occurred on the site has impacted the smaller stream channel (SA). The upper, intermittent portion of the stream is lacking aquatic function and has been filled with sediment. The lower, perennial portion of the channel is also impacted, but retains a bed and bank, along with other stream features. The most efficient method of controlling sediment on the site is to route stormwater through dry detention basins prior to discharge. This would effectively drain the upper portion of the smaller tributary, as there is no practical way to drain the landfill to ponds above this segment of the stream. Rather than continue trying to maintain the steep side slopes along this upper section, the County is proposing to fill in this area to gain the needed capacity described above, in conjunction with improving erosion control measures to the rest of the Site and restoring the function of the perennial stream segment. Avoidance of this impact could result in the removal of hydrology from the stream (due to rerouting of stormwater) and continued sedimentation along this intermittent reach during larger storm events.

Project Description

There are three major components to this project that are described below: the construction of the expanded C&D landfill, the removal and re-interment of waste outside the permitted footprint, and the restoration of the existing perennial stream buffer and removal of sediment.

The C&D landfill will be expanded in 5-year increments as shown on the attached plans. This will include the initial expansion of the landfill via filling of the intermittent drainage down to the existing road crossing. Initial activity would involve land clearing and grubbing, along with the installation of erosion control measures, including silt fencing, check dams, and silt basins shown in the attached plans. Unsuitable material would be removed and backfilled with subgrade material, consisting of fine grained soils. If required due to seepage of surface or and/or ground waters, a gravel (stone) underdrain would be used as fill and a buffer from the landfill subgrade, the underdrain would be wrapped in filter geotextile to provide a separator from embankment soils and to maintain long-term flow properties of the stone. The subgrade material would then be placed above the underdrain, and filled to the required 4-foot separation from ground water. Waste material would be placed in lifts until the proposed grades are achieved, at which time a low permeability soil cover will be placed and vegetated.

Waste removal and re-interment will occur in the locations shown in Figure 3. This will involve excavation of existing material down to natural soils. The waste will be moved to the expanded C&D cell described above, and the excavated area will be backfilled with on-site natural soils. Erosion control measures will be placed as shown on the attached plans to prevent sediment from reaching the intermittent stream channel. Slopes will be graded to match existing natural conditions and then reforested as described below.

In areas of waste removal and areas where there is no forested buffer within 50-feet of the perennial stream segments, a buffer will be re-established. In conjunction with this activity, the perennial stream segment below the existing road crossing will be hand-cleared of sediment from the channel. This work will be overseen by a qualified professional to ensure that the removal of sediment does not destabilize the channel. Buffer restoration work within the stream will occur between April 15 and October 15 to minimize potential effects on trout spawning. The forested 50-foot buffer will be reestablished using naturally occurring tree species common to the area, as detailed in the attached restoration plan (Attachment 5).

Avoidance and Minimization

The landfill expansion will impact 408 linear feet of intermittent channel and 0.01 (0.004) acres of headwater forest wetland. The intermittent channel lacks significant aquatic function and the extremely small wetland does not provide much function. The proposed impact has been minimized to the greatest extent practical given the site conditions. The landfill is built upon two ridges, one running between the two stream channels and another to the east of the smaller intermittent/perennial stream. This has resulted in a very thin, steep landfill design that is not efficient for waste capacity and has also created some erosion control challenges. The steep topography and side slopes of the landfill do not provide a lot of opportunity for sufficient erosion control devices to be installed and maintained. This contributed to sediment deposition within the smaller stream channel. Without re-designing the landfill, little can be done to improve the current conditions on the site, and the likelihood of additional sedimentation during larger storm events is high.

Avoidance of the proposed impacts would result in another inefficient design of a landfill surrounding the existing channels. There would be limited options for the collection and

treatment of runoff from the site. These options would likely route stormwater below the proposed impact area, potentially causing a drainage effect on the wetland and stream. The landfill limits have been designed to avoid the perennial segment of the stream channel, where a strong base flow and groundwater table can sustain the flow regime of the stream.

Current conditions on the Site have the potential to adversely affect trout habitat in Brushy Creek due to sedimentation. In addition, the limited buffers in some areas allow surface water temperatures to fluctuate. Therefore, some remedial action is required to rectify the existing conditions. While removal of all sediment from the intermittent/perennial stream would be optimal, the presence of the landfill limits the effectiveness of this measure. The lower (perennial) section of stream has relatively stable buffers and can be restored to a functional stream channel. The upper portion has less potential for restoration since an improved stormwater design would have to route discharges below this segment. The current permitted cells of the landfill create a difficult challenge in control of sediment due to their steep side slopes. Reconfiguration of the landfill will rectify this situation and improve the erosion control on the Site as described above.

In conjunction with the landfill expansion, the removal of waste within a 50-foot buffer of the perennial portion of the tributary will increase buffer function on the site and stabilize water temperature fluctuations. This waste removal, in combination with the restoration of the buffers described below will provide both erosion control and temperature fluctuation control in the downstream waters, therefore improving existing trout habitat.

Mitigation

The proposed impacts will be mitigated through on-site buffer restoration and stream enhancement. This plan has been discussed, in concept, with representatives of the USACE, NCDWQ, and NCWRC during a meeting on June 12, 2007. There was general consensus on the following points:

1. The intermittent channel to be impacted is not providing significant water quality or aquatic habitat functions.
2. The perennial channel (below the road crossing) is impacted, but can be restored through removal of sediment and enhancement of buffers.
3. Compensatory mitigation for the intermittent stream impacts would be provided on-site through the removal of sediment and restoration of buffers associated with the perennial stream channel.
4. The proposed filling of the upper intermittent portion of the stream channel, in conjunction with the restoration of the lower perennial portion of the stream channel, would be approvable and the best option for the Site considering the existing conditions.

The attached restoration plan addresses the requirements above and provides for the enhancement of buffers along both the perennial tributaries adjacent to the landfill. In addition, the remaining streams, wetlands, and associated trout buffers will be preserved during future expansions of the site, and an additional minor stream crossing will be removed and the stream

banks tied in to match existing conditions and re-vegetated according to the plan. This results in an overall compensation of approximately:

Proposed Mitigation Plan

Impact	**Mitigation**			
Stream	**Enhanced**[1]	**Restored**[2]	**Preserved**	**Future Preserved**[3]
408 lf intermittent	569 lf perennial	40 lf perennial	972 lf per.	4,073 lf per. & int.
Trout Buffer	**Enhanced**	**Restored**	**Preserved**	**Future Preserved**[3]
0.52 ac	0 ac	0.66 ac	4.20 ac	7.4 ac

1 Enhanced stream: sediment will be removed per the attached restoration plan
2 Restored stream: pipe to be removed and bed & bank reestablished per restoration plan
3 Future Preserved: areas outside the immediate project limits that have not been surveyed

Protected Species

During the analysis of the site for location restrictions under North Carolina solid waste regulations, an evaluation was performed to determine the potential for this project to impact species under the protection of the Endangered Species Act. The project was determined not to have an effect on any federally listed species. Documentation of this evaluation is included in Attachment 7.

Historical and Archaeological Resources

During the development of the site application for the Division of Solid Waste, a full survey of the property for historical and archaeological resources was performed by Garrow and Associates, Inc. There are no significant resources on the site, as documented in the attached report (Attachment 7).

Stormwater Management

A Stormwater Management Plan prepared by Richardson, Smith, Gardner & Associates, Inc. is attached (Attachment 8) for your review in conjunction with this application. The plan includes a written description of the erosion control and stormwater measures proposed on the Site. Impervious areas on the site are currently limited to access roads and the transfer station and scale house. This totals only 3.59 acres or 4.6% of the 78 acre site. The proposed landfill will result in no net increase in impervious area.

Upon closure of the landfill cell, the waste will be covered with a soil cap and vegetated. The stormwater runoff from this site will be routed through the proposed basins, which will be converted into dry detention basins in compliance with the NCDENR Stormwater BMP Manual. Although no trout habitat was found on the site, measures have been included to benefit downstream trout waters. The basins have a cool water release feature to limit temperature fluctuations, and shading has been incorporated into appropriate areas. The discharge water will predominantly flow through seepage within the ripr rap outlet structures (stepped boulder structures or cascades) rather than on the surface, further aerating and cooling the water.

We would appreciate your consideration of this information during the review of this application, and look forward to your favorable review of this project. Please contact myself (919-606-1065 or phil.may@carolinaeco.com) or Stacey Smith (919-828-0577 or stacey@rsgengineers.com) at your convenience if you have any questions or require further information.

Sincerely,
Carolina Ecosystems, Inc.

Philip May
Senior Environmental Scientist

Cc: Stacey Smith, P.E., Richardson, Smith, Gardner & Associates, Inc.
Buddy Norris, Avery County Solid Waste Director
Gray Hauser, NCDLR Raleigh
Alan Gaither, NCDENR Division of Waste Management
Michael Parker, NCDWQ Asheville Regional Office
Cyndi Karoly, NCDWQ 401 Permitting Unit
File

FIRST CITIZENS BANK
firstcitizens.com

14423

RICHARDSON SMITH GARDNER & ASSOC. INC.
14 N. BOYLAN AVE.
RALEIGH, NC 27603
919-828-0577

66-30/531
087

9/19/2008

PAY TO THE ORDER OF NCDENR $ **570.00

Five Hundred Seventy and 00/100********** DOLLARS

NCDENR
Stormwater and General Permits Unit
Division of Water Quality
1617 Mail Service Center
Raleigh, NC 27699-1617

MEMO Avery County C&D Landfill

MP

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RICHARDSON SMITH GARDNER & ASSOC. INC.

14423

NCDENR 9/19/2008

Date	Type	Reference	Original Amt.	Balance Due	Discount	Payment
9/19/2008	Bill		570.00	570.00		570.00
					Check Amount	570.00

Checking-First Citizen Avery County C&D Landfill 570.00

Attachment 1

ATTACHMENT 1

Copy of NCDENR Correspondence

CAROLINA
ECOSYSTEMS, INC.

8208 Brian Ct.; Garner, NC 27529
P:919-606-1065 – F:919-341-4474

September 19, 2008

Mr. T. Gray Hauser Jr.
NC Division of Land Resources
1612 Mail Service Center
Raleigh, NC 27699-1612

RE: Request for Trout Buffer Variance
Avery County Landfill Expansion
Newland, North Carolina

Dear Mr. Hauser;

The purpose of this letter and the attached plans is to request a variance under the North Carolina Sediment Pollution Control Act and the Division of Land Resources trout buffer regulations (15A NCAC 04B .0125) for the above referenced project.

This letter describes the project and the justification for the variance request. Also enclosed is supporting documentation for the request including site maps, engineering plans, site photographs, and stormwater analysis and calculations. We respectfully request your consideration of this information during your evaluation of this project. As requested in our meeting on July 24, 2008, this variance is being submitted concurrently with the attached Pre-Construction Notification to the US Army Corps of Engineers (USACE) and NC Division of Water Quality (NCDWQ) for a Nationwide Permit 39 authorization.

Site Background Information

The Avery County Landfill (Site) is located in the southwest portion of Avery County, North Carolina near the Mitchell County line. It is north of Brushy Creek Road as shown in Figure 1. The Site is within the French Broad River Basin, and contains an unnamed tributary to Brushy Creek. Brushy Creek and its tributaries are classified as Class C Trout waters by the North Carolina Department of Environment and Natural Resources (NCDENR Index No 7-2-29). The landfill facility consists of a municipal solid waste transfer station and inactive cells of a construction and demolition landfill. The Site comprises approximately 78 acres, most of which forested. The landfill is located in the southeastern portion of the property and is adjacent to two stream channels. The smaller of these channels is an intermittent and perennial tributary to Brushy Creek, and the landfill encompasses most of its watershed. The larger perennial stream to the west of the landfill almost bisects the property. Several smaller drainages and wetlands exist on the Site as shown in Figure 2. The topography of the Site is very steep, as is typical in this mountain region.

Project Purpose, Need, and Alternatives

The purpose of the Avery County Landfill Expansion is threefold. First, the County is in need of additional capacity for disposal of construction and demolition waste materials generated in the area. Second, the previous landfill activities have encroached beyond their permitted limits slightly, and removal of this waste is required to gain compliance with their solid waste permit. Finally, the expansion will be designed to provide increased erosion control measures and prevent downstream degradation of surface waters during larger storm events.

The County has evaluated its options regarding waste disposal and determined that continued disposal of C&D waste within its own landfill is preferred while capacity on the site still exists. The County transfers its municipal solid waste (MSW) through the on-site transfer station to a permitted landfill in Bristol, Virginia. This was not deemed feasible for the C&D waste due to the cost of transportation, the potential for increased hauling costs in the future outside the control of the County, and the fact that construction of a C&D landfill is much less cost than that of a MSW landfill due to the relatively inert nature of C&D waste. Off-site disposal alternatives are not feasible due to the lack of available County-owned lands, and the recent North Carolina solid waste regulations placing stringent siting requirements on new landfill sites.

The landfill is built upon two ridges, one running between the two stream channels and another to the east of the smaller intermittent/perennial stream. This has resulted in a very thin, steep landfill design that is not efficient for waste capacity and has also created some erosion control challenges. The steep topography and side slopes of the landfill do not provide a lot of opportunity for sufficient erosion control devices to be installed and maintained. This has resulted in sediment deposition within the smaller stream channel. Without re-designing the landfill, little can be done to improve the current conditions on the site, and the likelihood of additional sedimentation during larger storm events is high.

The presence of waste outside the permitted footprint of the landfill has created additional capacity requirements for the re-interment of this material when it is removed. The current landfill has reached capacity, and the existing waste stream combined with the removed material results in an increased need for additional landfill space. Due to the cost of transporting waste to other facilities, the County is planning on expanding the landfill rather than continuing to transfer the C&D waste. The current transfer of C&D waste, mixed with MSW, is causing logistical issues related to the volume and cost of hauling the waste. The mixed waste is more difficult to compact and therefore increases costs by reducing the tonnage in each load.

The sedimentation that has occurred on the site has impacted the smaller stream channel. The upper, intermittent portion of the stream is lacking aquatic function and has been filled with sediment. The lower, perennial portion of the channel is also impacted, but retains a bed and bank, along with other stream features. The most efficient method of controlling sediment on the site is to route stormwater through dry detention basins prior to discharge. This would effectively drain the upper portion of the smaller tributary, as there is no room for basins above this stream. Rather than continue to maintain the steep side slopes along this upper section, the County is proposing to fill in this area to gain the needed capacity described above, in conjunction with adding additional erosion control measures to the rest of the Site and restoring

the function of the perennial stream segment. Avoidance of this impact could result in the removal of hydrology from the stream (due to re-routing of stormwater) and continued sedimentation along this intermittent reach.

Project Description

There are three major components to this project that are described below: the construction of the expanded C&D landfill, the removal and re-interment of waste outside the permitted footprint, and the restoration of the existing perennial stream buffer and removal of sediment.

The C&D landfill will be expanded in 5-year increments as shown on the attached plans. This will include the initial expansion of the landfill via filling of the intermittent drainage down to the existing road crossing. Initial activity would involve land clearing and grubbing, along with the installation of erosion control measures, including silt fencing, check dams, and silt basins shown in the attached plans. Unsuitable material would be removed and backfilled with subgrade material, consisting of fine grained soils. If required due to seepage of surface and/or ground waters, a gravel (stone) underdrain would be used as fill and a buffer from the landfill subgrade, the underdrain would be wrapped in filter geotextile to provide a separator from embankment soils and to maintain long-term flow properties of the stone. The subgrade material would then be placed above the underdrain, and filled to the required 4-foot separation from ground water. Waste material would be placed in lifts until the proposed grades are achieved, at which time a low permeability ($k<1X10^{-5}$ cm/sec) soil cover will be placed and vegetated.

Waste removal and re-interment will occur in the locations shown in Figure 3. This will involve excavation of existing material down to natural soils. The waste will be moved to the expanded C&D cell described above, and the excavated area will be backfilled with on-site soils. Erosion control measures will be placed as shown on the attached plans to prevent sediment from reaching the intermittent stream channel. Slopes will be graded to match existing natural conditions and then reforested as described below.

In areas of waste removal and areas where there is no forested buffer within 50-feet of the perennial stream segments, a buffer will be re-established. In conjunction with this activity, the perennial stream segment below the existing road crossing will be hand-cleared of sediment from the channel. This work will be overseen by a qualified scientist to ensure that the removal of sediment does not destabilize the channel. Buffer restoration work within the stream will occur between April 15 and October 15 to minimize potential effects on trout spawning. The forested 50-foot buffer will be reestablished using naturally occurring tree species common to the area, as detailed in the attached plans.

Construction Schedule

A general construction schedule for this project is as follows:

Landfill Construction	August to December 2009
Waste Removal	April 2009
Sediment Removal	April 15 – October 15, 2009 or 2010
Buffer Restoration	May 2009? After cell construction

This schedule is subject to change depending on weather, availability of contractors, and timing of other approvals such as NC Division of Waste Management permits.

Stormwater Management

A Stormwater Management Plan prepared by Richardson Smith Gardner & Associates, Inc. is attached for your review in conjunction with this variance request. The plan includes a written description of the erosion control and stormwater measures proposed on the Site.

Upon closure of the landfill cell, the waste will be covered with a low permeability soil cap and vegetated. The stormwater runoff from this site will be routed through the proposed basins, which will be converted into dry detention basins in compliance with the NCDENR Stormwater BMP Manual. Although no trout habitat was found on the site, measures have been included to benefit downstream trout waters. The basins have a cool water release through a series of cascade features (stepped boulder structures) in the discharge channel prior to release in the stream buffer to limit temperature fluctuations. Additionally, shading has been incorporated into appropriate areas. The discharged water will predominantly flow through seepage within the riprap outlet structures (stepped boulder structures or cascades) rather than on the surface, further aerating and cooling the water.

Justification of Variance Request

This variance request has been proposed after careful evaluation of the existing conditions and future requirements of the Site, and consultation with regulatory agencies related to the proposed impacts. The following key points justify this request as it relates to trout buffer regulations:

1. The primary purpose of the trout buffer regulation is to control sediment and temperature fluctuations that would adversely affect trout spawning and survival. Current conditions on the Site have the potential to adversely affect trout habitat in Brushy Creek due to sedimentation. In addition, the limited buffers in some areas allow surface water temperatures to fluctuate. Therefore, some remedial action is required to rectify the existing conditions. While removal of all sediment from the intermittent/perennial stream would be optimal, the presence of the landfill limits the effect of this measure. The lower (perennial) section of stream has relatively stable buffers and can be restored to a functional stream channel. The upper portion has less potential for restoration since an improved stormwater design would have to route discharges below this segment. The current permitted cells of the landfill create a difficult challenge in control of sediment due to their steep side slopes. Reconfiguration of the landfill will rectify this situation and improve the erosion control on the Site as described above.

2. In conjunction with the landfill expansion, the removal of waste within a 50-foot buffer of the intermittent/perennial tributary will increase buffer function on the site and stabilize water temperature fluctuations. This waste removal, in combination with the restoration of the buffers described below will provide both erosion control and temperature fluctuation control in the downstream waters, therefore improving existing trout habitat.

3. The trout buffer regulations require a minimum 25-foot buffer on all surface waters, or an increased buffer to control sediment within the outer 25% of the buffer. The current buffers have not functioned to control sediment on site due to two reasons. First, in some areas the buffers are less than 25 feet, which will be rectified with the proposed plan. Also, the previous design of the landfill did not provide adequate erosion control, considering that the steep slopes require additional buffer widths to function properly. The proposed project will increase these buffers to 50-feet, including planting all areas that are currently not forested (with the exception of existing road crossings and other infrastrucure) and the areas where waste will be removed. Stormwater controls will include dry detention basins and energy dissipators to treat stormwater and control its discharge into adjacent waters.

4. A mitigation plan for the proposed impacts has been prepared and submitted to the USACE, NCDWQ, and NC Wildlife Resources Commission. Existing sediment within the perennial segment of stream channel will be removed by hand and the stream bed will be allowed to return to its natural function. Buffers will be restored by planting natural forest vegetation within 50 feet of the stream banks. The buffer restoration work within the stream channel will be performed between April 15th and October 15th to minimize any adverse effects on downstream trout spawning.

5. NC Wildlife Resource Commission biologists evaluated the streams associated with this site in September 2008. This survey showed that no trout habitat is present on the site, and a trout moratorium will not be required. Despite this, the proposed stream work in the perennial segment will be limited to typical trout moratorium time frames (between April 15 and October 15) in order to protect downstream resources. The installation of the underdrain and associated erosion control measures is the initial step in the construction of the project and is proposed for installation in the Fall of 2009. This will protect downstream waters from impact during construction.

Mitigation Plan

The proposed impacts will be mitigated through on-site buffer restoration and stream enhancement. This plan has been discussed, in concept, with representatives of the USACE, NCDWQ, and NCWRC during a meeting on June 12, 2007. There was general consensus on the following points:

1. The intermittent channel to be impacted is not providing significant water quality or aquatic habitat functions.
2. The perennial channel (below the road crossing) is impacted, but can be restored through removal of sediment and enhancement of buffers.
3. Compensatory mitigation for the intermittent stream impacts would be provided on-site through the removal of sediment and restoration of buffers associated with the perennial stream channel.
4. The proposed filling of the upper intermittent portion of the stream channel, in conjunction with the restoration of the lower perennial portion of the stream channel,

would be the best option for the Site considering the existing conditions.

The attached restoration plan addresses the requirements above and provides for the establishment of buffers along both the perennial tributaries adjacent to the landfill. In addition, the remaining streams, wetlands, and associated trout buffers will be preserved during future expansions of the site (if needed), and an additional minor stream crossing will be removed and the stream banks tied in to match existing conditions and re-vegetated according to the plan. This results in an overall compensation of approximately:

Proposed Mitigation Plan

Impact	**Mitigation**			
Stream	**Enhanced**[1]	**Restored**[2]	**Preserved**	**Future Preserved**[3]
408 lf intermittent	569 lf perennial	40 lf perennial	972 lf per.	4,073 lf per. & int.
Trout Buffer	**Enhanced**	**Restored**	**Preserved**	**Future Preserved**[3]
0.52 ac	0 ac	0.66 ac	4.20 ac	7.4 ac

1 Enhanced stream: sediment will be removed per the attached restoration plan
2 Restored stream: pipe to be removed and bed & bank reestablished per restoration plan
3 Future Preserved: areas outside the immediate project limits that have not been surveyed

The attached 404/401 PCN has been sent to these agencies for review and approval concurrently with this application. We would appreciate your consideration of this information during the review of this variance request, and look forward to your favorable review of this project. Please contact myself (919-606-1065 or phil.may@carolinaeco.com) or Mr. Stacey Smith, P.E. (919-828-0577 or stacey@rsgengineers.com) at your convenience if you have any questions or require further information.

Sincerely,
Carolina Ecosystems, Inc.

Philip May
Senior Environmental Scientist

Cc: Stacey Smith, P.E., Richardson, Smith, Gardner & Associates, Inc.
Buddy Norris, Avery County Solid Waste Director
Alan Gaither, NCDENR Division of Waste Management
Amanda Jones, USACE Asheville Regulatory Office
Michael Parker, NCDWQ Asheville Regional Office
Cyndi Karoly, NCDWQ 401 Permitting Unit
File

FIRST CITIZENS BANK
firstcitizens.com

14424

RICHARDSON SMITH GARDNER & ASSOC. INC.
14 N. BOYLAN AVE.
RALEIGH, NC 27603
919-828-0577

66-30/531
087

9/19/2008

PAY TO THE ORDER OF NCDENR - Land Quality Section $ **975.00

Nine Hundred Seventy-Five and 00/100********** DOLLARS

NCDENR - Land Quality Section
512 North Salisbury Street
Raleigh, NC 27604

MEMO Avery County C&D Landfill

MP

⑈014424⑈ ⑆053100300⑆0008615369 23⑈

RICHARDSON SMITH GARDNER & ASSOC. INC.

14424

NCDENR - Land Quality Section 9/19/2008

Date	Type	Reference	Original Amt.	Balance Due	Discount	Payment
9/19/2008	Bill		975.00	975.00		975.00
				Check Amount		975.00

Checking-First Citizen Avery County C&D Landfill 975.00

Attachment 2

ATTACHMENT 2

Pre-Construction Notification Form

Office Use Only: Form Version March 08

USACE Action ID No. _____ DWQ No. _____

(If any particular item is not applicable to this project, please enter "Not Applicable" or "N/A".)

I. Processing

1. Check all of the approval(s) requested for this project:
   - ☒ Section 404 Permit
   - ☐ Section 10 Permit
   - ☒ 401 Water Quality Certification
   - ☐ Riparian or Watershed Buffer Rules
   - ☐ Isolated Wetland Permit from DWQ
   - ☐ Express 401 Water Quality Certification

2. Nationwide, Regional or General Permit Number(s) Requested: 39

3. If this notification is solely a courtesy copy because written approval for the 401 Certification is not required, check here: ☐

4. If payment into the North Carolina Ecosystem Enhancement Program (NCEEP) is proposed for mitigation of impacts, attach the acceptance letter from NCEEP, complete section VIII, and check here: ☐

5. If your project is located in any of North Carolina's twenty coastal counties (listed on page 4), and the project is within a North Carolina Division of Coastal Management Area of Environmental Concern (see the top of page 2 for further details), check here: ☐

II. Applicant Information

1. Owner/Applicant Information
   Name: Buddy Norris, Avery County Solid Waste Director
   Mailing Address: Avery County
   P.O. Box 305
   Newland, NC 28657

   Telephone Number: 1-828-737-5420 Fax Number: _
   E-mail Address: buddy.norris@ncmail.net

2. Agent/Consultant Information (A signed and dated copy of the Agent Authorization letter must be attached if the Agent has signatory authority for the owner/applicant.)
   Name: Phil May
   Company Affiliation: Carolina Ecosystems, Inc.
   Mailing Address: 8208 Brian Court
   Garner, NC 27529

   Telephone Number: (919) 606-1065 Fax Number: (919) 341-4474
   E-mail Address: phil.may@carolinacco.com

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II. Project Information

Attach a **vicinity map** clearly showing the location of the property with respect to local landmarks such as towns, rivers, and roads. Also provide a detailed **site plan** showing property boundaries and development plans in relation to surrounding properties. Both the vicinity map and site plan must include a scale and north arrow. The specific footprints of all buildings, impervious surfaces, or other facilities must be included. If possible, the maps and plans should include the appropriate USGS Topographic Quad Map and NRCS Soil Survey with the property boundaries outlined. Plan drawings, or other maps may be included at the applicant's discretion, so long as the property is clearly defined. For administrative and distribution purposes, the USACE requires information to be submitted on sheets no larger than 11 by 17-inch format; however, DWQ may accept paperwork of any size. DWQ prefers full-size construction drawings rather than a sequential sheet version of the full-size plans. If full-size plans are reduced to a small scale such that the final version is illegible, the applicant will be informed that the project has been placed on hold until decipherable maps are provided.

1. Name of project: Avery County Landfill

2. T.I.P. Project Number or State Project Number (NCDOT Only): Not an NCDOT project

3. Property Identification Number (Tax PIN): 182100088310

4. Location
   County: Avery Nearest Town: Spruce Pine
   Subdivision name (include phase/lot number): Not a subdivision
   Directions to site (include road numbers, landmarks, etc.): From I-40 take US-221 (Exit 85) near Marion. Follow US-221 (takes a left in Marion) north to Linville Falls. North of Linville Falls, take a left onto Three Mile Road, which dead ends into 19E. Take a left on 19E, then another left onto Brushy Creek Road (watch for the airport signs). Follow Brushy Creek road until it ends at a gated road, the landfill is on the left.

5. Site coordinates (Lat/Long or decimal degrees): 35.960527 N; -81.970968 W
   (Note – If project is linear, such as a road or utility line, attach a sheet that separately lists the coordinates for each crossing of a distinct waterbody.)

6. Property size (acres): 78.2

7. Name of nearest receiving body of water: Brushy Creek

8. River Basin: French Broad
   (Note – this must be one of North Carolina's seventeen designated major river basins. The River Basin map is available at http://h2o.enr.state.nc.us/admin/maps/.)

9. Describe the existing conditions on the site and general land use in the vicinity of the project at the time of this application: Site consists of transfer station, inactive C&D landfill cells,

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operating C&D landfill cell, and previously timbered forest land in various stages of succession. Vicinity is primarily forest land and residential land.

10. Describe the overall project in detail, including the type of equipment to be used: Landfill expansion is proposed to fill the upper portion of the existing drainage between the landfill cells. This will entail construction of an underdrain detailed in the attached engineering plans, placement of the landfill liner subgrade, fine grained soil liner, and waste material. Upon reaching landfill capacity, the site will be covered with a low permeability soil cap and vegetated. Construction will include the use of standard equipment including pans, excavators, bulldozers, and track hoes as needed. Initial construction will also include the removal of waste within 50 feet of the perennial channel shown on the attached plans. Riparian buffers will be restored as described in the attached restoration plan. See cover letter and attached materials for additional details.

11. Explain the purpose of the proposed work: The purpose of the landfill is to provide Avery County and its citizens with a practical disposal option for their construction and land clearing waste materials generated within the county.

IV. Prior Project History

If jurisdictional determinations and/or permits have been requested and/or obtained for this project (including all prior phases of the same subdivision) in the past, please explain. Include the USACE Action ID Number, DWQ Project Number, application date, and date permits and certifications were issued or withdrawn. Provide photocopies of previously issued permits, certifications or other useful information. Describe previously approved wetland, stream and buffer impacts, along with associated mitigation (where applicable). If this is a NCDOT project, list and describe permits issued for prior segments of the same T.I.P. project, along with construction schedules.
A jurisdictional determination request was previously submitted to the US Army Corps of Engineers Asheville Regulatory Office on May 7, 2008.

V. Future Project Plans

Are any future permit requests anticipated for this project? If so, describe the anticipated work, and provide justification for the exclusion of this work from the current application.
The proposed project is the only projected impact related to landfill expansion for the next 20 years. However, a potential access or road crossing may be needed to provide equipment access to the western portion of the site for future use as a borrow area or landfill cell. This cannot be included in the current permit application due to the lack of current need for the western portion of the site in the next decade.

VI. Proposed Impacts to Waters of the United States/Waters of the State

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It is the applicant's (or agent's) responsibility to determine, delineate and map all impacts to wetlands, open water, and stream channels associated with the project. Each impact must be listed separately in the tables below (e.g., culvert installation should be listed separately from riprap dissipater pads). Be sure to indicate if an impact is temporary. All proposed impacts, permanent and temporary, must be listed, and must be labeled and clearly identifiable on an accompanying site plan. All wetlands and waters, and all streams (intermittent and perennial) should be shown on a delineation map, whether or not impacts are proposed to these systems. Wetland and stream evaluation and delineation forms should be included as appropriate. Photographs may be included at the applicant's discretion. If this proposed impact is strictly for wetland or stream mitigation, list and describe the impact in Section VIII below. If additional space is needed for listing or description, please attach a separate sheet.

1. Provide a written description of the proposed impacts: The proposed impact consists of placing an underdrain along the intermittent channel between the current landfill cells, followed by placing landfill subgrade fill and landfill liner above the drain. This impact will include the intermittent channel and a minor wetland area at the base of the current roadway crossing.
2. Individually list wetland impacts. Types of impacts include, but are not limited to mechanized clearing, grading, fill, excavation, flooding, ditching/drainage, etc. For dams, separately list impacts due to both structure and flooding.

Wetland Impact Site Number (indicate on map)	Type of Impact	Type of Wetland (e.g., forested, marsh, herbaceous, bog, etc.)	Located within 100-year Floodplain (yes/no)	Distance to Nearest Stream (linear feet)	Area of Impact (acres)
1	Fill	Headwater forest	No	0	0.004
Total Wetland Impact (acres)					0.004

3. List the total acreage (estimated) of all existing wetlands on the property: 0.704

4. Individually list all intermittent and perennial stream impacts. Be sure to identify temporary impacts. Stream impacts include, but are not limited to placement of fill or culverts, dam construction, flooding, relocation, stabilization activities (e.g., cement walls, rip-rap, crib walls, gabions, etc.), excavation, ditching/straightening, etc. If stream relocation is proposed, plans and profiles showing the linear footprint for both the original and relocated streams must be included. To calculate acreage, multiply length X width, then divide by 43,560.

Stream Impact Number (indicate on map)	Stream Name	Type of Impact	Perennial or Intermittent?	Average Stream Width Before Impact	Impact Length (linear feet)	Area of Impact (acres)
1	UT – Brushy Cr	Fill/drain	Intermittent	3'	408	0.03
Total Stream Impact (by length and acreage)					408	0.03

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5. Individually list all open water impacts (including lakes, ponds, estuaries, sounds, Atlantic Ocean and any other water of the U.S.). Open water impacts include, but are not limited to fill, excavation, dredging, flooding, drainage, bulkheads, etc.

Open Water Impact Site Number (indicate on map)	Name of Waterbody (if applicable)	Type of Impact	Type of Waterbody (lake, pond, estuary, sound, bay, ocean, etc.)	Area of Impact (acres)
Total Open Water Impact (acres)				0

6. List the cumulative impact to all Waters of the U.S. resulting from the project:

Stream Impact (acres):	0.03
Wetland Impact (acres):	0.004
Open Water Impact (acres):	0
Total Impact to Waters of the U.S. (acres)	0.034
Total Stream Impact (linear feet):	408

7. Isolated Waters
Do any isolated waters exist on the property? ☐ Yes ☒ No
Describe all impacts to isolated waters, and include the type of water (wetland or stream) and the size of the proposed impact (acres or linear feet). Please note that this section only applies to waters that have specifically been determined to be isolated by the USACE.
No isolated waters impacts.

8. Pond Creation
If construction of a pond is proposed, associated wetland and stream impacts should be included above in the wetland and stream impact sections. Also, the proposed pond should be described here and illustrated on any maps included with this application.
Pond to be created in (check all that apply): ☐ uplands ☐ stream ☐ wetlands
Describe the method of construction (e.g., dam/embankment, excavation, installation of draw-down valve or spillway, etc.):_____
Proposed use or purpose of pond (e.g., livestock watering, irrigation, aesthetic, trout pond, local stormwater requirement, etc.):_____
Current land use in the vicinity of the pond:_____
Size of watershed draining to pond:_____ Expected pond surface area:_____

VII. Impact Justification (Avoidance and Minimization)

Specifically describe measures taken to avoid the proposed impacts. It may be useful to provide information related to site constraints such as topography, building ordinances, accessibility, and financial viability of the project. The applicant may attach drawings of alternative, lower-impact site layouts, and explain why these design options were not feasible. Also discuss how impacts were minimized once the desired site plan was developed. If applicable, discuss construction techniques to be followed during construction to reduce impacts._____

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The landfill expansion will impact 408 linear feet of intermittent channel and 0.01 (0.004) acres of headwater forest wetland. The intermittent channel already lacks significant aquatic function and the extremely small wetland does not provide a great deal of function either. The proposed impact has been minimized to the greatest extent practical given the site conditions. The landfill is built upon two ridges, one running between the two stream channels and another to the east of the smaller intermittent/perennial stream. This has resulted in a very thin, steep landfill design that is not efficient for waste capacity and has also created some erosion control challenges. The steep topography and side slopes of the landfill do not provide a lot of opportunity for sufficient erosion control devices to be installed and maintained. This contributed to sediment deposition within the smaller stream channel. Without re-designing the landfill, little can be done to improve the current conditions on the site, and the likelihood of additional sedimentation during larger storm events is high.

Avoidance of the proposed impacts would result in another inefficient design of a landfill surrounding the existing channels. There would be limited options, again, for the collection and treatment of runoff from the site. These options would likely route stormwater below the proposed impact area, potentially causing a drainage effect on the wetland and stream. The landfill limits have been designed to avoid the perennial segment of the stream channel, where a strong base flow and groundwater table can sustain the flow regime of the stream.

Current conditions on the Site have the potential to adversely affect trout habitat in Brushy Creek due to sedimentation. In addition, the limited buffers in some areas allow surface water temperatures to fluctuate. Therefore, some remedial action is required to rectify the existing conditions. While removal of all sediment from the intermittent/perennial stream would be optimal, the presence of the landfill limits the effect of this measure. The lower (perennial) section of stream has relatively stable buffers and can be restored to a functional stream channel. The upper portion has less potential for restoration since an improved stormwater design would have to route discharges below this segment. The current permitted cells of the landfill create a difficult challenge in control of sediment due to their steep side slopes. Reconfiguration of the landfill will rectify this situation and improve the erosion control on the Site as described above.

In conjunction with the landfill expansion, the removal of waste within a 50-foot buffer of the intermittent/perennial tributary will increase buffer function on the site and stabilize water temperature fluctuations. This waste removal, in combination with the restoration of the buffers described below will provide both erosion control and temperature fluctuation control in the downstream waters, therefore improving existing trout habitat.

VIII. Mitigation

DWQ - In accordance with 15A NCAC 2H .0500, mitigation may be required by the NC Division of Water Quality for projects involving greater than or equal to one acre of impacts to freshwater wetlands or greater than or equal to 150 linear feet of total impacts to perennial streams.

SEP-19-2008(FRI) 10:58 SOLID WASTE (FAX)828 733 8209 P.008/010

USACE – In accordance with the Final Notice of Issuance and Modification of Nationwide Permits, published in the Federal Register on January 15, 2002, mitigation will be required when necessary to ensure that adverse effects to the aquatic environment are minimal. Factors including size and type of proposed impact and function and relative value of the impacted aquatic resource will be considered in determining acceptability of appropriate and practicable mitigation as proposed. Examples of mitigation that may be appropriate and practicable include, but are not limited to: reducing the size of the project; establishing and maintaining wetland and/or upland vegetated buffers to protect open waters such as streams; and replacing losses of aquatic resource functions and values by creating, restoring, enhancing, or preserving similar functions and values, preferable in the same watershed.

If mitigation is required for this project, a copy of the mitigation plan must be attached in order for USACE or DWQ to consider the application complete for processing. Any application lacking a required mitigation plan or NCEEP concurrence shall be placed on hold as incomplete. An applicant may also choose to review the current guidelines for stream restoration in DWQ's Draft Technical Guide for Stream Work in North Carolina, available at http://h2o.enr.state.nc.us/ncwetlands/strmgide.html.

1. Provide a brief description of the proposed mitigation plan. The description should provide as much information as possible, including, but not limited to: site location (attach directions and/or map, if offsite), affected stream and river basin, type and amount (acreage/linear feet) of mitigation proposed (restoration, enhancement, creation, or preservation), a plan view, preservation mechanism (e.g., deed restrictions, conservation easement, etc.), and a description of the current site conditions and proposed method of construction. Please attach a separate sheet if more space is needed.
   As discussed in the on-site review meeting with the USACE, NCDWQ, and NCWRC, mitigation will be provided via on-site restoration of riparian buffers associated with the perennial segment of the tributary, and removal of sediment from the channel in this reach. A restoration plan detailing this activity has been attached to this application. Mitigation for this impact includes:
   Stream Mitigation for 408 linear feet of intermittent channel lacking important function:
   - 5,045 linear feet of channel preserved (12:1 ratio)
   - 569 linear feet of perennial channel enhanced by sediment removal (1.4:1 ratio)
   - 40 linear feet of perennial channel restored by removal of crossing (0.1:1 ratio)

   Trout Buffer Mitigation for 0.524 acres of impact:
   - Preservation of 4.20 acres of buffer in the proposed site (8:1 ratio)
   - Future preservation of approximately 7.4 acres of buffer on site (14:1 ratio)
   - Restoration of 0.66 acres of buffer along the perennial tributaries (1.25:1 ratio)

2. Mitigation may also be made by payment into the North Carolina Ecosystem Enhancement Program (NCEEP). Please note it is the applicant's responsibility to contact the NCEEP at (919) 715-0476 to determine availability, and written approval from the NCEEP indicating that they are will to accept payment for the mitigation must be attached to this form. For additional information regarding the application process for the NCEEP, check the NCEEP website at http://h2o.enr.state.nc.us/wrp/index.htm. If use of the NCEEP is proposed, please check the appropriate box on page three and provide the following information:

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Amount of stream mitigation requested (linear feet): 0
Amount of buffer mitigation requested (square feet): 0
Amount of Riparian wetland mitigation requested (acres): 0
Amount of Non-riparian wetland mitigation requested (acres): 0
Amount of Coastal wetland mitigation requested (acres): 0

IX. Environmental Documentation (required by DWQ)

1. Does the project involve an expenditure of public (federal/state/local) funds or the use of public (federal/state) land? Yes ☒ No ☐

2. If yes, does the project require preparation of an environmental document pursuant to the requirements of the National or North Carolina Environmental Policy Act (NEPA/SEPA)? Note: If you are not sure whether a NEPA/SEPA document is required, call the SEPA coordinator at (919) 733-5083 to review current thresholds for environmental documentation. Yes ☐ No ☒

3. If yes, has the document review been finalized by the State Clearinghouse? If so, please attach a copy of the NEPA or SEPA final approval letter. Yes ☐ No ☐

X. Proposed Impacts on Riparian and Watershed Buffers (required by DWQ)

It is the applicant's (or agent's) responsibility to determine, delineate and map all impacts to required state and local buffers associated with the project. The applicant must also provide justification for these impacts in Section VII above. All proposed impacts must be listed herein, and must be clearly identifiable on the accompanying site plan. All buffers must be shown on a map, whether or not impacts are proposed to the buffers. Correspondence from the DWQ Regional Office may be included as appropriate. Photographs may also be included at the applicant's discretion.

1. Will the project impact protected riparian buffers identified within 15A NCAC 2B .0233 (Neuse), 15A NCAC 2B .0259 (Tar-Pamlico), 15A NCAC 02B .0243 (Catawba) 15A NCAC 2B .0250 (Randleman Rules and Water Supply Buffer Requirements), or other (please identify_____)? Yes ☐ No ☒

2. If "yes", identify the square feet and acreage of impact to each zone of the riparian buffers. If buffer mitigation is required calculate the required amount of mitigation by applying the buffer multipliers.

Zone*	Impact (square feet)	Multiplier	Required Mitigation
1		3 (2 for Catawba)	
2		1.5	
Total	0		0

* Zone 1 extends out 30 feet perpendicular from the top of the near bank of channel; Zone 2 extends an additional 20 feet from the edge of Zone 1.

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3. If buffer mitigation is required, please discuss what type of mitigation is proposed (i.e., Donation of Property, Riparian Buffer Restoration / Enhancement, or Payment into the Riparian Buffer Restoration Fund). Please attach all appropriate information as identified within 15A NCAC 2B .0242 or .0244, or .0260. Buffer mitigation associated with the trout buffers subject to the NC Division of Land Resources regulations are addressed in the attached restoration plan and variance request.

XI. Stormwater (required by DWQ)

Describe impervious acreage (existing and proposed) versus total acreage on the site. Discuss stormwater controls proposed in order to protect surface waters and wetlands downstream from the property. If percent impervious surface exceeds 20%, please provide calculations demonstrating total proposed impervious level.
Impervious areas will not be created by the project. Current impervious area on site is approximately 4.6% (3.59 acres). Impervious infrastructure such as scale house and transfer station have already been built on site for the operation of the previous landfill cells. The proposed construction will result in a vegetated cap over the landfill cell, which will not be impervious. Stormwater controls, including dry detention basins, level spreaders, and energy dissipators are detailed in the attached plans. Additional cool water measures are described in the stormwater management plan attached to this application.

XII. Sewage Disposal (required by DWQ)

Clearly detail the ultimate treatment methods and disposition (non-discharge or discharge) of wastewater generated from the proposed project, or available capacity of the subject facility.
Sanitary sewage on site is currently treated by an on site septic system. Leachate generated from the waste is hauled to a POTW (public owned treatment works) plant in Boone, NC. No additional sewage will be created by the proposed project.

XIII. Violations (required by DWQ)

Is this site in violation of DWQ Wetland Rules (15A NCAC 2H .0500) or any Buffer Rules?
Yes ☐ No ☒

Is this an after-the-fact permit application? Yes ☐ No ☒

XIV. Cumulative Impacts (required by DWQ)

Will this project (based on past and reasonably anticipated future impacts) result in additional development which could impact nearby downstream water quality? Yes ☐ No ☒
If yes, please submit a qualitative or quantitative cumulative impact analysis in accordance with the most recent North Carolina Division of Water Quality policy posted on our website at http://h2o.enr.state.nc.us/newetlands. If no, please provide a short narrative description:

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The expansion of the landfill will not increase development in the area. Landfill expansion has not been associated with increased development in the vicinity, and there is no indication that this site will be different. As the mountain region becomes increasingly popular for residential developments, there is a likelihood that development would occur in the vicinity of the landfill. However, this project will not add to that potential and could decrease it.

XV. Other Circumstances (Optional):

It is the applicant's responsibility to submit the application sufficiently in advance of desired construction dates to allow processing time for these permits. However, an applicant may choose to list constraints associated with construction or sequencing that may impose limits on work schedules (e.g., draw-down schedules for lakes, dates associated with Endangered and Threatened Species, accessibility problems, or other issues outside of the applicant's control).

19 SEPT 2008

Applicant/Agent's Signature **Date**

(Agent's signature is valid only if an authorization letter from the applicant is provided.)

SEP-19-2008(FRI) 10:59 SOLID WASTE (FAX)828 733 8209 P.012/012

Attachment 3

ATTACHMENT 3

Figures

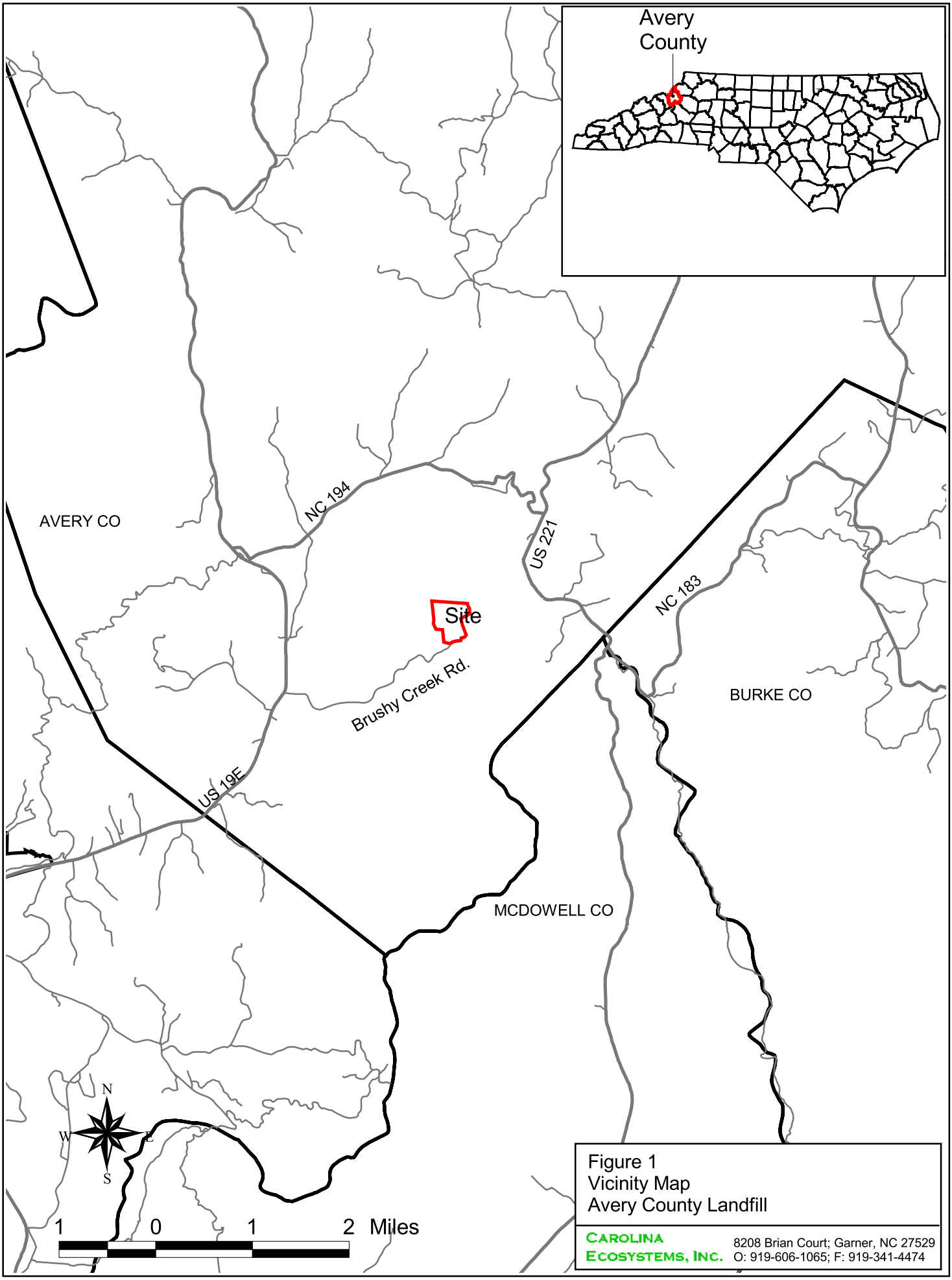


Figure 1
Vicinity Map
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474

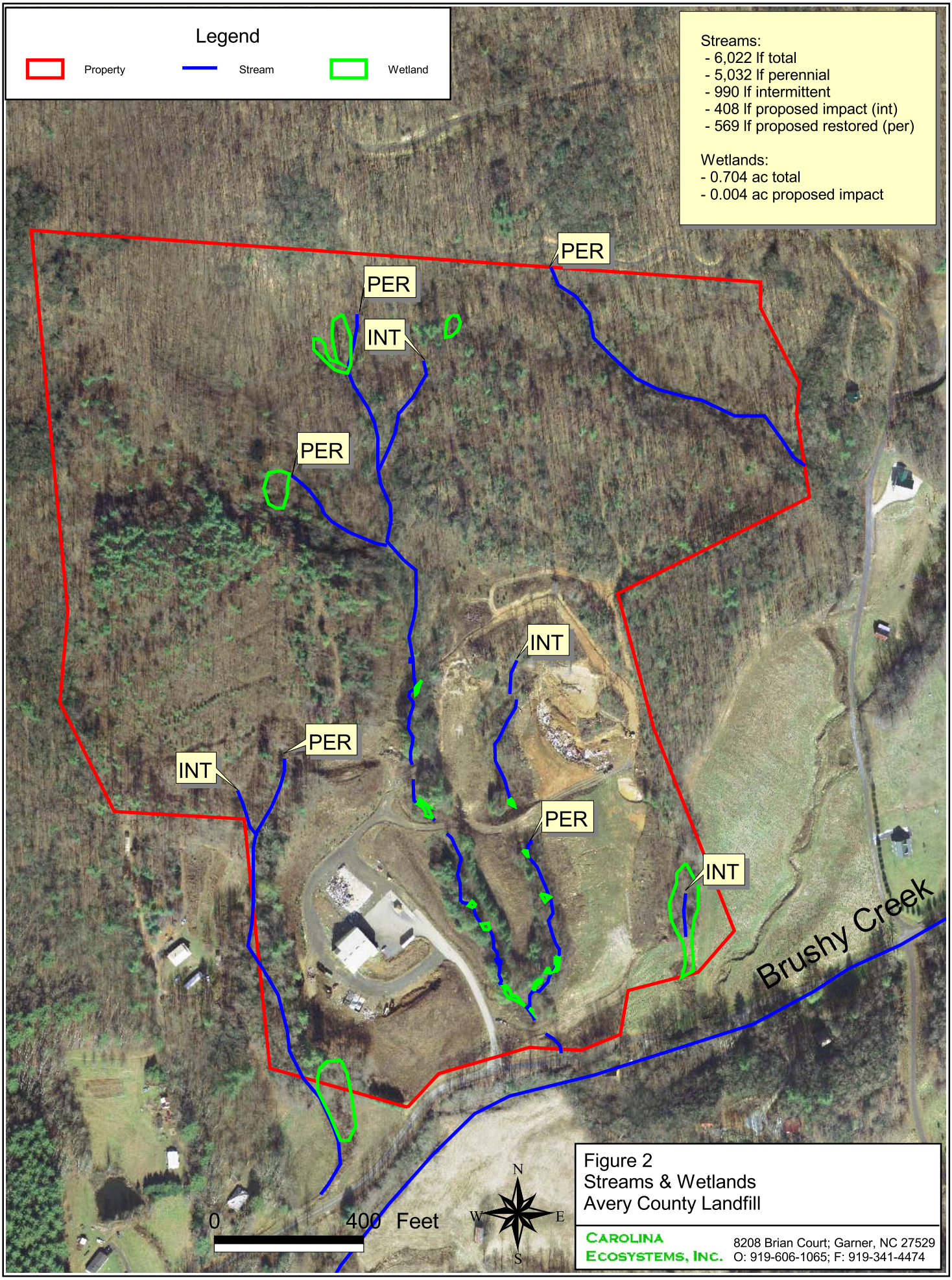


Figure 2
Streams & Wetlands
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474

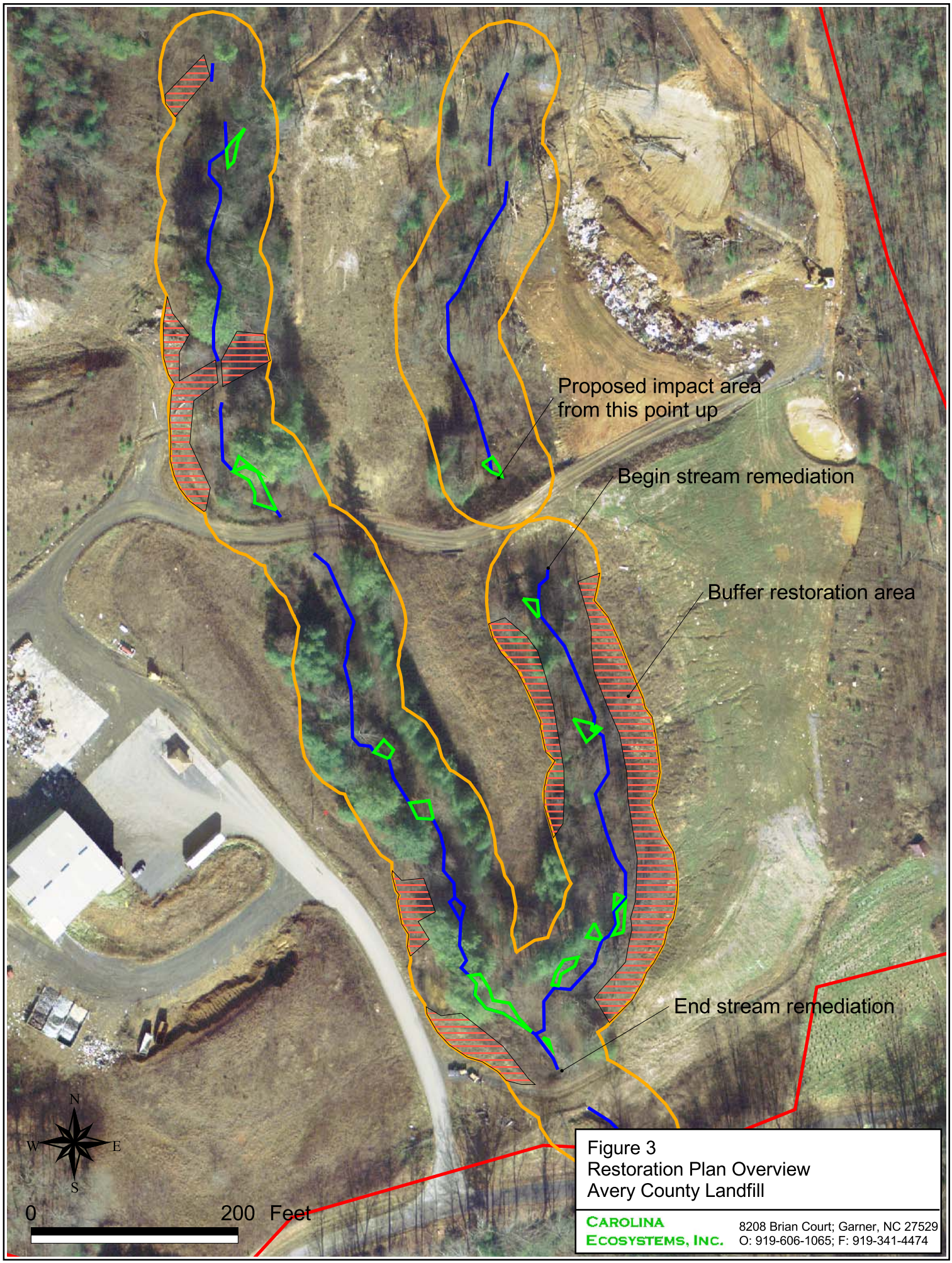


Figure 3
Restoration Plan Overview
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474

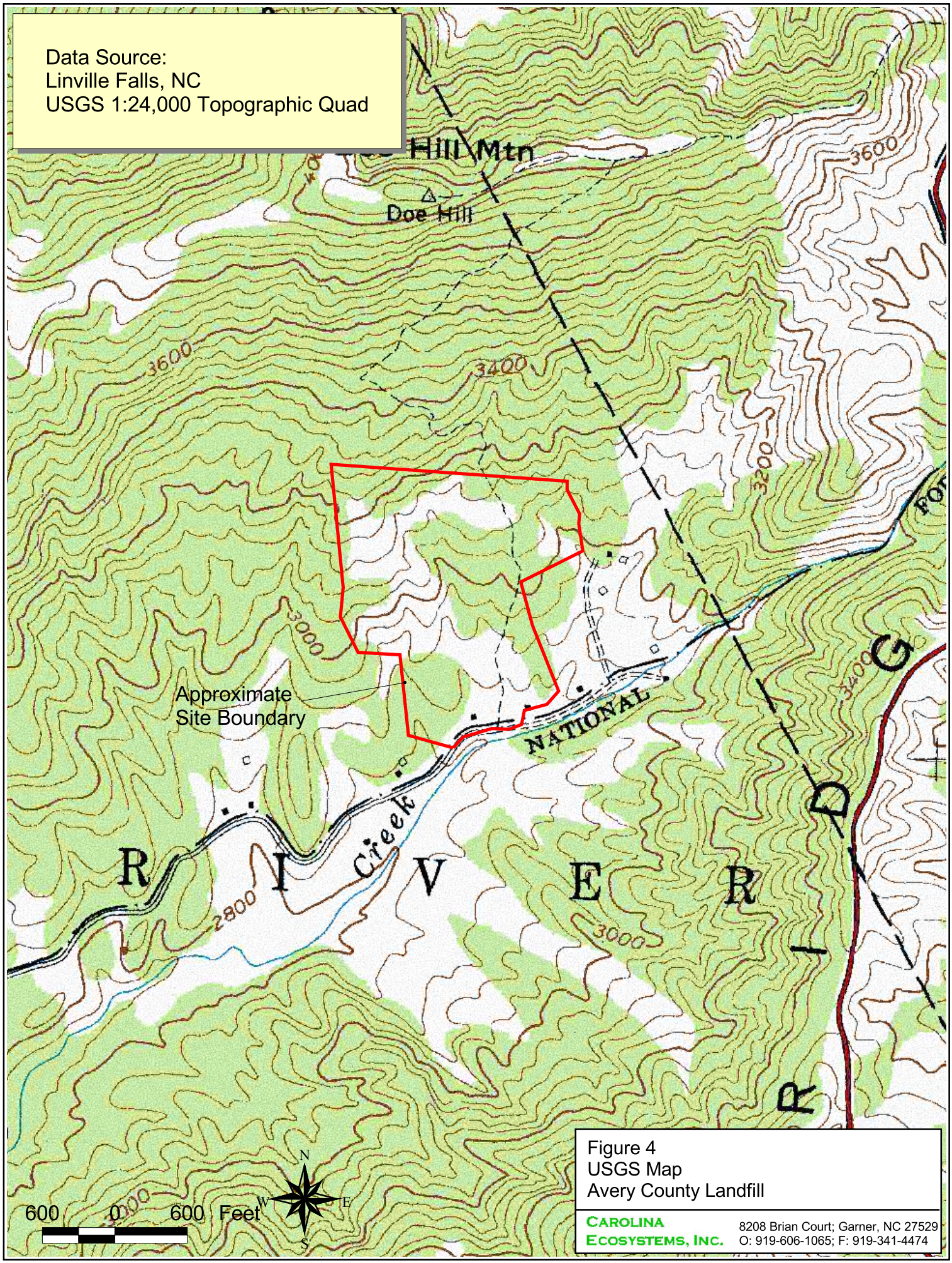


Figure 4
USGS Map
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474

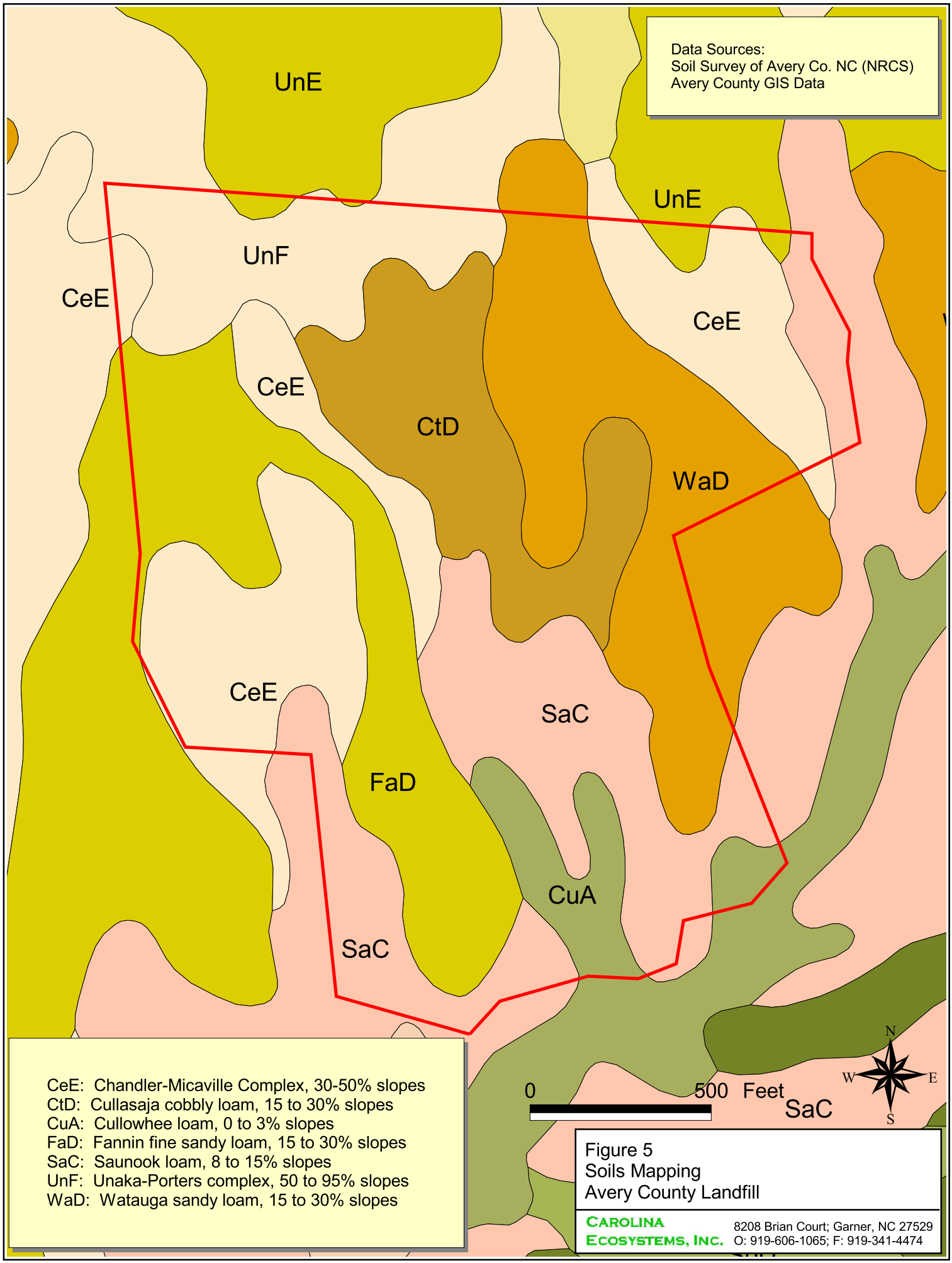
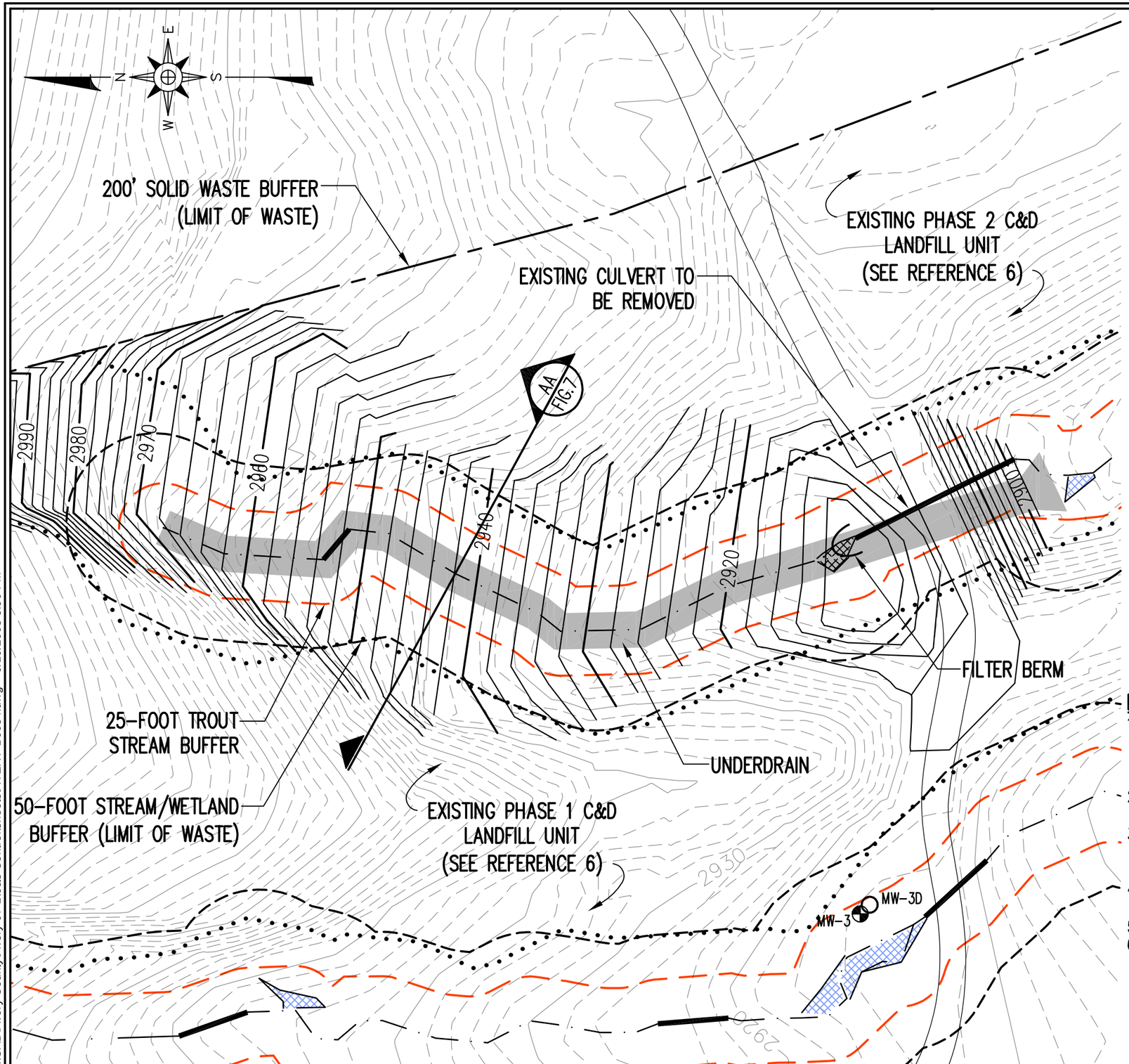


Figure 5
Soils Mapping
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474



LEGEND

2840	EXISTING 10' CONTOUR (SEE REFERENCE 1)
	EXISTING 2' CONTOUR
3000	PROPOSED 10' CONTOUR
	PROPOSED 2' CONTOUR
	200-FOOT SOLID WASTE BUFFER
	PERMITTED WASTE LIMITS
	APPROX. STREAM LOCATION (SEE REFERENCE 3, 5)
	WETLANDS (SEE REFERENCE 3)
	50-FOOT STREAM AND WETLAND BUFFER
	25-FOOT TROUT STREAM BUFFER
	WETLAND IMPACT AREA
	MONITORING WELL
	PIEZOMETER

REFERENCES

1. OVERALL SITE TOPOGRAPHY FROM NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, DATA GENERATED FROM LIDAR DATED MARCH 2005, TOPO IN AREAS IN AND SURROUNDING PHASES 1 AND 2 FROM FIELD SURVEY DATED 9/07, BY SURVEYING SOLUTIONS, P.C.
2. SITE PROPERTY LINE AND MONITORING WELL LOCATIONS FROM FIELD SURVEYS DATED 9/07 AND 1/14/08, BY SURVEYING SOLUTIONS, P.C.
3. STREAM AND WETLAND LOCATIONS IN NORTHERN SECTOR OF SITE OBTAINED FROM GPS FIELD SURVEY DATED 4/07, BY CAROLINA ECOSYSTEMS, INC.
4. STREAMS AND WETLANDS NEAR PHASE 1 AND 2 FROM FIELD SURVEY DATED 2/18/08 BY SURVEYING SOLUTIONS, P.C.
5. BRUSHY CREEK LOCATION FROM AVERY COUNTY GIS DEPARTMENT.
6. NC SOLID WASTE PERMIT NO. 06-03.

0 60' 120' 180'

RICHARDSON SMITH GARDNER & ASSOCIATES
14 N. Boylan Ave.
Raleigh, N.C. 27603
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fax: 919-828-3899
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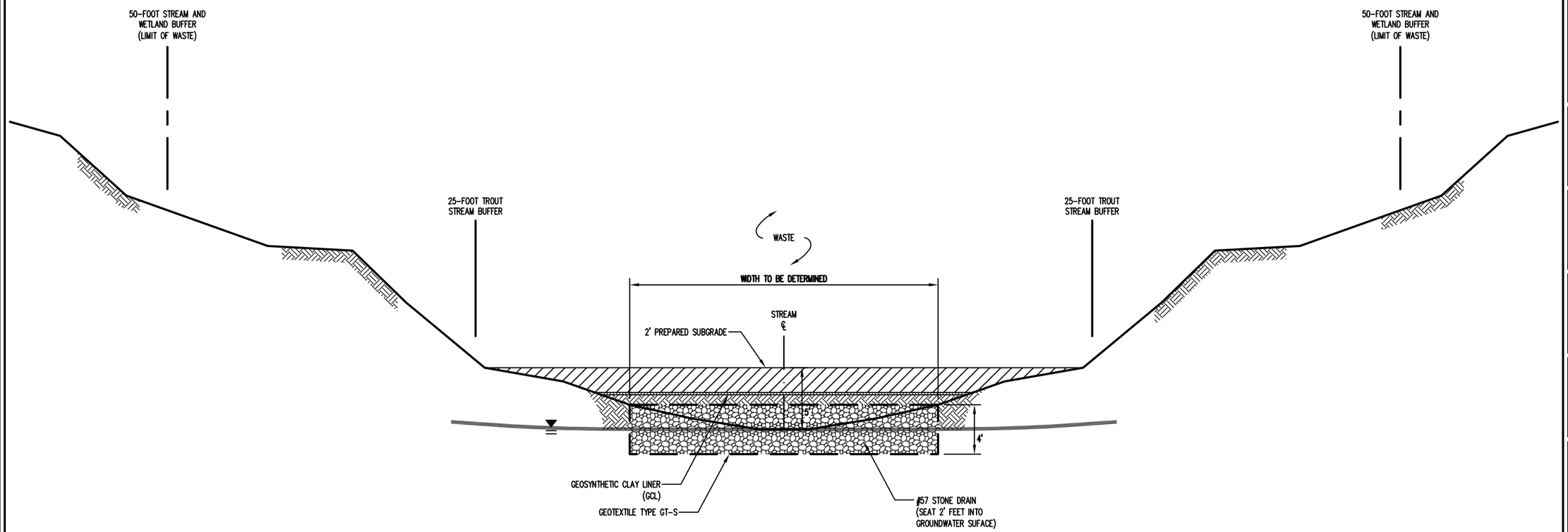
FIGURE NO.	6
FILE NAME	AVERY-B0054
SCALE:	AS SHOWN
PROJECT NO.	AVERY 07-1
CHECKED BY:	S.A.S.
DRAWN BY:	C.T.J.
DATE:	SEPT. 2008

TITLE: AVERY COUNTY C&D LANDFILL STORMWATER MANAGEMENT PLAN STREAM IMPACT AREA

G:\CAD\Avery County\Avery 07-1\e&s Control\sheets\AVERY-B0054.dwg - 9/19/2008 3:50 PM



STREAM IMPACT TYPICAL SECTION

DETAIL
NOT TO SCALE

AA
FIG.7

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FIGURE NO.	7
FILE NAME	AVERY-B0055
SCALE:	N.T.S.
PROJECT NO.	AVERY 07-1
CHECKED BY:	S.A.S.
DRAWN BY:	C.T.J.
DATE:	SEPT. 2008

TITLE:
AVERY COUNTY C&D LANDFILL
STORMWATER MANAGEMENT PLAN
STREAM IMPACT
TYPICAL SECTION

G:\CAD\Avery County\Avery 07-1\e&s Control\sheets\AVERY-B0055.dwg - 9/19/2008 3:48 PM

Attachment 4

ATTACHMENT 4

Site Photographs

Photo 1: Impact area shown between two cells of the landfill.

Photo 2: Upper end of intermittent channel near seasonal seep/spring.

Photo 3: Lower end of impact area – intermittent channel above road crossing.

Photo 4: Detailed view of upper reach of intermittent stream.

Photo 5: Upper portion of mitigation area (impact area begins at right side.

Photo 6: Perennial stream channel – upper reach below impact area.

Photo 7: Impacted reach of perennial stream to be remediated.

Attachment 5

ATTACHMENT 5

On-Site Mitigation Plan

Avery County Landfill
On-Site Mitigation Plan

This on-site mitigation plan has been developed based on the need to have a stable, healthy, and natural plant community established along the on-site streams where disturbance has occurred or waste will be removed. The site and surrounding area was investigated to determine existing conditions and to develop the target plant community to restore to these areas. It was determined that the Chestnut Oak Forest community type as described in *Classification of the Natural Communities of North Carolina – Third Approximation* was the appropriate target community for these stream buffer areas. This plan will provide for a stable stream buffer with plant species that should restore these areas to the natural plant communities that was likely here prior to their disturbance.

In addition, this plan addresses the remediation of previous impacts to the streams on site. This includes removal of sediment from the perennial channel between the landfill cells and removal of an existing 40' pipe in the channel to the west of the landfill. This work is intended to allow the aquatic habitat in the streams to recover, and to improve water quality in the streams and downstream trout habitat.

1.0 Stream Buffer Restoration Plan

1.1 Soil Preparation

The site will undergo large earth moving activities prior to the restoration efforts. These activities will likely result in compacted soil and subsoil. The areas to be restored as stream buffer will need to be properly prepared to ensure adequate growing conditions. If compaction or loss of topsoil has occurred, the following actions must be taken in the stream buffer restoration areas before final seedbed/woody planting preparation begins.

- All disturbed areas within the buffer restoration zones that have been compacted must be rip-tilled in such a manner as to allow plant root growth in the subsoil. All heavy equipment such as large excavators/bulldozers is prohibited from entering the restoration zone after the rip-tilling has been completed.
- In disturbed areas within the buffer restoration zones, final grade elevations shall be attained by the application of 6 to 10 inches of topsoil to all disturbed areas within the restoration zones.
- The topsoil shall be disked to ensure proper connection with the subsoil and prevention of surface compaction. This activity shall be done in dry weather conditions with satisfactory soil moisture.
- All erosion control/permanent seeding soil preparation criteria shall then be implemented. See **Erosion Control Notes** for details.

1.2 Stream Buffer Plant List

(SB): All disturbed areas denoted on plans as SB shall be planted with plants selected from the following list.

Scientific Name	Common Name	Layer	Spacing (ft) On-Center	Plant Size	Distribution
Pinus strobus	White Pine	Tree	8x8	Container	Random
Liriodendron tulipifera	Tulip Poplar	Tree	8x8	Container	Random
Quercus prinus	Chestnut Oak	Tree	8x8	Container	Random
Quercus rubra	Northern Red Oak	Tree	8x8	Container	Random
Quercus coccinea	Scarlet Oak	Tree	8x8	Container	Random
Fagus grandifolia	American Beech	Tree	8x8	Container	Random
Acer rubrum	Red Maple	Tree	8x8	Container	Random
Carpinus caroliniana	Ironwood	Tree	8x8	Container	Random
Kalmia latifolia	Mountain Laurel	Shrub	8x8	Container	Random
Rhododendron maximum	Great Laurel	Shrub	8x8	Container	Random

1.3 Planting Requirements

- **The Stream Buffer Zone shall be planted with at least six (6) of the above species.**
- **No species shall make up more than 30% of the total planted stems in each SB area.**
- **No species shall make up less than 10% of the total planted stems in each SB area.**
- **No plant substitutions beyond the list above are allowed.**

The following are the weather and soil conditions that must be present at the site during all planting of the stream buffer zones.

- **Temperature greater than 35^0F and less than 85^0F**
- **Relative Humidity greater than 30%**
- **Wind less than 10 miles/hour**
- **Soil is moist to the surface**
- **Soil surface is protected by an organic mulch layer or equivalent protection**
- **Soil has been ripped and disked such that compaction will not inhibit growth**

The stream buffer restoration areas should be adequately marked before planting commences.

The correct spacing of vegetation should be checked by the On-Site Supervisor on a regular basis.

1.3.1 Plant Distribution

Random Distribution – take all six (6) plant species selected for planting from the plant list in the proper percentages to meet the planting requirements. Mix the plants so that they are all planted randomly at the 8' spacing called for in this plan. If done properly, sometimes two or more of the same species will be planted adjacent to each other and other times there may only be one plant of a species completely surrounded by one or more other species.

1.3.2 Planting Method

The following describes the general planting techniques to be followed when installing the plants. However, these techniques may be modified if the contractor believes that other techniques will improve health and survival of the plants.

<u>Containerized Plants (equal to or larger than 16 cubic inches)</u>

i. Containerized plants must be robust healthy growing plants.
ii. The root system must be vigorous and dense enough to hold the shape of the container once removed.
iii. Container vegetation must always be handled by the container and never by the tops of the plants.
iv. Containerized plants must be stored in the shade and kept moist until installation.
v. If soil is compacted, the area of planting shall be loosened to a depth equal to that of the root ball for a radius of one (1) feet around each plant.
vi. Install containerized plants only when soil is moist and/or wet.
vii. Before installation, remove any damaged roots and loosen any circling or compacted roots.
viii. Install containerized plants using an appropriate implement such that a hole is created that will allow the plant to be inserted without any bending, binding, or breaking of roots.
ix. Container stock shall be planted in a vertical position with the root collar approximately 0.5 inches below the soil surface. The planting trench or hole shall be deep and wide enough to permit roots to spread out and down without J-rooting.

x. After planting, the soil shall be tamped firmly to eliminate air pockets.
xi. A 2 foot radius of a 3- to 4-inch layer of organic mulch such as straw must then be placed on the soil surface around the entire plant.
xii. If dry conditions occur following planting, a method to water the plants should be developed and implemented.

Plant spacing is called out on a grid basis such as 8 x 8, etc. This spacing refers to planting the plants 8 feet apart from each other in all directions within a planting zone. This spacing does not relate to planting distance from other zones or the planting distance at the zone boundary.

Planting shall begin 2' in from the planting zone boundary nearest to the stream. Planting will then proceed away from the stream on an 8' spacing. The plants will be planted along all other boundaries to within a distance of 4 feet or less from any boundary edge. This is likely to result in an outer row being planted closer than the designated 8' spacing.

Some existing stream buffer areas are to remain undisturbed. These areas should be protected from encroachment and no additional planting will be done in these areas. If some of these areas are impacted during construction activities, then the stream buffer restoration plan shall be implemented for those areas as well.

In addition to the woody plants to be planted in the stream buffer areas, the soil will be prepared, seeded and protected according to the temporary and permanent seeding requirements for the entirety of the site. However, no fescue, lespedeza, or other aggressive nonnative grasses are allowed to be planted in the stream buffer areas.

1.3.3 Planting Warranty

For all planted material, the contractor shall warrant an 80% survival rate against defects including mortality and poor growth, except for defects resulting from abuse by other parties and abnormal weather conditions.

2.0 Stream Daylighting and Remediation

2.1 Stream Daylighting

The approximate 40' pipe within the stream channel just west of the existing landfill, and within the proposed buffer restoration area, will be removed and the banks returned to natural conditions. This will be accomplished through the following steps:

- Removing the pipe during a dry period with low-flow conditions in the stream channel.
- Reestablishing the banks to match upstream and downstream contours.
- Stabilizing the stream banks with erosion control blanket down to, but not including, the bed of the stream.
- Planting the stream bank as described in Section 1.0 of this plan, along with the associated buffers.
- Appropriate sediment and erosion control measures will be used during this work.

2.2 Sediment Removal

The perennial channel between the two landfill cells, from the road crossing down to its confluence with the larger stream, will be enhanced through the removal of deposited sediment from within the channel. This will be accomplished in the following manner:

- Carolina Ecosystems, Inc. or other qualified personnel will inspect the stream channel prior to the start of the work, and place staking along the banks to indicate the areas and approximate depth of the sediment removal.
- Removal of the sediment will be performed by hand using shovels or other hand tools. No mechanized equipment will be used within the channel.
- Several staging areas for excavated materials will be established along the channel for deposition of the material. This material will then be moved by on-site equipment to an appropriate location with adequate sediment and erosion controls.
- The staging areas will be located in coordination with the buffer restoration and will be planted as described in Section 1.0 when work is completed. Each staging area will have silt fence placed on the downstream sides to prevent material from re-entering the channel.
- Sediment will be removed down to a depth just above the original bed of the stream in order to not disturb the channel dimensions.
- This work will be performed during a low-flow or dry period and appropriate sediment and erosion control measures will be implemented during this work.

3.0 Conclusions

This plan will be implemented in conjunction with the Avery County Landfill expansion. It will serve to provide compensation for the removal of 408 linear feet of intermittent channel that currently does not provide significant aquatic habitat, and to remediate previous secondary impacts from landfill operations. The result of this work will be a decrease in sedimentation of downstream trout habitat, an increase in the stability of temperature fluctuations within the channel, and a re-colonization of the affected stream channel by typical aquatic macrobenthos over the long term.

Attachment 6

ATTACHMENT 6

Delineation Information

North Carolina Division of Water Quality – Stream Identification Form Version 3.1

Date: 9/25/07	**Project:** Avery Co LF	**Latitude:**
Evaluator: Phil May	**Site:** SA-Upper	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 23.5	**County:** Avery	**Other** *e.g. Quad Name:* Linville Falls

A. Geomorphology (Subtotal = 9.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

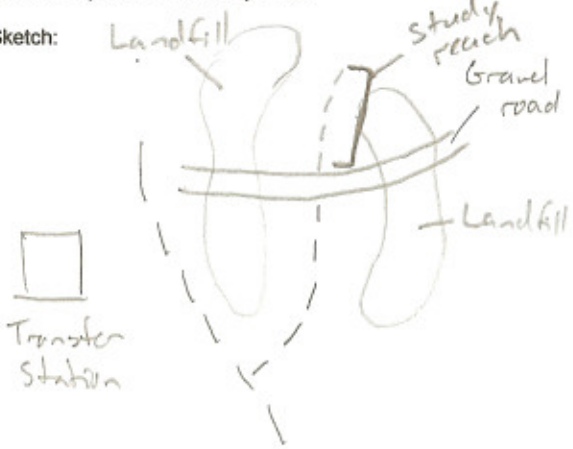
C. Biology (Subtotal = 6)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Intermittent portion of stream between landfill cells. Above road crossing. Heavy impact from sedimentation.

Sketch:



SA-Upper

USACE STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	1
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	0
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	0
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	3
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	4
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	0
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						34

* These characteristics are not assessed in coastal streams.

North Carolina Division of Water Quality – Stream Identification Form Version 3.1

Date: 9/25/07	**Project:** Avery Co LF	**Latitude:**
Evaluator: Phil May	**Site:** SA - Upper	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 33.5	**County:** Avery	**Other** *e.g. Quad Name:* Linville Falls

A. Geomorphology (Subtotal = 15)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 11)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

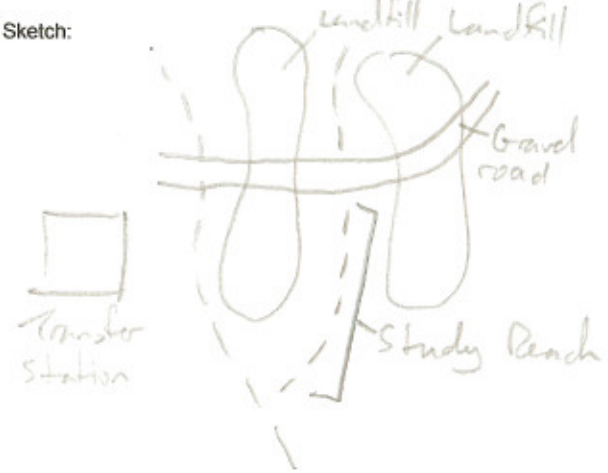
C. Biology (Subtotal = 7.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Lower reach of stream between landfill cells. Heavily impacted by sediment.

Sketch:



SA- Lower

USACE STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	1
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	1
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	0
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	3
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						45

* These characteristics are not assessed in coastal streams.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Avery County Landfill **Applicant / Owner:** RSG Engineers/Avery County **Investigator:** Phil May - Carolina Ecosystems, Inc.	**Date:** 9/24/07 **County:** Avery **State:** NC
Do normal circumstances exist on the site? Yes ☒ No ☐ **Is the site significantly disturbed (Atypical situation)?** Yes ☐ No ☒ **Is the area a potential problem area?** Yes ☐ No ☒ (explain on reverse if needed)	**Community ID:** Up **Transect ID:** WC **Plot ID:** 101

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Pinus strobus	T	FACU	9.		
2. Rhododendron maximum	S	FAC-	10.		
3. Quercus rubra	T	FACU	11.		
4. Polystichum acrostichoides	H	FAC	12.		
5. Lonicera japonica	V	FAC-	13.		
6. Rubus sp.	H		14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 20%

Remarks:
Limited herb layer. Vegetation is thin buffer between landfill and stream with little diversity.

HYDROLOGY

☐ **Recorded Data (Describe In Remarks):**
- ☐ Stream, Lake, or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

☒ **No Recorded Data Available**

Field Observations:

Depth of Surface Water: - (in.)

Depth to Free Water in Pit: - (in.)

Depth to Saturated Soil: - (in.)

Wetland Hydrology Indicators

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12"
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators:
- ☐ Oxidized Roots Channels in Upper 12"
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks:
No hydrology indicators.

SOILS

Map Unit Name
(Series and Phase): Culhowee loam, 0-3% slopes **Drainage Class:** Somewhat poorly

Taxonomy (Subgroup): Aquic haplumbredts **Confirm Mapped Type?** Yes ☐ No ☐

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0	A	10YR 6/6			Sandy loam
4	B	2.5Y 5/6	7.5YR 5/6	Common, small	Clay loam

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed On Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:
No hydric soil indicators.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ☐ No ☒
Wetland Hydrology Present? Yes ☐ No ☒
Hydric Soils Present? Yes ☐ No ☒

Is the Sampling Point Within a Wetland? Yes ☐ No ☒

Remarks:
Disturbed upland community adjacent to wetland and the existing landfill cells.

Attachment 7

ATTACHMENT 7

Protected Species and Archaeological Reports/Correspondence

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Parks and Recreation

Michael F. Easley, Governor | William G. Ross Jr., Secretary | Lewis R. Ledford, Director

REC'D MAR 27 200

March 26, 2008

Joan A. Smyth
Senior Hydrogeologist
Richardson Smith Gardener & Associates
14 N. Boylan Avenue
Raleigh, NC 27603

Dear Ms. Smyth:

The North Carolina Division of Parks and Recreation has reviewed your site location for the proposed C&D landfill expansion in Avery County, NC (letter dated March 26, 2006). There are no state parks, recreation areas, or scenic areas that are within the State Nature and Historic Preserve in the vicinity of this site.

Please let me know if you need additional information.

Sincerely,

Brian L. Strong, Head
Natural Resources Program

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RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services

March 26, 2008

Mr. Brian Strong
North Carolina Division of Parks and Recreation
1615 Mail Service Center
Raleigh, NC 27699-1615

RE: State Nature and Historic Preserve Evaluation
Avery County C&D Landfill
Ingalls, North Carolina

Dear Mr. Strong:

Richardson Smith Gardner and Associates, Inc. (RSG) on behalf of Avery County is preparing a Site Study investigation for a proposed C&D landfill expansion. Part of this investigation is a determination as to whether the proposed expansion will impact any State Nature and Historic Preserves.

The current (active) landfill site and expansion area are located at 2175 Brushy Creek Road, Spruce Pine, Avery County, North Carolina 28777. A site map depicting the landfill location is attached for your review.

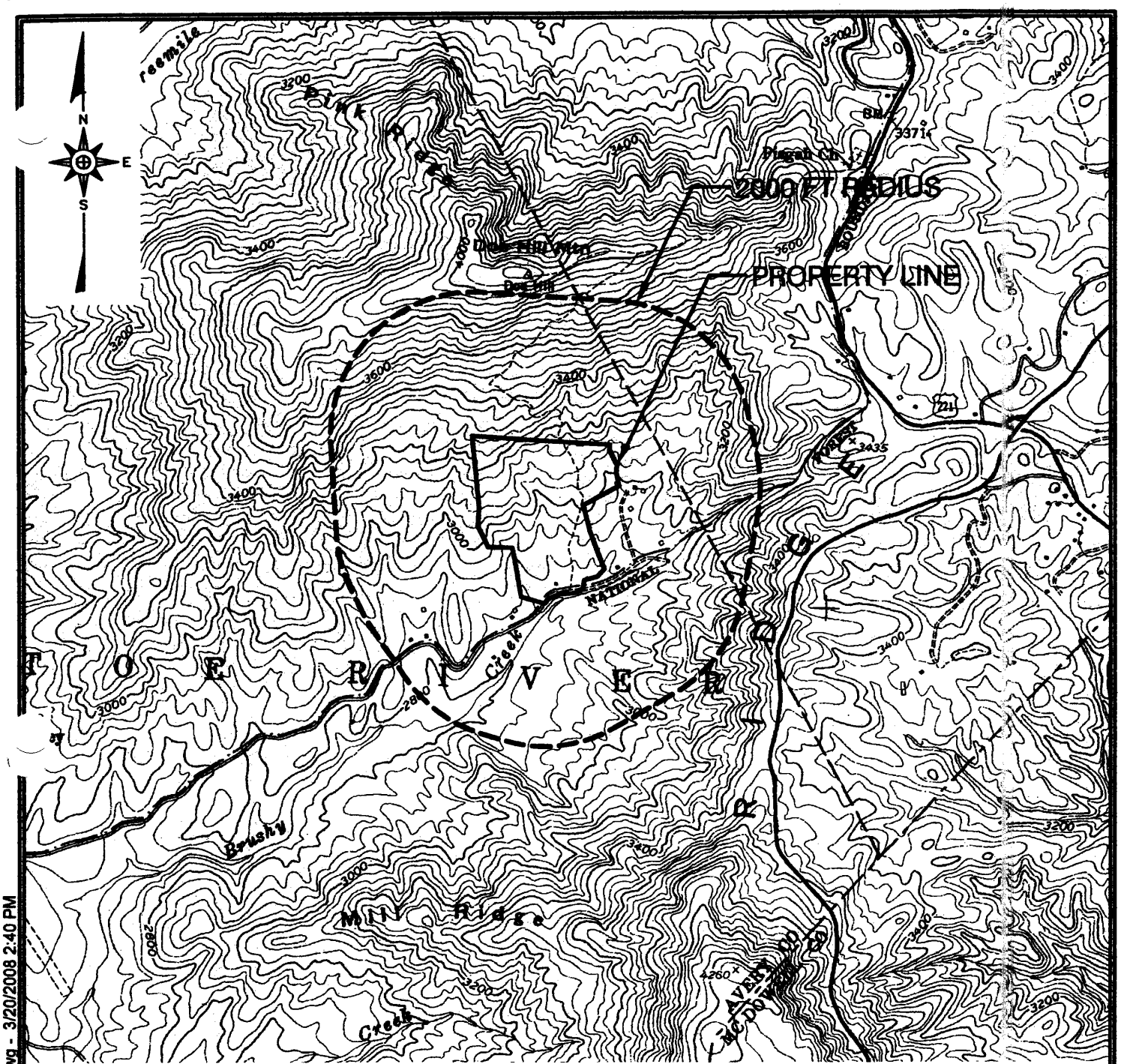
Thank you for your assistance in this matter. If you have any questions, please contact me at joan@rsgengineers.com or at (919) 828-0577 x 122.

Sincerely,
Richardson Smith Gardner and Associates, Inc.

Joan A. Smyth

Joan A. Smyth, P.G.
Senior Hydrogeologist

attachments



REFERENCE:

1. U.S.G.S. QUADRANGLE "LINVILLE FALLS, NC" 1956, PHOTO INSPECTED 1984

0 2000' 4000' 6000'

AVERY COUNTY C&D LANDFILL
SITE VICINITY MAP

RICHARDSON SMITH GARDNER & ASSOCIATES
14 N. Boylan Ave.
Raleigh, N.C. 27603
www.rsgengineers.com
ph: 919-828-0577
fax: 919-828-3899

SCALE:	DRAWN BY:	CHECKED BY:	DATE:	PROJECT NO.	FIGURE NO.	FILE NAME
AS SHOWN	J.A.L.	J.A.S.	Mar. 2008	AVERY 07-1	1	AVERY-A0021

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State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Parks & Recreation

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
Dr. Philip K. McKnelly, Director

MUNICIPAL ENGINEERING
RECEIVED
AUG 1 1995
SERVICES COMPANY

DEHNR

July 27, 1995

Mr. Robert Joyner
Municipal Engineering Services Co. PA
P.O. Box 97
Garner, NC 27529

SUBJECT: Rare Species, High Quality Natural Communities, and Significant Natural Areas in the Proposed Avery County C&D Landfill Project Area, Avery County, North Carolina

Dear Mr. Joyner:

The North Carolina Natural Heritage Program does not have records of known rare species, high quality natural communities, or significant natural areas occurring at the proposed Avery County C&D Landfill project site or within a 1-mile radius of the project site. To our knowledge, this project area has not been systematically inventoried and we cannot definitively state that rare species or significant natural areas do not occur there.

Enclosed is a list of rare species that are known to occur in Avery County. If suitable habitat for any of these species occurs in the project area, then those species may be present at the project site. If it is necessary to be certain that this site does not contain rare species, a field survey would need to be conducted.

I am returning to you the two project reports you loaned to me.

Please contact me at the address below or call me at (919) 733-7701 if you have any questions or need further information.

Sincerely,

Inge Smith

Inge Smith
Information Specialist
Natural Heritage Program

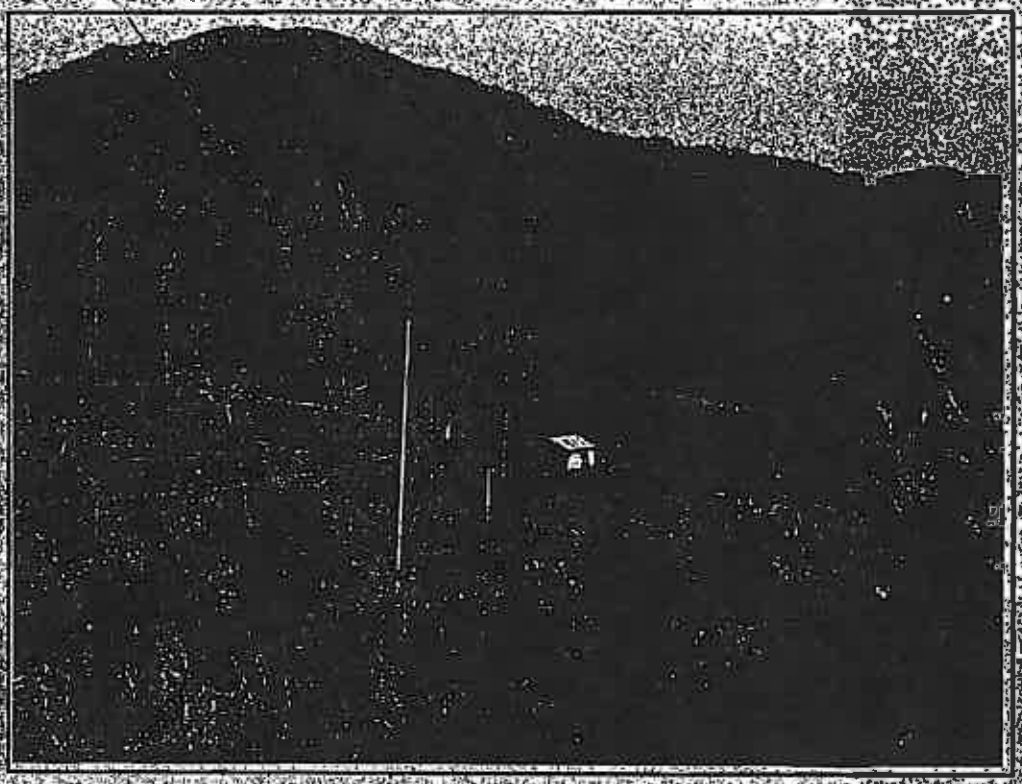
/iks

Enclosures

P.O. Box 27687, Raleigh, North Carolina 27611-7687 — Telephone 919-733-4181 — FAX 919-715-2085

JUL 2 1995

PHASE I ARCHAEOLOGICAL INVESTIGATIONS OF THE AVERY COUNTY C&D LANDFILL, AVERY COUNTY, NORTH CAROLINA



Garrow & Associates, Inc.

1994

PHASE I ARCHAEOLOGICAL INVESTIGATIONS OF THE AVERY COUNTY C&D LANDFILL AND TRANSFER STATION, AVERY COUNTY, NORTH CAROLINA

Submitted to:

Municipal Engineering Services Company, P.A.
P.O. Box 94
Garner, North Carolina 27529

Submitted by:

Garrow & Associates, Inc.
417 North Boylan Avenue
Raleigh, North Carolina 27603
Project # 94-33-15-1637

Prepared by:

Joel D. Gunn Principal Investigator

December 1994

ABSTRACT

A Phase I archaeological survey of a 78-acre property was conducted between November 21 and 23, 1994 by Garrow & Associates, Inc. for Municipal Engineering Services Company of Garner, North Carolina. The property is the proposed location of a construction and demolition landfill and transfer Station and is located in the southern portion of Avery County, North Carolina—a region of steep slopes and varied terrain. The parcel is located on sloping terrain that begins at Brushy Creek road in the valley bottom and rises to the west up the flanks of Doe Hill Mountain.

The survey used a combination of surface inspection, systematic shovel testing, and soil probes. Shovel tests were placed every 30 m along the first terrace above Brushy Creek, on a system of ridge toe slopes that can be followed to a high terrace, and on the high terrace itself. The high terrace is at about 600 feet above Brushy Creek. Sixty-two shovel tests were excavated, of which eight were positive. Most of the 64 artifacts collected during the project were found during surface inspection.

Two prehistoric sites and two historic sites were discovered. The first historic site (31AV78) was found on the first terrace on the north side of Brushy Creek. A structure appears at this location on the 1956 USGS map, and a concrete cellar was identified in the field. The original structure appears to have burned and the foundation is currently being built upon again. Artifacts found in shovel testing included a flake and twentieth century glass. No intact deposits were found.

The second historic site (31AV79) was a red sandstone foundation located at the head of the western most tributary of Brushy Creek within the project area. No structure appears at this location on the 1956 USGS map. Six shovel tests were excavated of which four were positive. They contained artifacts of twentieth century age, and no intact deposits were found. No evidence of burning or other destruction was found suggesting that materials from the structure were scavenged.

The first prehistoric site (31AV80) was identified as a surface lithic scatter on the end of a ridge toe overlooking the first terrace. Shovel tests were also excavated, but all 35 lithic artifacts of quartz and rhyolite were recovered from the surface. No features or intact midden deposits were identified. Soil probes revealed no buried soil horizons.

The second prehistoric site (31AV81) was found in a shovel test pit excavated on the highest terrace 600 feet above Brushy Creek. Quartz flakes were recovered from the plow zone of that test pit, but no other artifacts were recovered from the systematic grid of shovel test pits placed around the initial find.

The field studies indicate that all four of the archaeological sites on the property are deflated, disturbed, and/or too recent in age to be eligible for the National Register of Historic Places. No further archaeological studies are recommended.

ACKNOWLEDGMENTS

This project benefited from the assistance of a number of individuals. Mr. Robert Joyner of Municipal Engineering, P.A. was instrumental in initiation of the project, and providing information necessary to its successful completion.

Joel D. Gunn served as Field Director. The field crew consisted of Matt Jorgenson, who also served as laboratory assistant. Kathy Wilson assisted with artifact identification and graphics preparation. Daniel Cassedy provided overall project management and report editing, and Beth Cassedy assisted with graphics and report production.

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I. INTRODUCTION

This report documents Phase I archaeological fieldwork performed by Garrow & Associates, Inc. for Municipal Engineering Services Company at the Avery County Construction and Demolition Landfill and Transfer Station. The study area is located in the southern part of Avery County in the extreme western part of the state of North Carolina 25 miles east of the Tennessee state line (Figure 1). The scope of work for the project delineated a 78 acre property that was evaluated at the Phase I level. A crew of two persons conducted fieldwork from November 21 to 23, 1994. The project was conducted to locate all archaeological sites on the property, and, where possible, to assess their eligibility for inclusion in the National Register of Historic Places.

Background research at the Office of State Archaeology State Site Files in Raleigh indicated that there were no previously reported archaeological sites in the project area or in the immediate vicinity, but the terrace and ridge nose landforms with the property were identified as archaeologically sensitive landforms based on other studies in the region. The scarcity of reported sites in the region is most likely reflective of a lack of previous archaeological studies rather than an indication of a lack of prehistoric occupations.

The survey began with a systematic pedestrian reconnaissance to evaluate surface conditions and search for visible features and artifacts. Much of the land was eroded and had sufficient exposed soil to allow surface inspection. Systematic shovel testing was then used to search for sites in areas that lacked surface exposures and to evaluate sites first identified from surface finds. A total of 62 shovel tests was excavated at 30 m intervals on a project grid in flat areas, and at 5 m intervals on identified sites and near structures. A one-inch tube sampler was also used to probe several colluvial deposits to ensure that no horizons were buried beneath the reach of the shovel tests.

The survey identified two prehistoric lithic flake scatters and two twentieth century historic structural remnants. None of the four sites appear to contain significant cultural deposits.

The following chapters contain the methodology and results of the Phase I investigations. Chapters II and III provide environmental and cultural contexts for the project area. Chapter IV presents the research design and methodology employed. The results of the investigations are presented in Chapter V, and Chapter VI contains a summary of the investigations and offers recommendations.

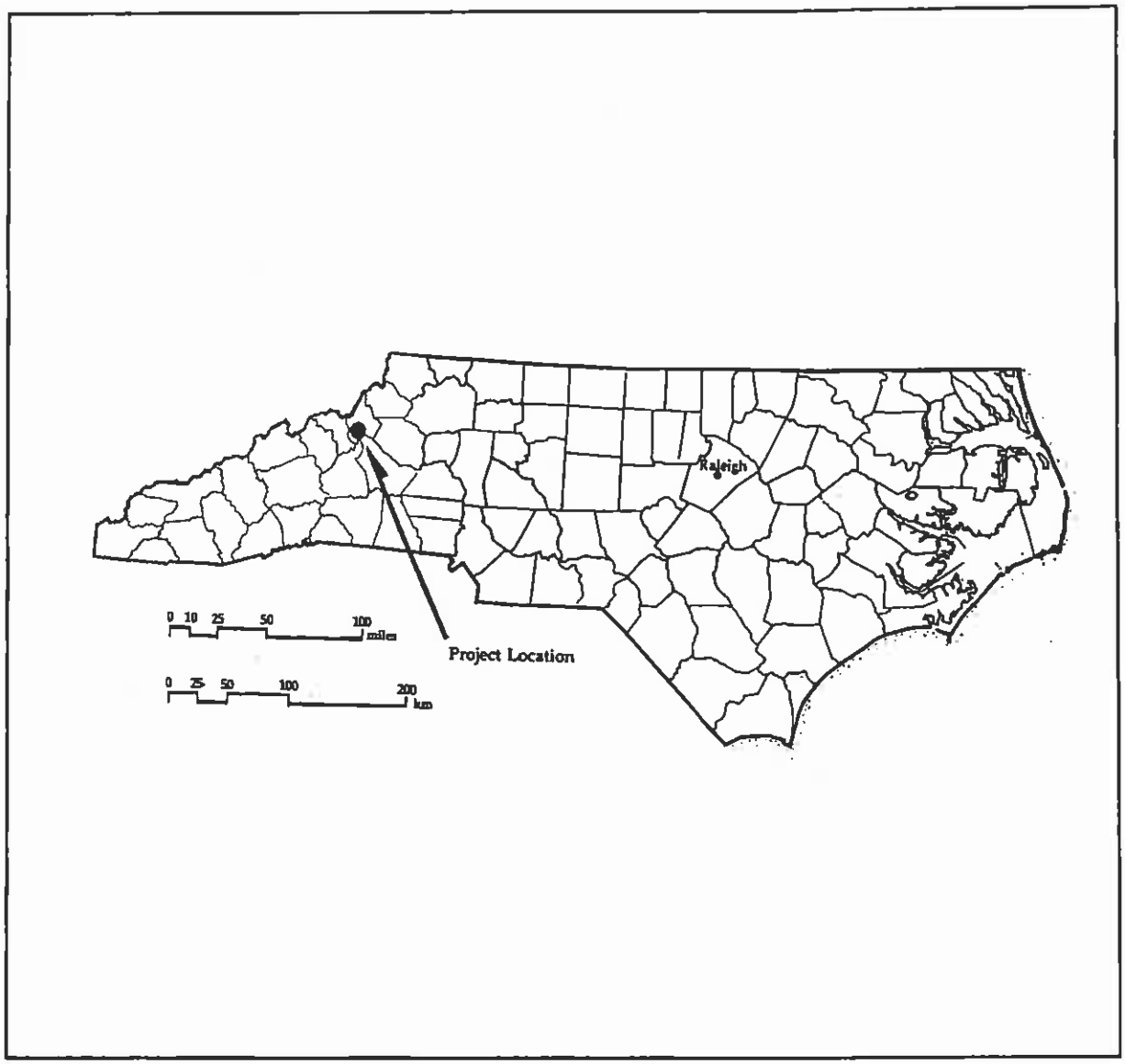


Figure 1. Project Location Map.

II. ENVIRONMENTAL SETTING

PROJECT SETTING

The Avery County Landfill property is located seven miles northeast of Spruce Pine, North Carolina in the small drainage of Brushy Creek, which is a tributary of the North Toe River (Figure 2). The Blue Ridge Parkway passes 0.6 miles east of the property at an elevation of about 3,500 feet, and the Linville Gorge Wilderness is located just east of the parkway.

The landfill property extends approximately 140 m along the northern bank of Brushy Creek near the end of Brushy Creek Road. It extends north from the creek approximately 650 m and widens to more than 600 m at the north end. The level of the creek is about 2,840 feet above mean sea level (amsl). The property ranges in elevation from 2,840 feet to 3,480 feet amsl. To the north of the property, Doe Hill Mountain rises rapidly to 4,080 feet. To the immediate north of the property, this rise presents itself as a sheer cliff face. The property is divided by two unnamed branches, called here the East and West Branches (Figure 3). Flanking each of these is a ridge, here referred to as the West, Mid, and East Ridges. The 1956 7.5 minute Linville Falls quadrangle map shows a structure near Brushy Creek Road; a foundation of relatively recent construction appears at this location, but we could not determine if it is a new construction on an old house site, or a rebuilding on the previous house foundation. The map does not show what is a wide, deep-cut road up the west side of the East Branch to a stone quarry at about 3,000 feet elevation. This will be referred to as the Quarry Road.

PHYSIOGRAPHY

Avery County is located within the Blue Ridge physiographic province in very high relief terrain. The project area is 0.6 miles west of the eastern Continental Divide. Immediately surrounding hills (within a mile) rise to about 4,000 feet amsl. A ridge of northeast-southwest trending mountains crosses the site environs with peaks greater than 5,000 feet amsl. Grandfather Mountain 15 miles to the northeast rises to 5,837 feet amsl. Twenty miles to the southeast is Mount Mitchell which rises to 6,684 feet amsl, the highest peak east of the Mississippi River. Brushy Creek flows southwest into the North Toe River, which is a tributary of the French Broad River. To the northeast in the adjoining Linville River drainage, the terrain is generally around 3,500 feet amsl forming a high plateau. This plateau is quite elevated relative to surrounding basins such as the Asheville basin to the west at about 2,300 feet amsl.

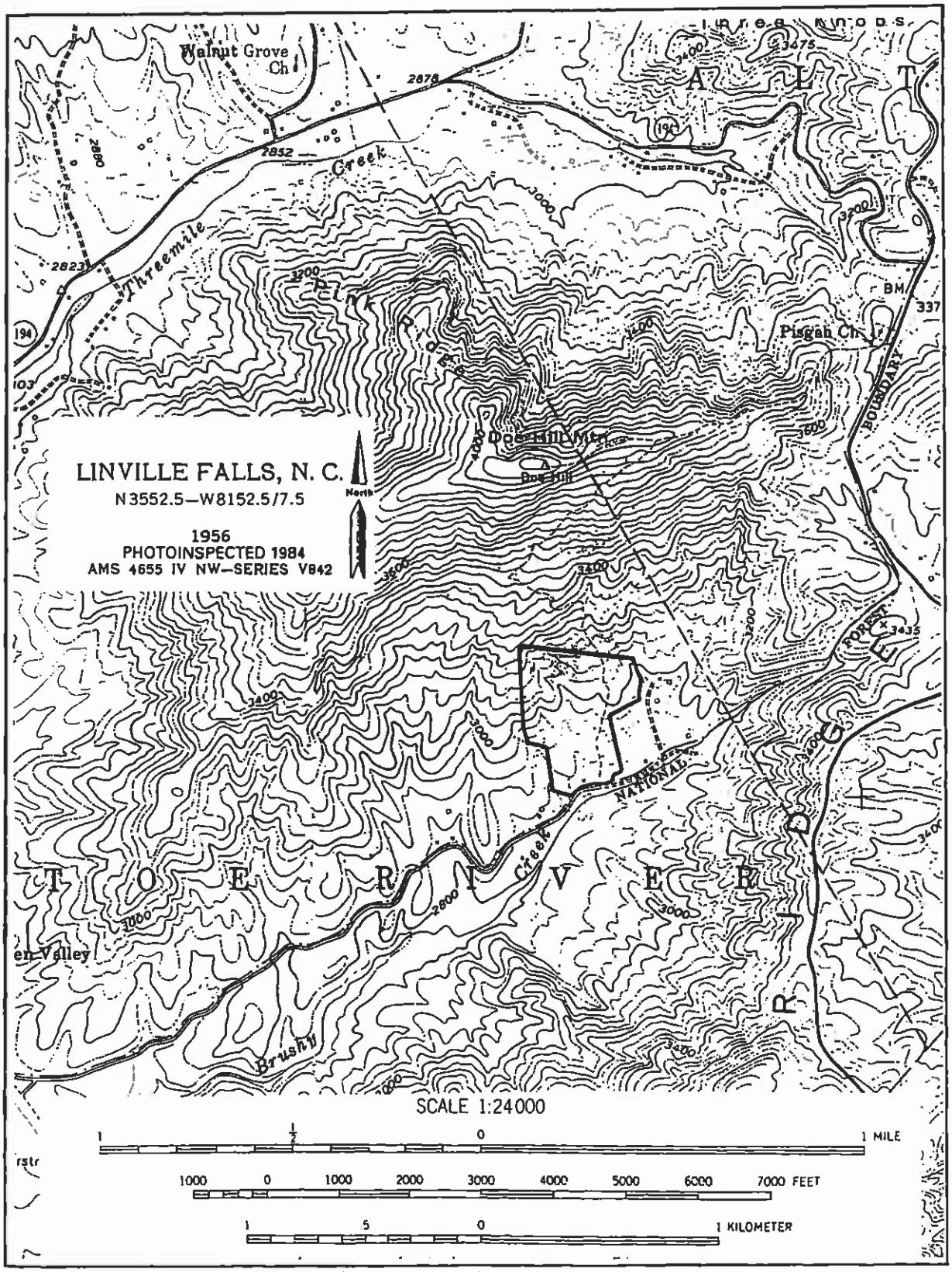


Figure 2. Topographic Map of the Project Area .

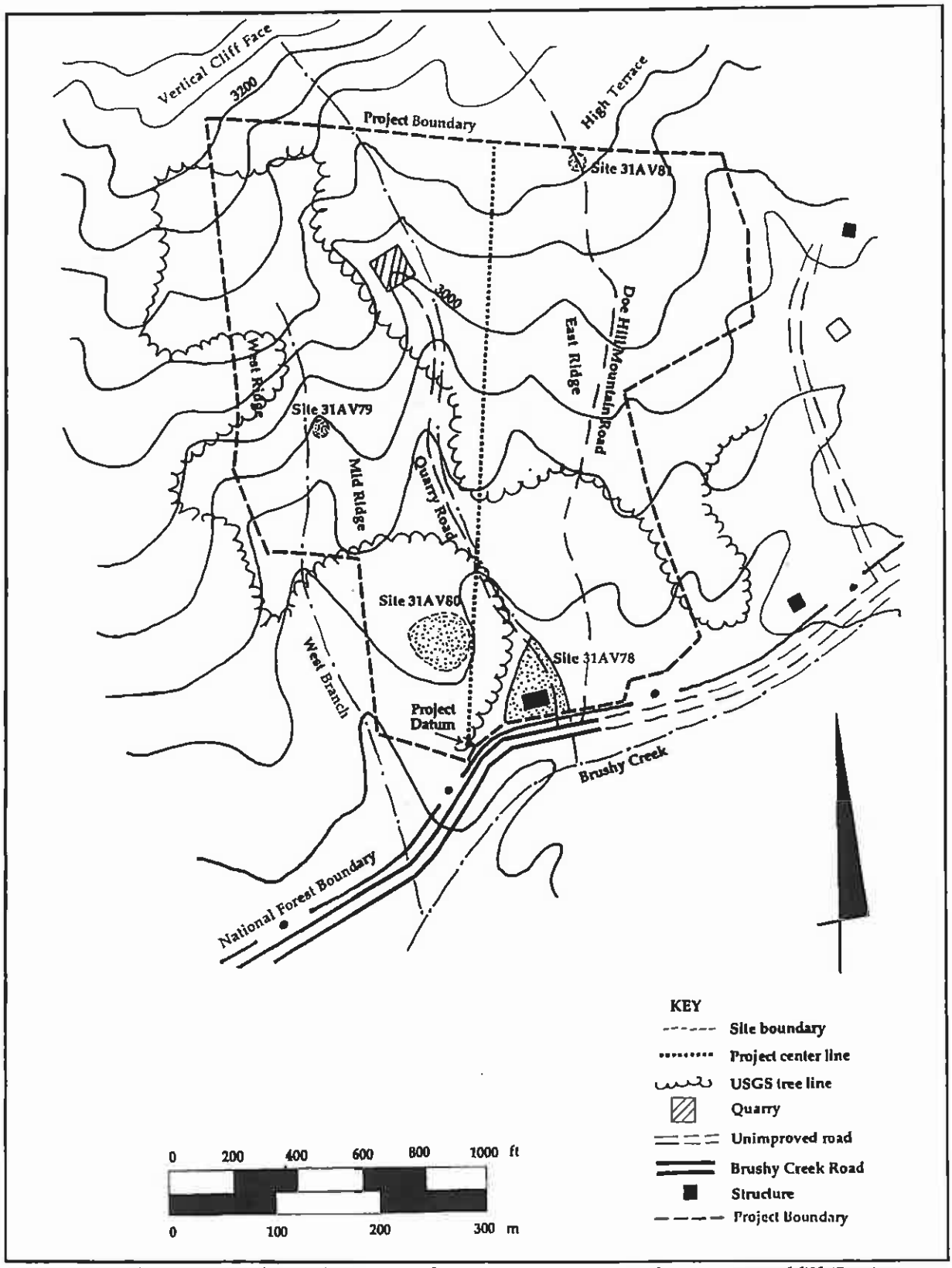


Figure 3. Plan View of Landforms and Sites in the Avery County Landfill Project.

GEOLOGY

The Blue Ridge was formed in the earlier epochs of the last 1.1 billion years by geological processes acting on the North American continental ancestral mass of Laurentia (Hatcher and Goldberg 1991). These processes included deformation, metamorphism, thrust sheet movements, rifting, volcanism, and sedimentation (Horton and Zullo 1991:9; Hatcher and Goldberg 1991:33-35). The bedrock under the site is an intrusive member of the Blue Ridge belt dating to the Devonian period about 390 million years ago (North Carolina Geological Survey 1985). It is composed primarily of dioritic rocks containing quartz and moscovite. Much of both rocks were observed in the field. The area around Spruce Pine is well known for feldspar quarrying. It is used extensively in the ceramics industry and for other novel uses such as making sand for golf courses. The Brushy Creek valley has been extensively quarried as can be observed by driving along Brushy Creek Road. A road has been prepared on the survey property that runs up to what appears to be a small quarry. The nature of this quarry was not determined.

SOILS

There is no soil survey currently available for Avery County. The general soil map of North Carolina reports that the southern part of Avery County is within the Hayesville-Fannin soil association. This association occurs where valleys are wide enough to allow the development of relatively deep soils.

CLIMATE

The climate in Avery County reflects its elevated position. It and two adjoining counties enjoy the lowest July minimum temperatures in the state. The average minimum temperature in July is 56°F (Epperson 1971). Correspondingly, the length of the frost free growing season is the lowest in the state at 24 weeks. Low temperatures in January average about 24.0°F. The average high temperatures in July are 80°F. The average annual rainfall is 48 inches. This is much lower than the 60 or even 80 inches in some areas of the Blue Ridge Front. This probably results from rain shadows of the towering mountains in the area.

PALEOENVIRONMENT

The contemporary climate and vegetation of the study area are products of a long and complex process of natural and man-induced change. The average winter temperatures in the study area were considerably colder during the glacial period, which lasted from ca. 23,000 to 13,000 B.C. At that time, the study area was covered

by a boreal, northern coniferous forest in which pines and spruce were dominant (Delcourt and Delcourt 1983; Whitehead 1973). The climate warmed and precipitation increased from ca. 13,000 to 8,000 B.C., the period during which the first people arrived in North Carolina. During this time (the Late Wisconsin glacial period), coniferous forests were replaced by northern hardwoods as dominant overstory species (Bryson et al. 1970; Watts 1975, 1980; Whitehead 1973). The period from ca. 6,000 to 3,000 B.C. is referred to as the Altithermal, and was a period of continued warming, but decreased precipitation (Bryson et al. 1970; Watts 1975). The dominant overstory vegetation that survived was the oak-hickory forest (Watts 1975; Whitehead 1973). The climate since ca. 3,000 B.C. has cooled slightly, with a possible increase in precipitation. The oak-hickory forests of earlier times have decreased in size, and have become increasingly intermixed with pines (Wharton 1977).

Climatological studies over the past few decades have shown that important changes occur over much shorter intervals than the well-understood Pleistocene-Holocene transition. At the same time, it has become increasingly apparent that changes at annual and decadal time scales are important to human adaptations. Annual climatic measurements are not available for the whole of human occupation of the area, although they do encompass the Middle and Late Woodland and historic periods. Stahle et al. (1991) have found that bald cypress tree rings are good indicators of climate in the Southeast. Thousand-year-plus tree ring series have been analyzed for all of the mid and south Atlantic states, and work is on-going for development of a year-by-year precipitation chronology for the last 10-15 centuries. The nearest source of tree rings is the Black River area in eastern North Carolina. Precipitation has been found to be generally correlated from North Carolina to Georgia. Thus, annual climate can now play a role in interpretation of past human activities along with the more stable elements of geology, pedology, vegetation, and fauna.

FLORA

Because a day's walk can include as much as 5,000 feet of relief, the vegetation in the vicinity of the project area is highly variable by vertical zone. In the river valleys the pre twentieth-century vegetation would have consisted of mesic oak-chestnut forests. Between 2,700 and 4,200 feet amsl, there were hemlock-spruce-balsam fir forests. Because of rich mast crops, the forests would have readily supported large animal and human populations (Dorwin 1975:3-5; Purrington 1983:95). Delcourt and Delcourt (1983) have documented long-term fluctuations in vegetation zone elevations through pollen analysis. This vegetational variability would have been an important factor in the potential for human occupation of higher altitudes.

FAUNA

A varied fauna would have found a rich existence in the upland temperate forests. Ecological analysis indicates that white-tailed deer would have inhabited the forests at a rate of about 400 head per 10 square miles (Dorwin 1975). A similar area would have supported about five black bears, an important element of most Native American subsistence regimes. The bear appears to have filled a role similar to that of the hog in European diet. Black bears were previously very common, but the population has been depleted in the past century. Elk would have been available in unknown frequencies during some intervals when human populations were low. Thousands of rodents, such as squirrels, and birds, such as turkeys, would have supplied a rich protein diet if not over-exploited.

LANDSCAPE SETTING OF PREHISTORIC SITES

The positioning of the two prehistoric sites on overlooks of the Brushy Creek valley, and the proximity of the drainage to the Blue Ridge summit suggests that the valley may have served as a migration route for herd animals between the North Toe and Linville River watersheds. The elevation of the gap between the two drainages falls to 3,200 feet as compared to the more usual 4,000 feet or more of surrounding mountains. The upper most site (see Doe Hill Mountain Road Site below) is at the same elevation as the gap and would have offered the first or last opportunity to observed herds as the passed through the gap. The lower site (see Mid Ridge Site below) is similarly placed for observation at a narrow location in the valley an proximate to any potential trail. The highly skilled knapping of quality quartz in this site implies the presence of Pleistocene or Middle Holocene big game hunters.

III. CULTURAL BACKGROUND

INTRODUCTION

The archaeological and historical context for the project area was established by the evaluation and synthesis of previous research conducted in the Appalachian summit region. Coe (1964), Egloff (1967), Keel (1976), Dickens (1976), Purrington (1983), and Moore (1986) provided regional overviews and details of regional archaeological sequence. These documents and additional reports from surrounding regions in Tennessee and North Carolina were referenced to develop research expectations for the project. As Purrington (1983) points out, the Appalachian Summit has been regarded as a culturally marginal area by some (Swanton 1946:37), and held in higher regard by others. Keel (1976), for example, viewed the substantial accomplishments of the Cherokee and their antecedents as largely indigenous. The writings emanating from the Cherokee Project (1964-1971; Dickens 1976:8-9) argued a more open system with local accomplishments bolstered by outside influences (Dickens 1976:213). During a 1986 conference on Cherokee prehistory (Moore 1986), several scholars elaborated on combinations of the two alternative models of continuity and population replacement, generally preferring syntheses of the two positions. The more recent investigations point to interaction between the Appalachian Summit peoples and the surrounding Piedmont inhabitants. The models tend to hint at, rather than explicate, summit and piedmont regions as regionally symbiotic for human populations, one acting as refugium when conditions are inappropriate in the other. Existing literature suggests intermittent occupations of the Appalachian uplands during the Holocene (Bass 1977; Schroedl 1986; Hudson 1986). Paired with nearby piedmonts, the Appalachian plateau provides an extremely fruitful landscape for the study of changing human adaptations.

PREHISTORIC OVERVIEW

The prehistory of the project area can be divided into four basic time/cultural periods. These periods—Paleoindian, Archaic, Woodland, and Mississippian—relate to both social and technological changes. Both Keel (1976:18) and Dickens (1976:10) divide the periods into phases, some of which overlap in time and name, which vary in precise definition.

Paleoindian Period (ca. 12,000-8,000 B.C.)

Paleoindian occupation is known predominantly from surface sites. Paleoindian groups are presumed to have been highly mobile with a subsistence strategy based

on migratory (and now-extinct) large animals such as mastodons. They are known to have relied on other plant and animal food resources, as well (Purrington 1983). Settlements are thought to include small temporary camps and less common base camps that were occupied by loosely organized bands. Paleoindians selected high quality lithics for tools and many Paleoindian sites that have been found in the Piedmont are linked to important source areas. The high degree of curation in the tool assemblage causes problems in the recognition of Paleoindian assemblages. Key diagnostics of this period are fluted and unfluted lanceolate projectile points. Formal flake tools, such as endscrapers, gravers, retouched blades, and burins, are also associated with the Paleoindian period (Gardner 1979). Keel suggests that during the earlier Clovis phase (before 9,000 B.C.), Paleoindians in the mountains were confined south of an east-west line at the latitude of Asheville because of permafrost to the north (Keel 1976). The later Paleoindian phase appears to include Dalton (Goodyear 1982) and perhaps Hardaway (Ward 1983) points and their related cultures.

Most of our knowledge about the earlier part of the Paleoindian period in the Southeast, when fluted points were the dominant form, has come from surface finds gathered by archaeologists and collectors rather than from controlled excavations. The number of actual sites of this period with extensive artifact assemblages in secure context has been increasing in recent years.

Approximately 405 fluted points have been found in North Carolina to date (Anderson 1990). Almost all of these points were from surface contexts. As a result, interpretation of fluted-point Paleoindian occupations locally is difficult. While the hunting of late Pleistocene megafauna, specifically mammoth, mastodon, bison, and other now-extinct species is suspected, evidence for Paleoindian period exploitation of animals of any kind is rare in the Southeast. Equivocal associations of artifacts with mammoth remains have been reported from Florida (Hoffman 1983), together with more secure associations with bison, *Bison antiquus*, and giant land tortoise, *Geochelone crassiscutata* (Clausen et al. 1979; Webb et al. 1984). There have been several finds of worked ivory (Goodyear 1991). While megafauna may well have been hunted, it is highly likely that a more diversified subsistence strategy was followed, particularly as the Pleistocene floral and faunal assemblages were replaced by more modern, Holocene assemblages. In all probability, Paleoindian subsistence economy included the hunting of smaller mammals and the collection of some plant foods. Many Paleoindian sites in the Southeast appear to be associated with riverine rather than upland locations, suggesting an aquatic orientation (Gagliano 1977); in addition, the climate was essentially Holocene in the lower south from 11,000 B.C., again arguing for an early adjustment to Holocene forest rather than Pleistocene steppes.

Over the course of the Paleoindian period, fluted point forms underwent a general reduction in size, and true fluting gave way to basal thinning. Terminal Paleoindian assemblages locally are identified by Hardaway/Dalton projectile point forms, broad, thin, triangular bifaces with deeply concave bases and shallow side

notches (Coe 1964:64) which are thought to date from ca. 10,500-9,800 B.C. (Goodyear 1982). The Hardaway complex, consisting of Dalton-like points and preforms, has been found in the lowest levels of the Hardaway and Haw River sites in the piedmont of North Carolina (Coe 1964; Claggett and Cable 1982).

Although hundreds of Dalton points are known from surface contexts in North and South Carolina, the type is not appreciably more common than the earlier lanceolate Paleoindian forms. The Hardaway/Dalton complex is thought to represent "a regionalized technological modification of Paleoindian projectile point style" (Oliver 1985:197), possibly reflecting a change in adaptive strategies away from the hunting of megafauna and towards the utilization of small game and the increased collection of plant resources (McNett et al. 1977). Oliver (1985:199) has suggested that such an inference is supported by an apparent decrease in point size from the Hardaway/Dalton to subsequent Early Archaic Palmer projectile point forms.

Overall population density during the Paleoindian period is often thought to have been fairly low. In the South, however, large numbers of sites in the late Paleoindian period, and evidence for territories discovered in several regions, indicates relatively rapid population evolutions (Gunn and Brown 1982). Climate and vegetation were changing rapidly at this time, as the continental ice sheets retreated to the north. Initial Paleoindian groups probably encountered a mixed coniferous forest/parkland vegetational mosaic, which was gradually replaced by northern hardwoods (summarized in Claggett and Cable 1982). The retreat of the glaciers coincided with a marked rise in sea level, resulting in the flooding of large areas of the Coastal Plain. Ward (1983:64) has suggested that the generally spatially restricted site distribution and the low density of cultural materials suggests a low level of sociopolitical information. In actuality, however, fairly sophisticated information exchange and mating networks would have had to exist for such low density populations even to remain reproductively viable (Wobst 1974; Anderson and Hanson 1985), suggesting a greater complexity for these societies than is traditionally inferred. O'Steen (1983) has found that late Paleoindian groups were exploiting uplands more frequently than their predecessors. This generally indicates over-exploitation of lowlands, and perhaps overpopulation.

Archaic Period (ca. 8,000-1,000 B.C.)

The Archaic period exhibits an increase in the density and horizontal dispersal of archaeological remains. It is characterized by a reliance on large animals and wild plant resources, which became increasingly stabilized and broad based over time. Group organization was presumed to be fairly mobile, making use of seasonally available resources in different areas of the Southeast. Caldwell (1958) has termed the maximizing adaptation (scheduled hunter-forager) to the environment in the Eastern woodlands during the Archaic period "primary forest efficiency." Group size gradually increased during this period, culminating in a fairly complex society in the Late Archaic. By the end of the Archaic, the basic cultural framework for the

following cultural periods had been established. Diagnostic markers of the Archaic period include a variety of notched projectile point types such as Kirk/Palmer, bifurcates, and later stemmed projectile point types such as Stanly, Morrow Mountain, Guilford, and Savannah River (Coe 1964). By the Middle Archaic, groundstone items such as axes, atlatl weights, and grinding stones become more commonplace. In portions of the Southeast, changes occur during the Terminal Archaic, including an increased focus on riverine resources and the introduction of ceramic vessels (fiber-tempered wares) and soapstone vessels. There is an increasing localization of artifact styles by the end of the Archaic; this trend subsequently becomes more pronounced. Villages (reflected by increasing site size) become more common in the Late Archaic.

In its most common expression, the Archaic period is viewed as one in which the predominantly big-game hunting of the Paleoindian period was replaced by a more generalized or diffuse hunting and gathering way of life (Griffin 1967; Cleland 1976). The Archaic period formally begins with the onset of Holocene, post-glacial, climatic conditions in the east, and has been subdivided into three sub-periods, the Early, Middle, and Late Archaic. The Archaic was a relatively long and successful foraging adaptation, with subsistence based on hunting, fishing, and the collection of wild plant resources. Diagnostic projectile points form the primary criteria used to identify and date these occupations.

The technology of the Archaic peoples of the Southeast appears to have been progressively more diverse than that of Paleoindians. Over the course of the Archaic, for example, increasing numbers of artifact and tool types appear, such as groundstone woodworking and plant processing implements, carved and polished stone bowls, atlatl weights, and stone pipes and beads (Griffin 1967; Jennings 1975:127-129). Regional differentiation in projectile point and other artifact styles also occurs, suggesting the emergence and elaboration of local cultures or cultural traditions. This cultural variability is thought to be partially related to localized differences in environment and subsistence resources, and to an increasing regional population base, with a concomitant circumscription of group territories and mobility (Ford 1974).

Early Archaic (ca. 8,000-6,000 B.C.). During the Early Archaic, the vegetation matrix of mixed coniferous forest was replaced by mixed hardwood communities dominated by oak, hemlock, beech, and maple (Claggett and Cable 1982:212). A modern faunal assemblage was in place, following the extinction of the Pleistocene megafauna. The Early Archaic is subdivided into earlier Corner Notched and later Bifurcate traditions, named for the shapes of the projectile points used to recognize these occupations. Corner Notched tradition (ca. 7,800-7,000 B.C.) components are identified by the presence of Palmer and Kirk projectile points, while Bifurcate tradition (ca. 7,000-6,000 B.C.) assemblages are identified by a range of bifurcate-based forms, including the succeeding St. Albans, LeCroy, and Kanawha types (Gardner 1974; Chapman 1975; Claggett and Cable 1982). Low regional population density, coupled with a continued high degree of group mobility, is inferred for this period,

although the nature of settlement patterns and technological organizational strategies remains the subject of some discussion (Claggett and Cable 1982).

Middle Archaic (ca. 6,000-4,000 B.C.). During the Middle Archaic, the cool, moist conditions of the Early Holocene gave way to the warmer, drier climate of the mid Holocene Hypsithermal interval. This pattern may be reversed at higher altitudes. Extensive estuarine marshes and riverine swamps began to emerge in coastal regions as sea level ceased its post Pleistocene rise, perhaps as early as 6,000 B.C. during a Middle Holocene sea level high stand (see Tanner 1993), but certainly after 2,500 B.C. The northern hardwoods vegetational matrix was replaced by an oak-hickory forest, which was in turn replaced by a southern hardwoods-pine forest characterized by the species occupying the region today (Claggett and Cable 1982:212-216; Delcourt and Delcourt 1983; Delcourt and Delcourt 1985; Delcourt et al. 1980; Carbone 1974).

Archaeologically, the transition from the Early Archaic to the Middle Archaic is characterized by the appearance of stemmed rather than notched projectile points, and an increased incidence of groundstone tools, including atlatl weights, axes, and grinding implements. Three subperiods within the Middle Archaic are recognized in some regions. These are identified by the presence of Stanly Stemmed (ca. 6,000-5,000 B.C.), Morrow Mountain I and II (ca. 5,000-4,200 B.C.), and Guilford Lanceolate (ca. 4,200-3,500 B.C.) projectile points, following the classic Archaic sequence first identified by Coe (1964).

Late Archaic (ca. 4,000-1,000 B.C.). During the Late Archaic period, population appears to have grown markedly and to have concentrated in riverine and estuarine settings. Climatic conditions were warm, moist, and unusually stable. Sea level appears to have been relatively stable, rising to within ca. 2-4 m of its present stand; only minor fluctuations on the order of one to a few meters occurred (Colquhoun and Brooks 1986). Grinding implements, polished stone tools, and carved soapstone bowls become fairly common, suggesting increased use of plant resources, and possibly changes in subsistence strategies and cooking technologies. Although evidence is minimal, the first experiments with horticulture probably occurred at this time, with the cultivation of plants such as squash, sunflower, and *Chenopodium* (Ford 1981; Cowan 1985; Smith 1989). Sites occur in a wide range of environmental zones, which suggests considerable intensification in the use of the area. Settlements appear to have been occupied for longer periods of time than in earlier periods, and the existence of formal residential base camps occupied seasonally or longer is inferred, together with a range of smaller resource exploitation sites such as hunting, fishing, or plant collecting stations (Mathis 1979; Claggett and Cable 1982; Ward 1983; Mouer 1991). In addition, many sites from this period contain evidence of prepared floors, post molds from structures, and features such as storage pits, all of which indicate a more sedentary lifestyle than is suggested for earlier periods (Simmons and Steen 1987:7).

The Late Archaic has been divided into a series of subperiods or phases, identified primarily by the presence of diagnostic projectile points. The basic outlines for this sequence were first developed at the Doerschuk, Gaston, and Lowdes Ferry sites by Coe (1964). Terminal Middle Archaic/initial Late Archaic occupations (ca. 4,200-3,500 B.C.) are marked by the presence of Guilford Lanceolate (Coe 1964:43-44) projectile points, characterized by long, narrow, thick blades and straight, rounded, or concave bases. Contemporaneous with or slightly later than these types are side- and corner-notched stemmed forms, variously described as Halifax in eastern North Carolina (Coe 1964; Oliver 1985), and MALA (which are somewhat larger than the Halifax type) in South Carolina (Sassaman 1985). The distinctive Savannah River Stemmed type—a large, broad-bladed, square stemmed point—appears ca. 3,000 B.C. and lasts to ca. 1,500 B.C. Sites dating to the Late Archaic period are found in a wide range of environmental zones, with major settlements in riverine bottoms, suggesting intensive use of a wide range of resources (White 1982; Ward 1983; Bass 1977).

The terminal Archaic/initial Woodland occupation, ca. 1,500-500 B.C., is identified by the presence of smaller stemmed point forms such as Small Savannah River and Gypsy Stemmed (Oliver 1985). A reduction in the size of these stemmed forms, on the average, is clearly indicated over the course of the Late Archaic/Early Woodland in the region (Oliver 1981, 1985). Soapstone vessels are in use at this time in some areas, and towards the end of this interval pottery appears. Stallings Island fiber tempered ceramics were manufactured as early as 500 B.C. (Anderson et al. 1982; Trinkley 1990). A continuation of previous Late Archaic subsistence and settlement strategies, with the addition of pottery, seems to have occurred.

Woodland Period (ca. 1,000 B.C.-A.D. 800)

The Woodland period began about 1,000 B.C. and continued until the appearance of the Mississippian adaptation around 800 A.D. Across the eastern Woodlands the period is marked by the appearance of widespread pottery use, a greatly increased role for horticulture in subsistence economies, and an elaboration of mortuary ceremonialism, including the appearance of burial mounds (Griffin 1967:180).

In the greater Southeast, the Woodland period began with a transition from the Late Archaic that was marked by increasing sedentism and changes in food storage and preparation technologies. Subsistence strategies were a continuation of earlier hunter-forager ways, with an increased reliance on the cultivation of native plants (Yarnell and Black 1985). Religious life, as evidenced by increased ceremonialism and the development of burial mounds, became more sophisticated during the Woodland period. Large triangular projectile points are diagnostic of the Woodland period. Ceramics became more refined and regional differentiation of wares, particularly with respect to temper, paste, and surface decoration, became manifest during the period. However, some regions in the Appalachian Summit continued with the Archaic way of life well into the Woodland period. For example, in the

upper Hiwassee Valley in extreme western North Carolina, there appears to have been no Early Woodland equivalent (Dorwin 1975).

Early Woodland (ca. 1,000-400 B.C.). Initial Woodland occupations, which are thought to reflect a more or less unchanged continuation of preceding Late Archaic lifeways, are characterized by sand tempered cord marked, fabric marked, net impressed, and stamped pottery (Coe 1964:27-29). The Early Woodland occupation of the region continued into the subsequent Middle Woodland phase (ca. 400 B.C.-A.D. 400), which is characterized by cord marked, fabric impressed, and (rarely) linear check stamped, crushed quartz tempered pottery (Coe 1964:30-32). Site density appears to have increased considerably over previous periods and a settlement pattern characterized by relatively permanent riverine base camps and interior specialized exploitation camps is inferred (Mathis 1979; Ward 1983).

Middle Woodland (ca. 400 B.C.-A.D. 800). The Middle Woodland period is characterized by an intensification of long-distance trade throughout the eastern Woodlands, although evidence for direct participation of local groups in the classic Hopewell interaction sphere exchange network remains minimal. Horticulture is thought to have become increasingly important, and the cultivation of maize may have been initiated at this time, although its importance was not realized until the subsequent Late Woodland and Mississippian periods. Numerous large and small sites have been found dating to this period, suggesting periodic aggregation and dispersion, or some kind of a village/base camp-specialized resource extraction station settlement dichotomy. Diagnostic artifacts dating to this period include sand and crushed quartz tempered fabric impressed and cord marked ceramics, usually described as Yadkin (see Blanton et al. 1986:9-20 for a discussion of what is meant by "Yadkin" in the Piedmont), as well as lesser quantities of material resembling Connestee series wares from the Appalachian Summit (Keel 1976; Dickens 1976), and Deptford series types from the Coastal Plain and lower Piedmont.

Late Woodland (ca. A.D. 800-1200). The Late Woodland period on the Atlantic Coast saw the emergence of sedentary village life based on intensive maize agriculture, and the development of complex tribal and chiefdom-level political forms. Located at the fringe of the area occupied by groups characterized by the generalized Southeastern Mississippian culture and adaptation, the late prehistoric occupations of the study area can be characterized as reflecting a continuation of the Woodland tradition, with an admixture of Mississippian cultural elements in some areas and on some sites. Specific diagnostics useful for unequivocally identifying sites of this period are difficult to pin down. The later Woodland cultural sequence is very poorly documented and described at the present (Goodyear et al. 1979; Ward 1983). Except where Mississippian components have been identified, evidence for the intensive cultivation of maize remains minimal, suggesting continued reliance on wild plant and animal resources (Claggett 1985:48). In the Appalachian Summit, the Late Woodland is all but invisible, raising as yet unanswered questions about its character there (Dickens 1986:74).

Mississippian Period (ca. A.D. 1000-1540)

The Mississippian period is marked by a rise of ceremonialism expressed architecturally in large public constructions, development of maize agriculture, and more rigid social organizations. These took the form of ranked societies. In some regions, settlement became securely permanent, notable archaeologically as villages in which houses were rebuilt many times. Toward the centers of these societies, villages were frequently associated with large public constructions, including truncated pyramidal mounds fronting plazas.

There is increasing evidence that territorial boundaries between societies were closely maintained during the Mississippian period. Chiefdoms appear to have been supported by warrior elites. Males buried in ceremonial centers of lesser importance such as Etowah in Georgia and Chucalissa in Tennessee, were larger than the general population in some communities, and displayed more traumatic injuries than the general population (M. Powell 1992). Peripheral villages, such as King in Georgia, do not show a divergence between elite and non-elite traumatic injuries. At the largest of the ceremonial centers, Moundville in Alabama, there were fewer injuries among elite males. This may indicate that sizable organization at Moundville required an administrative elite separate from a warrior class. Studies of relations between native societies and Spanish expeditions suggest that supra-chiefdom level organization was maintained through a system in which paramount chiefs traveled from fief to fief displaying royal prerogatives and power, and received gifts and tribute from subverted groups (Smith and Hally 1992).

Although most or all of the Mississippian material culture attributes appeared during the preceding Woodland period, they did not become widespread until after ca. A.D. 1000. Artifacts diagnostic of the Mississippian period in the southern Appalachians include small triangular projectile points and ceramic series much less refined than Woodland ceramic types. Complicated stamped pottery became less intricate and was poorly executed. Although agriculture was an important source of food, analyses of floral and faunal remains from Mississippian sites document the persistence of wild resources as a major component of the diet. Ferguson (1971, 1975) has observed that the appearance of Mississippian culture occurs progressively later as one moves from the west eastward over the southern Appalachian area. This suggests that the development of this culture in the Carolinas reflects an expansion from established centers in Georgia.

During the fifteenth and sixteenth centuries, factors antecedent to, and coeval with, European conquest brought an end to the Mississippian lifestyle, although elements of the material culture, belief systems, place names, and social structure of classic Mississippian society lingered into the eighteenth century as viable social organizations, and elements of material culture remain a part of modern American lifeways.

HISTORICAL OVERVIEW

The Historic era is divided in four periods: the Ethnohistoric period (1492-1599), which consists primarily of observations of Native Americans by explorers; the Colonial period (1600-1775); the Antebellum period (1776-1865); and the Postbellum period (after 1866). Early European colonial settlement began at Jamestown, Virginia in 1604 and spread along the coastal regions following 1650. After a series of wars with interior Indian groups beginning with Bacon's Rebellion in 1676, and culminating in the second decade of the 1700s with the Tuscarora and Yamasee Wars, settlement began to penetrate inland. Following 1750, populations of various origins—Scotch-Irish, German, Pennsylvanian, and Chesapeake Tidewater—converged on the Piedmont below the Blue Ridge Mountains and created a distinctive regional cultural pattern (W. Powell 1989). In 1775, following negotiations with the Cherokee by Daniel Boone, who was sponsored by Judge Richard Henderson, European settlers from the Piedmont began to filter through the mountains to the west (Gunn et al. 1991a).

In the eighteenth and early nineteenth centuries, the economy of the North Carolina piedmont was primarily subsistence farming. This trend continued until the development of transportation systems (based on plank roads in the 1830s and railroads following 1837) lessened the isolation of non-coastal regions and allowed some development of market-oriented farming (Powell 1989; Gunn and Wilson 1992).

Through the nineteenth century there was an increasing emphasis on cotton mills to reduce Southern dependence on Northern technology and industry. After the Civil War, many factories were established and became the working environment for many North Carolinians; textile production became the dominant industry in most of the Piedmont, but furniture manufacture was also important. By the end of the century, North Carolina was the leading industrial state in the South.

The Appalachian Summit was occupied by Cherokees at contact. In the last few years, substantial effort has been invested in the reconstruction of the routes of the sixteenth-century de Soto, Luna, and Pardo expeditions (Hudson 1990; Smith and Hally 1992). Opinion varies on the route taken by the expeditions. Later, English and French traders penetrated the area (Egloff 1967). Settlers followed the English traders, ultimately resulting in pressure for European settlement on the Cherokee homeland. The Cherokee generally maintained favorable, if ambivalent, relations with the English during the Colonial period. The American Revolutionary War marked the beginning of a period of unfavorable external relations and treaty agreements beginning in 1775. Encroachment on Cherokee territory continued through the subsequent 63 years. In 1838, the United States Army forcibly removed a large proportion of the Cherokee to Oklahoma territory on the "Trail of Tears." A few thousand people who escaped the removal managed to reorganize themselves and acquire a homeland on the skirts of the Great Smoky Mountains highland (Gilbert 1943; Gulick 1958).

The Appalachian Summit region remained relatively quiet during the time between the removal of the Cherokee and the Civil War. It was spared most of the tremors propagated by the War between the States, a time when many mountain communities became refuges for people from disrupted regions on the Atlantic Coast, Piedmont, and Cumberland Plateau. Sherman's military operations swirled around the south end of the Appalachian Mountains. Only Stoneman's Raiders struck into the mountains, reaching Asheville in 1865.

IV. RESEARCH DESIGN AND METHODOLOGY

RESEARCH DESIGN

The occurrence of prehistoric sites below river narrows is well documented by Coe (1964) and Claggett and Cable (1982). This principle also appears to apply in relatively high gradient streams of the mountains such as the Swannanoa River (Gunn and Cassedy 1993). Below the narrows, eddies form behind the protective rock, and levees form along the constrained channel. Over time, the levees build downstream, providing raised, dry surfaces for human occupation (Joffre Coe, personal communication 1992; Gunn et al. 1991b). There are also measurable site preservation effects up stream from narrows. Coves with rich alluvial soils and wide floodplains form upstream from narrows as a result of flooding. If the cove extend up stream to the next narrows, complementary depositional effects accrue from both upstream and downstream processes. An example appears to be the location of the Waren Wilson Site in Buncombe County (Gunn and Cassedy 1993).

A resistant ridge of rock such as that noted above occurs about 0.5 km west of the project area. On the north side of Brushy Creek it appears as a toe of Doe Hill Mountain. There is a broadening of the Brushy Creek floodplain both above and below the toe. This suggests a relatively rich soil for such an elevated circumstance as exists at the head of Brushy Creek immediately below the Blue Ridge Divide. This contention is supported by the presence of a well established farm across Brush Creek from the project area (see cover). Such situations typically have both prehistoric and ethnohistoric sites on overlooks on adjacent toes (see for example Riggs 1993; Gunn and Lilly 1994).

In addition to questions about relationships of settlements to stream processes, other relations pertinent to cultural change in the high valleys of the Appalachian Summit require further scrutiny. As discussed earlier, there is no clearly delineated transitional process between the Late Archaic and Woodland cultures. It is unclear if the Appalachian Summit was inhabited during the later Late Woodland (ca. A.D. 600-1000) (Bass 1977; Robinson et al. 1994). Questions relevant to these problems follow.

1. Was upper Brushy Creek occupied continuously or intermittently through the Holocene? If it was occupied during the poorly known Late Archaic to Early Woodland transition, are there detectable transitional processes evident in the artifact inventories that would shed light on the transition?

2. Was upper Brushy Creek inhabited more or less continuously than other similar area above (such as the ridge summits investigated by Purrington) and below (such as the Cherokee towns)? Answers to this

question will determine if breaks in occupation are landform specific or region-wide.

3. Does upper Brushy Creek possess stratigraphic integrity by which episodes of occupation and abandonment can be characterized as erosional or depositional? Lowland rivers in the Southeast can generally be shown to be aggrading during the Middle Holocene (2,500-5,500 B.C.) and degrading during the Early and Late Holocene (Brakenridge 1980). Do channel aggradation and degradation show an opposite trend in upland rivers?

FIELD METHODS

To map activities on a consistent grid, the now-unused gate post on the north side of Brushy Creek Road at the southwest corner of the property was established as a project datum. A mapping base line was extended north from the southwest corner of the property (see Figure 2). This primary north-south transect was designated the East 1000 meters line, and it was marked with orange flagging tape every 30 m. From this base line surfaces that were of less than 15° slope were surveyed on east-west transects.

Phase I survey proceeded by two methods: 1) surface inspection, and 2) shovel testing. Surface inspection was possible in many areas due to eroded soil conditions, but areas with less than 25 percent surface visibility were shovel tested using a 30 meter interval between test pits. All sediments excavated from shovel tests were screened through 1/4 inch hardware cloth. Artifacts were collected in zip-lock plastic bags and labeled with the project name, date, provenience unit, and the recorder's initials. Strata were profiled and Munsell color and texture were recorded in test units.

In areas where colluvium had collected (mostly in the second terrace field, but also in the Mid Ridge Site), a one-inch tube sample was also used to reconnoiter for buried soil horizons that might contain archaeological deposits.

LABORATORY METHODS

The artifacts were returned to the Garrow & Associates, Inc. Raleigh, North Carolina facility, where they were washed, labeled, identified, and catalogued. All recovered remains were cleaned as appropriate for their raw material. Most were washed in clean water and air-dried. Each artifact was individually catalogued along with its site provenience, level, method of recovery, and type. Types of prehistoric remains were identified following Coe (1964), Oliver (1985), Broyles (1971), Keel (1976), and Dickens (1976), among others. An inventory of artifacts was assembled on a

spreadsheet (Appendix 1). Project materials are currently being curated at Garrow & Associates, Inc.'s Raleigh office; they will be transferred to a permanent repository at the conclusion of the project.

ASSESSMENT OF SIGNIFICANCE

A site's potential significance is determined by its ability to meet one of four criteria established for determining the eligibility of a property for listing on the National Register of Historic Places, as established in 36CFR60.4. These criteria include:

> A. The resource is associated with events that have made a significant contribution to the broad pattern of history.
>
> B. The resource is associated with the lives of persons significant in the past.
>
> C. The resource embodies distinctive characteristics of a type, period, or method of construction, or represents the work of a master, possesses high artistic value, or represents a significant and distinguishable entity whose components may lack individual distinction.
>
> D. The resource has yielded or is likely to yield information important to history or prehistory.

In addition to meeting one of these criteria, a resource also must possess integrity (i.e., retain some of its original setting, possess features that distinguish the resource and permit its association with a particular criterion). Glassow (1977) provides a guide for the assessment of the significance and integrity of archaeological sites. Sites possess five properties that can be evaluated to determine significance. These properties include the variety of remains, or clusters of remains, encountered within a specific resource, the quantity of remains, the clarity of archaeological deposits, "the integrity" (e.g., state of preservation or completeness of an assemblage) of archaeological deposits, and the environmental context of a particular locale. Each of these properties of a particular resource can be assessed to determine whether the resource possesses historical significance and sufficient integrity to be eligible for listing on the National Register of Historic Places.

Most significant archaeological sites will meet Criterion D of the National Register criteria. In order to contribute information important to history or prehistory, however, a site must be considered within a framework informed by both the nature and condition of the local and regional archaeological resource base, and by current and future research considerations (discussed above).

V. RESULTS OF INVESTIGATIONS

For purposes of archaeological survey, the topography of the property divides conveniently into two parcels: a second terrace at about 2,480 feet amsl, and a high terrace at about 3,480 feet amsl. Abandoned fields begin in the low elevations of the second terrace and wind up the mountain side following toe ridges to the high terrace. The surface stratum is generally red clay except where low slope angles and vegetation inhibit erosion. The age of the red clay is pre-Holocene while most of the colluvium is probably historic in origin if circumstance exist similar to those most often observed in the region. The steep valley wall separates the terraces and is in most locations too steep for archaeological sites and in some places even to walk upon. At the foot of the valley wall is the floodplain of Brushy Creek. It is across Brushy Creek Road and outside the property boundary.

SURVEY OVERVIEW

Phase I surface inspection identified one prehistoric site and the locations of structures at two historic sites, and shovel testing identified a second prehistoric site. Shovel testing was organized around sites and structures and on 30 m transects. Transects were run east and west from the project base line where slopes. were sufficiently low, less than 15°, to justify investigation. This resulted in the two nature areal subdivisions of the property discussed above (see Figure 3). During the course of the investigations, shovel tests were excavated in the second terrace, and on the high terrace. The positive shovel tests produced both prehistoric artifacts and historic artifacts. Artifact categories are analyzed to provide temporal and functional interpretations of the site.

A road extends from a trailer near the southeast corner of the property up to a basin at the head of the East Branch. Near the trailer is a cluster of structures and remains of structures, which was inventoried as the first historic archaeological site (31AV78). The road forks to the east and to the west, both forks following the contour of the mountain. The east fork eventually joins the old road to the top of Doe Hill Mountains that appears on the topographic map. The west fork goes into the West Branch drainage to the west where it passes by a red sandstone foundation, which is the second historic archaeological site identified (31AV79).

The first prehistoric site (31AV80) was found on the surface at the third shovel test north of the project datum. It was located on a ridge toe overlooking the trailer and the cove. Artifacts were found entirely on the surface. A second prehistoric site (31AV81) was found by shovel testing on the high terrace. It was located on the edge of the high terrace overlooking the valley.

HISTORIC SITES

Two historic period sites were found. Both represent the locations of former structures no longer intact.

31AV78—Trailer Site

The Trailer Site is the location of Alan Arbuthnot's camping trailer (Figure 4). It is on a relatively flat area (slope approximately seven percent) west of the confluence of the East Branch and Brushy Creek (Figure 5). The elevation of the site is 2,860 feet amsl. It occupies a narrow stretch of arable land on the second terrace. It is directly below (to the southeast of) the elevation from which the Mid Ridge Site overlooks the second terrace and floodplain. The slope between the two sites may be a terraced field. West of the site is a small field of reasonably flat and fertile colluvial sediment.

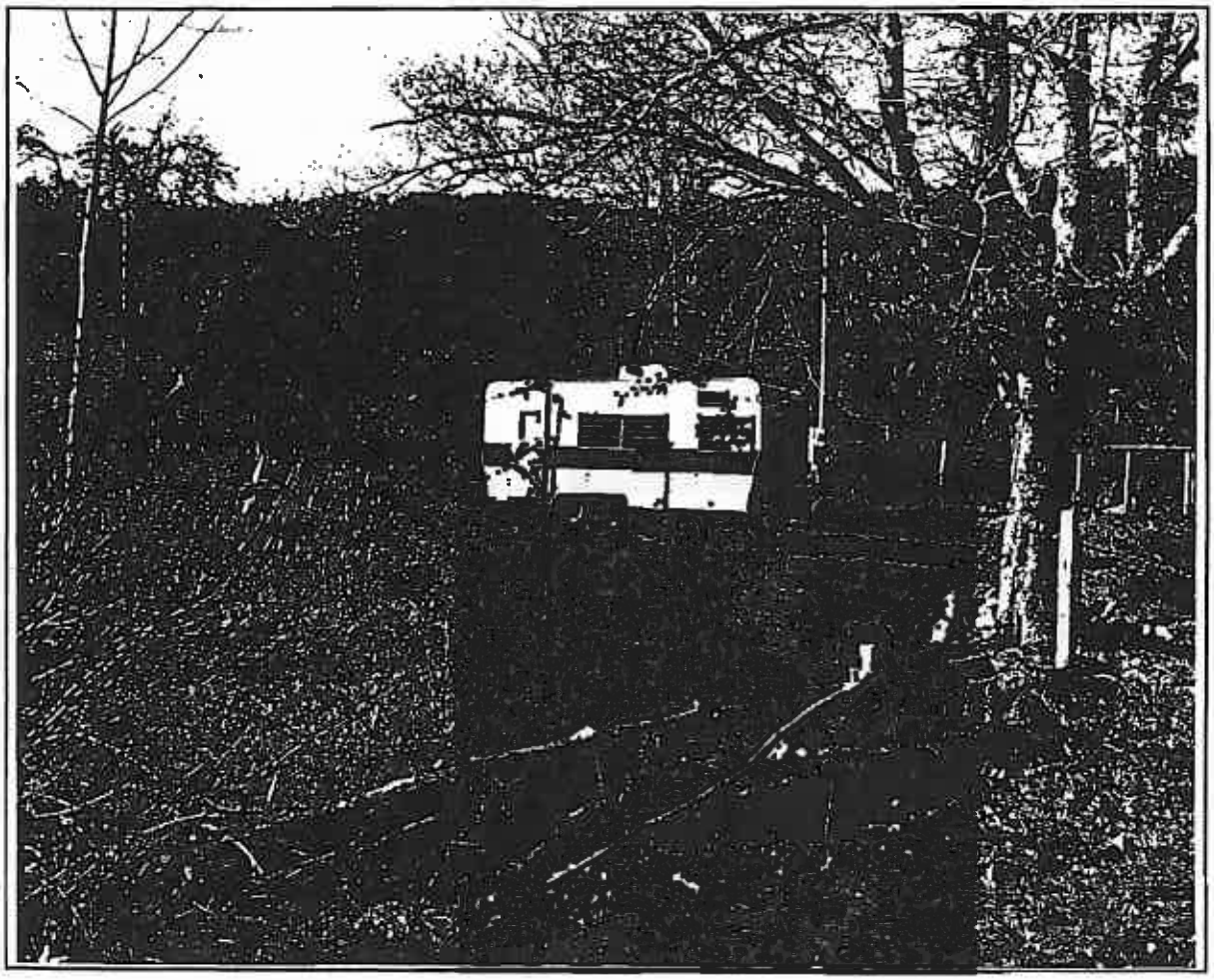


Figure 4. Site 31AV78, View is north.

There is evidence of a structure in the area, including a symbol on the 1956 USGS 7.5 minute quadrangle. Across the Quarry Road from the trailer is a concrete cellar that could be from the older structure. We observed charred wood in the cellar although it is not clear that it represents the burning of the building. The cellar is in the process of being constructed upon again as new wooden beams have been placed on the concrete walls.

Seven shovel tests were excavated in the area of the site. The three positive shovel tests in the vicinity of the cellar revealed three artifacts (Table 1). One is an octagonal bottle base fragment that could have come from a perfume bottle or similar container from earlier in the twentieth century. A second piece of glass supports an argument for burning of the structure; it was a piece of fire-crazed glass. The third artifact was a flake, perhaps evidence of low level prehistoric interest in the location.

Table 1. Historic Artifacts from the Avery County Landfill Survey.

Site	Glass	Wire Nail	Flake	Radio part	Whiteware	Total
31AV78	2	0	1	0	0	3
31AV79	11	3	0	1	1	16
Total	13	3	1	1	1	19

Other evidence of human activity in the area of the site included a circle of stones 1.5 m across about 10 m to the south of the cellar. Within the circle were three triangular stones placed on end. To the north along the Quarry Road was a wooden structure that appeared to be a barn or garage (Figure 6). It now contains curing lumber. It probably dates to the twentieth century.

Other shovel tests in the vicinity of the trailer and foundation yielded no artifacts, but did indicate disturbance, perhaps imported soil for a yard. A typical shovel test showed two strata. Stratum I (0-5 cm) consisted of brown (7.5YR 3/2) sandy loam mixed with reddish sand. Stratum II (5-30+) consisted of dark yellowish brown (10YR 4/4) sandy loam that was about 30 percent gravel.

This site displays a low density of artifacts and the integrity of the sediments is questionable. There appears to be no potential for intact deposits or other accumulations of artifacts unambiguously associated with the site and capable of yielding historically valuable information on vernacular architecture or lifeways in the region. Site 31AV78 does not appear to be eligible for the National Register of Historic Places, and no further work is recommended.

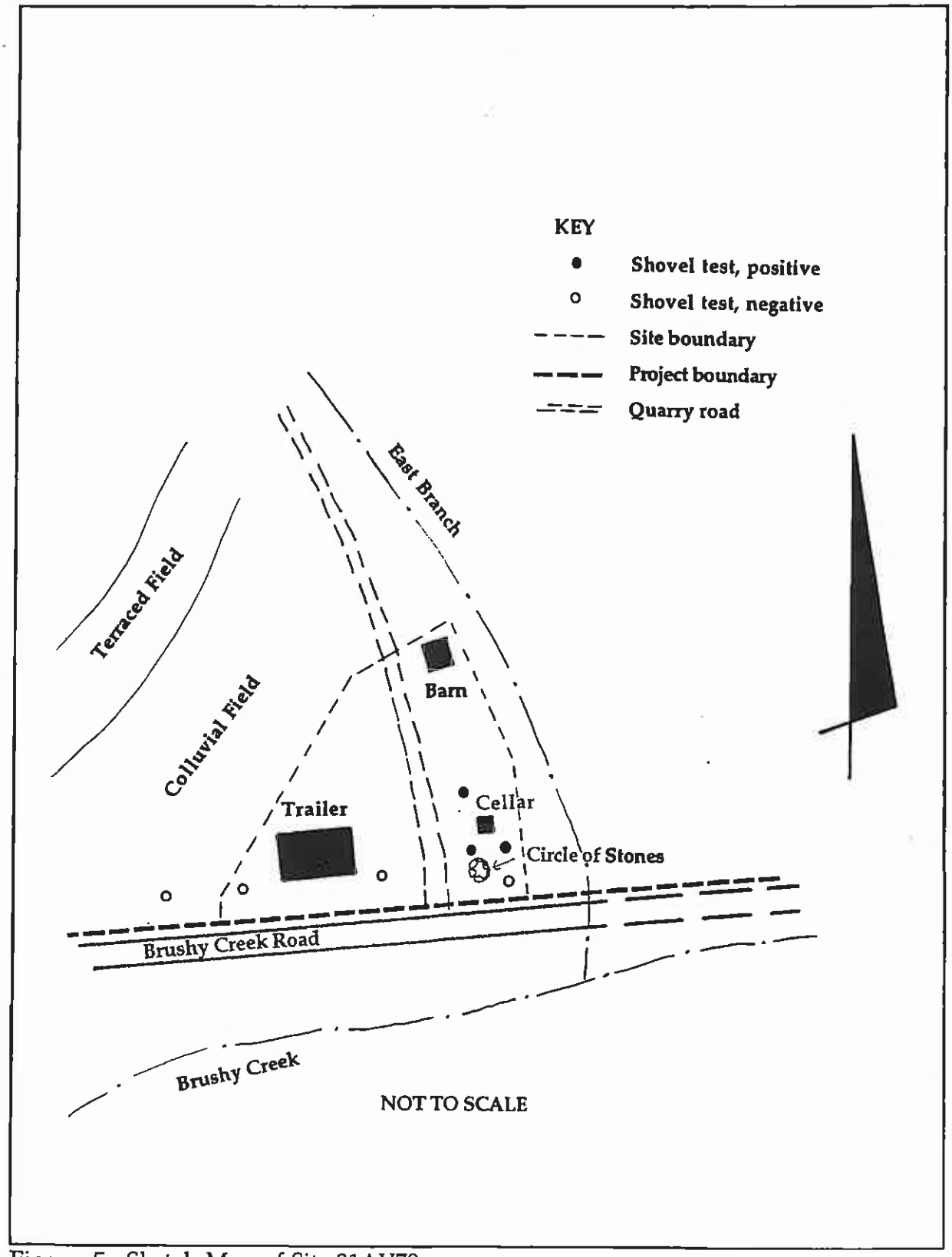


Figure 5. Sketch Map of Site 31AV78.

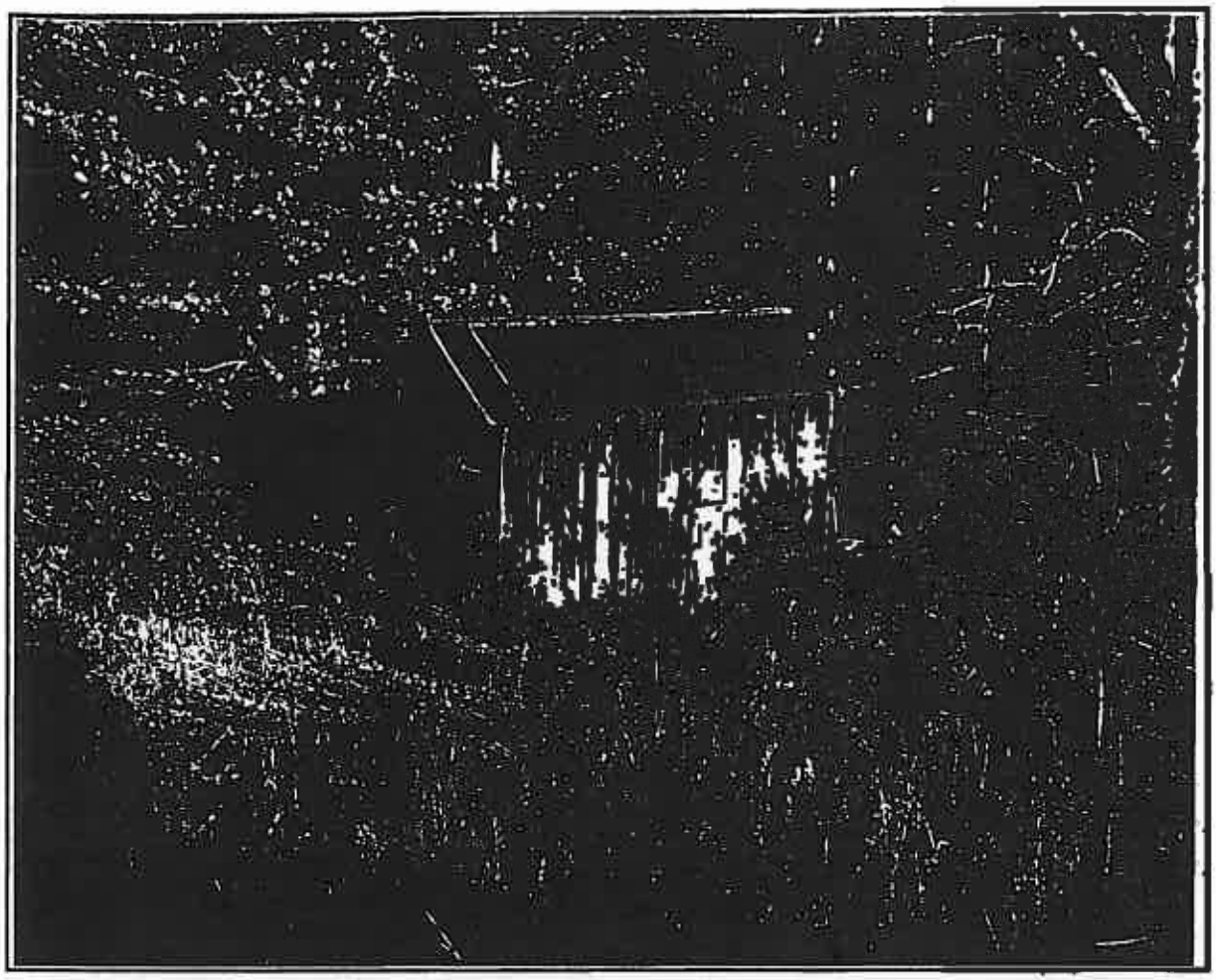


Figure 6. View East of Barn near Site 31AV78.

31AV79—Cottontail House Site

The Cottontail House Site is a red sandstone foundation at the head of the West Branch. (Figure 7). It is on the last relatively flat area before the head of the valley rises abruptly to the high terrace (Figure 8). It is at an elevation of 2,960 feet amsl. At this elevation the slope doubles from 13 percent to 27 percent. The location is marked as being part of the old field system on the USGS 7.5 minute quadrangle; it is, however, a rolling terrain. Two check dams cross the West Branch about 20 m to the west.

There is no symbol for a structure at this location on the 1956 USGS 7.5 minute quadrangle, so it may have been demolished by then. There is no evidence of outlying buildings around the structure. It is however, surrounded by poplars for about 100 m in all directions that may be about 50 years old. Two white pines, one of which is has fallen across the south course of the foundation (Figure 7), also appear to be about 50 years old. This was determined by measuring and comparing the circumference of a similar tree downed on another part of the property. A white

pine of similar stature has grew within the foundation since the building was demolished. A yucca plant was observed on the down hill side of the structure.

Figure 7. Foundation at Site 31AV79. View is northeast.

Seven shovel tests were excavated in the area of the site. Four positive shovel tests and selective surface collection returned 16 artifacts (see Table 1). Eleven fragments of glass containers were found. A milk glass zinc lid liner suggests an early twentieth century date. A handle of a water pitcher and a whiteware fragment likewise implicate the early twentieth century or perhaps late nineteenth. Three wire nails were found; all were severely bent. Two shovel tests placed within the foundation revealed no charcoal, only severely bent wire nails. The general lack of indication of destruction by fire and low quantity of artifacts indicates that the structure was carefully scavenged rather than burned. Such behavior is considered to be an indication of difficult times and suggests a 1930s demolition of the building.

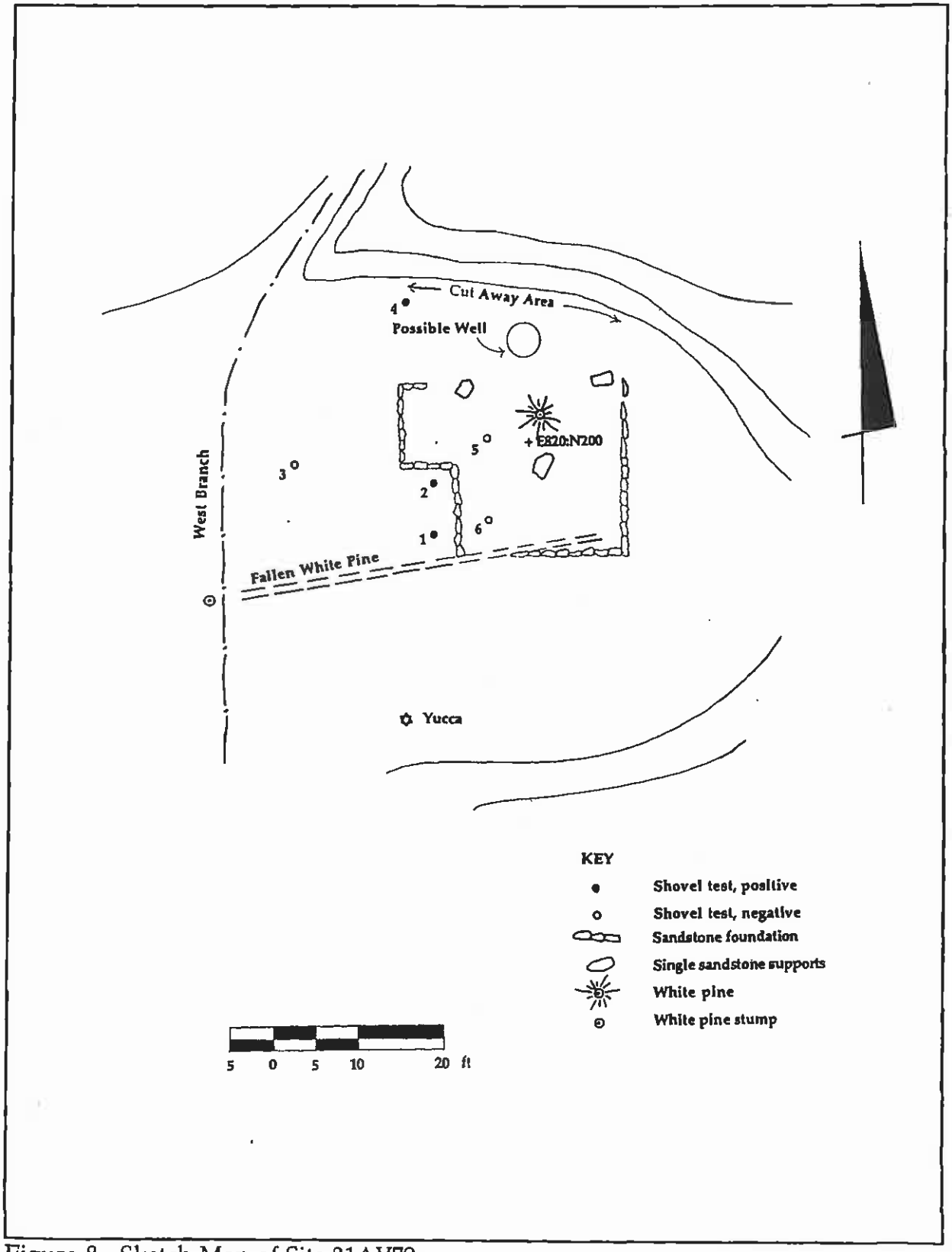


Figure 8. Sketch Map of Site 31AV79.

Beer cans with steel sides and aluminum tops, and fully removable pull tabs were found in a trash pile to the north of the house. In this pile, there was also the dial from a solid-state radio. These 1960s technologies probably post date the structure. A typical shovel test showed two strata. Stratum I (0-5 cm) consisted of dark brown (10YR 3/3) gravelly sandy loam. Stratum II was largely gravel and bedrock.

Between the house and the bank on the uphill side is a circle of stones 1.5 m in diameter forming a platform . The bank was excavated to level the plot for the building. The platform could be a well, cistern, or chimney base. It was not investigated beyond cleaning and photographing.

The artifacts indicate the structure may date to the early part of the twentieth century. There appears to be no potential for intact deposits or other accumulations of artifacts associated with the site capable of yielding historically valuable information on vernacular architecture or lifeways in the region. Site 31AV79 does not appear to be eligible for the National Register of Historic Places, and no further work is recommended

PREHISTORIC SITES

31AV80—Mid Ridge Site

The Mid Ridge Site is a surface scatter of mostly quartz lithics (Figure 9). It is on the toe of the middle ridge at an elevation of 2,890 feet amsl (Figure 10). The location overlooks the highest cove in the Brushy Creek watershed, the last fragment of serviceable land before climbing to the pass between the North Toe and Linville River drainages. Beyond the pass lies the Avery County Plateau with lands higher than in the Brushy Creek drainage.

The site is eroded around the edges of the toe exposing red clay and quartz boulders. On top of the ridge are two oaks surrounded by heavy underbrush. A field road has been bulldozed across the ridge about 30 m north of the oaks. A spoil pile from the dozing resides on the northwest part of the site on the edge of the hill. North of the road are rows of Christmas trees. The site ends with the road and Christmas trees. It may be that the ridge was graded to removed undesirable vegetation taking the site to the north of the road with it.

Five shovel tests were excavated in the area of the site, but all artifacts were collected from the surface (Table 2). Of the 39 artifacts collected, 35 could be identified as clearly of human workmanship and four were pieces of high quality quartz of questionable human association. Of the 35 lithics, 33 were of quartz and two were of flow-banded rhyolite.

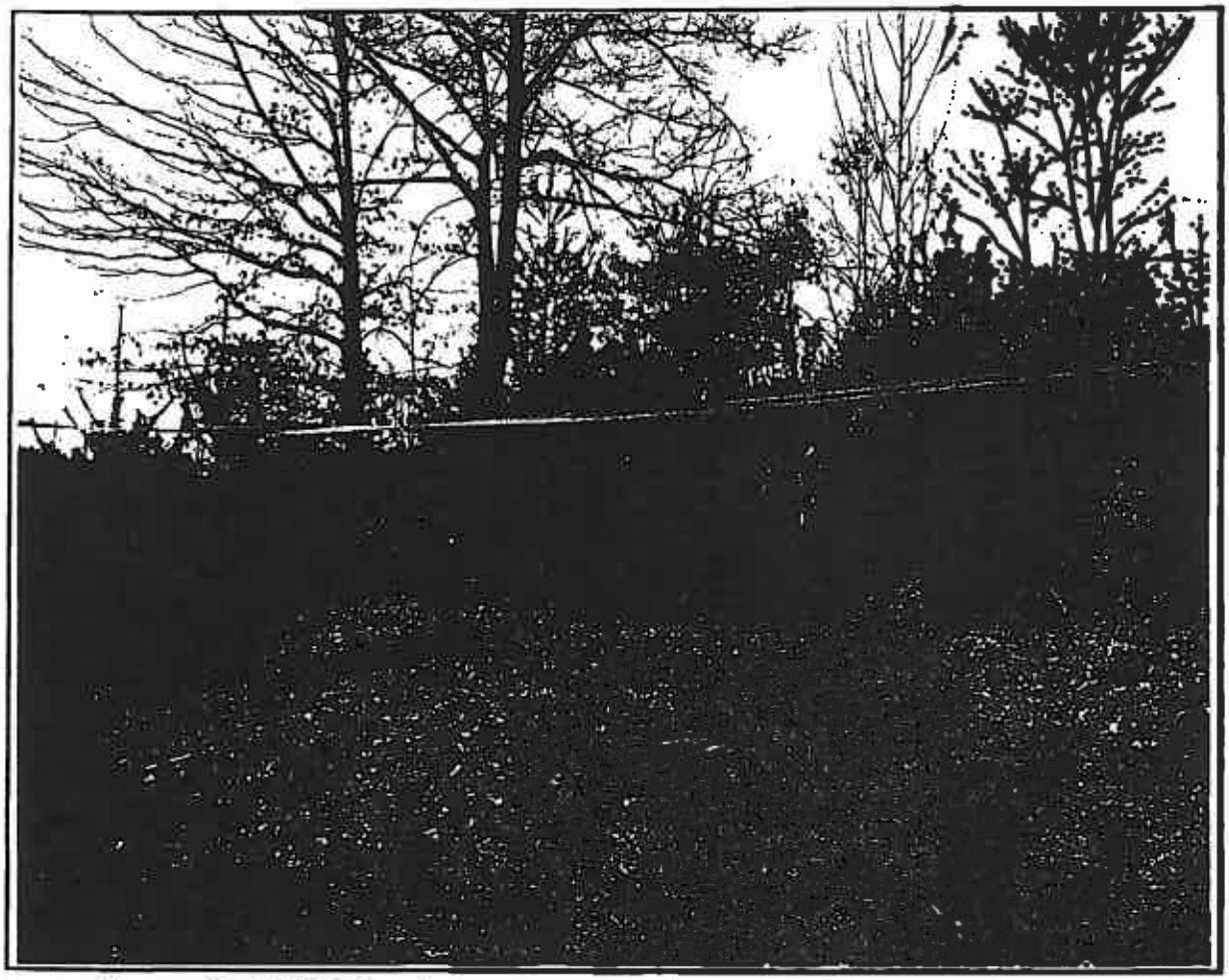


Figure 9. Site 31AV80, View is west.

Table 2. Prehistoric Lithic Artifacts from the Avery County Landfill Survey*.

Site	Core	Microcore	Large Flake	Small Flake	Chopper/ Tool	Total
31AV80	2	4	9	18 (2 rhy.)	2	35
31AV81	1	1	0	4	0	6
Total	3	5	9	22	2	42

*All are quartz except where noted.

There are no temporally diagnostic artifacts from the site. All artifacts were flakes or cores. Large boulders of high quality quartz were observed eroding from the side of the ridge (Figure 11). Though the amount of debitage was not great, the combined presence of flakes and eroding boulders suggests a quarry site if not a workshop. About 40 percent of the top of the hill was eroded and free of vegetation. All of the artifacts observed on the surface were collected.

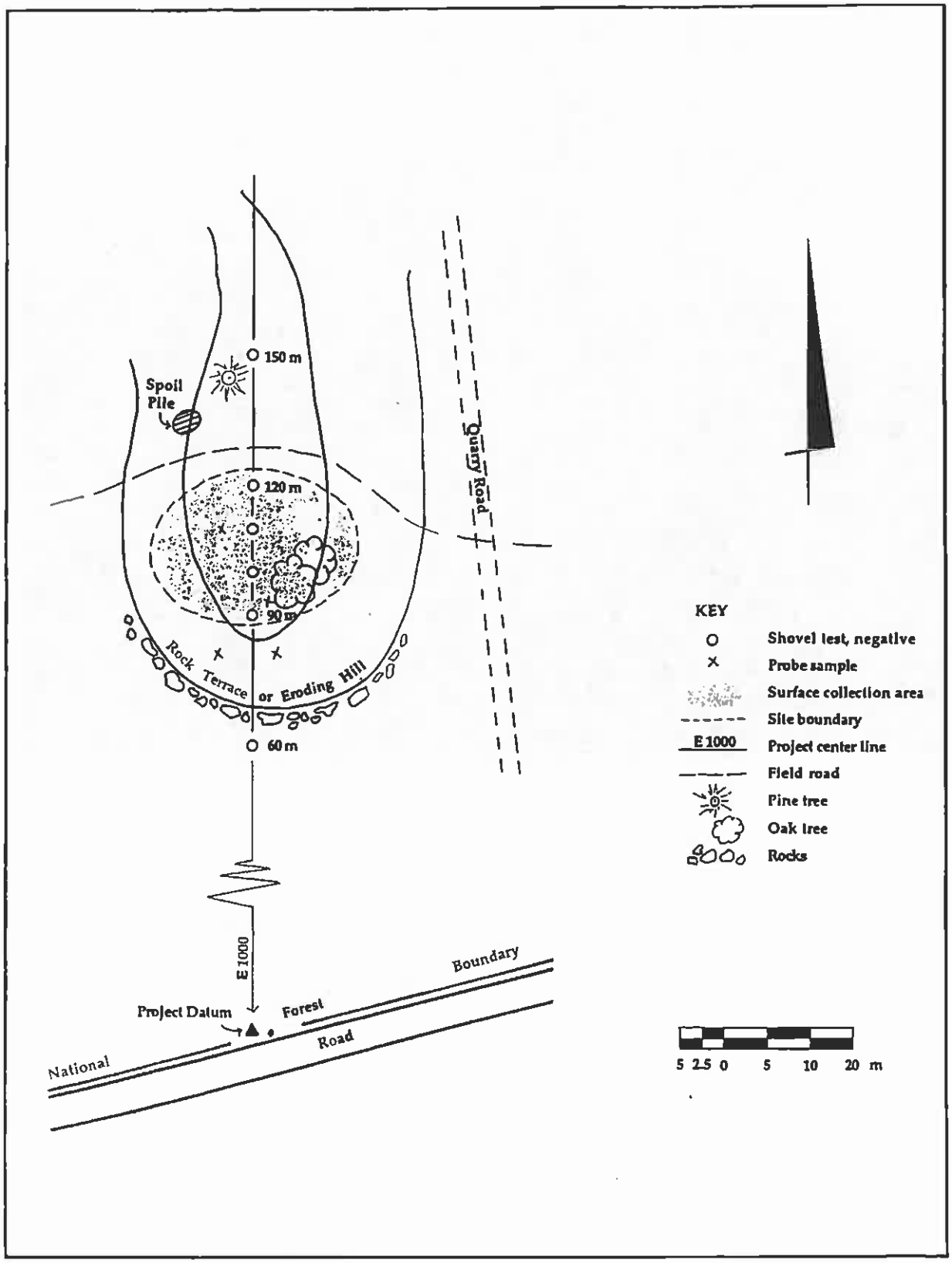


Figure 10. Sketch Map of Site 31AV80.

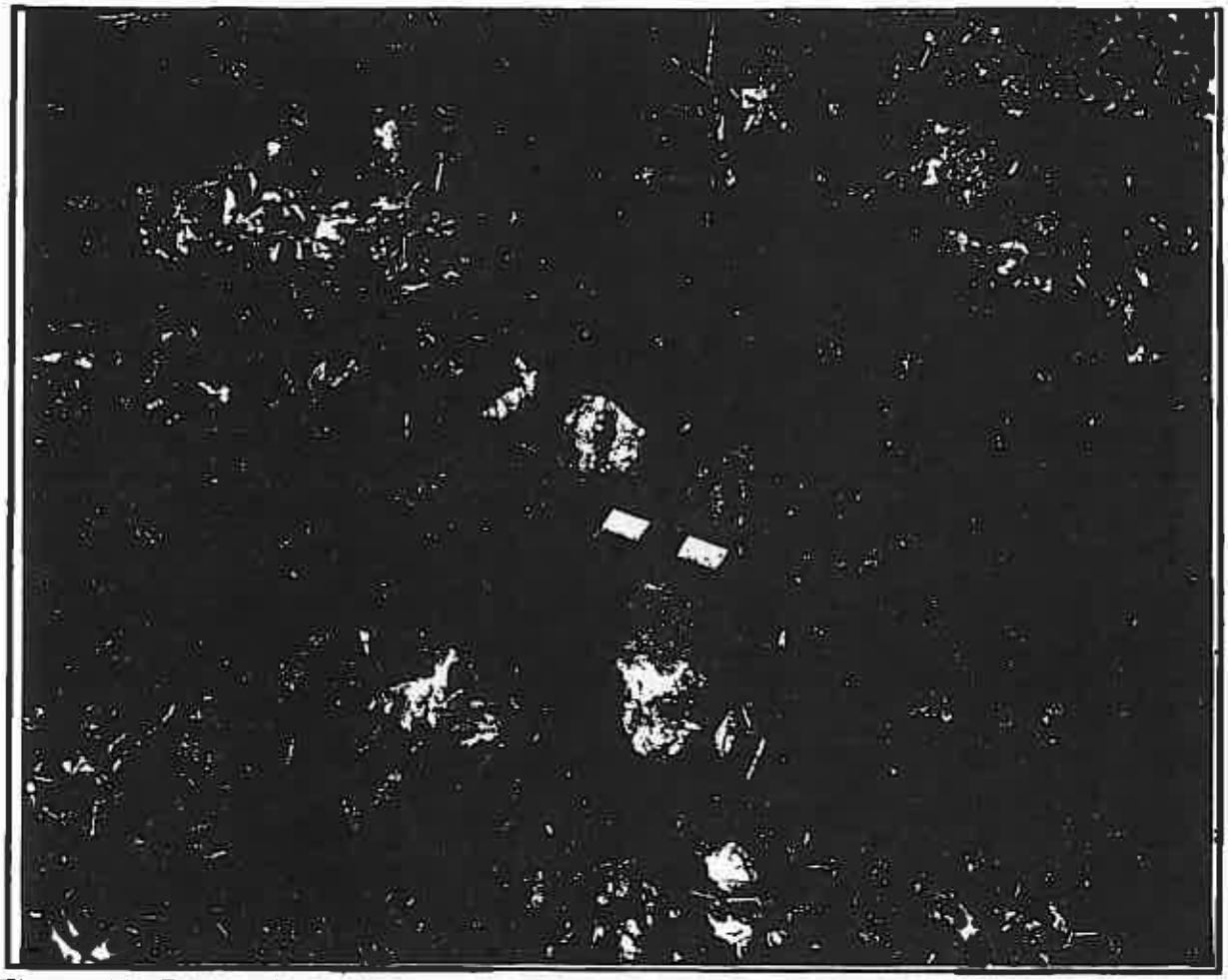


Figure 11. Exposed High Quality Quartz Boulder at Site 31AV80.

The rhyolite flakes appear to have been struck from the same block of material although they were found 30 m apart on opposite sides of the ridge crest. The banding is relatively fine averaging approximately 1 mm from band to band. Both are clearly bifacing flakes as judged by the platform configuration. The shorter of the two flakes (11 mm) was not a thinning flake (Figure 12, top); it did not cross over the center crest of the biface; the terminal edges were thin and shattered away. The longer of the flakes (34 mm) crossed the center crest removing flake scar spines from the opposite side, and thus it is a bifacial thinning flake. A portion of the terminal end may represent an *outre passé* removal. If so, the biface was 34 mm across.

Comparing the coarse and fine patterns of the flow bands, as in comparing tree rings, suggests that the two flakes were removed from opposite sides of the same biface at the same location. The size and relationships of the two flakes indicate that the knapper first removed the short, small flake from one side to strengthen the platform. The biface was then turned over and the long thinning flake driven from the other side. The platform strengthening step was required because of a small hinge fracture near the platform end of the long flake. This is a normal knapping procedure.

That the two rhyolite flakes were found alone in field of quartz may indicate that the large flake was removed from a bifacial core as an expedient tool to be used on location and discarded. Edges on the large flake would have been appropriate for cutting and/or scrapping. A possible notch in the terminal end of the large flake could have been used for de-barking a shaft. This could have been something to do while waiting in a hunting stand.

The 33 quartz pieces represent a range of knapping and tool functions. Two appear to be choppers. Chopper A (4-L1, Figure 12, bottom) is prepared on a biface. A thick flake (40 cm) was bifacially retouched. The terminal end of the flake was end struck from two directions to prepare a bit. The second chopper B (6-L3, Figure 12, bottom) is more problematic because it is simply a very large flake that has a sharp, bit-like terminal end. There is damage on the terminal end that could be from use. The two artifacts are distinctive, if in nothing else, at least in their size. Chopper A weights 211 g and B 144 g. The largest of the artifacts in the next class size, cores, weighs only 77 g.

Six cores were collected. Two of the cores are normal sized flakes cores (6-L14 = 86 g, 5-L6 = 77 g, Figure 13, top). The faces of the cores have distinctly cleaner and less crazed appearances than the sides. Assuming that the ruddy, crazed appearance of the sides are the natural state of the cobbles, similar appearances of the platform on 6-L14 suggests that it was found with an appropriate platform angle, while 5-L6 has a prepared platform.

Four artifacts are microcores (average weight 12 g, Figure 13, bottom). Although occasional microblade-like removals were made, most of the products were definable as platform core flakes. This corresponds to the small flakes found on the site. Two of the specimens (6-L1 and 6-L4) are bipolar cores. Specimen 6-L10 may be a bipolar core that broke during removal or it may be a unipolar core. Specimen 8-L1 is clearly a unipolar core.

Sixteen of the flakes were small enough to have come from a microcore. Of these, only one may be a bipolar flake. The remainder are small flakes were removed with regular flake core knapping techniques. Six of the flakes were medium sized (average weight 14 g). All were unspectacular core flakes. Three flakes were large (average weight 22 g) and had a consistent outline that expanded from the platform (Figure 14). The platform configuration suggests that one is a bifacing flake (6-L2). The other two have the platforms of flake cores, but they are thin like bifacing flakes. Two were directed toward removing hinge fractures (6-L2, 7-L3). Specimen 6-L2 had suffered two previous failures ending in deep hinge fractures. To correct the problem, the platforms was strengthened mightily and the hinges blasted away with a strong blow. The same tactic was used in 7-L3, but with less spectacular effort. Specimen 5-L7 is the platform end remnant of a very long and hard driven percussion flake, probably in the process of making a very large, thin biface.

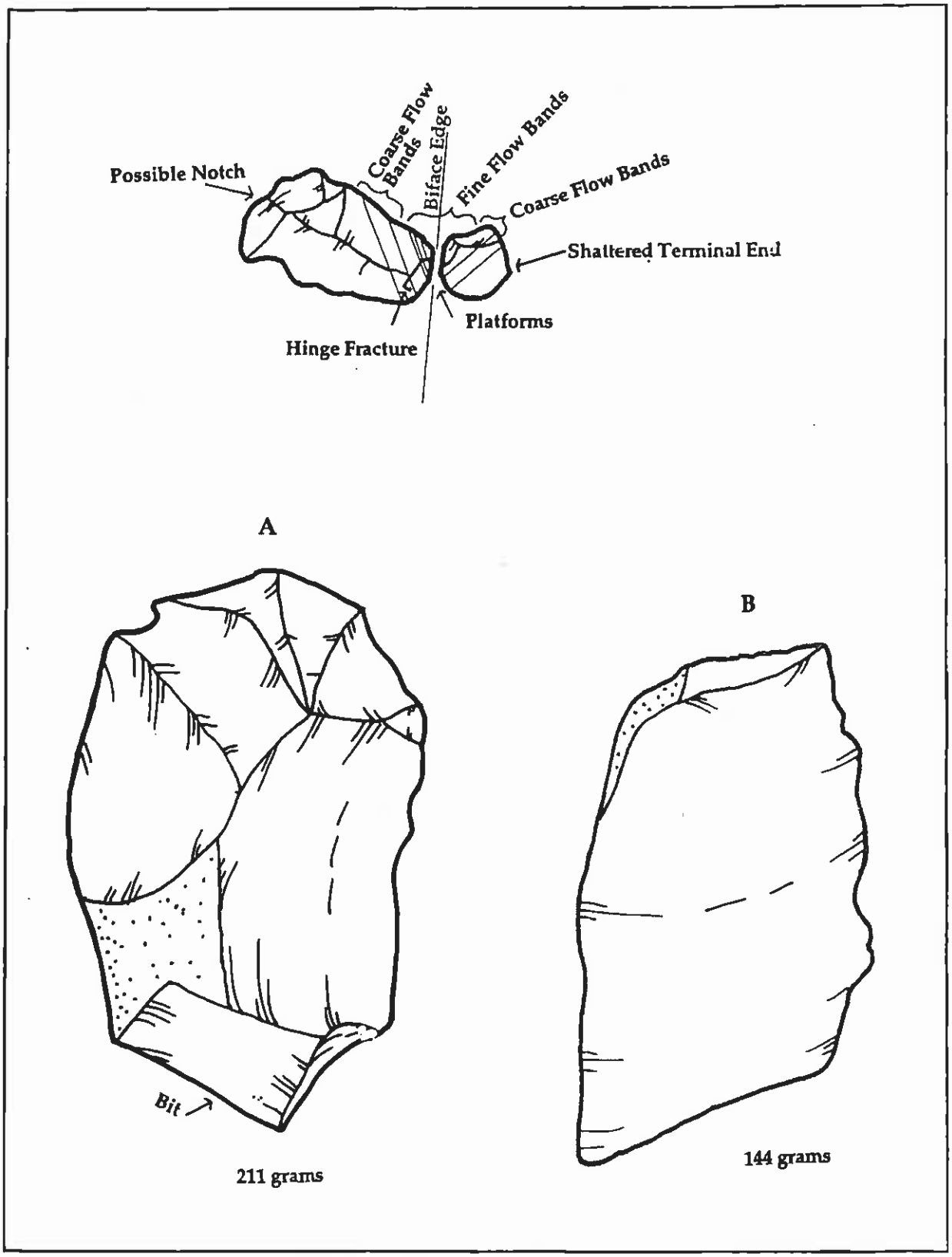


Figure 12. Artifacts from 31AV80. Top, Rhyolite Bifacing Flakes, Bottom, Choppers.

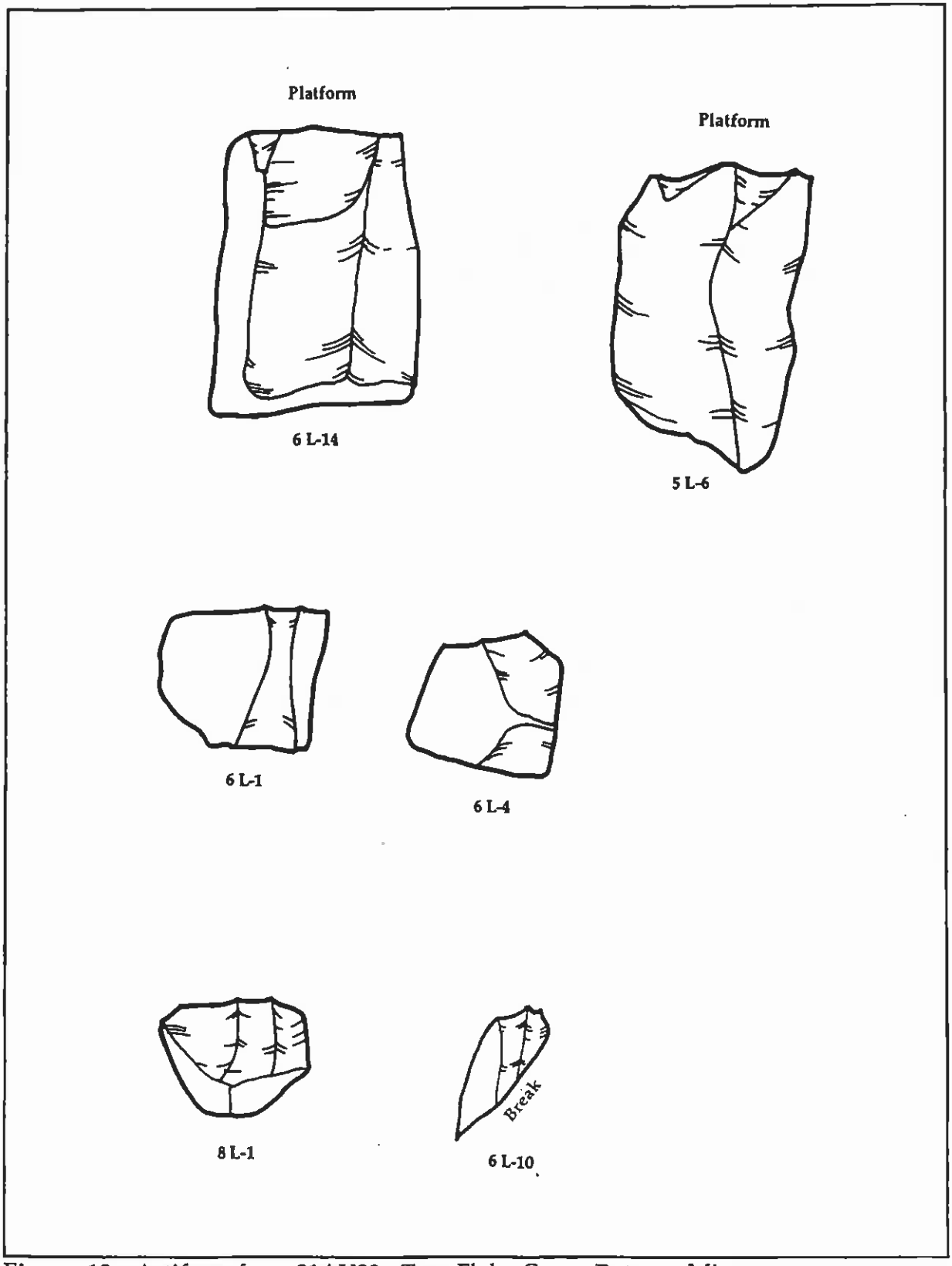


Figure 13. Artifacts from 31AV80. Top, Flake Cores, Bottom, Microcores.

Taken as a whole, the knapping techniques suggest a wide range of knowledge and considerable skill. Off course, because of the deflated state of the site there is no way to know if the knowledge and skill were all on the site in one visit, or multiple visits over thousands of years. That there are so few lithics might lead one to suspect few or even one visit. Since quartz is a favored material of the Middle Holocene Morrow Mountain culture in high altitudes (Bass 1977), perhaps they visited the site briefly when vegetation was sparse and found the quartz readily available, though bringing rhyolite along in a curated resource kit.

Six shovel tests were excavated on the site. A typical shovel test showed one stratum (0-30+ cm) consisting of yellowish red (10YR 5/8) clayey loam with some gravel. Four one inch soil probes were taken to 1 m below the surface to search for buried A soil horizons and features. None were found. The sediments all appeared to be well developed saprolite with only quartz surviving.

There appears to be no potential for intact deposits or other accumulations of artifacts associated with the site capable of yielding valuable information on prehistoric lifeways in the region. Though interesting, the artifacts densities are low and most of them were probably collected by this project. Site 31AV80 does not appear to be eligible for the National Register of Historic Places, and no further work is recommended.

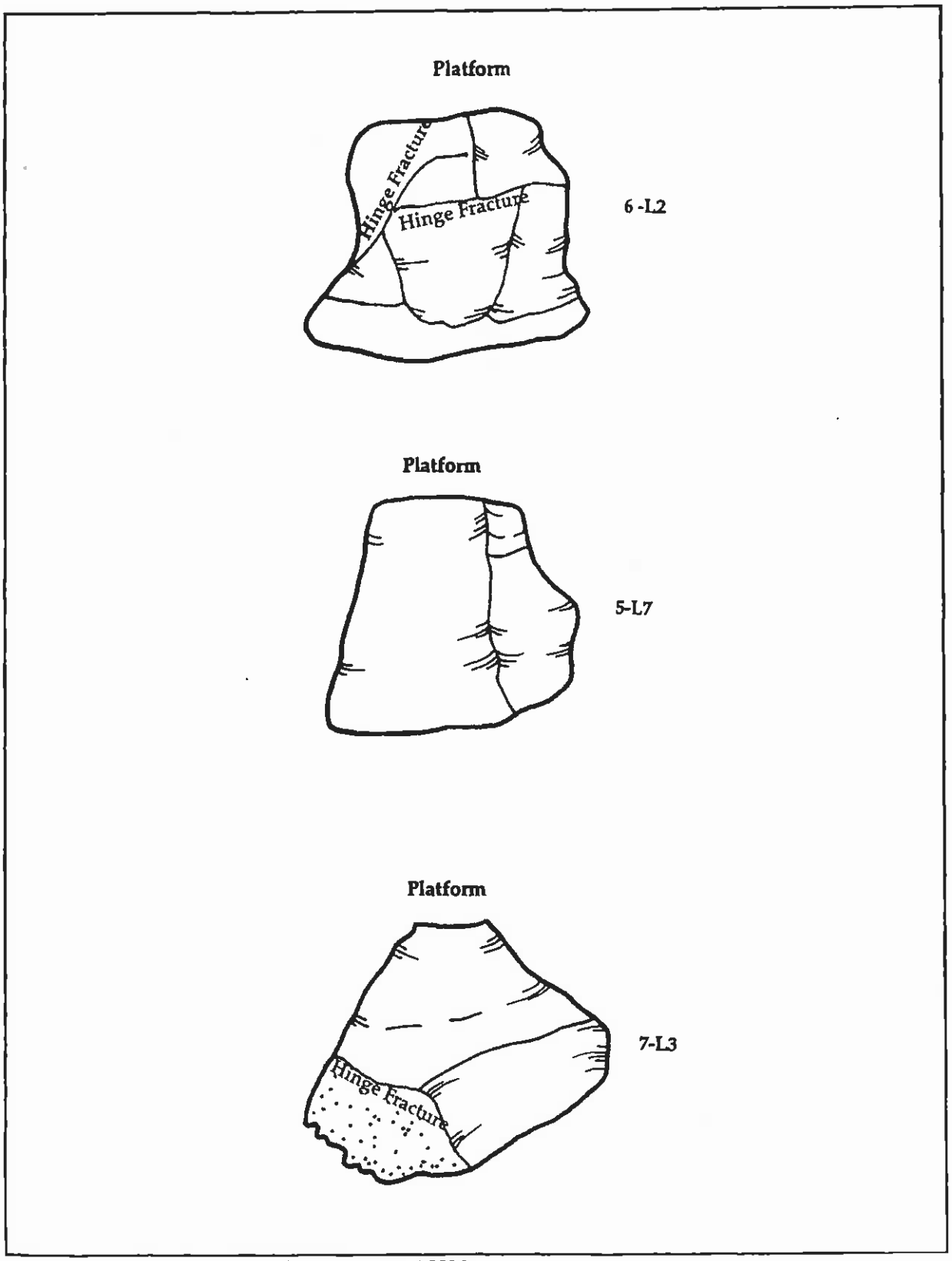


Figure 14. Large Flakes from Site 31AV80.

31AV81—Doe Hill Mountain Road Site

The Doe Hill Mountain Road Site is a plow zone scatter of quartz lithics. It was first identified by shovel testing along the valley side of the high terrace. It is on a toe of the high terrace at an elevation of 3,080 feet amsl, 190 feet above the Mid Ridge Site. The location has, in the absence of vegetation, an unobstructed vista of the upper Brushy Creek cove, Brushy Creek gap and opposing slopes of Humpback Mountain.

The site is on the edge of the high terrace (Figure 15). It is at present covered with pines and small hardwoods, but is indicated by the 1956 USGS 7.5 minute quadrangle to have been a part of the old field system (see Figure 3). A road mapped as leading from the end of Brushy Creek Road to the top of Doe Hill Mountain, the Doe Hill Mountain Road, passes through the site. As is frequently the case, sites and modern roads co-occur because, like modern vehicular traffic, ancient travelers followed and camped on avenues of least resistance to movement, and that offered the driest circumstance.

Seven shovel tests were excavated in the area of the site on a systematic 5 m grid pattern. Four contained questionable rocks, and only one had clearly identifiable quartz artifacts (see Table 2). The shovel test contained a bifacial tool, a microcore, and four flakes of quartz. The microcore is bipolar in one facet. It has been worked in on multiple faces reducing it to a wedge shaped remnant. The four flakes are all small platform flakes (average weight 0.25 g). None of them come from the microcore.

The microcore technology from this site is comparable to that at the Mid Ridge Site. The presence of the flakes that are not from the core suggests that the activities were more extensive than one core and four flakes might imply by themselves, but not much. Like Mid Ridge, the artifacts suggest one visit to the location during all of the thousands of years it could have been used.

The shovel test containing the artifacts showed two strata, stratum I (0-25 cm) consisting of olive yellow (2.5Y 6/6) sandy loam. All of the artifacts were in this stratum. Stratum II (25-40+ cm) consisted of yellowish brown loamy gravel with red mottles. It was very compact and probably near bedrock.

There appears to be no potential for intact deposits or other accumulations of artifacts associated with the site capable of yielding valuable information on prehistoric lifeways in the region. Though a interesting part of the landscape regime, the artifact densities are very low and spatially limited. Site 31AV81 does not appear to be eligible for the National Register of Historic Places and no further work is recommended.

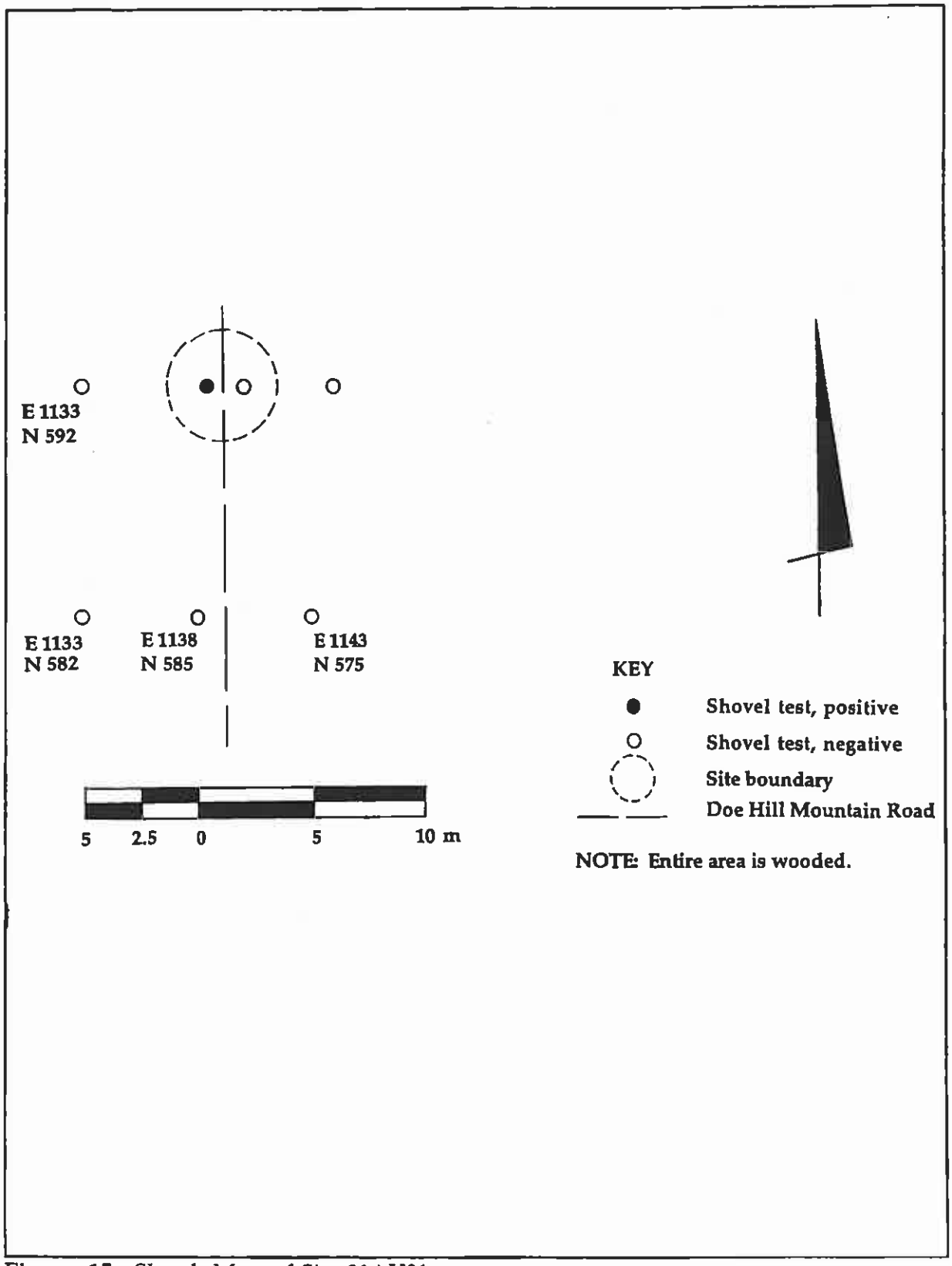


Figure 15. Sketch Map of Site 31AV81.

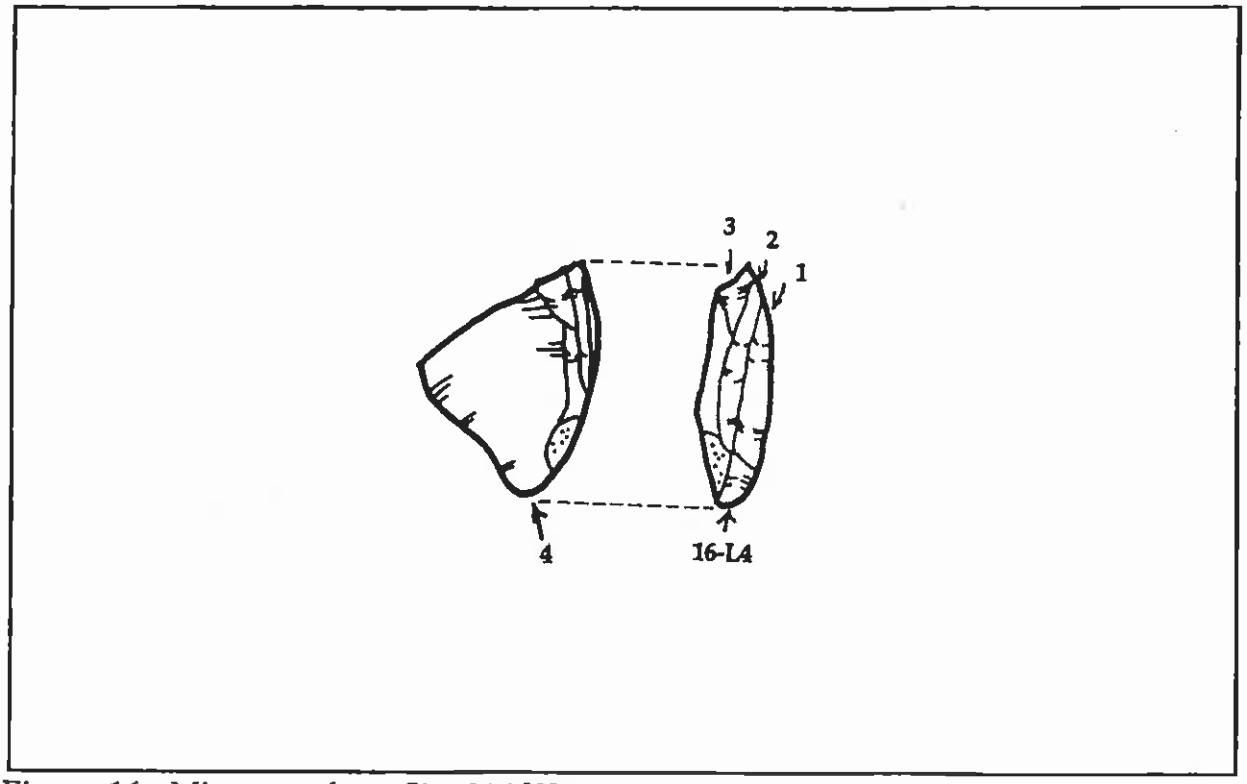


Figure 16. Microcore from Site 31AV81.

VI. SUMMARY AND RECOMMENDATIONS

SUMMARY

Phase I survey was conducted on the Arbuthnot property by Garrow & Associates, Inc. between November 21 and 23, 1994. Two prehistoric sites were examined on the property. Neither contained intact deposits. Two historic building sites were also found. Both appear to be too recent and disturbed to be of archaeological importance and neither contained important architectural remains.

Occupation during the historic period appears to be confined to this century. No prehistoric diagnostic artifacts were found. Circumstantial evidence and the use of quartz lithic materials may imply a Middle Holocene occupation. The occupation was extremely ephemeral and many amount to no more than a single hunting expedition in 10,000 years.

LANDSCAPE RECONSTRUCTION

The location of the historic sites can be explained by proximity to steep but arable land. The depth of the soil in the old field system is notable given the steepness of many of the parcels within the field system. That the field system was given attention cannot be doubted. On the upper terrace below the cliff face we noted many piles of field stones. It was perhaps worth mentioning that all of the field stones were piles around living trees. That suggests that the field was opened relatively recently, within the lifetime of medium sized trees (Figure 17). This suggests that the field was opened relatively late, during the early or middle part of this century, and abandoned soon thereafter. If the trees with field stones are taken as standing during the farming of the fields, then the field was not cleared during its use.

The prehistoric occupation of the property was even more ephemeral. During 10,000 years of human occupation we identified artifacts representing at the most a few hours of occupation. During that time the location of the sites suggests watching for herd animals to pass through the Brushy Creek watershed, perhaps on seasonal migrations to the high pastures of the Avery Plateau to the northeast. The presumed emphasis on quartz at high elevation during the Middle Holocene (Bass 1977) and the presumed drought at lower elevations during the same period due to Altithermal conditions are mutually suggestive however tenuous. Under such conditions herd animals would have sought elevated pastures during drier seasons and hunters would have been on the lookout. Taking the scarcity of artifacts as a cue, and since examination of the map suggests much broader and richer avenues to the same lands were available through Three Mile Creek on the other side of Doe

Hill Mountain, one might suppose that the hunters thought it was a good idea once, learned differently, and subsequently chose other hunting grounds.

Figure 17. View North on the Upper Terrace at the Avery County Landfill Project.

An alternative model might be constructed based on the idea that people tend to occupy elevated lands during times of scarcity. The moment of occupation might have come as the onset of Middle Holocene conditions cramped populations at lower altitudes. As regional populations achieved equilibrium with the new conditions, the marginal lands of Brushy Creek were no longer of interest.

RECOMMENDATIONS

Our investigations documented the presence of two historic and two prehistoric sites. None of them contain intact deposits or sufficient density of artifacts or features to significantly contribute to the understanding of regional cultural change or lifeways. None of the sites appear to be eligible for the National Register of Historic Places. No further archaeological work is recommended on the property.

REFERENCES CITED

Anderson, David G.
1990 The Paleoindian Colonization of Eastern North America: A View from the Southeastern United States. In *Research in Economic Anthropology*, edited by JAI Press Inc., pp. 163-216, Supplement 5. Greenwich, Connecticut.

Anderson, David G., Charles E. Cantley, and A. Lee Novick
1982 *The Mattassee Lake Sites: Archaeological Investigations Along the Lower Santee River in the Coastal Plain of South Carolina.* Archeological Services Branch, National Park Service, Special Publications. Atlanta.

Anderson, David G., and Glen T. Hanson
1985 The Early Archaic Occupation of the Savannah River Basin. Paper presented at the 42nd Annual Meeting of the Southeastern Archaeological Conference, Birmingham, Alabama.

Bass, Quentin R., III
1977 *Prehistoric Settlement and Subsistence Patterns in the Great Smoky Mountains.* Submitted to the National Park Service, Knoxville. University of Tennessee, Knoxville.

Blanton, Dennis B., Christopher Espenshade, and Paul E. Brockington, Jr.
1986 *An Archaeological Study of 38SU83: A Yadkin Phase Site in the Upper Coastal Plain of South Carolina.* Garrow & Associates, Inc., Atlanta. Submitted to South Carolina Department of Highways and Public Transportation, Columbia.

Boyd, C. Clifford, Jr.
1986 *Archaeological Investigations in the Watauga Reservoir, Carter and Johnson Counties, North Carolina.* Submitted to the Tennessee Valley Authority, Knoxville. University of Tennessee, Department of Anthropology, Knoxville.

Brackenridge, Robert G.
1980 Widespread Episodes of Stream Erosion During the Holocene and Their Climatic Causes. *Nature* 283:655-656.

Broyles, Bettye J.
1971 *Second Preliminary Report: the St. Albans Site, Kanawha County, West Virginia, 1964-1968.* Report of Archaeological Investigations 3. West Virginia Geological and Economic Survey, Morgantown.

Bryson, Reid A., David A. Baerreis, and W. M. Wendland
1970 The Character of the Late Glacial and Post Glacial Climatic Changes. In *Pleistocene and Recent Environments of the Central Great Plains*, edited by W. Dort, Jr. and J. K. Jones, Jr., pp. 53-74. University of Kansas Special Publications No. 3 Lawrence.

Caldwell, Joseph R.
1958 *Trend and Tradition in the Prehistory of the United States.* American Anthropological Association, Memoir 88.

Carbone, Victor A.
1974 The Paleo-Environment of the Shenandoah Valley. In *The Flint Run Paleo-Indian Complex: A Preliminary Report, 1971-1973 Seasons*, edited by William M. Gardner. Catholic University of America, Department of Anthropology Occasional Paper No. 1. Washington, D.C.

Cashion, Jerry C.
1970 *Fort Butler and the Cherokee Indian Removal from North Carolina.* Submitted to the North Carolina Department of Cultural Resources, Division of Archives and History, Raleigh.

Claggett, Stephen R. (editor)
1985 *Resource Planning Protection Process (RP3) Study for Rocky River and the South Yadkin River Basins (The South Yadkin RP3 Study Area) North Carolina.* U.S. Army Corps of Engineers, Wilmington District.

Claggett, Stephen R., and John S. Cable
1982 *The Haw River Sites: Archaeological Investigations at Two Stratified Sites in the North Carolina Piedmont.* Commonwealth Associates, Inc., Jackson, Michigan. Submitted to U.S. Army Corps of Engineers, Wilmington District.

Clausen, C. J., A. D. Cohen, Cesaire Emeliani, J. A. Holman, and Jerry J. Stipp
1979 Little Salt Spring Florida: A Unique Underwater Site. *Science* 203:609-614.

Cleland, Charles E.
1976 The Focal-Diffuse Model: An Evolutionary Perspective on the Prehistoric Cultural Adaptations of the Eastern United States. *Mid-Continental Journal of Archaeology* 1:59-76.

Coe, Joffre L.
1964 The Formative Cultures of the Carolina Piedmont. *Transactions of the American Philosophical Society* 54(5). Philadelphia.

Colquhoun, Donald J., and Mark J. Brooks
1986 New Evidence from the Southeastern U.S. for Eustatic Components in the Late Holocene Sea Levels. *Geoarchaeology* 1:275-291.

Cowan, C. Wesley
1985 Understanding the Evolution of Plant Husbandry in Eastern North America: Lessons from Botany, Ethnography, and Archaeology. In *Prehistoric Food Production in North America*, edited by Richard I. Ford, pp. 205-243. Museum of Anthropology, University of Michigan, Anthropological Papers 75. Ann Arbor.

Davis, R. P. Stephen, Jr.
1987 *Aboriginal Settlement Patterns in the Little Tennessee River Valley.* Tennessee Valley Authority, Publications in Anthropology No. 50.

1990 *Aboriginal Settlement Patterns in the Little Tennessee River Valley.* University of Tennessee Department of Anthropology Report of Investigations No. 50, Knoxville, and Tennessee Valley Authority Publications in Anthropology No. 54. Chattanooga.

Delcourt, Hazel R., and Paul A. Delcourt
1985 Quaternary Palynology and Vegetational History of the Southeastern United States. In *Pollen Records of Late-Quaternary North American Sediments*, edited by V. M. Bryant and R. G. Holloway, pp. 1-37. American Association of Stratigraphic Palynologists Foundation.

Delcourt, Paul A., and Hazel R. Delcourt
1983 Late Quaternary Vegetational Dynamics and Community Stability Reconsidered. *Quaternary Research* 19:265-271.

Delcourt, Paul A., Hazel R. Delcourt, Ronald C. Brister, and Laurence E. Lackey
1980 Quaternary Vegetation History of the Mississippi Embayment. *Quaternary Research* 13:111-132.

Dickens, Roy S.
1976 *Cherokee Prehistory: The Pisgah Phase in the Appalachian Summit Region.* University of Tennessee Press, Knoxville.

1986 An Evolutionary-Ecological Interpretation of Cherokee Cultural Development. In *The Conference on Cherokee Prehistory: The Archaeology of an Appalachian Culture*, assembled by David Moore, pp. 81-94. Warren Wilson College, Swannanoa, North Carolina.

Dorwin, John T.
1975 *Upper Hiwassee River Survey 1974-1975*. Archeology Laboratory, Western Carolina University, Cullowhee, North Carolina. Submitted to the North Carolina Department of Cultural Resources, Division of Archives and History, Raleigh.

Egloff, Brian J.
1967 *Analysis of Ceramics from Historic Cherokee Towns*. Unpublished Master's thesis, University of North Carolina, Department of Anthropology, Chapel Hill.

Epperson, D. L.
1971 *Weather and Climate in North Carolina*. Agricultural Extension Service, North Carolina State University.

Fenton, William N., and John Gulick (editors)
1961 *Symposium on Cherokee and Iroquois Culture*. Bureau of American Ethnology, Bulletin 180, Smithsonian Institution, Washington D.C.

Ferguson, Leland G.
1971 *South Appalachian Mississippian*. Ph.D. dissertation, Department of Anthropology, University of North Carolina, Chapel Hill. University Microfilms, Ann Arbor.

1975 Mississippian Artifacts and Geography. Paper presented at the Annual Meeting of the Southern Anthropological Society, Clearwater Beach, Florida.

Ford, Richard I.
1974 Northeastern Archaeology: Past and Future Directions. *Annual Review of Anthropology* 1:385-413.

1981 Gathering and Farming Before A.D. 1000: Patterns of Prehistoric Cultivation North of Mexico. *Journal of Ethnobiology* 1:6-27.

Gagliano, Sherwood M.
1977 *Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf*. Submitted to the Office of Archeology and Historic Preservation, National Park Service, Washington, D.C.

Gardner, William M.
1974 The Flint Run Complex: Pattern and Process During the Paleo-Indian to Early Archaic. In *The Flint Run Paleo-Indian Complex: A Preliminary Report, 1971-1973 Seasons*, edited by William M. Gardner, pp. 5-47. Catholic University of America, Department of Anthropology Occasional Paper No. 1.

1979 Paleo-Indian Settlement Patterns and Site Distribution in the Middle Atlantic. Ms. on file, Department of Anthropology, Catholic University.

1983 Stop Me if You've Heard This One Before: The Flint Run PaleoIndian Complex Revisited. *Archaeology of Eastern North America* 11:49-59.

Garrow, Patrick H., and Marvin T. Smith
1973 The King Site (9F1-5) Excavations, April 1971 through August 1973: Collected Papers, Rome, Georgia. Ms. on file, Garrow & Associates, Inc., Atlanta.

Gearing, Fred O.
1962 *Priests and Warriors: Social Structures for Cherokee Politics in the 18th Century*. American Anthropological Association Memoir 93.

Gilbert, William Harlen, Jr.
1943 *The Eastern Cherokees*. Bureau of American Ethnology, Bulletin 133, Smithsonian Institution, Washington, D.C.

Glassow, Michael
1977 Issues in Evaluating the Significance of Archaeological Resources. *American Antiquity* 42:413-420.

Goodyear, Albert C.
1982 The Chronological Position of the Dalton Horizon in the Southeastern United States. *American Antiquity* 47:382-395.

1991 The Early Holocene Occupation of the Southeastern United States: A Geoarchaeological Summary. In *Ice Age Peoples of North America*, edited by Robson Bonnichsen, G. Grison, and Karen Turnmire, Center for the Study of the First Americans, Orono.

Goodyear, Albert C., John House, and Neal Ackerly
1979 *Laurens-Anderson: An Archaeological Study of the Inter-riverine Piedmont*. Institute of Archaeology and Anthropology, University of South Carolina Studies 4.

Griffin, James B.
1967 Eastern North America Archaeology: A Summary. *Science* 156:175-191.

Gulick, John
1958 Language and Passive Resistance among the Eastern Cherokee. *Ethnohistory* 5(1):60-81.

Gunn, Joel D., and David O. Brown
1982 *Eagle Hill: A Late Quaternary Upland Site in Western Louisiana*. Center for Archaeological Research, The University of Texas at San Antonio, Special Report 12.

Gunn, Joel D., and Kathy J. Wilson
1992 *Phase I Archaeological Investigations of the Anson County Regional Landfill, Anson County, North Carolina.* Garrow & Associates, Inc., Raleigh. Submitted to Chambers Development Company, Smyrna, Georgia.

Gunn, Joel D., Lawrence E. Abbott, and Jean Hendrickson
1991a *The Richard Henderson Home: Archaeological Data Recovery at Satterwhite Point (31VN102), Vance County, North Carolina.* Brockington and Associates, Inc., Chapel Hill. Submitted to the U.S. Army Corps of Engineers, Wilmington District.

Gunn, Joel D., Marian D. Roberts, Barbara Lucas, Carol J. Poplin, and Eric C. Poplin
1991b *Historical and Archaeological Survey and Historic Properties Management Plan for the W. Kerr Scott Reservoir, Wilkes County, North Carolina.* Brockington and Associates, Inc., Atlanta. Submitted to the U.S. Army Corps of Engineers, Wilmington District.

Gunn, Joel D., and Daniel F. Cassedy
1993 *Comprehensive Archaeological Survey Proposal for the Northern Swannanoa Sanitary Sewer Interceptor Project, Metropolitan Sewerage District,Buncombe County, North Carolina.* Proposal submitted by Garrow & Associates, Inc., Raleigh.

Gunn, Joel D., and T. G. Lilly
1993 *Phase I Archaeological Investigations of the Brake Property and Sherlin Site (31CY44), Clay County, North Carolina.* Submitted to the Tennessee Valley Authority, Norris, Tennessee.

Hatcher, Robert D., and Steven A. Goldberg
1991 The Blue Ridge Geological Province. In *Geology of the Carolinas,* edited by Wright J. Horton and Victor A. Zullo, pp. 11-35. University of Tennessee Press, Knoxville.

Henry, V. Gary
1992 Long-Term Site Survey of Sandymush and Newfound Creeks, Buncombe and Madison Counties, North Carolina. Paper presented at the Upland Archaeological Conference, Appalachian State University, Boone.

Hoffman, Charles A.
1983 A Mammoth Kill Site in the Silver Springs Run. *Florida Anthropologist* 36:83-87.

Horton, Wright J., and Victor A. Zullo (editors)
1991 *The Geology of the Carolinas: Carolina Geological Society Fiftieth Anniversary Volume.* University of Tennessee Press, Knoxville.

Hudson, Charles M.
1986 Some Thoughts on the Early Social History of the Cherokees. In *The Conference on Cherokee Prehistory: The Archaeology of an Appalachian Culture*, assembled by David Moore, pp. 139-153. Warren Wilson College, Swannanoa, North Carolina.

1990 *The Juan Pardo Expeditions: Exploration of the Carolinas and Tennessee, 1566-1568*. Smithsonian Institution Press, Washington, D.C.

Jennings, Jesse D.
1975 *Prehistory of North America*. McGraw Hill, New York.

Keel, Bennie C.
1976 *Cherokee Archaeology: A Study of the Appalachian Summit*. University of Tennessee Press, Knoxville.

Keel, Bennie C., and Brian J. Egloff
1984 The Cane Creek Site, Mitchell County, North Carolina. *Southern Indian Studies* XXXIII:3-44.

Kurath, Gertrude P.
1961 Effects of Environment on Cherokee-Iroquois Ceremonialism, Music, and Dance. In *Symposium on Cherokee and Iroquois Culture*, edited by W. Fenton and J. Gulick, pp. 173-196.

Lewis, Thomas M. N., and Madeline Kneberg
1946 *Hiwassee Island: An Archeological Account of Four Tennessee Indian Peoples*. University of Tennessee Press, Knoxville.

Lounsbury, Floyd G.
1961 Iroquois-Cherokee Linguistic Relations. In *Symposium on Cherokee and Iroquois Culture*, edited by W. Fenton and J. Gulick, pp. 9-18.

Mathis, Mark
1979 General Settlement Models. In *North Carolina Statewide Archaeological Survey: Introduction and Application to Three Highway Projects in Hertford, Wilkes, and Ashe Counties, North Carolina*, assembled by Mark Mathis, pp. 24-37. North Carolina Archaeological Council.

McNett, Charles W., Barbara A. McMillan, and Sydney B. Marshall
1977 The Shawnee Minisink Site. In *Amerinds and Their Paleoenvironments in Northeastern North America*, edited by Walter S. Newman and Bert Salwen, pp. 282-296. Academic Press, New York.

Moore, David G. (assembler)
1986 *The Conference on Cherokee Prehistory*. Warren Wilson College, Swannanoa, North Carolina.

North Carolina Geological Survey
1985 Geological Map of North Carolina. North Carolina Geological Survey, Raleigh.

Oliver, Billy
1981 *The Piedmont Tradition: Refinement of the Savannah River Stemmed Point Type.* Unpublished Master's thesis, Department of Anthropology, University of North Carolina, Chapel Hill.

1985 *Tradition and Typology: Basic Elements of the Carolina Projectile Point Sequence,* edited by Roy S. Dickens and Trawick Ward, pp. 195-211. University of Alabama Press, Birmingham.

O'Steen, Lisa D.
1983 *Early Archaic Settlement Patterns in the Wallace Reservoir: An Inner Piedmont Perspective.* Unpublished Master's thesis, Department of Anthropology, University of Georgia, Athens.

Powell, Mary Lucas
1992 In the Best of Health? Disease and Trauma Among the Mississippian Elite. In *Lords of the Southeast: Social Inequality and the Native Elites of Southeastern North America,* edited by A. Barker and T. Pauketat, Archaeological Papers of the American Anthropological Association No. 3. Washington, D.C.

Powell, William S.
1989 *North Carolina: Through Four Centuries.* University of North Carolina Press, Chapel Hill.

Purrington, Burton L.
1983 Ancient Mountaineers: An Overview of Prehistoric Archaeology of North Carolina's Western Mountain Range. In *The Prehistory of North Carolina: An Archaeological Symposium,* edited by Mark A. Mathis and Jeffrey J. Crow, pp. 83-160. North Carolina Department of Cultural Resources, Division of Archives and History, Raleigh.

Riggs, Brett H.
1992 Removal Period Cherokee Households in Southwestern North Carolina. Paper presented at the Upland Archaeological Conference, Appalachian State University, Boone.

1993 Cherokee Households and Communities during the Removal Period in Western North Carolina. Paper presented at the Spring Conference of the North Carolina Archaeological Society, Appalachian State University, Boone.

Robinson, Kenneth W.

1989 *Archaeological Excavations Within the Alternate Pipeline Corridor Passing Through the Harsh Bottom Site (31CE41), Cherokee County, North Carolina.* Submitted to the Cherokee County Commissioners, Murphy, North Carolina.

1992 Two Connestee Phase Sites in Western North Carolina: The Harshaw Bottoms and Tyler-Laughridge Sites. Paper presented at the Upland Archaeological Conference, Appalachian State University, Boone.

Robinson, Kenneth W., Ruth Y. Wetmore, and David G. Moore

1994 Conestee Chronology and Culture: New Evidence from Western North Carolina. Paper presented at the 51st SEAC Conference, Lexington, Kentucky.

Schroedl, Gerald F.

1986 Toward an Explanation of Cherokee Origins in East Tennessee. In *The Conference on Cherokee Prehistory: The Archaeology of an Appalachian Culture*, assembled by David Moore, pp. 122-138. Warren Wilson College, Swannanoa, North Carolina.

Senior, Christopher

1982 *A Preliminary Analysis of Pisgah Phase Ceramics from the Ward Wilson Site, Northwestern North Carolina.* Unpublished Master's thesis, Department of Anthropology, The Catholic University of America, Washington, D.C.

Setzler, Frank M., and Jesse D. Jennings

1941 *Peachtree Mound and Village Site, Cherokee County, North Carolina.* Smithsonian Institution, Bureau of American Ethnology, Bulletin 131. U.S. Government Printing Office, Washington, D.C.

Simmons, Joe, and Carl Steen

1987 *South Carolina Highway 52 Survey: Black and Santee River Crossings, Williamsburg and Berkeley Counties.* South Carolina Institute of Archeology and Anthropology, Underwater Antiquities Management Program. Submitted to South Carolina Department of Highways and Public Transportation, Columbia.

Smith, Bruce D.

1989 Origins of Agriculture in Eastern North America. *Science* 246:1566-1571.

Smith, Marvin T., and David J. Hally
1992 Chiefly Behavior: Evidence from Sixteenth Century Spanish Accounts. In *Lords of the Southeast: Social Inequality and the Native Elites of Southeastern North America*, edited by A. Barker and T. Pauketat. Archaeological Papers of the American Anthropological Association, Number 3.

Stahle, David W., John G. Hehr, and Malcolm K. Cleaveland
1991 Baldcypress Dendroclimatology in the Southeastern United States. Proposal submitted to the National Science Foundation, Washington, D.C.

Sullivan, Lynn P.
1987 The Mouse Creek Phase Household. In *Southeastern Archaeology* 6(1):16-29.

Swanton, John R.
1946 *Indians of the Southeastern United States.* Bureau of American Ethnology, Bulletin 137. Smithsonian Institution, Washington, D.C.

Trinkley, Michael
1990 *An Archaeological Context for the South Carolina Woodland Period.* Chicora Foundation Research Series 22. Columbia.

United States Geological Survey (USGS)
1956 Linville Falls, North Carolina quadrangle map, 7.5 minute series. U.S. Geological Survey, Reston, Virginia.

Ward, H. Trawick
1983 A Review of Archaeology in the North Carolina Piedmont: A Study of Change. In *The Prehistory of North Carolina: An Archaeological Symposium*, edited by M. Mathis and J. Crow, pp. 53-81. North Carolina Division of Archives and History, Raleigh.

Watts, W. A.
1975 *Vegetation Record for the Past 20,000 Years from a Small Marsh on Lookout Mountain, Northwestern Georgia.* Geologic Society of America Bulletin 86.
1980 Late-Quaternary Vegetation History at White Pond on the Inner Coastal Plain of South Carolina. *Quaternary Research* 13:187-199.

Wauchope, Robert
1966 *Archaeological Survey of Northern Georgia.* Memoirs of the Society for American Archaeology, No. 21. Salt Lake City.

Webb, S. David, Jerald T. Milanich, Roger Alexon, and James S. Dunbar
1984 A *Bison Antiquus* Kill Site, Wacissa River, Jefferson County, Florida. *American Antiquity* 49(2):384-392.

Wharton, Charles H.
1977 *The Natural Environments of Georgia.* Georgia Department of Natural Resources, Office of Planning and Research, Resource Planning Section, Atlanta.

White, John. W.
1982 *An Integration of Late Archaic Settlement of the South Carolina Piedmont.* Unpublished Master's thesis, Department of Anthropology, University of Arkansas, Fayetteville.

Whitehead, Donald R.
1973 Late-Wisconsin Vegetation Changes in Unglaciated North America. *Quaternary Research* 3:621-631.

Wobst, Martin
1974 Boundary Conditions for Paleolithic Social Systems: A Simulation Approach. *American Antiquity* 39:147-178.

Yarnell, Richard A., and M. Jean Black
1985 Temporal Trends Indicated by a Survey of Archaic and Woodland Plant Food Remains from Southeastern North America. *Southeastern Archaeology* 4(2):93-102.

APPENDICES

AVERY CO. C&D LANDFILL AND TRANSFER STATION

Site #	Site Name*	Exca-vator	Bag #	Project Grid Provenience East	North	Test /Surf.	Quan-tity	Contents
31AV78**	Trailer	JG	11	1060	60	STP	1	1 glass, crazed
31AV78**	Trailer	MJ	12	1060	90	STP	1	1 flake
31AV78**	Trailer	JG	13	1090	60	STP	1	1 glass, octagonal bottle, 20 c.
31AV79**	CH	MJ	20	818	267	STP 1	1	1 hist. cer. whiteware 19/20th c.
31AV79**	CH	MJ	21	818	269	STP 2	7	6 glass, 1 pitcher handle
31AV79**	CH	MJ	22	813	270	STP 3	3	1 glass, 2 wire nails
31AV79**	CH	JG	23	819	270	STP 6	1	1 wire nail
31AV79**	CH	MJ	24	820	270	Surf.	1	1 milk glass from zinc lid liner 19/20 c.
31AV79**	CH	MJ	25	820	270	Surf.	3	2 bottle, 1 radio part
31AV80	MRS	JG	4	970	100	Surf.	5	4 flakes (1 rhy.), 1 bifacial chopper
31AV80	MRS	JG	5	1010	100	Surf.	8	5 flakes (1 rhy.), 3 cores
31AV80	MRS	JG	6	1000	100	Surf.	20	1 core, 3 microcores, 16 flakes
31AV80	MRS	JG	7	1020	120	Surf.	4	4 flakes
31AV80	MRS	JG	8	1000	130	Surf.	1	1 worked stone
31AV80	MRS	JG	18	1000	120	Surf.	1	1 flake
31AV81	DHMRS	JG	16	1140	599	STP	6	4 flakes, 1 microcore, 1 bifacial tool
						Total	64	

*NOTE: CH = Cottontail House Site
MRS = Mid Ridge Site
DHMRS = Doe Hill Mtn. Road Site

APPENDIX 1: ARTIFACT INVENTORY

APPENDIX 2: RESUME OF PRINCIPAL INVESTIGATOR

JOEL GUNN

Education

1974, Ph.D., Anthropology, University of Pittsburgh.

1971, M.A., Anthropology, University of Kansas.

1968, B.A., History, University of Kansas.

Certifications

1993 Society of Professional Archaeologists

Areas of Specialization

Archaeology: Lithic analysis, Settlement Patterns, Numerical Analysis, Data Management. Climatology: Global-Regional Climatic Impacts, Tree rings, Hydrology, Social Impacts.

Summary of Experience

Dr. Gunn is a well respected professional archaeologist with 20 years experience in the field. His background includes teaching at major universities, pure research, and archaeological contracting, and his field experience has been gained on archaeological sites in the Middle Atlantic and Southeast. He has most recently conducted projects in North and South Carolina, Virginia, and Texas.

Formerly a professor at the University of Texas at San Antonio, Dr. Gunn has pursued contract archaeology in the private sector since 1989. He has been a Senior Archaeologist for Garrow & Associates for the last three years. He has directed projects throughout the Southeast, including studies in Richmond, Clarke County, and Henry County in Virginia.

Dr. Gunn's areas of emphasis are lithic analysis and global climate change as it effects regional prehistoric ecology, land use patterns, and technology. He has published numerous books, articles, chapters, and reports on lithic analysis and climate modeling.

CAROLINA
ECOSYSTEMS, INC.

8208 Brian Ct.; Garner, NC 27529
P:919-606-1065 – F:919-341-4474

March 17, 2008

Stacey Smith, P.E.
Richardson, Smith, Gardner & Associates, Inc.
14 North Boylan Avenue
Raleigh, NC 27603

RE: Protected Species Evaluation
Avery County Landfill
Newland, North Carolina

Dear Stacey,

As requested Carolina Ecosystems, Inc. (CEI) investigated the above referenced site for occurrences of, and potential habitat for, species listed by the US Fish and Wildlife Service (USFWS) as protected under the Endangered Species Act (ESA). This study was performed to identify any potential for the proposed expansion of the Avery County Landfill, and any future work within its proposed facility boundary, to cause harm to or jeopardize any of the species under the jurisdiction of the ESA. In addition, the results of this study are intended to document compliance with the ESA for permit submittals to the NC Division of Waste Management, NC Division of Water Quality, and US Army Corps of Engineers.

The ESA protects certain species of plants and animals that have declining populations or habitat and potentially could go extinct without protection and recovery programs. These species are listed by the USFWS by county and are updated periodically. In addition, the N.C. Natural Heritage Program (NCNHP) maintains a database of the location and status of occurrences of rare plants, animals, and natural communities within the State. An evaluation of the Avery County Landfill property (Site) for the potential occurrence of these species is included below, along with a biological conclusion on the likelihood of the species being affected by the proposed expansion.

Methods

The USFWS listed species for Avery County were checked to determine historical and current occurrences of federally-listed species within Avery County (01/31/08 Update). In addition, the NCNHP element occurrence database was checked to confirm locations of federally-listed species within a 1-mile radius of the Site. The species listed by USFWS for Avery County are presented in Table 1, while the database occurrences recorded by NCNHP are shown in Figure 2. The species descriptions, habitats, and occurrence history of each of the federally listed species was reviewed prior to performing field surveys. Base maps of the Site were prepared showing

available information including topography, color infra-red aerial photography, and color aerial photography. Analysis of this information was performed to determine preliminary natural community boundaries for further study.

The Site was reviewed by experienced biologists to determine if potential habitat for the listed species is present. The Site was traversed and the natural communities identified on the base mapping was field verified and adjusted. If a natural community provided potential habitat, additional surveys for those species occurring within the habitat type were performed. The Site was reviewed on April 9 2007, September 24-25 2007, November 20 2007, and March 12 2008.

Table 1
Federally Protected Species in Avery County, NC

Common Name	Scientific Name	Federal Status*	Habitat Present?	Biological Conclusion
Bog turtle	*Clemmys muhlenbergii*	T(S/A)	No	No Effect
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*	E	No	No effect
Virginia big-eared bat	*Corynorhinus townsendii virginianus*	E	No	No effect
Spruce-fir moss spider	*Microhexura montivaga*	E	No	No effect
Blue Ridge goldenrod	*Solidago spithamaea*	T	No	No effect
Heller's blazing star	*Liatris helleri*	T	No	No effect
Roan mountain bluet	*Hedyotis purpurea* var. *montana*	E	No	No effect
Spreading avens	*Geum radiatum*	E	No	No effect
Rock gnome lichen	*Gymnoderma lineare*	E	No	No effect

*E = Endangered; T = Threatened; T(S/A) = Threatened due to similarity of appearance

Natural Communities

The Avery County landfill is located in southeast Avery County, slightly over 1-mile from the McDowell County line. The Site is situated in the Blue Ridge Mountain Physiographic Region, and is within the Catawba Basin watershed. Topography on the Site is quite steep and typical of low-mountain areas, ranging from 2,855 to 3,325 feet above sea level.

The Site consists of an active transfer station facility, a construction and demolition landfill, cleared or disturbed areas, and forested areas as shown on Figure 3. Several natural communities exist within the boundaries of the Site, however all the communities show strong evidence of past human alteration including timber activity. Each community type encountered is described briefly below, along with its dominant plant species.

Hardwood Forest (Photos 1 & 2)

Much of the northern portion of the Site consists of hardwood forest along the steeper slopes of the ridge above the Site. This community consists primarily of American beech (*Fagus grandifolia*), tulip poplar (*Liriodendron tulipifera*), oaks (*Quercus sp.*), pignut hickory (*Carya glabra*), yellow birch (*Betula lutea*), and scattered young white pines (*Pinus strobus*). Most of this community consists of young forest growth including stands of saplings and areas of larger trees up to 14 inches diameter. No stands of mature hardwood forest are present on the Site. The understory varies from relatively sparse areas to dense thickets of rhododendron (*Rhododendron catawbiense*) and some mountain laurel (*Kalmia latifolia*), as described below.

Mixed Pine-Hardwood Forest (Photos 3 & 4)

This community comprises most of the Site, and includes many of the species listed in the Hardwood Forest above. The white pines in this area are more mature and make up a larger portion of the canopy species than in the hardwood forest areas. This community shows strong evidence of historical disturbance from logging activities, including old road beds and ruts.

Pine Stands (Photo 5)

This community is comprised almost entirely of white pine, with a understory of hardwood saplings that is usually quite sparse. It is located on a ridge slope northwest of the existing landfill and transfer station.

Rhododendron Thicket (Photo 6)

Although rhododendrons occur throughout the Site in the understory, especially in the hardwood forest and along the drainages, this area is comprised almost entirely of one species and is larger than the other stands. The stand is located on the northwest corner of the Site, but a large portion of the community is located off-site. Little other vegetation is growing in the understory due to the heavy shading effects of the rhododendron.

Protected Species Evaluation

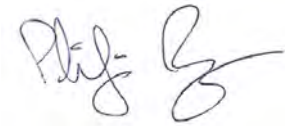
Of the species listed by the USFWS for Avery County, the majority occur in high elevation mountain communities including balds, rocky summits and outcrops, or spruce-fir forests. The Site is not located within a high elevation area, and none of the natural communities present on the Site provide potential habitat for the listed species. The only species in Table 1 that occurs at the lower elevations typical of the Site is the bog turtle. No occurrences of this species are recorded within 1-mile of the Site, however two bog turtle occurrences are recorded just beyond this radius (Figure 2). The occurrences are in typical bog turtle habitats, such as bogs or wet meadows and thickets. These habitats are not present on the Site. In addition, the bog turtle is listed due to similarity of appearance to the northern bog turtle. Land management activities that may affect this species are not subject to consultation with USFWS for this species.

Due to the lack of potential habitat for the species listed in Table 1, no further surveys of the property are recommended at this time. No consultation under Section 7 of the ESA is required with the USFWS for the C&D landfill expansion. Pending permit applications, including the Clean Water Act Section 404/401 permit, will provide opportunity for the USFWS and NCWRC to comment on the project and concur with this finding.

This evaluation is based on the current USFWS list of species with potential to occur in Avery County. There are an additional thirty species listed as Federal Species of Concern. These species are not provided protection under the ESA, but have potential to be upgraded to "candidate" or protected species if their status declines. Prior to any future project development on the Site, not including the current C&D landfill expansion, the listed species should be checked and if necessary this evaluation should be updated.

Please contact us at your earliest convenience if you have any questions or concerns related to this evaluation. We appreciate the opportunity to be of service to Avery County and Richardson, Smith, Gardner and Associates, Inc.

Sincerely,
Carolina Ecosystems, Inc.



Phil May
Senior Environmental Scientist

cc: Buddy Fowler, Avery County
Joan Smyth, P.G. Richardson, Smith, Gardner & Associates, Inc.

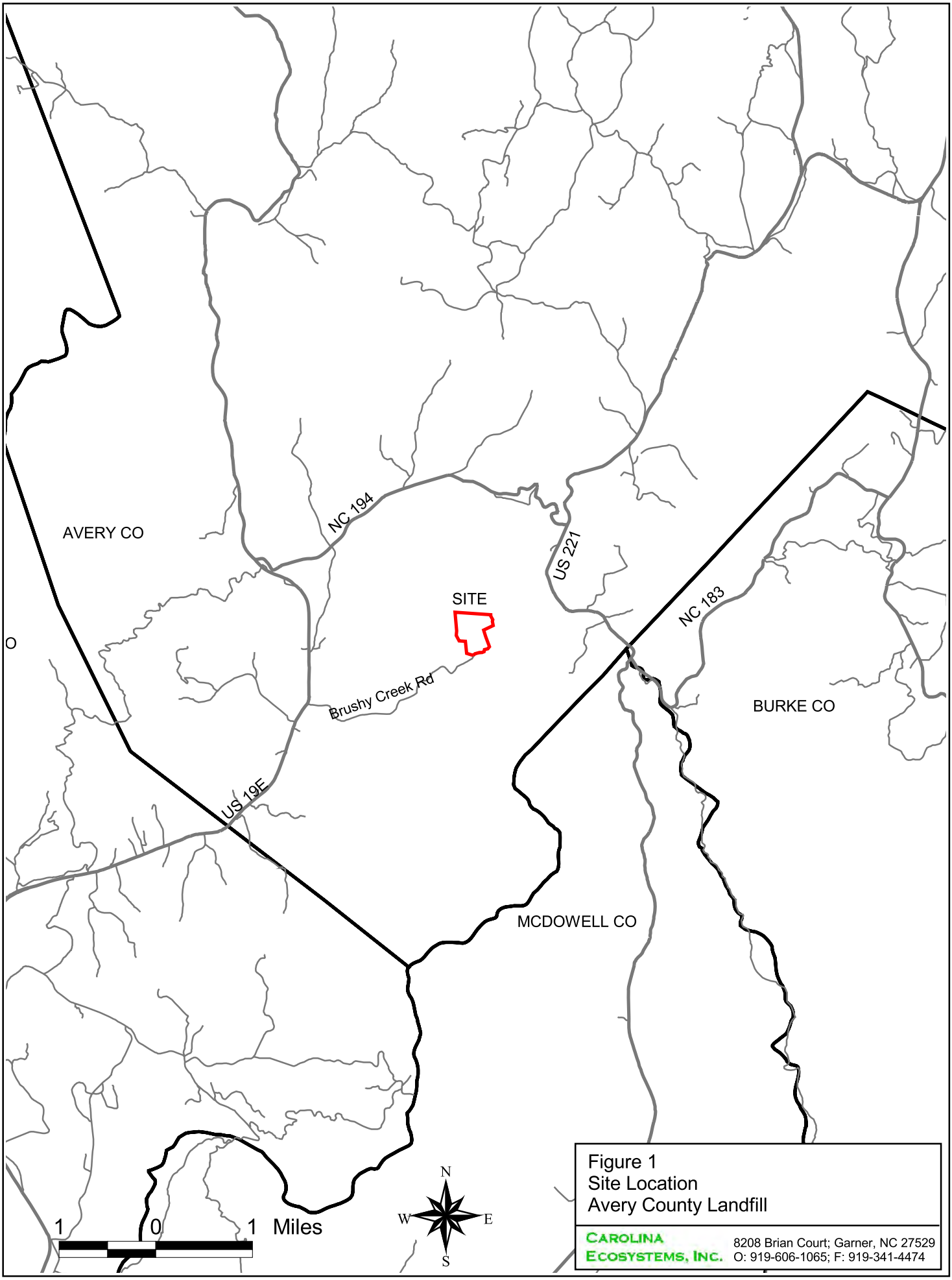


Figure 1
Site Location
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474

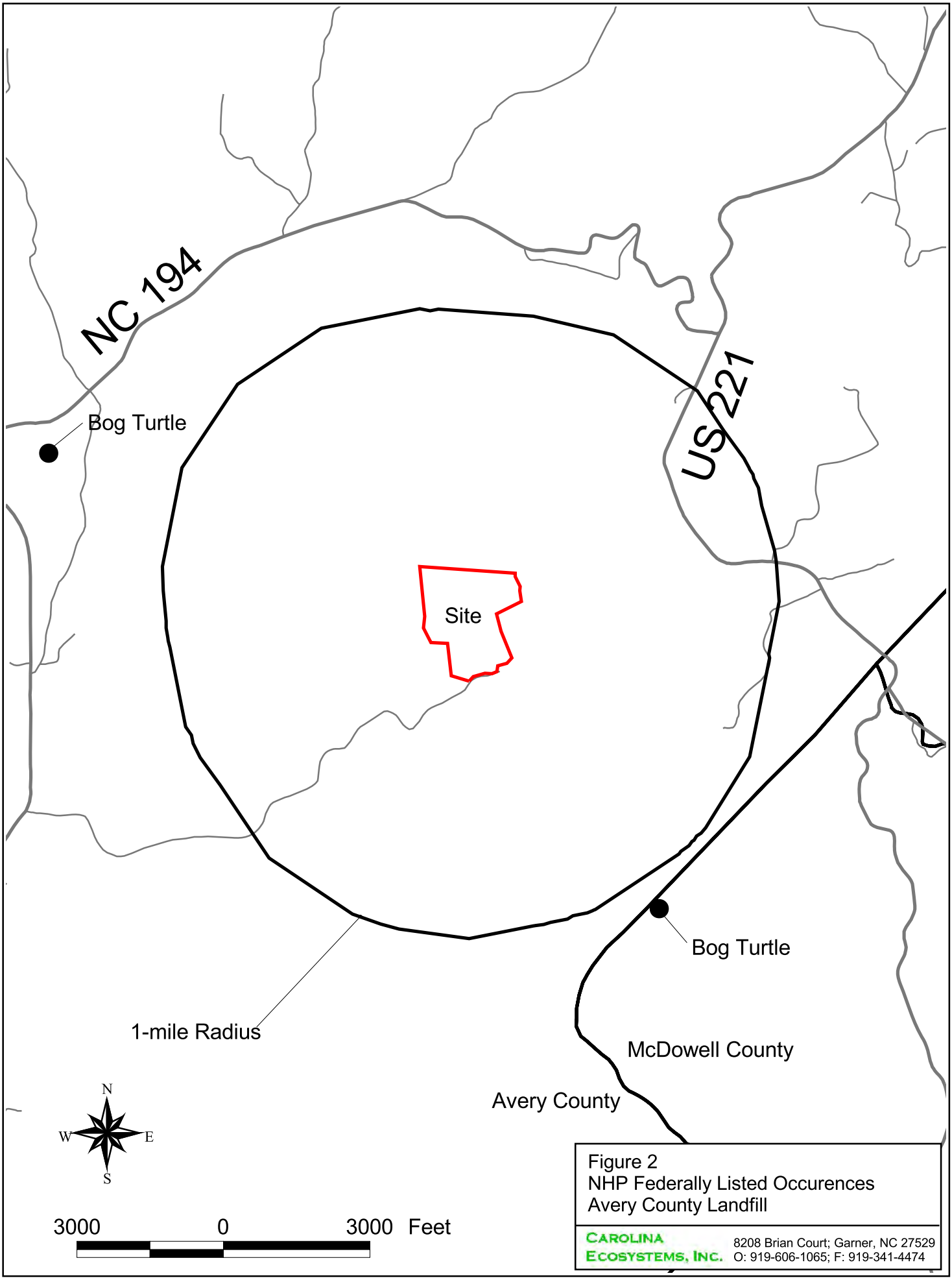


Figure 2
NHP Federally Listed Occurences
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474

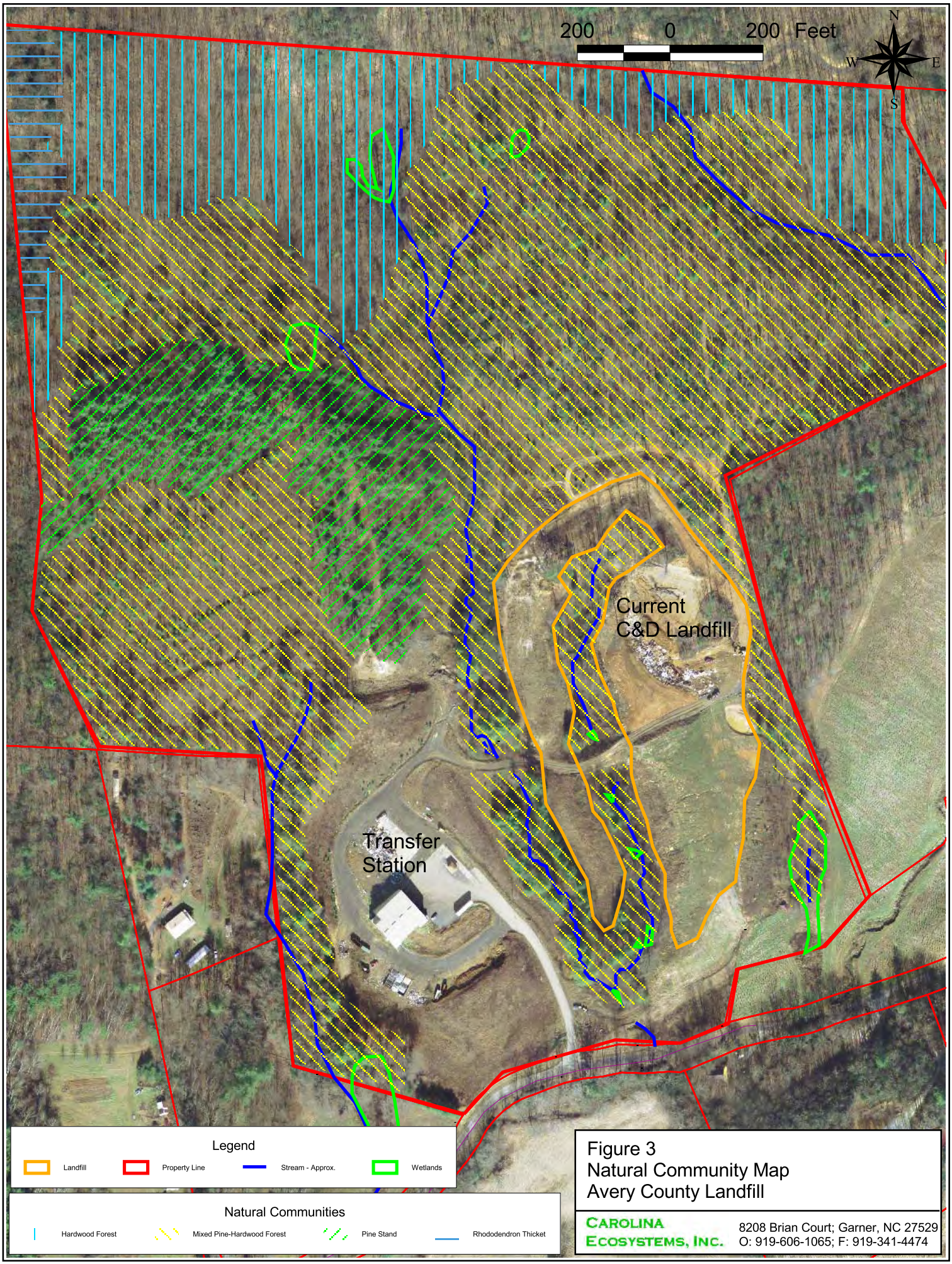


Figure 3
Natural Community Map
Avery County Landfill

CAROLINA ECOSYSTEMS, INC.
8208 Brian Court; Garner, NC 27529
O: 919-606-1065; F: 919-341-4474

Photo 1: Hardwood forest along slopes on the northern portion of the Site.

Photo 2: Hardwood forest – detailed view.

Photo 3: Mixed pine-hardwood forest between the landfill cells.

Photo 4: Mixed pine-hardwood forest along northwestern slopes of the Site.

Photo 5: Portion of pine stand west of the current landfill area.

Photo 6: Rhododendron thicket in northwest corner of the Site.

ATTACHMENT 8

Stormwater Management Plan

Stormwater Management Plan

Avery County C&D Landfill
Ingalls, North Carolina
NC Solid Waste Permit No. 06-03

Prepared For:

Avery County
175 Linville Street
Newland, North Carolina 28657

September 2008

RICHARDSON SMITH GARDNER
& ASSOCIATES
ENGINEERING & GEOLOGICAL
SERVICES

PRINTED ON 100% RECYCLED PAPER

Financial Responsibility Form

FINANCIAL RESPONSIBILITY/OWNERSHIP FORM
SEDIMENTATION POLLUTION CONTROL ACT

No person may initiate any land-disturbing activity on one or more acres as covered by the Act before this form and an acceptable erosion and sedimentation control plan have been completed and approved by the Land Quality Section, N.C. Department of Environment and Natural Resources. (Please type or print and, if the question is not applicable or the e-mail and/or fax information unavailable, place N/A in the blank.)

Part A.

1. Project Name: Avery County C&D Landfill – Stormwater Management Plan - Modification

2. Location of land-disturbing activity: County: Avery City or Township : Toe River Township

   Highway/Street Brushy Creek Road Latitude N35° 57' 42.93" Longitude W 81° 58' 18.88"

3. Approximate date land-disturbing activity will commence: April 2009

4. Purpose of development (residential, commercial, industrial, institutional, etc.): Commercial

5. Total acreage disturbed or uncovered (including off-site borrow and waste areas): 22 ac.total (15 ac. additional)

6. Amount of fee enclosed: $975_____. The application fee of $65.00 per acre (rounded up to the next acre) is assessed without a ceiling amount (Example: a 9-acre application fee is $585).

7. Has an erosion and sediment control plan been filed? Yes_____ No_____ Enclosed__X__

8. Person to contact should erosion and sediment control issues arise during land-disturbing activity:

   Name Buddy Norris E-mail Address buddy.norris@ncmail.net

   Telephone 828-737-5420 Cell # _____ Fax # _____

9. Landowner(s) of Record (attach accompanied page to list additional owners):

   Avery County (Name) 828-737-5420 (Telephone) 828-733-8209 (Fax Number)

   P O Box 640 (Current Mailing Address) 175 Linville Street (Current Street Address)

   Newland (City) NC (State) 28657 (Zip) Newland (City) NC (State) 28657 (Zip)

10. Deed Book No. 266 Page No. 646 Provide a copy of the most current deed.

Part B.

1. Person(s) or firm(s) who are financially responsible for the land-disturbing activity (Provide a comprehensive list of all responsible parties on an attached sheet):

   Avery County (Name) buddy.norris@ncmail.net (E-mail Address)

   P O Box 640 (Current Mailing Address) 175 Linville Street (Current Street Address)

   Newland (City) NC (State) 28657 (Zip) Newland (City) NC (State) 28657 (Zip)

   Telephone 828-737-5420 Fax Number 828-733-8209

2. (a) If the Financially Responsible Party is not a resident of North Carolina, give name and street address of the designated North Carolina Agent:

Name _____ E-mail Address _____

Current Mailing Address _____ Current Street Address _____

City _____ State _____ Zip _____ City _____ State _____ Zip _____

Telephone _____ Fax Number _____

(b) If the Financially Responsible Party is a Partnership or other person engaging in business under an assumed name, **attach a copy of the Certificate of Assumed Name.** If the Financially Responsible Party is a Corporation, give name and street address of the Registered Agent:

Name of Registered Agent _____ E-mail Address _____

Current Mailing Address _____ Current Street Address _____

City _____ State _____ Zip _____ City _____ State _____ Zip _____

Telephone _____ Fax Number _____

The above information is true and correct to the best of my knowledge and belief and was provided by me under oath (This form must be signed by the Financially Responsible Person if an individual or his attorney-in-fact, or if not an individual, by an officer, director, partner, or registered agent with the authority to execute instruments for the Financially Responsible Person). I agree to provide corrected information should there be any change in the information provided herein.

Henry C. Norris, Jr. — Type or print name

Solid Waste Director — Title or Authority

Signature

19 SEPT 2008 — Date

I, Sondra S. Austin, a Notary Public of the County of Avery State of North Carolina, hereby certify that Henry C. Norris, Jr. appeared personally before me this day and being duly sworn acknowledged that the above form was executed by him.

Witness my hand and notarial seal, this 19 day of September, 2008

SONDRA S. AUSTIN NOTARY PUBLIC AVERY COUNTY, NC

Seal

Sondra S. Austin

Notary

My commission expires May 22, 2010

Deed

BK | PG
2660646

FILED #

95 JAN 20 PM 3:16

TAMI J. BAKER
REGISTER OF DEEDS
AVERY COUNTY, N.C.

AVERY
16

01-20-95

$370.00

STATE OF NORTH CAROLINA

Real Estate
Excise Tax

Excise Tax 370.00

Recording Time, Book and Page

Tax Lot No. ..... Parcel Identifier No. .....

Verified by ..... County on the ..... day of ....., 19.....

by .....

NO Recording fee due to being County Work - Nancy Cook

Mail after recording to William B. Cocke, Jr., P.O. Box 606, Newland, NC 28657

This instrument was prepared by William B. Cocke, Jr., Attorney at Law

Brief description for the Index 78.115 acres, Toe River Tsp.

NORTH CAROLINA GENERAL WARRANTY DEED

THIS DEED made this 20th day of January, 19 95, by and between

GRANTOR	GRANTEE
ALLAN ARBUTHNOT and wife, MARIE W. ARBUTHNOT	AVERY COUNTY, NORTH CAROLINA

Enter in appropriate block for each party: name, address, and, if appropriate, character of entity, e.g. corporation or partnership.

The designation Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine or neuter as required by context.

WITNESSETH, that the Grantor, for a valuable consideration paid by the Grantee, the receipt of which is hereby acknowledged, has and by these presents does grant, bargain, sell and convey unto the Grantee in fee simple, all that certain lot or parcel of land situated in the City of ....., Toe River Township, Avery County, North Carolina and more particularly described as follows:

See attached Schedule A incorporated herein by reference

Property Transfer Code Number
Date 1-30-95 By CG

Taxes Paid Through
1994
By MMS Date 11/20/95

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Printed by agreement with the N. C. Bar Assoc. — 1991

2660648

Schedule A

Warranty Deed from Allan Arbuthnot and wife, Marie W. Arbuthnot, to Avery County, North Carolina, dated January 20, 1995.

BEGINNING at a 38-inch chestnut oak at a fence corner in the Radcliff Estate line and running thence with the fence and the Radcliff Estate line the following courses and distances: South 64°35'40" West 573.94 feet to a fence post, South 12°06'40" East 375.32 feet to a 12-inch black gum, South 18°10'50" East 568.98 feet to a fence post, South 45°04'30" West 143.35 feet to a fence post, South 78°34'50" West 185.43 feet to an iron stake, and South 13°24'30" West 131.78 feet to a fence post on the north side of Brushy Creek Road (NCSR 1101); thence leaving the Radcliff Estate line and running with the north side of Brushy Creek Road the following courses and distances: South 64°33'40" West 104.40 feet, South 83°35'40" West 64.40 feet, South 89°00'10" West 169.77 feet, South 72°45'40" West 119.67 feet, South 63°53'20" West 71.48 feet, and South 39°08'00" West 72.72 feet to an iron found, corner of Roger Wise; thence leaving the north side of Brushy Creek Road and running with the Roger Wise line and a fence North 70°46'50" West 342.41 feet to an iron set, North 08°01'50" West 696.52 feet to an iron set, and North 85°50'30" West 345.15 feet to a 10-inch sourwood, corner of Uninin Corporation; thence leaving the Roger Wise line and running with the Uninin Corporation line and the fence North 23°22'50" West 334.16 feet to an 8-inch maple, North 08°35'50" East 242.08 feet to a triple maple, and North 02°56'30" West 1,024.41 feet to an iron set in the Radcliff Estate line; thence leaving the Uninin Corporation line and running with the Radcliff Estate line South 83°31'00" East 974.67 feet to a fence post and South 83°57'50" East 982.21 feet to an oak stump on the east side of a branch; thence with said branch and continuing with the Radcliff Estate line the following courses and distances: South 05°19'20" West 72.09 feet, South 23°17'00" East 214.78 feet, South 51°29'20" East 20.64 feet, South 12°55'30" West 84.42 feet, South 02°04'50" East 37.67 feet and South 07°31'30" East 183.99 feet to the point of beginning. Being two tracts containing 41.50 acres and 36.615 acres, respectively, containing in the aggregate 78.115 acres, as shown on a map of survey prepared by William E. Arrowood, RLS L-1510, dated August 12, 1988.

This conveyance is made subject to the following reservations:

1. Grantor shall have the right to remove the following, provided that the same are removed on or prior to January 20, 1996, to-wit: the two barns measuring 10 feet x 20 feet and 17 feet x 22 feet;

2. Grantor shall have the right to remove the following, provided that the same are removed on or prior to March 31, 1995, to-wit: all hemlock seedlings, boxwood shrubbery, and a total of 30 trees;

on or prior to March 31, 1995 and continue to use telephone and power services through and including March 31, 1995.

26606 7

The property hereinabove described was acquired by Grantor by instrument recorded in Book 194, Page 882

A map showing the above described property is recorded in Plat Book ..... page .....

TO HAVE AND TO HOLD the aforesaid lot or parcel of land and all privileges and appurtenances thereto belonging to the Grantee in fee simple.

And the Grantor covenants with the Grantee, that Grantor is seized of the premises in fee simple, has the right to convey the same in fee simple, that title is marketable and free and clear of all encumbrances, and that Grantor will warrant and defend the title against the lawful claims of all persons whomsoever except for the exceptions hereinafter stated. Title to the property hereinabove described is subject to the following exceptions:

1. Reservations set forth hereinabove.
2. Road right-of-way along Brushy Creek Road (NCSR 1101).

IN WITNESS WHEREOF, the Grantor has hereunto set his hand and seal, or if corporate, has caused this instrument to be signed in its corporate name by its duly authorized officers and its seal to be hereunto affixed by authority of its Board of Directors, the day and year first above written.

..... (Corporate Name)

By: .....

..... President

ATTEST:

.....

..... Secretary (Corporate Seal)

USE BLACK INK ONLY

Allan Arbuthnot (SEAL)
Allan Arbuthnot

Marie W. Arbuthnot (SEAL)
Marie W. Arbuthnot

..... (SEAL)

..... (SEAL)

SEAL-STAMP

R. KATHRYN HUTCHESON NOTARY PUBLIC AVERY COUNTY, N.C.

NORTH CAROLINA, Avery County.

I, a Notary Public of the County and State aforesaid, certify that Allan Arbuthnot and wife, Marie W. Arbuthnot Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this 20th day of January, 1995

My commission expires: August 21, 1998 R. Kathryn Hutcheson Notary Public

SEAL-STAMP

NORTH CAROLINA, ... County.

I, a Notary Public of the County and State aforesaid, certify that .....

personally came before me this day and acknowledged that ..... he is ..... Secretary of

Use Black

_____ a North Carolina corporation, and that by authority duly given and as the act of the corporation, the foregoing instrument was signed in its name by its _____ President, sealed with its corporate seal and attested by _____ as its _____ Secretary.

Witness my hand and official stamp or seal, this _____ day of _____, 19____

My commission expires _____ _____ Notary Public

The foregoing Certificate(s) of R. Kathryn Hutcheson - NP

is/are certified to be correct. This instrument and this certificate are duly registered at the date and time and in the Book and Page shown on the first page hereof.

Tamela T. Baker REGISTER OF DEEDS FOR Avery COUNTY

By Rhonda Hollifield Deputy/Assistant - Register of Deeds

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Erosion and Sedimentation Control Plan
Preliminary Review Checklist

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES
LAND QUALITY SECTION

EROSION and SEDIMENTATION CONTROL PLAN PRELIMINARY REVIEW CHECKLIST

The following items shall be incorporated with respect to specific site conditions, in an erosion & sediment control plan:

LOCATION INFORMATION

- x Project location (roads, streets, landmarks)
- x North arrow and scale

GENERAL SITE FEATURES (Plan elements)

- x Legend: North arrow, scale, etc.
- x Property lines
- x Existing contours (topographic lines)
- x Proposed contours
- x Limits of disturbed area (provide acreage total, delineate limits, and label)
- x Planned and existing building locations and elevations
- x Planned & existing road locations & elevations
- x Lot and/or building numbers
- x Geologic features: rock outcrops, seeps, springs, wetland and their limits, streams, lakes, ponds, dams, etc.
- x Easements and drainage ways
- x Profiles of streets, utilities, ditch lines, etc.
- NA Stockpiled topsoil or subsoil locations
- NA If the same person conducts the land-disturbing activity & any related borrow or waste activity, the related borrow or waste activity shall constitute part of the land-disturbing activity unless the borrow or waste activity is regulated under the Mining Act of 1971, or is a landfill regulated by the Division of Waste Management. If the land-disturbing activity and any related borrow or waste activity are not conducted by the same person, they shall be considered separate land-disturbing activities and must be permitted either thru the Sedimentation Pollution Control Act as a **one-use borrow site** or through the Mining Act.
- NA Required Army Corps 404 permit and Water Quality 401 certification (e.g. stream disturbances over 150 linear feet)

EROSION CONTROL MEASURES (on plan)

- x Legend
- NA Location of temporary measures
- x Location of permanent measures
- x Construction drawings and details for temporary and permanent measures
- x Maintenance requirements of measures
- x Contact person responsible for maintenance

SITE DRAINAGE FEATURES

- x Existing and planned drainage patterns (include off-site areas that drain through project)
- x Method of determination of and calculations for Acreage of land being disturbed
- x Size and location of culverts and sewers
- x Soil information: type, special characteristics
- x Soil information below culvert storm outlets
- x Name and classification of receiving water course or name of municipal operator (only where stormwater discharges are to occur)

STORMWATER CALCULATIONS

- x Pre-construction runoff calculations for each outlet from the site (at peak discharge points)
- x Design calculations for peak discharges of runoff (including the construction phase & the final runoff coefficients of the site)
- x Design calcs of culverts and storm sewers
- x Discharge and velocity calculations for open channel and ditch flows (easement & right-of-ways)
- x Design calcs of cross sections and method of stabilization of existing and planned channels (include temporary linings)
- x Design calcs and construction details of energy dissipators below culvert and storm sewer outlets (diameters & apron dimensions)
- x Design calcs and dimension of sediment basins
- x Surface area and settling efficiency information for proposed sediment traps and/or basins

VEGETATIVE STABILIZATION

- x Area & acreage to be vegetatively stabilized
- x Method of soil preparation
- x Seed type & rates (temporary & permanent)
- x Fertilizer type and rates
- x Mulch type and rates

NOTE: **Plan should include provisions for groundcover on exposed slopes within 21 calendar days following completion of any phase of grading; permanent groundcover for all disturbed areas within 15 working days or 90 calendar days (whichever is shorter) following completion of construction or development.**

FINANCIAL RESPONSIBILITY/OWNERSHIP FORM

- x Completed, signed & notarized FR/O Form
- x Accurate application fee ($65.00 per acre rounded up the next acre with no ceiling amount)
- NA Certificate of assumed name, if the owner is a partnership
- NA Name of Registered Agent (if applicable)
- x Copy of the most current Deed for the site

NOTE: **For the Express Permitting Option, inquire at the local Regional Office for availability.**

NARRATIVE AND CONSTRUCTION SEQUENCE

- x Narrative describing the nature & purpose of the construction activity
- x Construction sequence related to erosion and sediment control (including installation of critical measures prior to the initiation of the land-disturbing activity & removal of measures after areas they serve are permanently stabilized)
- x Bid specifications related only to erosion control

Stormwater Management Plan

Avery County
C&D Landfill
Ingalls, North Carolina

Prepared for:
Avery County Landfill,
175 Linville Street
Newland NC 28657

To the Attention of:
Mr. Buddy Norris
Avery County

RSG Project No. Avery 07-1

Thomas B. Maier, P.E..
Senior Project Engineer

Stacey A. Smith, P.E.
Project Manager

NORTH CAROLINA PROFESSIONAL SEAL 023002 ENGINEER STACEY A. SMITH

September 2008

RICHARDSON SMITH GARDNER & ASSOCIATES
ENGINEERING & GEOLOGICAL SERVICES

PRINTED ON 100% RECYCLED PAPER

AVERY COUNTY
C&D LANDFILL

STORMWATER MANAGEMENT PLAN

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AVERY COUNTY
C&D LANDFILL

STORMWATER MANAGEMENT PLAN

1.0 NARRATIVE

1.1 Project Description

Avery County operates a construction and demolition debris (C&D) landfill under North Carolina Solid Waste Permit No. 06-03 at their facility located off of Brushy Creek Road, Ingalls, North Carolina. The facility is located approximately 2 miles northeast of the intersection of Highway 19 East and Brushy Creek Road and 1.5 miles northeast of the Avery County Airport (**Figure 1**). Avery County proposes to expand the existing C&D landfill. The proposed expansion will result in a total disturbed area of 22 acres (15 acres additional, as explained below) and will expand the landfill disposal area by 9.3 acres.

The disturbed area for the proposed expansion includes 7 acres of area previously disturbed under the existing Erosion Control Plan[1] for the site. Therefore, the disturbed area not previously permitted is 15 acres.

1.2 Contact Information

1.2.1 Engineer: For questions regarding this erosion and sedimentation control plan, please contact the following:

Richardson Smith Gardner & Associates, Inc.
Attn.: Stacey A. Smith, P.E.
14 N. Boylan Ave.
Raleigh, NC 27607
Phone: (919) 828-0577
Fax: (919) 828-3899.

1.2.2 Owner: The owner of the site and the person to contact should sediment control issues arise during the land-disturbing activity is as follows:

Avery County Landfill (Site and Scale house)
2175 Brushy Creek Road
Newland, NC 28657

Avery County Landfill (Office)
175 Linville Street

[1] "Erosion Control Plan for County of Avery Solid Waste Management Facility, Linville Falls, North Carolina", prepared by Municipal Engineering Services Co., PA, Garner and Boone, North Carolina, September 1995.

Newland NC 28657
Phone: 828-737-5420
Contact: Buddy Norris

1.3 Existing Site Conditions

Existing ground surface elevations vary from elevation 3140 feet above mean sea level (ft-msl) within the northeast corner of the property to about 2870 ft-msl within the southeast portion of the site. Topographically, the site is generally sloping to the south at an average of 15 to 20 percent. The landfill site is located adjacent to Brushy Creek which is classified as a Class C Trout Water in this area. There is an unnamed tributary located between Phase 1 and Phase 2 of the existing landfill that drains southward to Brushy Creek. West of the disposal area, there is another unnamed tributary. Both of these are on-site groundwater discharge features. The property is not zoned as there is no county-wide zoning in Avery County.

1.4 Adjacent Areas

The C&D landfill is bounded on the south by Brushy Creek Road and to all other directions by private property. Access to the site is from Brushy Creek Road which connects with Highway 19E to the west. Both of these roads serve as primary routes of waste transportation.

1.5 Site Soils Information

The native surficial soils at the site fall under the categories of Saunook Loam (SaC) according to the GIS Website for Avery County. Generally, this series varies from sandy loam to silt loam to loamy sand. Based on the permeability of sandy loam, a hydrologic soil group (HSG) "B" is considered for purposes of runoff calculations.

2.0 DESIGN GUIDELINES AND PROCEDURES

The erosion and sediment control design for the landfill was conducted based on guidelines and procedures as set forth in the following references:

1. HydroCAD Software Solutions, LLC (2004), HydroCAD Stormwater Modeling System Owner's Manual - Version 7, Chocorua, NH.

2. North Carolina Division of Land Resources, North Carolina Erosion & Sediment Control Planning & Design Manual (updated June 1, 2006).

3. Malcom, H. Rooney (1989 & 2003 Supplement), Elements of Urban Stormwater Design, NC State Univ., Raleigh, NC.

4. 15A NCAC 04B.0124 Design Standards in Sensitive Watersheds.

3.0 RUNOFF CALCULATIONS

All stormwater flow volumes were calculated using the HydroCAD computer program (utilizing USDA-NRCS (SCS) methods) and/or the Rational Method based on a 25-year 24-hour storm event. This storm event, which is a requirement of current North Carolina solid waste regulations, exceeds the 10-year event required by current North Carolina Sediment Control regulations. Rainfall quantities and/or intensities used in the analyses were derived from NOAA-35 and TP-40 data and have been included in **Appendix A**. Drainage areas were determined using a planimeter and/or AutoCAD on topographic sheets of the project area. For each drainage area, runoff curve numbers (SCS methods) and/or runoff coefficients (Rational Method) were selected based on ground cover conditions. Times of concentration were calculated by HydroCAD using SCS methods.

The peak discharge from the 25-year 24-hour storm event and 10-year 24-hour storm event were evaluated for both pre developed and post developed conditions and summarized in **Table 1**.

TABLE 1: SUMMARY OF RUNOFF VALUES

Pre–development Condition				Post–development Condition			
Discharge Point (As shown in HydroCAD Model)	Area (Ac)	10-Year Storm (cfs)	25-Year Storm (cfs)	Discharge Point (As shown in HydroCAD Model)	Area (Ac)	10-Year Storm (cfs)	25-Year Storm (cfs)
Drainage Area-1	1.8	7	10	Basin-1	3.73	0.5	2.4
Drainage Area-2	13.5	36	52	Basin-2	5.7	1.9	8.0
				Basin-3	5.12	1.9	7.9
				Basin-4	3.9	1.0	5.7

3.1 Stormwater Outlet Protection

Outlet velocities adjacent or into wetlands need to be at non-erosive velocities (<2 fps) for the 10-year storm.

TABLE 2: SUMMARY OF VELOCITY

Discharge Point	10-year 24-hr Storm Velocity (fps)
Basin-1	0.4
Basin-2	0.5
Basin-3	0.5
Basin-4	1.0

Table 2 shows that the maximum velocities are less than the maximum permissible velocity (2.0 fps) (even for points not discharging to wetlands) and thus protect the wetlands from erosion.

4.0 EROSION AND SEDIMENTATION CONTROL MEASURES - INITIAL

The following erosion and sedimentation control measures are to be constructed as part of the proposed landfill expansion. Appendices A, B and C to this plan include calculations, total nitrogen loading estimation, technical specifications, and plans and details for each of these measures, respectively.

In most cases, the following erosion and sedimentation control measures were designed using the final drainage areas which were found to represent a worst case for design.

4.1 Sediment Basins

There are four (4) basins (Basin-1, Basin-2, Basin-3 & Basin-4) that will serve the site. Basins-1, 2 and 3 will be located in the eastern area of the project site and basin-4 will be located on southern area of the project site. All these basins are designed in accordance with E&SCCP&DM Section 6.61.

Sediment basin design is subject to several requirements. The sediment basins must provide a basin volume of 1,800 ft^3/acre of disturbed area. Other E&SCP&DM requirements for permanent basins include riser/barrel principal spillways and emergency weir-type spillways. The principal spillways must have a capacity of 0.2 ft^3 /second/acre of drainage area. This flow must be met with one foot of driving head. The crest of the emergency spillways is set one foot above the invert of the riser and must pass the peak run-off from the design storm event with one foot of freeboard to the crest of berm. The risers must also be provided with a method of dewatering the basin. In addition to E&SCP&DM requirements, each sediment basin was designed to have an adequate surface area to achieve an 80% settling efficiency of a 40 micron (silt size) particle at the peak discharge from the design storm. Each sediment basin was modeled with the HydroCAD computer program and a spreadsheet was used to verify the design requirements.

4.2 Cascades

The principal and emergency spillways of Basin-2 and Basin-3, as well as the principal spillway of Basin-1, discharge into cascades, which are stepped rock chutes. The cascade is a hybrid between an artificial rock chute and a natural stepped-bed high-gradient stream. The stepped-bed configuration is used to: i) dissipate energy and thus maintain stability of the channel lining under high-gradient flow conditions; and ii) create turbulent and nappe flows to achieve evaporative cooling and increase dissolved oxygen during warm months, thus rendering the outflow suitable for discharge to cold water streams. The cascades are designed to accommodate the peak discharge from the 100-year 24-hour storm without overtopping and without exceeding the allowable shear stress and/or velocity of the selected channel lining.

4.3 Culverts

There are four (4) culverts (C-3A, C-3B, C-3C and C-4 etc.) which will convey flow beneath roadways and embankments. The number in the culvert name indicates the basin that it flows toward. Culverts that contain a letter in their name receive water from another pipe (either a side slope swale or another culvert). Culverts were designed using HydroCAD program. Where required, culvert outlets were designed with outlet stabilization based on criteria set forth in E&SCP&DM, Section 6.41.

4.4 Drop Inlets

Three (3) weir-type drop inlets (DI-3A, DI-3B and DI-3C) will be used to route flows into basin-3. The number in the drop inlet name indicates the basin that it flows toward. Drop inlets that contain a letter in their name receive water from another drop inlet (via culvert) and direct runoff. These drop inlets were designed by a spreadsheet based on an analysis of the flow capacity of the open sides (weirs) of the drop inlet compared to the maximum flow from the design storm. Prior to vegetative stabilization of the perimeter channel, each drop inlet will be protected from sedimentation by a placing a wire mesh and coarse aggregate filter around all sides of the drop inlet.

4.5 Silt Fence

Silt fencing design was based on criteria set forth in E&SCP&DM, Section 6.62 including the limitation of 100 feet of fencing for each ¼ acre of drainage area.

4.6 Vegetative Stabilization

Vegetative stabilization will be in accordance with the seeding schedule in the project specifications (provided as an attachment to this plan). The seeding schedule was based on Table 6.11k of E&SCP&DM which is applicable to this site.

5.0 EROSION AND SEDIMENTATION CONTROL MEASURES - FINAL

The following erosion and sedimentation control measures are to be constructed as a part of the final cover construction. Appendices A, B and C to this plan include calculations, technical specifications, and plans and details for each of these measures, respectively.

5.1 Side Slope Swales

Side slope swales (diversion berms) will be placed along final cover side slopes at forty (40) foot vertical increments. The swales are designed as a V-channel having two (2) feet deep, with slopes of 3H:1V on the landfill side and $1^1/_2$H:1V on the swale side. Flow from the side slope swales is directed to the down pipes or drop inlets. The capacity and need for lining of the swales was checked for maximum 25-year storm event using the swale that had the largest inflow area, 1.70 acres, with the Rational Formula. Based on the calculated velocity and shear stress, all side slope swales require TRM (Turf Reinforcement Matting) lining.

5.2 Down Pipes

Three (3) down pipes (DP-1, DP-2 & DP-3) that will be used to carry flows from side slope swales to the bottom of final cover slopes. Down pipes were designed based on an analysis of inlet and outlet control under the influence of the design storm to determine the governing headwater condition. Down pipes will be adequately anchored to the landfill side slopes by use of a soil cover and each will be outleted directly to basins.

6.0 SCHEDULE FOR IMPLEMENTATION

All erosion control measures will be placed before any land disturbance or waste placement may begin in that portion of the site which drains to the erosion control measures. Vegetative stabilization of disturbed areas will be in accordance with the following requirements:

- Temporary or permanent ground cover (or other acceptable measure(s)) adequate to restrain erosion on erodible slopes or other areas will be stabilized within fifteen (15) working days or twenty-one (21) calendar days following completion of any phase of grading.

7.0 INSPECTION AND MAINTENANCE

All erosion and sedimentation control measures will be inspected at least once every seven calendar days and within 24 hours after any storm event of greater than 0.5 inches of rain per 24 hour period. A rain gauge will be maintained on the site and a record of the rainfall amounts and dates will be kept properly.

During inspections, any stormwater discharges from the site will be observed for stormwater discharge characteristics to evaluate the effectiveness of the erosion and sedimentation control measures incorporating Best Management Practices (BMPs). If visible sedimentation is leaving

the disturbed limits of the site, corrective action will be taken immediately to control the discharge of sediments.

Repairs to erosion and sedimentation control measures will be made as needed and accumulated sediment removed if necessary. All sediments which are removed from erosion and sedimentation control measures will be disposed of in an approved manner at a location to be designated by the Engineer in such a manner that further erosion and sedimentation will not occur.

Appendix A

Stormwater Calculations

AVERY COUNTY
C&D LANDFILL

STORMWATER MANAGEMENT PLAN

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8.0 Outlet Protection Analysis

9.0 Outlet Velocity Analysis

Analysis of Design Storms

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

SHEET: 1 / 1
JOB #: Avery 07-1
DATE: 7/17/08
BY: KBS
CHKD BY: GGM

Avery County C&D Landfill
Analysis of Design Storms

LOCATION: **Avery County, NC**

SOURCE: **NOAA , North Carolina**
http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nc_pfds.html

DEPTH-DURATION-FREQUENCY TABLE

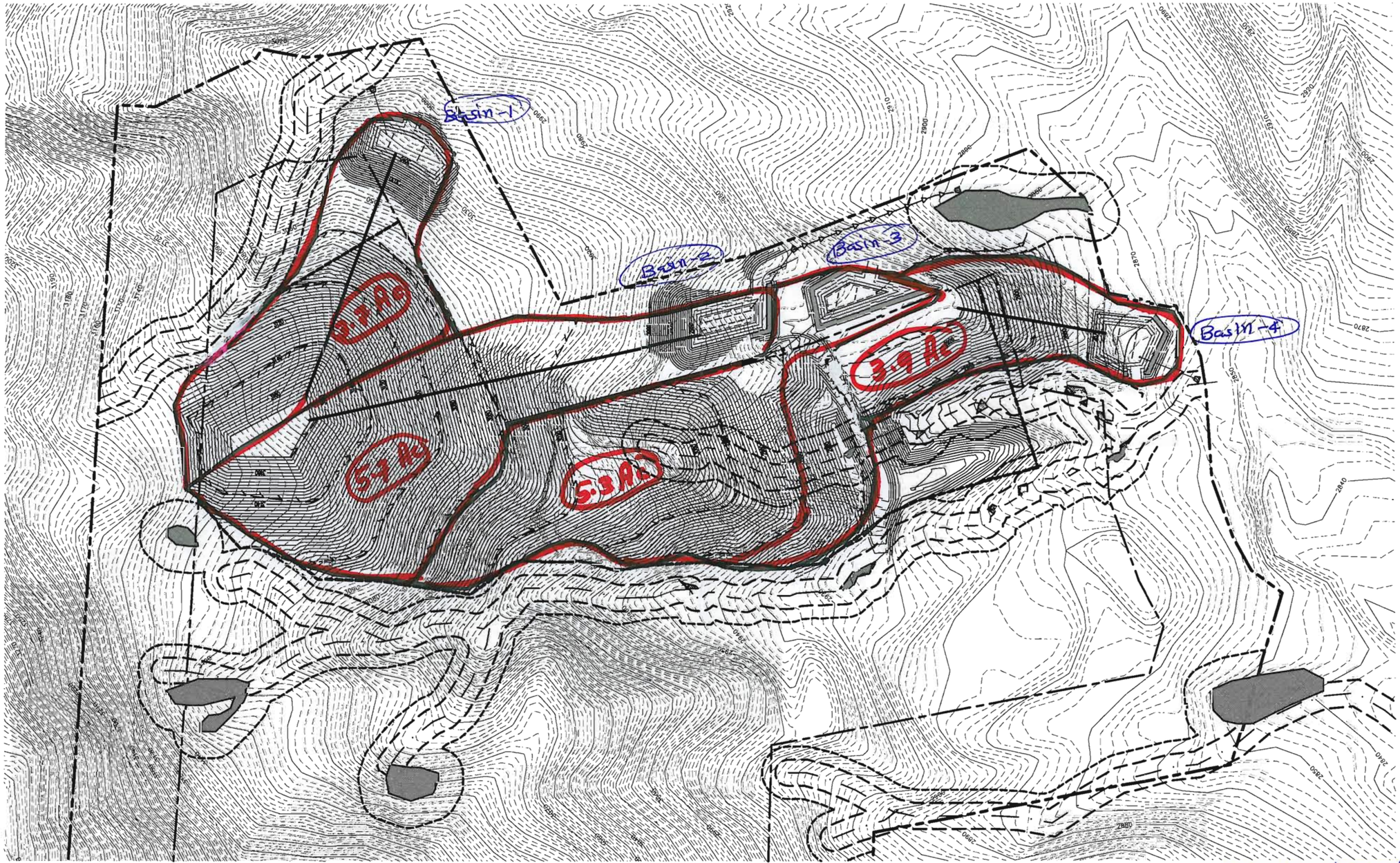
DURATION	RETURN PERIOD 2-YR (in)	5-YR (in)	10-YR (in)	25-YR (in)	50-YR (in)	100-YR (in)
5 min	0.42	0.53	0.61	0.70	0.77	0.84
10 min	0.67	0.85	0.97	1.11	1.22	1.33
15 min	0.85	1.08	1.23	1.41	1.55	1.68
30 min	1.17	1.53	1.78	2.09	2.33	2.57
60 min	1.47	1.97	2.31	2.78	3.16	3.54
2 hr	1.68	2.30	2.77	3.43	3.98	4.58
3 hr	1.81	2.47	2.97	3.70	4.32	5.00
6 hr	2.29	3.07	3.67	4.55	5.30	6.14
12 hr	2.95	3.92	4.63	5.63	6.44	7.32
24 hr	3.66	4.96	5.91	7.23	8.30	9.45

INTENSITY-DURATION-FREQUENCY TABLE

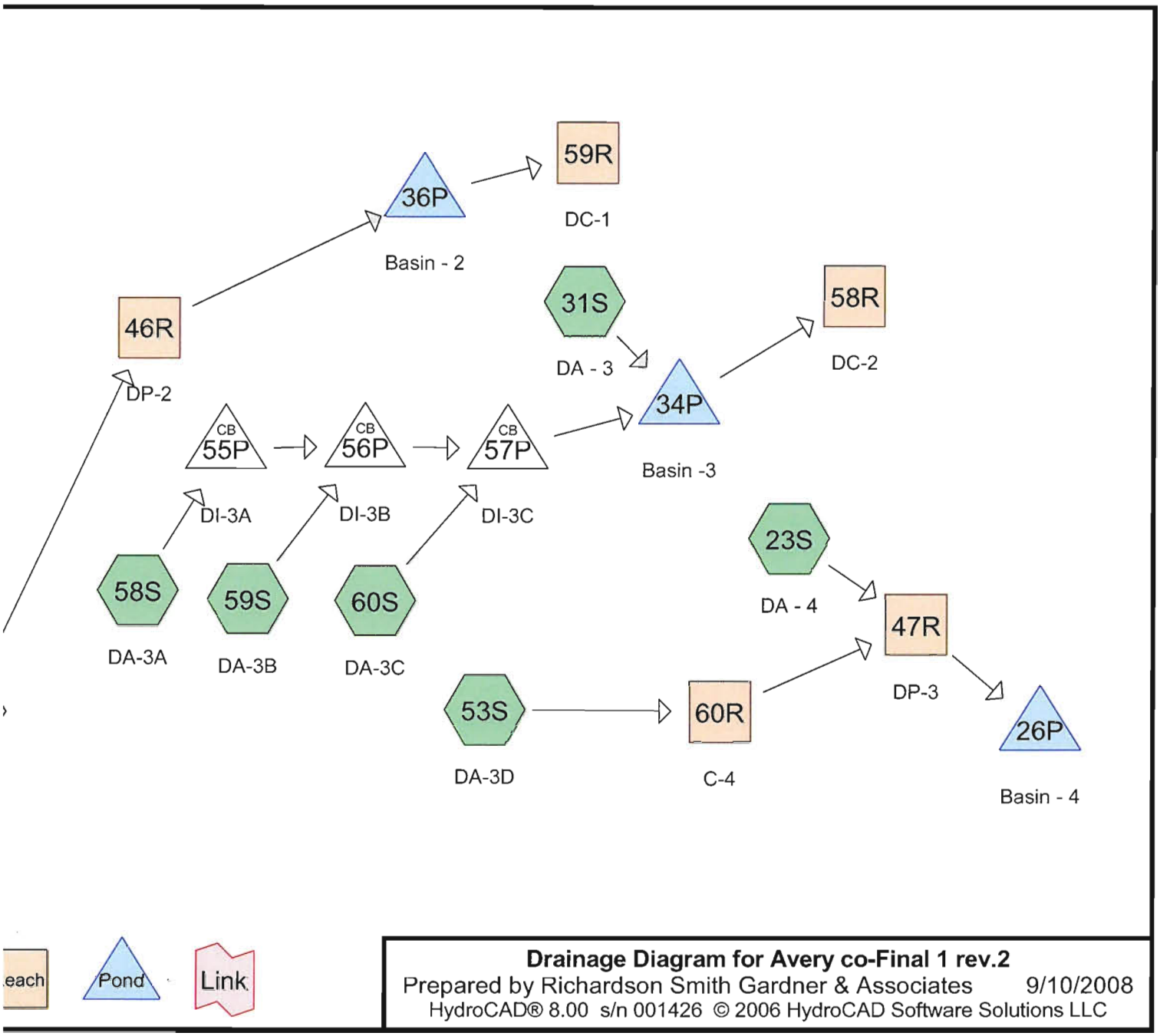
DURATION	RETURN PERIOD 2-YR (in/hr)	5-YR (in/hr)	10-YR (in/hr)	25-YR (in/hr)	50-YR (in/hr)	100-YR (in/hr)
5 min	5.04	6.36	7.32	8.40	9.24	10.08
10 min	4.02	5.10	5.82	6.66	7.32	7.98
15 min	3.40	4.32	4.92	5.64	6.20	6.72
30 min	2.34	3.06	3.56	4.18	4.66	5.14
60 min	1.47	1.97	2.31	2.78	3.16	3.54
2 hr	0.84	1.15	1.39	1.72	1.99	2.29
3 hr	0.60	0.82	0.99	1.23	1.44	1.67
6 hr	0.38	0.51	0.61	0.76	0.88	1.02
12 hr	0.25	0.33	0.39	0.47	0.54	0.61
24 hr	0.15	0.21	0.25	0.30	0.35	0.39

HydroCAD Analysis

HydroCAD Analysis for Post-developed Condition
(25 – Year Storm Event)



Post - Development Condition.



each Pond Link

Drainage Diagram for Avery co-Final 1 rev.2
Prepared by Richardson Smith Gardner & Associates 9/10/2008
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Subcatchment 23S: DA - 4

Runoff = 17.96 cfs @ 11.96 hrs, Volume= 0.768 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
2.700	69	50-75% Grass cover, Fair, HSG B
2.700		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 31S: DA - 3

Runoff = 3.79 cfs @ 11.96 hrs, Volume= 0.162 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
0.570	69	50-75% Grass cover, Fair, HSG B
0.570		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 35S: DA - 2

Runoff = 37.92 cfs @ 11.96 hrs, Volume= 1.622 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
5.700	69	50-75% Grass cover, Fair, HSG B
5.700		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 41S: DA - 1

Runoff = 24.81 cfs @ 11.96 hrs, Volume= 1.061 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
3.730	69	50-75% Grass cover, Fair, HSG B
3.730		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 53S: DA-3D

Runoff = 7.98 cfs @ 11.96 hrs, Volume= 0.341 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
1.200	69	50-75% Grass cover, Fair, HSG B
1.200		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 58S: DA-3A

Runoff = 7.12 cfs @ 11.96 hrs, Volume= 0.304 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
1.070	69	50-75% Grass cover, Fair, HSG B
1.070		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 59S: DA-3B

Runoff = 12.77 cfs @ 11.96 hrs, Volume= 0.546 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
1.920	69	50-75% Grass cover, Fair, HSG B
1.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 60S: DA-3C

Runoff = 10.38 cfs @ 11.96 hrs, Volume= 0.444 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
1.560	69	50-75% Grass cover, Fair, HSG B
1.560		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

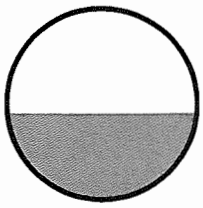
Reach 45R: DP-1

Inflow Area = 3.730 ac, Inflow Depth > 3.41" for 25-yr event
Inflow = 24.81 cfs @ 11.96 hrs, Volume= 1.061 af
Outflow = 24.20 cfs @ 11.97 hrs, Volume= 1.061 af, Atten= 2%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 31.65 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 10.56 fps, Avg. Travel Time= 0.8 min

Peak Storage= 403 cf @ 11.96 hrs, Average Depth at Peak Storage= 0.68'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 58.63 cfs

18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 520.0' Slope= 0.3115 '/'
Inlet Invert= 3,170.00', Outlet Invert= 3,008.00'



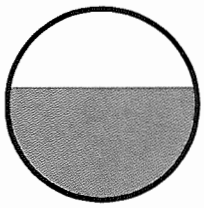
Reach 46R: DP-2

Inflow Area = 5.700 ac, Inflow Depth > 3.41" for 25-yr event
Inflow = 37.92 cfs @ 11.96 hrs, Volume= 1.622 af
Outflow = 36.69 cfs @ 11.97 hrs, Volume= 1.621 af, Atten= 3%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 34.41 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 11.76 fps, Avg. Travel Time= 1.1 min

Peak Storage= 815 cf @ 11.96 hrs, Average Depth at Peak Storage= 0.89'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 57.15 cfs

18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 750.0' Slope= 0.2960 '/'
Inlet Invert= 3,170.00', Outlet Invert= 2,948.00'



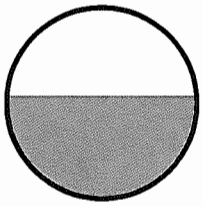
Reach 47R: DP-3

Inflow Area = 3.900 ac, Inflow Depth > 3.41" for 25-yr event
Inflow = 25.90 cfs @ 11.96 hrs, Volume= 1.110 af
Outflow = 25.42 cfs @ 11.96 hrs, Volume= 1.109 af, Atten= 2%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 26.48 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 8.95 fps, Avg. Travel Time= 0.6 min

Peak Storage= 310 cf @ 11.96 hrs, Average Depth at Peak Storage= 0.81'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 45.49 cfs

18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 320.0' Slope= 0.1875 '/'
Inlet Invert= 2,930.00', Outlet Invert= 2,870.00'



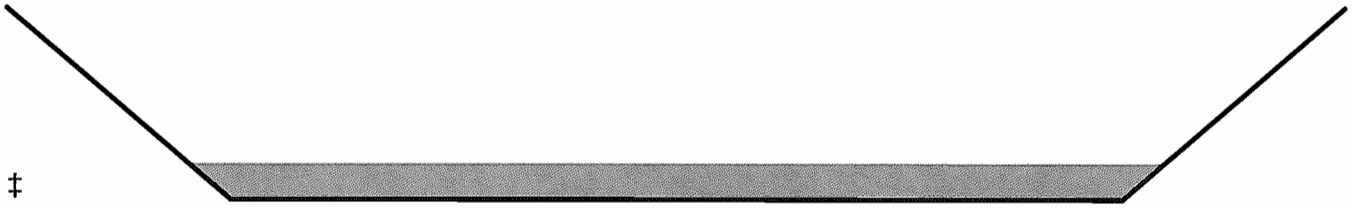
Reach 58R: DC-2

Inflow Area = 5.120 ac, Inflow Depth > 2.08" for 25-yr event
Inflow = 7.93 cfs @ 12.12 hrs, Volume= 0.889 af
Outflow = 7.90 cfs @ 12.16 hrs, Volume= 0.886 af, Atten= 0%, Lag= 2.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.17 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 2.31 fps, Avg. Travel Time= 2.4 min

Peak Storage= 543 cf @ 12.12 hrs, Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 140.52 cfs

8.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 340.0' Slope= 0.1471 '/'
Inlet Invert= 2,928.00', Outlet Invert= 2,878.00'



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Reach 59R: DC-1

Inflow Area = 5.700 ac, Inflow Depth > 2.05" for 25-yr event
Inflow = 7.97 cfs @ 12.14 hrs, Volume= 0.975 af
Outflow = 8.12 cfs @ 12.17 hrs, Volume= 0.972 af, Atten= 0%, Lag= 1.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.26 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 2.44 fps, Avg. Travel Time= 2.5 min

Peak Storage= 589 cf @ 12.10 hrs, Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 142.56 cfs

8.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 370.0' Slope= 0.1514 '/'
Inlet Invert= 2,942.00', Outlet Invert= 2,886.00'

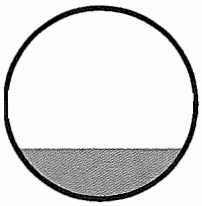
Reach 60R: C-4

Inflow Area = 1.200 ac, Inflow Depth > 3.41" for 25-yr event
Inflow = 7.98 cfs @ 11.96 hrs, Volume= 0.341 af
Outflow = 7.94 cfs @ 11.96 hrs, Volume= 0.341 af, Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 21.11 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.88 fps, Avg. Travel Time= 0.2 min

Peak Storage= 28 cf @ 11.96 hrs, Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 51.46 cfs

18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 75.0' Slope= 0.2400 '/'
Inlet Invert= 2,918.00', Outlet Invert= 2,900.00'



Pond 26P: Basin - 4

Inflow Area =	3.900 ac,	Inflow Depth >	3.41"	for	25-yr event
Inflow =	25.42 cfs @	11.96 hrs,	Volume=	1.109 af	
Outflow =	5.65 cfs @	12.13 hrs,	Volume=	0.671 af,	Atten= 78%, Lag= 9.8 min
Primary =	5.65 cfs @	12.13 hrs,	Volume=	0.671 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,867.48' @ 12.13 hrs Surf.Area= 8,642 sf Storage= 24,036 cf

Plug-Flow detention time= 154.7 min calculated for 0.671 af (60% of inflow)
Center-of-Mass det. time= 78.7 min (864.9 - 786.2)

Volume	Invert	Avail.Storage	Storage Description
#1	2,864.00'	49,396 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

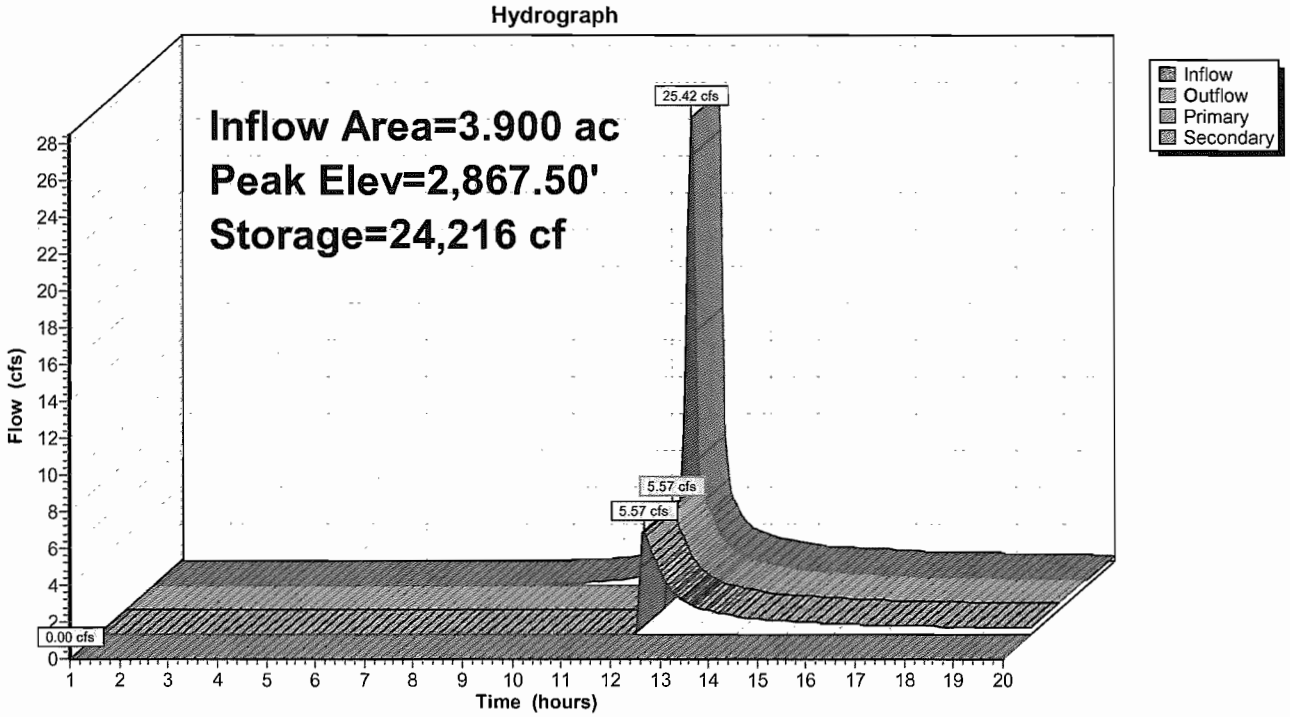
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,864.00	5,293	0	0
2,866.00	7,109	12,402	12,402
2,868.00	9,184	16,293	28,695
2,870.00	11,517	20,701	49,396

Device	Routing	Invert	Outlet Devices
#1	Primary	2,864.00'	**15.0" x 60.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,860.00' S= 0.0667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	2,867.00'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Primary	2,865.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#4	Secondary	2,868.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=5.59 cfs @ 12.13 hrs HW=2,867.47' (Free Discharge)
- **1=Culvert** (Passes 5.03 cfs of 9.97 cfs potential flow)
  - **2=Riser** (Weir Controls 5.03 cfs @ 2.25 fps)
- **3=Orifice/Grate** (Orifice Controls 0.56 cfs @ 6.47 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=2,864.00' (Free Discharge)
- **4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 26P: Basin - 4



Pond 34P: Basin -3

Inflow Area =	5.120 ac,	Inflow Depth >	3.41"	for	25-yr event	
Inflow =	34.06 cfs @	11.96 hrs,	Volume=		1.457 af	
Outflow =	7.93 cfs @	12.12 hrs,	Volume=		0.889 af,	Atten= 77%, Lag= 9.5 min
Primary =	7.93 cfs @	12.12 hrs,	Volume=		0.889 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=		0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,934.83' @ 12.12 hrs Surf.Area= 8,677 sf Storage= 30,986 cf

Plug-Flow detention time= 139.1 min calculated for 0.887 af (61% of inflow)
Center-of-Mass det. time= 64.2 min (849.9 - 785.7)

Volume	Invert	Avail.Storage	Storage Description
#1	2,929.00'	42,088 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

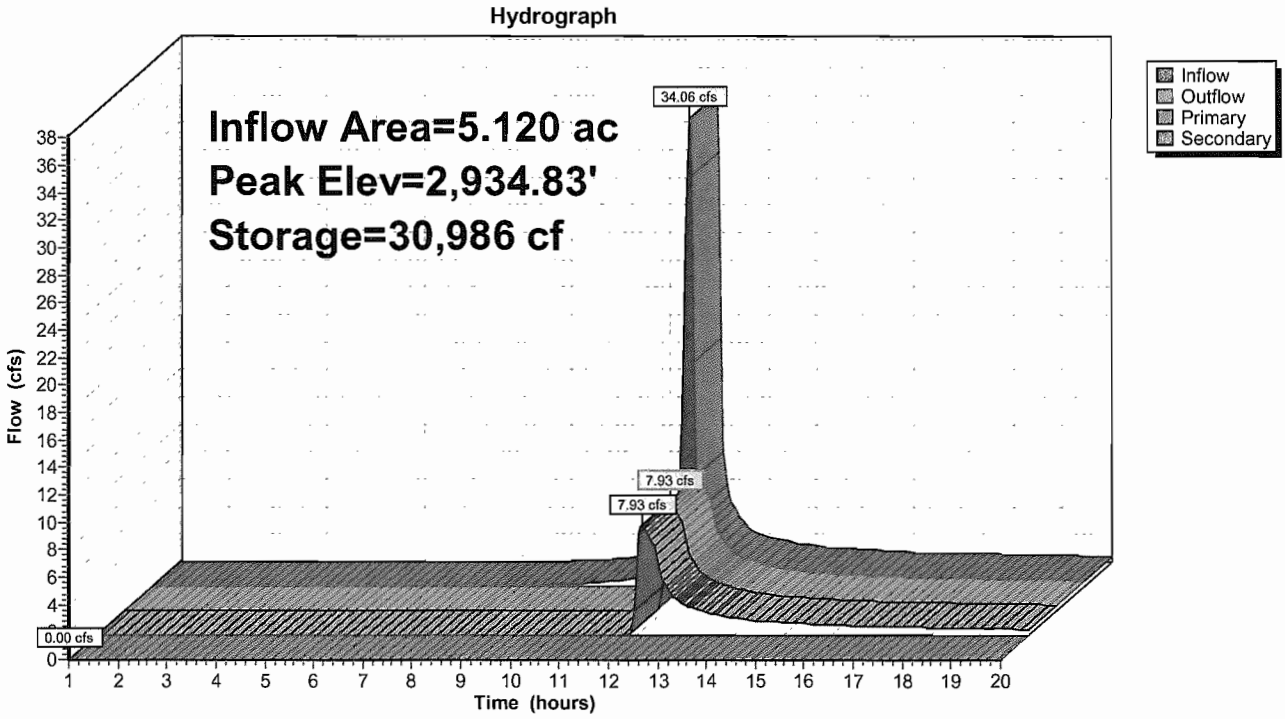
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,929.00	2,524	0	0
2,930.00	3,325	2,925	2,925
2,932.00	5,234	8,559	11,484
2,934.00	7,549	12,783	24,267
2,936.00	10,272	17,821	42,088

Device	Routing	Invert	Outlet Devices
#1	Primary	2,929.00'	**15.0" x 100.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900 Outlet Invert= 2,928.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	2,934.00'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Device 1	2,931.50'	**2.0" Vert. Orifice/Grate** C= 0.600
#4	Secondary	2,935.00'	**10.0' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=7.87 cfs @ 12.12 hrs HW=2,934.82' (Free Discharge)
└─**1=Culvert** (Passes 7.87 cfs of 10.63 cfs potential flow)
  ├─**2=Riser** (Orifice Controls 7.69 cfs @ 4.35 fps)
  └─**3=Orifice/Grate** (Orifice Controls 0.19 cfs @ 8.66 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=2,929.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 34P: Basin -3



Pond 36P: Basin - 2

Inflow Area =	5.700 ac,	Inflow Depth >	3.41"	for	25-yr event
Inflow =	36.69 cfs @	11.97 hrs,	Volume=	1.621 af	
Outflow =	7.97 cfs @	12.14 hrs,	Volume=	0.975 af,	Atten= 78%, Lag= 10.3 min
Primary =	7.97 cfs @	12.14 hrs,	Volume=	0.975 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,948.84' @ 12.14 hrs Surf.Area= 9,185 sf Storage= 34,793 cf

Plug-Flow detention time= 142.4 min calculated for 0.975 af (60% of inflow)
Center-of-Mass det. time= 66.3 min (852.8 - 786.5)

Volume	Invert	Avail.Storage	Storage Description
#1	2,943.00'	46,331 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

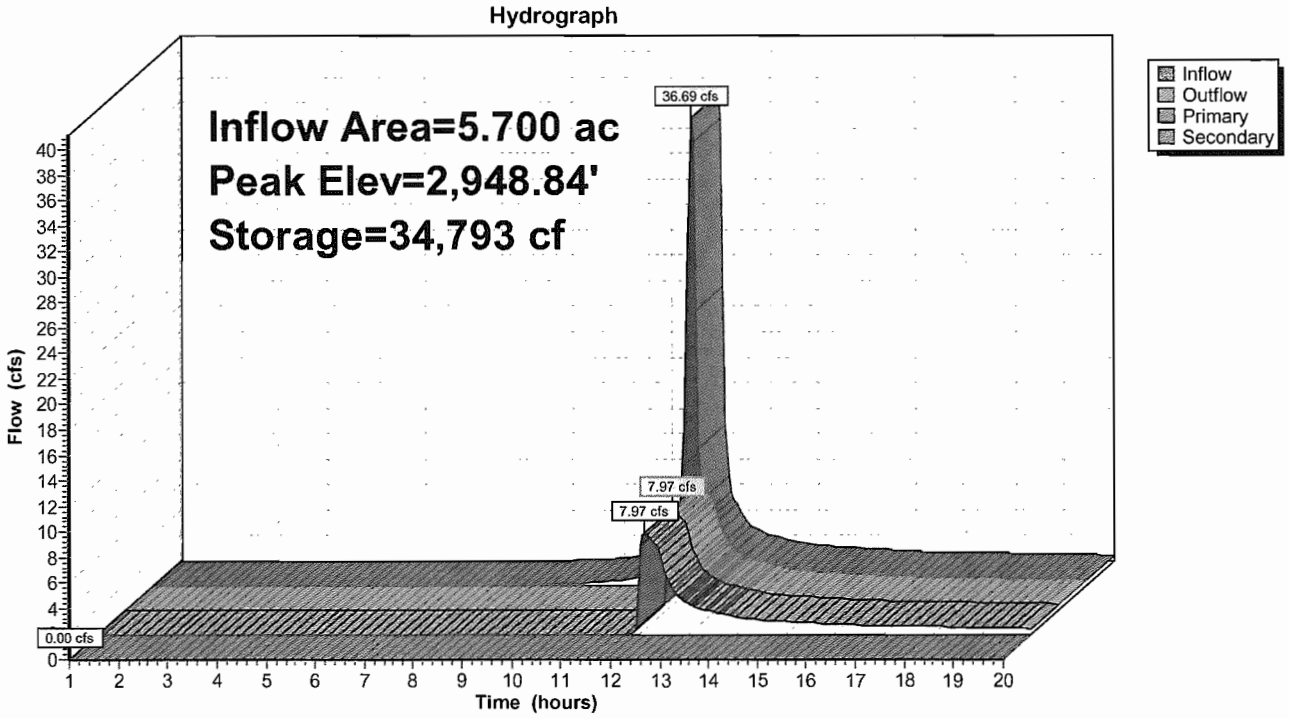
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,943.00	3,153	0	0
2,944.00	4,001	3,577	3,577
2,946.00	5,919	9,920	13,497
2,948.00	8,134	14,053	27,550
2,950.00	10,647	18,781	46,331

Device	Routing	Invert	Outlet Devices
#1	Primary	2,943.00'	**15.0" x 50.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,942.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	2,948.00'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Device 1	2,945.50'	**2.0" Vert. Perforated Holes** C= 0.600
#4	Secondary	2,949.00'	**20.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=7.95 cfs @ 12.14 hrs HW=2,948.83' (Free Discharge)
└─**1=Culvert** (Passes 7.95 cfs of 13.48 cfs potential flow)
  ├─**2=Riser** (Orifice Controls 7.76 cfs @ 4.39 fps)
  └─**3=Perforated Holes** (Orifice Controls 0.19 cfs @ 8.68 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=2,943.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 36P: Basin - 2



Pond 44P: Basin - 1

Inflow Area =	3.730 ac,	Inflow Depth >	3.41"	for 25-yr event	
Inflow =	24.20 cfs @	11.97 hrs,	Volume=	1.061 af	
Outflow =	2.42 cfs @	12.44 hrs,	Volume=	0.506 af,	Atten= 90%, Lag= 28.7 min
Primary =	2.42 cfs @	12.44 hrs,	Volume=	0.506 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 3,011.78' @ 12.44 hrs Surf.Area= 9,104 sf Storage= 26,203 cf

Plug-Flow detention time= 179.5 min calculated for 0.505 af (48% of inflow)
Center-of-Mass det. time= 99.1 min (885.4 - 786.3)

Volume	Invert	Avail.Storage	Storage Description
#1	3,008.00'	49,609 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

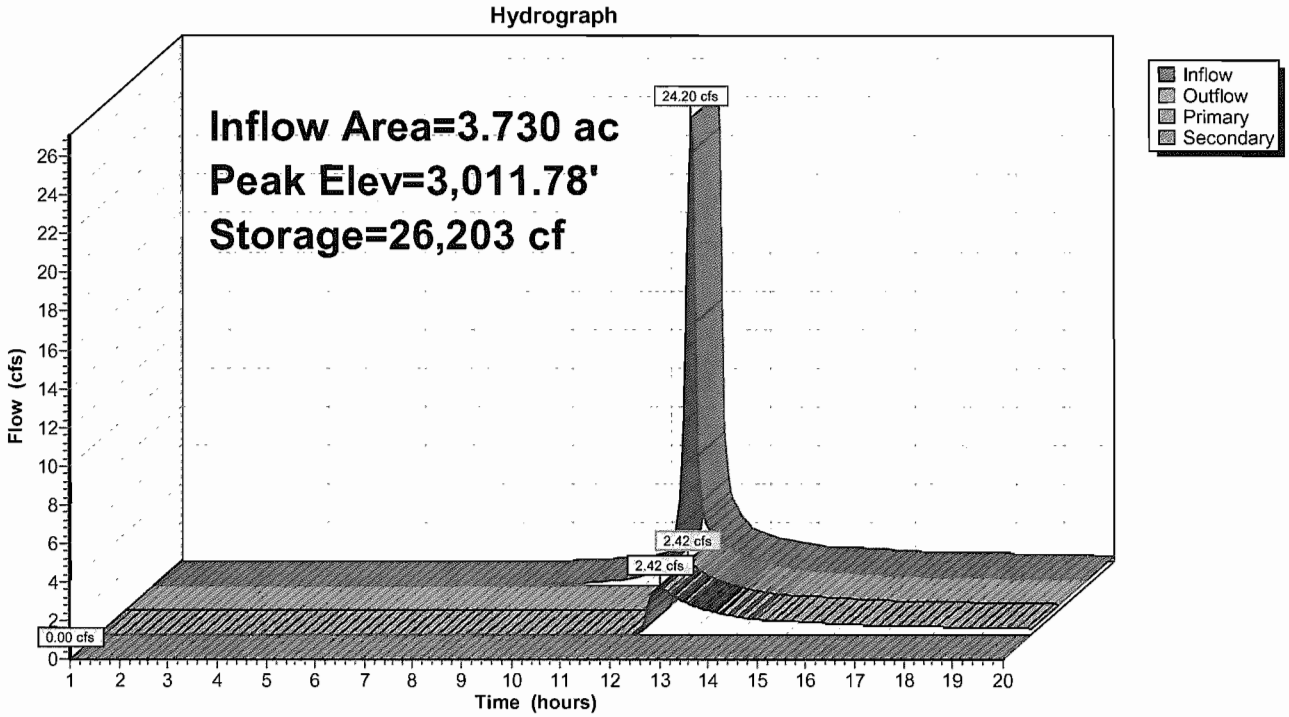
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
3,008.00	4,888	0	0
3,010.00	6,992	11,880	11,880
3,012.00	9,365	16,357	28,237
3,014.00	12,007	21,372	49,609

Device	Routing	Invert	Outlet Devices
#1	Primary	3,008.00'	**15.0" x 45.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 3,006.00' S= 0.0444 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	3,011.50'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Device 1	3,010.00'	**2.0" Vert. Orifice/Grate** C= 0.600
#4	Secondary	3,012.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=2.41 cfs @ 12.44 hrs HW=3,011.78' (Free Discharge)
└─**1=Culvert** (Passes 2.41 cfs of 10.49 cfs potential flow)
  ├─**2=Riser** (Weir Controls 2.28 cfs @ 1.73 fps)
  └─**3=Orifice/Grate** (Orifice Controls 0.14 cfs @ 6.27 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=3,008.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 44P: Basin - 1



Pond 55P: DI-3A

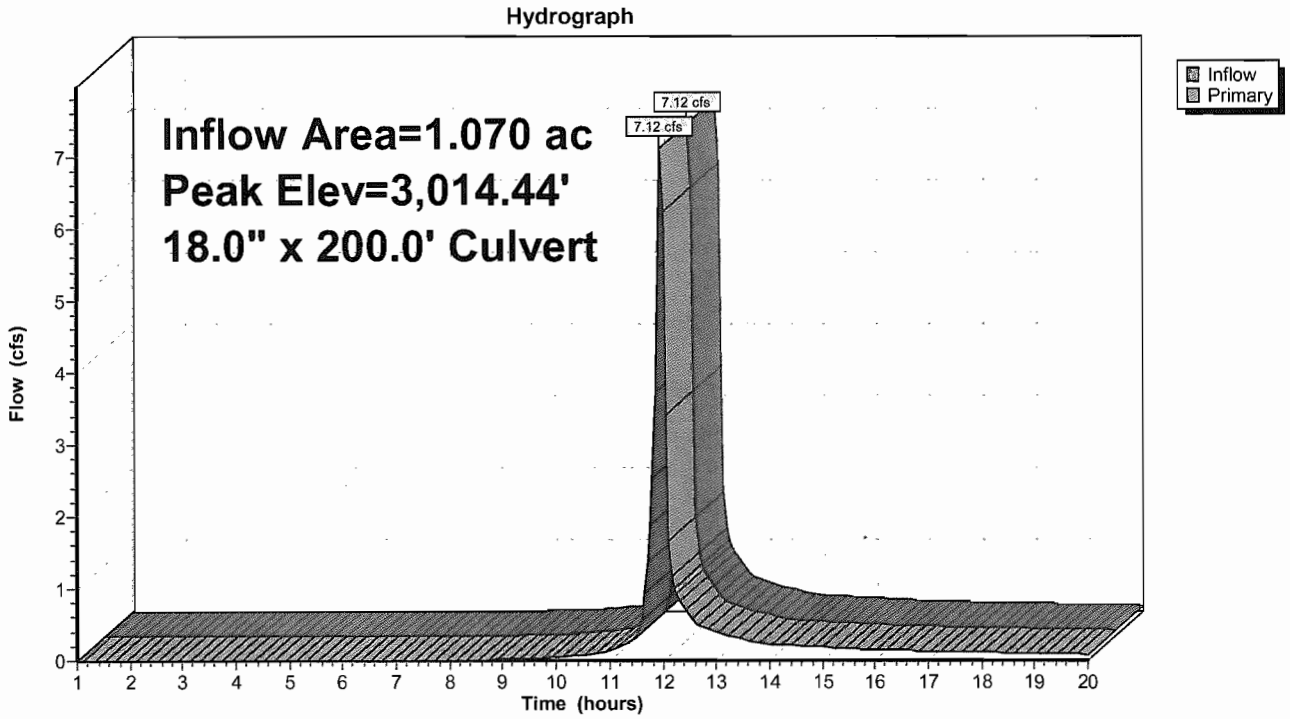
Inflow Area =	1.070 ac,	Inflow Depth >	3.41"	for	25-yr event	
Inflow =	7.12 cfs @	11.96 hrs,	Volume=		0.304 af	
Outflow =	7.12 cfs @	11.96 hrs,	Volume=		0.304 af,	Atten= 0%, Lag= 0.0 min
Primary =	7.12 cfs @	11.96 hrs,	Volume=		0.304 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 3,014.44' @ 11.96 hrs
Flood Elev= 3,016.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	3,013.00'	**18.0" x 200.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,973.00' S= 0.2000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=6.97 cfs @ 11.96 hrs HW=3,014.41' (Free Discharge)
└**1=Culvert** (Inlet Controls 6.97 cfs @ 4.04 fps)

Pond 55P: DI-3A



Pond 56P: DI-3B

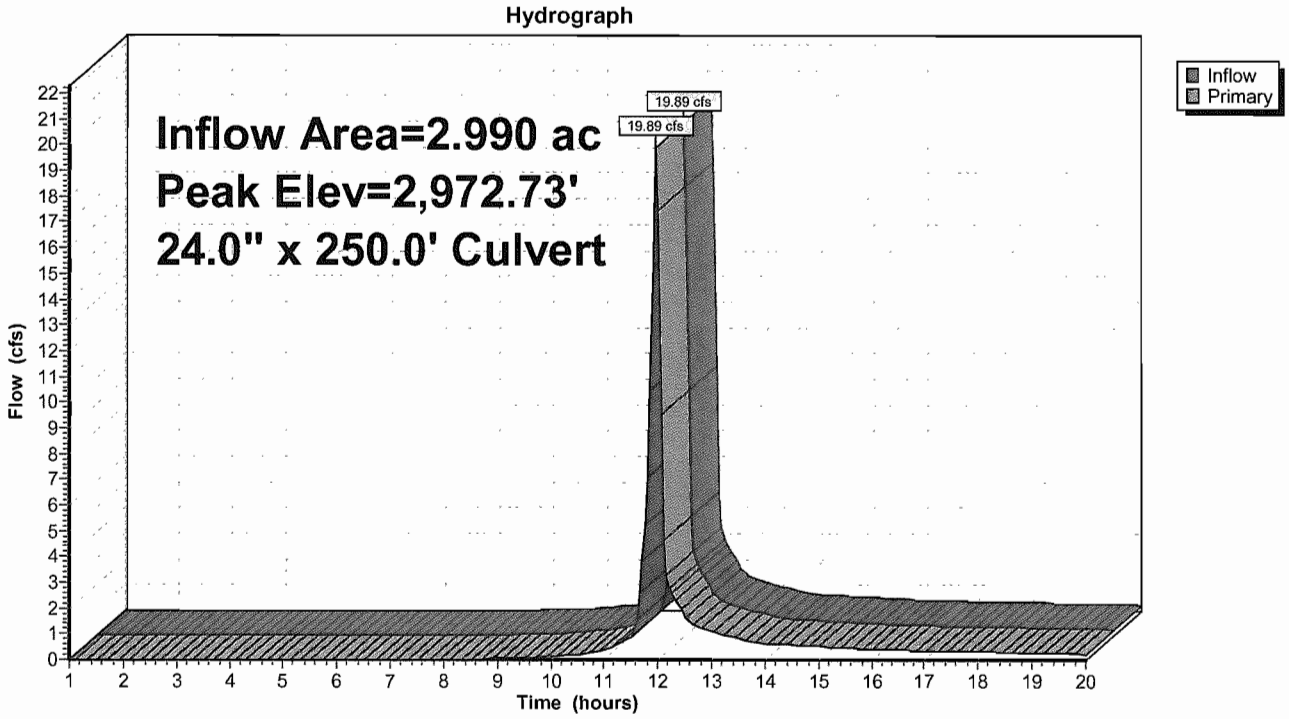
Inflow Area =	2.990 ac,	Inflow Depth >	3.41"	for	25-yr event	
Inflow =	19.89 cfs @	11.96 hrs,	Volume=		0.851 af	
Outflow =	19.89 cfs @	11.96 hrs,	Volume=		0.851 af,	Atten= 0%, Lag= 0.0 min
Primary =	19.89 cfs @	11.96 hrs,	Volume=		0.851 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,972.73' @ 11.96 hrs
Flood Elev= 2,976.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	2,970.00'	**24.0" x 250.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,939.00' S= 0.1240 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=19.46 cfs @ 11.96 hrs HW=2,972.65' (Free Discharge)
└**1=Culvert** (Inlet Controls 19.46 cfs @ 6.19 fps)

Pond 56P: DI-3B



Pond 57P: DI-3C

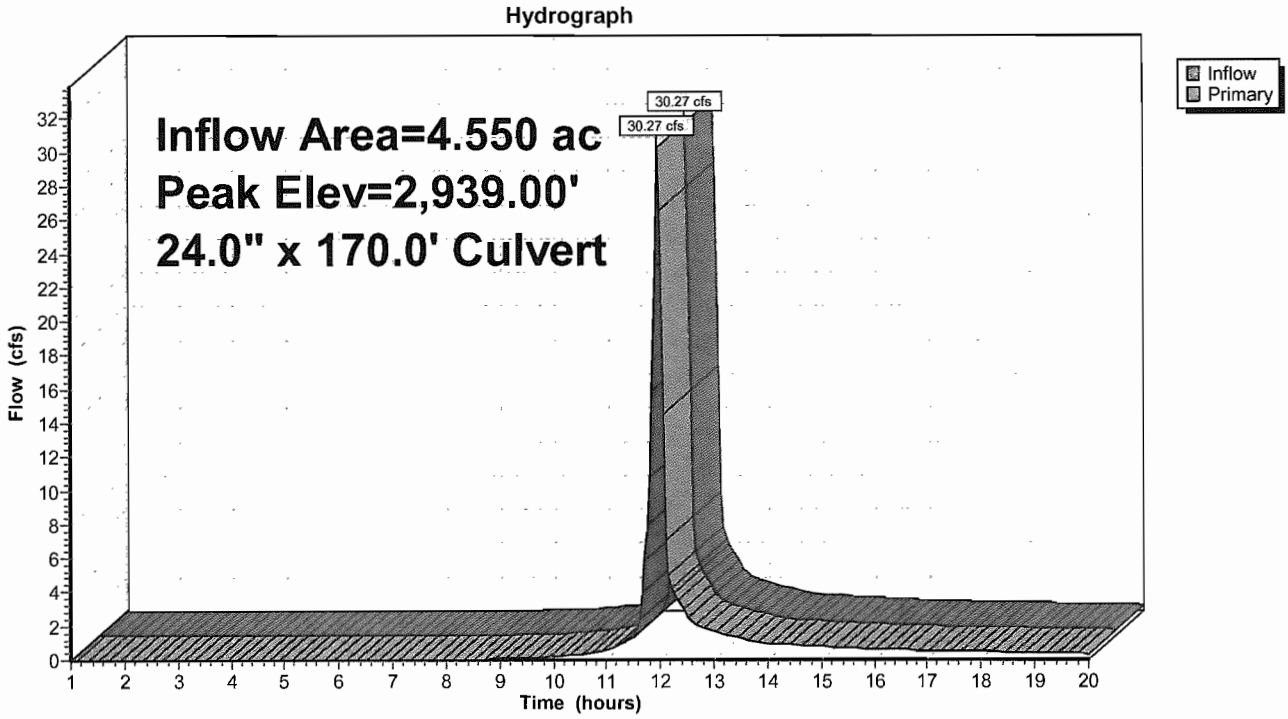
Inflow Area =	4.550 ac,	Inflow Depth >	3.41"	for	25-yr event	
Inflow =	30.27 cfs @	11.96 hrs,	Volume=		1.295 af	
Outflow =	30.27 cfs @	11.96 hrs,	Volume=		1.295 af,	Atten= 0%, Lag= 0.0 min
Primary =	30.27 cfs @	11.96 hrs,	Volume=		1.295 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,939.00' @ 11.96 hrs
Flood Elev= 2,942.00'

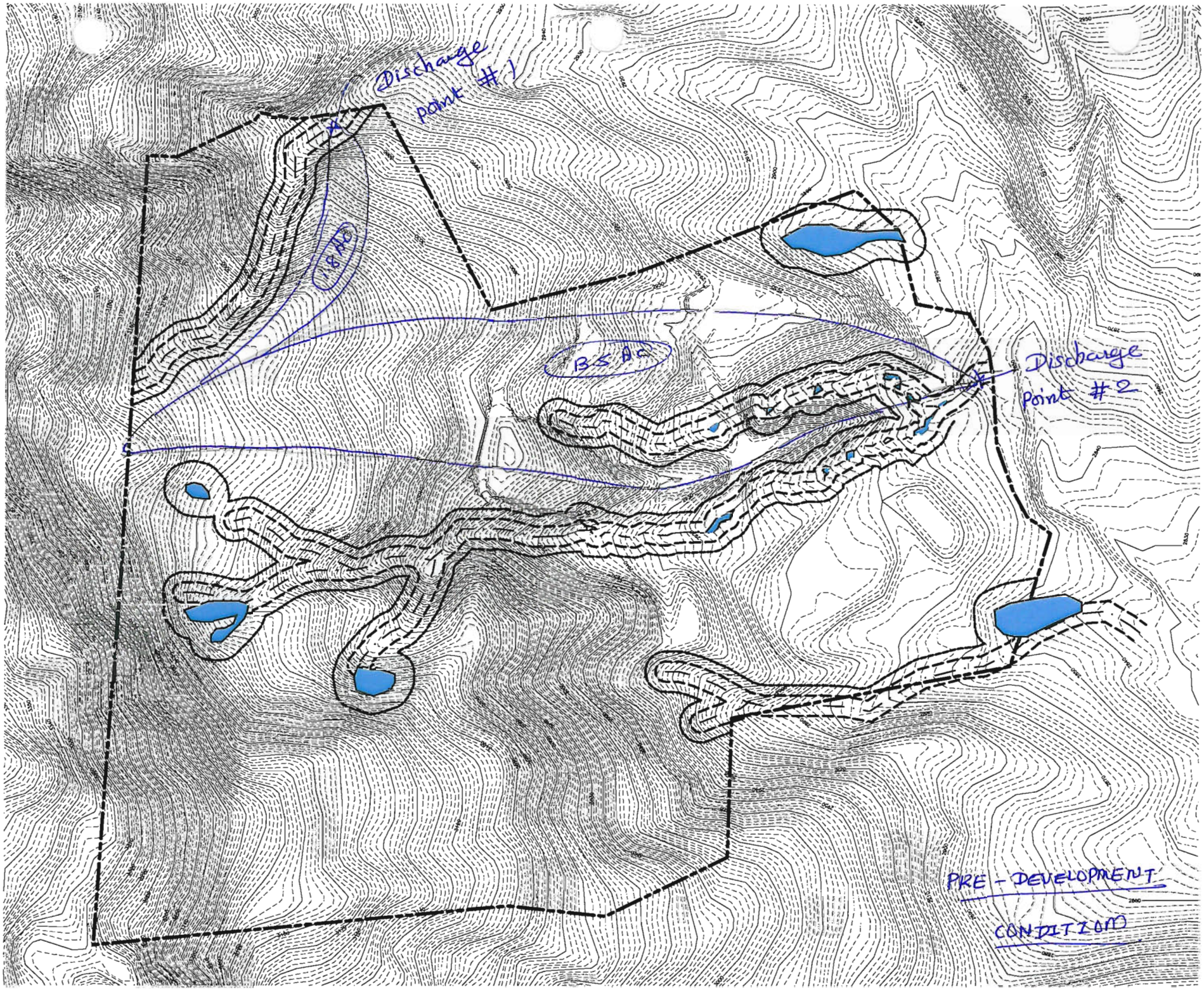
Device	Routing	Invert	Outlet Devices
#1	Primary	2,934.00'	**24.0" x 170.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,930.00' S= 0.0235 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=29.61 cfs @ 11.96 hrs HW=2,938.83' (Free Discharge)
└**1=Culvert** (Inlet Controls 29.61 cfs @ 9.42 fps)

Pond 57P: DI-3C

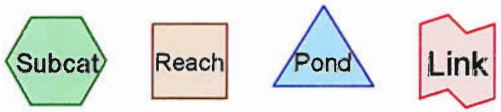


HydroCAD Analysis for Pre-developed Condition
(25 – Year Storm Event)


Discharge point #1
1.8 AC
8.5 AC
Discharge Point #2
PRE - DEVELOPMENT CONDITION
1" = 300'

Drainage Area-1

Drainage Area -2



Drainage Diagram for Avery County - pre development flow

7/15/2008

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Subcatchment 1S: Drainage Area-1

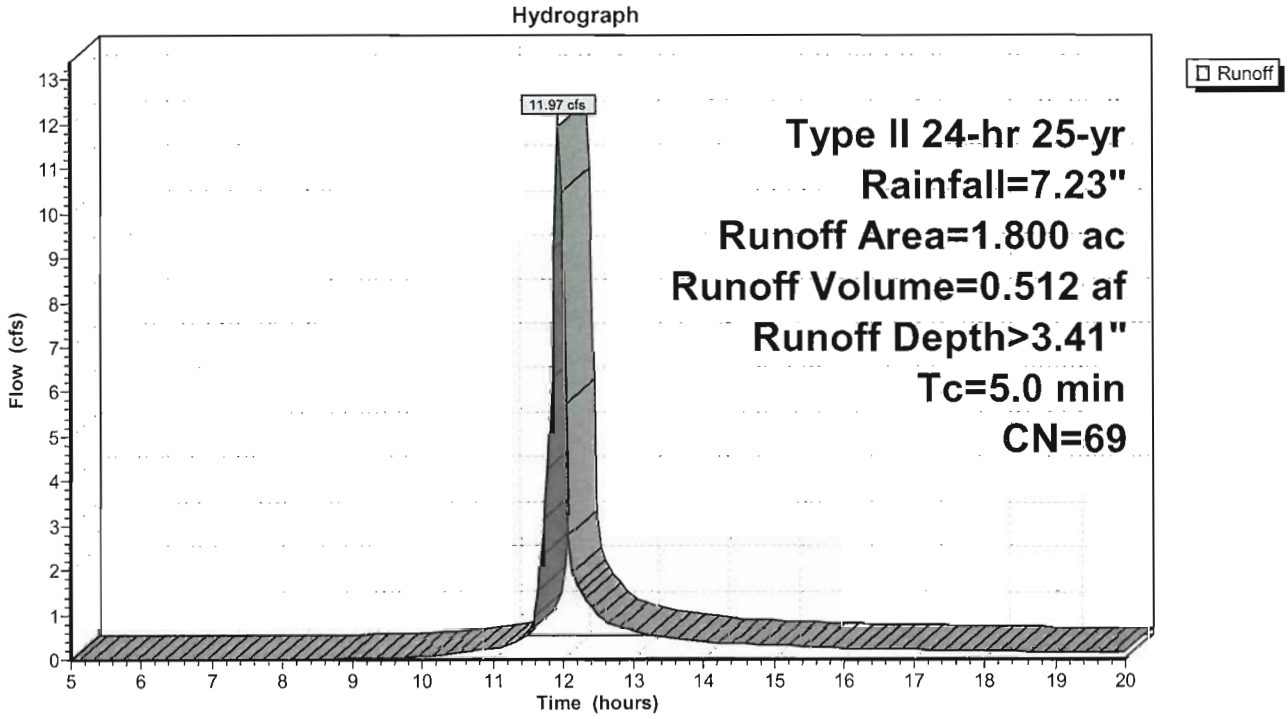
Runoff = 11.97 cfs @ 11.96 hrs, Volume= 0.512 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
1.800	69	50-75% Grass cover, Fair, HSG B
1.800		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Drainage Area-1



Subcatchment 2S: Drainage Area -2

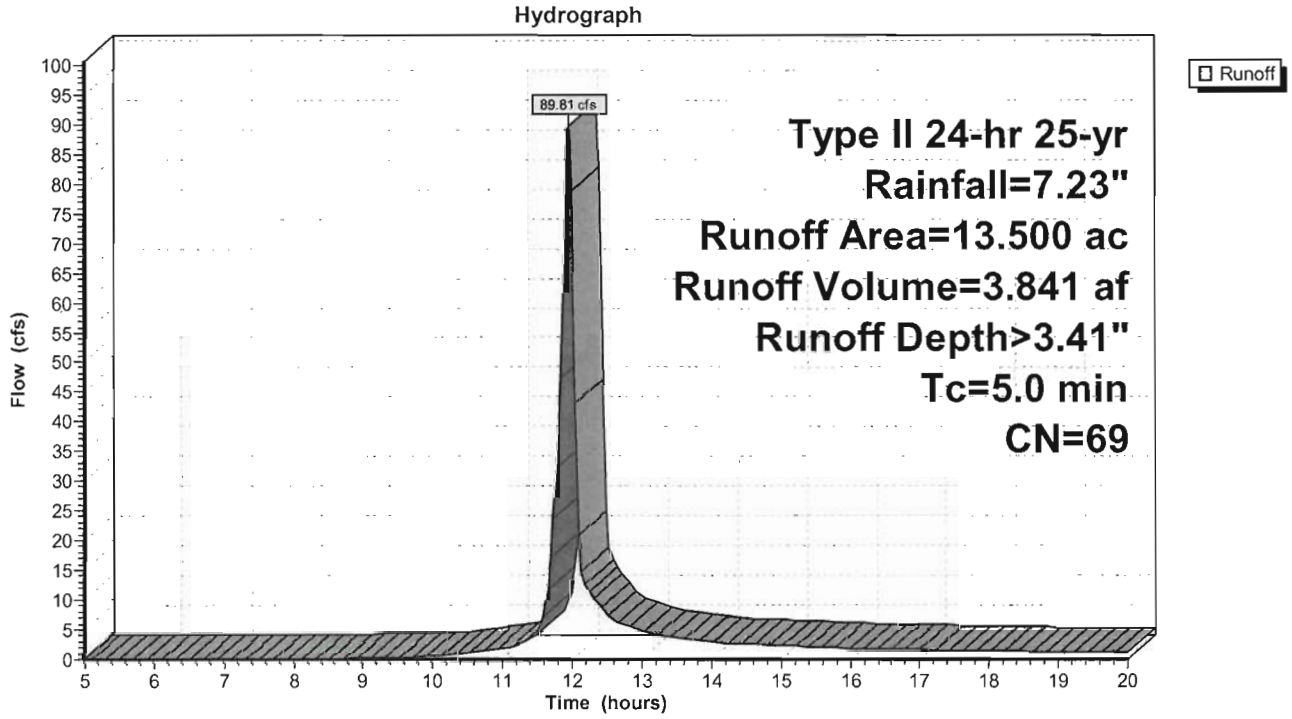
Runoff = 89.81 cfs @ 11.96 hrs, Volume= 3.841 af, Depth> 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=7.23"

Area (ac)	CN	Description
13.500	69	50-75% Grass cover, Fair, HSG B
13.500		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: Drainage Area -2



HydroCAD Analysis for Post-developed Condition
(10 – Year Storm Event)

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 23S: DA - 4 Runoff Area=2.700 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=12.86 cfs 0.545 af

Subcatchment 31S: DA - 3 Runoff Area=0.570 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=2.72 cfs 0.115 af

Subcatchment 35S: DA - 2 Runoff Area=5.700 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=27.15 cfs 1.150 af

Subcatchment 41S: DA - 1 Runoff Area=3.730 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=17.77 cfs 0.753 af

Subcatchment 53S: DA-3D Runoff Area=1.200 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=5.72 cfs 0.242 af

Subcatchment 58S: DA-3A Runoff Area=1.070 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=5.10 cfs 0.216 af

Subcatchment 59S: DA-3B Runoff Area=1.920 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=9.15 cfs 0.387 af

Subcatchment 60S: DA-3C Runoff Area=1.560 ac Runoff Depth>2.42"
Tc=5.0 min CN=69 Runoff=7.43 cfs 0.315 af

Reach 45R: DP-1 Avg. Depth=0.56' Max Vel=28.90 fps Inflow=17.77 cfs 0.753 af
D=18.0" n=0.013 L=520.0' S=0.3115 '/' Capacity=58.63 cfs Outflow=17.29 cfs 0.752 af

Reach 46R: DP-2 Avg. Depth=0.72' Max Vel=31.70 fps Inflow=27.15 cfs 1.150 af
D=18.0" n=0.013 L=750.0' S=0.2960 '/' Capacity=57.15 cfs Outflow=26.21 cfs 1.149 af

Reach 47R: DP-3 Avg. Depth=0.66' Max Vel=24.30 fps Inflow=18.54 cfs 0.787 af
D=18.0" n=0.013 L=320.0' S=0.1875 '/' Capacity=45.49 cfs Outflow=18.17 cfs 0.786 af

Reach 58R: DC-2 Avg. Depth=0.08' Max Vel=2.92 fps Inflow=1.85 cfs 0.468 af
n=0.035 L=340.0' S=0.1471 '/' Capacity=140.52 cfs Outflow=1.85 cfs 0.465 af

Reach 59R: DC-1 Avg. Depth=0.08' Max Vel=2.97 fps Inflow=1.88 cfs 0.507 af
n=0.035 L=370.0' S=0.1514 '/' Capacity=142.56 cfs Outflow=1.88 cfs 0.504 af

Reach 60R: C-4 Avg. Depth=0.34' Max Vel=19.15 fps Inflow=5.72 cfs 0.242 af
D=18.0" n=0.013 L=75.0' S=0.2400 '/' Capacity=51.46 cfs Outflow=5.68 cfs 0.242 af

Pond 26P: Basin - 4 Peak Elev=2,867.15' Storage=21,266 cf Inflow=18.17 cfs 0.786 af
Primary=1.04 cfs 0.320 af Secondary=0.00 cfs 0.000 af Outflow=1.04 cfs 0.320 af

Pond 34P: Basin -3 Peak Elev=2,934.23' Storage=26,017 cf Inflow=24.39 cfs 1.033 af
Primary=1.85 cfs 0.468 af Secondary=0.00 cfs 0.000 af Outflow=1.85 cfs 0.468 af

Pond 36P: Basin - 2 Peak Elev=2,948.23' Storage=29,455 cf Inflow=26.21 cfs 1.149 af
Primary=1.88 cfs 0.507 af Secondary=0.00 cfs 0.000 af Outflow=1.88 cfs 0.507 af

Pond 44P: Basin - 1 Peak Elev=3,011.58' Storage=24,419 cf Inflow=17.29 cfs 0.752 af
Primary=0.50 cfs 0.200 af Secondary=0.00 cfs 0.000 af Outflow=0.50 cfs 0.200 af

Pond 55P: DI-3A Peak Elev=3,014.12' Inflow=5.10 cfs 0.216 af
18.0" x 200.0' Culvert Outflow=5.10 cfs 0.216 af

Pond 56P: DI-3B Peak Elev=2,971.87' Inflow=14.24 cfs 0.603 af
24.0" x 250.0' Culvert Outflow=14.24 cfs 0.603 af

Pond 57P: DI-3C Peak Elev=2,937.05' Inflow=21.68 cfs 0.918 af
24.0" x 170.0' Culvert Outflow=21.68 cfs 0.918 af

Total Runoff Area = 18.450 ac Runoff Volume = 3.722 af Average Runoff Depth = 2.42"
100.00% Pervious Area = 18.450 ac 0.00% Impervious Area = 0.000 ac

Subcatchment 23S: DA - 4

Runoff = 12.86 cfs @ 11.96 hrs, Volume= 0.545 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
2.700	69	50-75% Grass cover, Fair, HSG B
2.700		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 31S: DA - 3

Runoff = 2.72 cfs @ 11.96 hrs, Volume= 0.115 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
0.570	69	50-75% Grass cover, Fair, HSG B
0.570		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 35S: DA - 2

Runoff = 27.15 cfs @ 11.96 hrs, Volume= 1.150 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
5.700	69	50-75% Grass cover, Fair, HSG B
5.700		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 41S: DA - 1

Runoff = 17.77 cfs @ 11.96 hrs, Volume= 0.753 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
3.730	69	50-75% Grass cover, Fair, HSG B
3.730		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 53S: DA-3D

Runoff = 5.72 cfs @ 11.96 hrs, Volume= 0.242 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
1.200	69	50-75% Grass cover, Fair, HSG B
1.200		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 58S: DA-3A

Runoff = 5.10 cfs @ 11.96 hrs, Volume= 0.216 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
1.070	69	50-75% Grass cover, Fair, HSG B
1.070		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 59S: DA-3B

Runoff = 9.15 cfs @ 11.96 hrs, Volume= 0.387 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
1.920	69	50-75% Grass cover, Fair, HSG B
1.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 60S: DA-3C

Runoff = 7.43 cfs @ 11.96 hrs, Volume= 0.315 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
1.560	69	50-75% Grass cover, Fair, HSG B
1.560		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

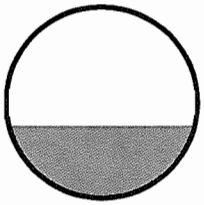
Reach 45R: DP-1

Inflow Area = 3.730 ac, Inflow Depth > 2.42" for 10-yr event
Inflow = 17.77 cfs @ 11.96 hrs, Volume= 0.753 af
Outflow = 17.29 cfs @ 11.97 hrs, Volume= 0.752 af, Atten= 3%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 28.90 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 9.90 fps, Avg. Travel Time= 0.9 min

Peak Storage= 316 cf @ 11.96 hrs, Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 58.63 cfs

18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 520.0' Slope= 0.3115 '/'
Inlet Invert= 3,170.00', Outlet Invert= 3,008.00'



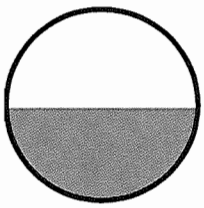
Reach 46R: DP-2

Inflow Area = 5.700 ac, Inflow Depth > 2.42" for 10-yr event
Inflow = 27.15 cfs @ 11.96 hrs, Volume= 1.150 af
Outflow = 26.21 cfs @ 11.97 hrs, Volume= 1.149 af, Atten= 3%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 31.70 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 11.03 fps, Avg. Travel Time= 1.1 min

Peak Storage= 632 cf @ 11.97 hrs, Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 57.15 cfs

18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 750.0' Slope= 0.2960 '/'
Inlet Invert= 3,170.00', Outlet Invert= 2,948.00'



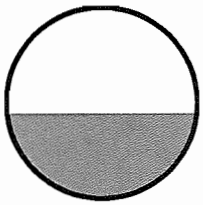
Reach 47R: DP-3

Inflow Area = 3.900 ac, Inflow Depth > 2.42" for 10-yr event
Inflow = 18.54 cfs @ 11.96 hrs, Volume= 0.787 af
Outflow = 18.17 cfs @ 11.97 hrs, Volume= 0.786 af, Atten= 2%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 24.30 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 8.40 fps, Avg. Travel Time= 0.6 min

Peak Storage= 242 cf @ 11.96 hrs, Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 45.49 cfs

18.0" Diameter Pipe, n= 0.013 Corrugated PE, smooth interior
Length= 320.0' Slope= 0.1875 '/'
Inlet Invert= 2,930.00', Outlet Invert= 2,870.00'



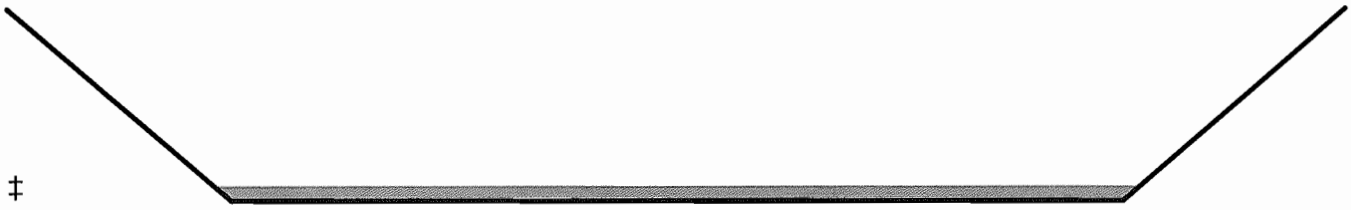
Reach 58R: DC-2

Inflow Area = 5.120 ac, Inflow Depth > 1.10" for 10-yr event
Inflow = 1.85 cfs @ 12.59 hrs, Volume= 0.468 af
Outflow = 1.85 cfs @ 12.65 hrs, Volume= 0.465 af, Atten= 0%, Lag= 3.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.92 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.91 fps, Avg. Travel Time= 3.0 min

Peak Storage= 215 cf @ 12.61 hrs, Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 140.52 cfs

8.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 340.0' Slope= 0.1471 '/'
Inlet Invert= 2,928.00', Outlet Invert= 2,878.00'



‡

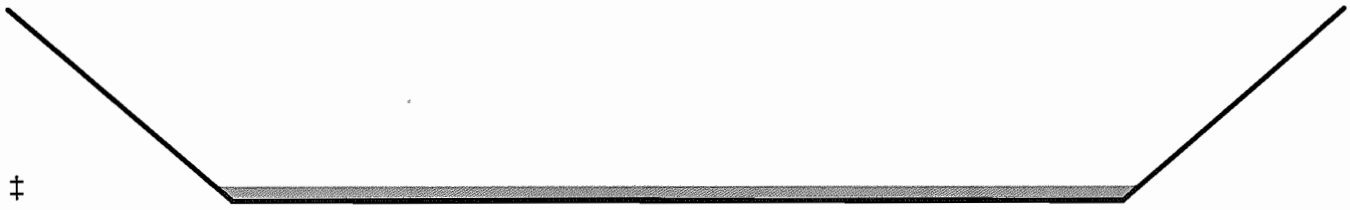
Reach 59R: DC-1

Inflow Area = 5.700 ac, Inflow Depth > 1.07" for 10-yr event
Inflow = 1.88 cfs @ 12.71 hrs, Volume= 0.507 af
Outflow = 1.88 cfs @ 12.77 hrs, Volume= 0.504 af, Atten= 0%, Lag= 3.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.97 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 2.00 fps, Avg. Travel Time= 3.1 min

Peak Storage= 235 cf @ 12.74 hrs, Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 142.56 cfs

8.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 370.0' Slope= 0.1514 '/'
Inlet Invert= 2,942.00', Outlet Invert= 2,886.00'



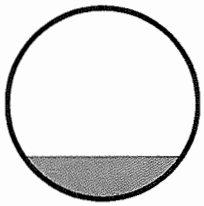
Reach 60R: C-4

Inflow Area =	1.200 ac,	Inflow Depth >	2.42"	for	10-yr event
Inflow =	5.72 cfs @	11.96 hrs,	Volume=	0.242 af	
Outflow =	5.68 cfs @	11.96 hrs,	Volume=	0.242 af,	Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 19.15 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.45 fps, Avg. Travel Time= 0.2 min

Peak Storage= 22 cf @ 11.96 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 51.46 cfs

18.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 75.0' Slope= 0.2400 '/'
Inlet Invert= 2,918.00', Outlet Invert= 2,900.00'



Pond 26P: Basin - 4

Inflow Area =	3.900 ac,	Inflow Depth >	2.42"	for	10-yr event
Inflow =	18.17 cfs @	11.97 hrs,	Volume=	0.786 af	
Outflow =	1.04 cfs @	13.02 hrs,	Volume=	0.320 af,	Atten= 94%, Lag= 63.2 min
Primary =	1.04 cfs @	13.02 hrs,	Volume=	0.320 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,867.15' @ 13.02 hrs Surf.Area= 8,302 sf Storage= 21,266 cf

Plug-Flow detention time= 213.2 min calculated for 0.320 af (41% of inflow)
Center-of-Mass det. time= 127.2 min (920.7 - 793.5)

Volume	Invert	Avail.Storage	Storage Description
#1	2,864.00'	49,396 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,864.00	5,293	0	0
2,866.00	7,109	12,402	12,402
2,868.00	9,184	16,293	28,695
2,870.00	11,517	20,701	49,396

Device	Routing	Invert	Outlet Devices
#1	Primary	2,864.00'	**15.0" x 60.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,860.00' S= 0.0667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	2,867.00'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Primary	2,865.50'	**2.0" Vert. Orifice/Grate** C= 0.600
#4	Secondary	2,868.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=1.03 cfs @ 13.02 hrs HW=2,867.15' (Free Discharge)
└─**1=Culvert** (Passes 0.90 cfs of 9.39 cfs potential flow)
└─**2=Riser** (Weir Controls 0.90 cfs @ 1.27 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.13 cfs @ 6.03 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=2,864.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 34P: Basin -3

Inflow Area =	5.120 ac,	Inflow Depth >	2.42"	for	10-yr event
Inflow =	24.39 cfs @	11.96 hrs,	Volume=	1.033 af	
Outflow =	1.85 cfs @	12.59 hrs,	Volume=	0.468 af,	Atten= 92%, Lag= 37.8 min
Primary =	1.85 cfs @	12.59 hrs,	Volume=	0.468 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,934.23' @ 12.59 hrs Surf.Area= 7,858 sf Storage= 26,017 cf

Plug-Flow detention time= 192.0 min calculated for 0.467 af (45% of inflow)
Center-of-Mass det. time= 108.2 min (901.2 - 793.0)

Volume	Invert	Avail.Storage	Storage Description
#1	2,929.00'	42,088 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,929.00	2,524	0	0
2,930.00	3,325	2,925	2,925
2,932.00	5,234	8,559	11,484
2,934.00	7,549	12,783	24,267
2,936.00	10,272	17,821	42,088

Device	Routing	Invert	Outlet Devices
#1	Primary	2,929.00'	**15.0" x 100.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900 Outlet Invert= 2,928.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	2,934.00'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Device 1	2,931.50'	**2.0" Vert. Orifice/Grate** C= 0.600
#4	Secondary	2,935.00'	**10.0' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.84 cfs @ 12.59 hrs HW=2,934.23' (Free Discharge)
└─**1=Culvert** (Passes 1.84 cfs of 10.01 cfs potential flow)
  ├─**2=Riser** (Weir Controls 1.67 cfs @ 1.56 fps)
  └─**3=Orifice/Grate** (Orifice Controls 0.17 cfs @ 7.83 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=2,929.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 36P: Basin - 2

Inflow Area =	5.700 ac,	Inflow Depth >	2.42"	for	10-yr event
Inflow =	26.21 cfs @	11.97 hrs,	Volume=	1.149 af	
Outflow =	1.88 cfs @	12.71 hrs,	Volume=	0.507 af,	Atten= 93%, Lag= 44.4 min
Primary =	1.88 cfs @	12.71 hrs,	Volume=	0.507 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,948.23' @ 12.71 hrs Surf.Area= 8,423 sf Storage= 29,455 cf

Plug-Flow detention time= 197.5 min calculated for 0.507 af (44% of inflow)
Center-of-Mass det. time= 112.6 min (906.5 - 793.9)

Volume	Invert	Avail.Storage	Storage Description
#1	2,943.00'	46,331 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,943.00	3,153	0	0
2,944.00	4,001	3,577	3,577
2,946.00	5,919	9,920	13,497
2,948.00	8,134	14,053	27,550
2,950.00	10,647	18,781	46,331

Device	Routing	Invert	Outlet Devices
#1	Primary	2,943.00'	**15.0" x 50.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,942.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	2,948.00'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Device 1	2,945.50'	**2.0" Vert. Perforated Holes** C= 0.600
#4	Secondary	2,949.00'	**20.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60

Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.87 cfs @ 12.71 hrs HW=2,948.23' (Free Discharge)
└─**1=Culvert** (Passes 1.87 cfs of 12.68 cfs potential flow)
  ├─**2=Riser** (Weir Controls 1.70 cfs @ 1.57 fps)
  └─**3=Perforated Holes** (Orifice Controls 0.17 cfs @ 7.83 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=2,943.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 44P: Basin - 1

Inflow Area =	3.730 ac,	Inflow Depth >	2.42"	for	10-yr event
Inflow =	17.29 cfs @	11.97 hrs,	Volume=	0.752 af	
Outflow =	0.50 cfs @	14.95 hrs,	Volume=	0.200 af,	Atten= 97%, Lag= 178.9 min
Primary =	0.50 cfs @	14.95 hrs,	Volume=	0.200 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 3,011.58' @ 14.95 hrs Surf.Area= 8,868 sf Storage= 24,419 cf

Plug-Flow detention time= 279.7 min calculated for 0.200 af (27% of inflow)
Center-of-Mass det. time= 187.9 min (981.6 - 793.7)

Volume	Invert	Avail.Storage	Storage Description
#1	3,008.00'	49,609 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
3,008.00	4,888	0	0
3,010.00	6,992	11,880	11,880
3,012.00	9,365	16,357	28,237
3,014.00	12,007	21,372	49,609

Device	Routing	Invert	Outlet Devices
#1	Primary	3,008.00'	**15.0" x 45.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 3,006.00' S= 0.0444 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	3,011.50'	**18.0" Horiz. Riser** Limited to weir flow C= 0.600
#3	Device 1	3,010.00'	**2.0" Vert. Orifice/Grate** C= 0.600
#4	Secondary	3,012.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.48 cfs @ 14.95 hrs HW=3,011.58' (Free Discharge)
└─**1=Culvert** (Passes 0.48 cfs of 10.16 cfs potential flow)
  ├─**2=Riser** (Weir Controls 0.36 cfs @ 0.93 fps)
  └─**3=Orifice/Grate** (Orifice Controls 0.13 cfs @ 5.89 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=3,008.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 55P: DI-3A

Inflow Area = 1.070 ac, Inflow Depth > 2.42" for 10-yr event
Inflow = 5.10 cfs @ 11.96 hrs, Volume= 0.216 af
Outflow = 5.10 cfs @ 11.96 hrs, Volume= 0.216 af, Atten= 0%, Lag= 0.0 min
Primary = 5.10 cfs @ 11.96 hrs, Volume= 0.216 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 3,014.12' @ 11.96 hrs
Flood Elev= 3,016.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	3,013.00'	**18.0" x 200.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,973.00' S= 0.2000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=4.96 cfs @ 11.96 hrs HW=3,014.10' (Free Discharge)
└**1=Culvert** (Inlet Controls 4.96 cfs @ 3.57 fps)

Pond 56P: DI-3B

Inflow Area = 2.990 ac, Inflow Depth > 2.42" for 10-yr event
Inflow = 14.24 cfs @ 11.96 hrs, Volume= 0.603 af
Outflow = 14.24 cfs @ 11.96 hrs, Volume= 0.603 af, Atten= 0%, Lag= 0.0 min
Primary = 14.24 cfs @ 11.96 hrs, Volume= 0.603 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,971.87' @ 11.96 hrs
Flood Elev= 2,976.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	2,970.00'	**24.0" x 250.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 2,939.00' S= 0.1240 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=13.88 cfs @ 11.96 hrs HW=2,971.83' (Free Discharge)
└**1=Culvert** (Inlet Controls 13.88 cfs @ 4.61 fps)

Pond 57P: DI-3C

Inflow Area = 4.550 ac, Inflow Depth > 2.42" for 10-yr event
Inflow = 21.68 cfs @ 11.96 hrs, Volume= 0.918 af
Outflow = 21.68 cfs @ 11.96 hrs, Volume= 0.918 af, Atten= 0%, Lag= 0.0 min
Primary = 21.68 cfs @ 11.96 hrs, Volume= 0.918 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 2,937.05' @ 11.96 hrs
Flood Elev= 2,942.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	2,934.00'	**24.0" x 170.0' long Culvert** CPP, square edge headwall, Ke= 0.500

Outlet Invert= 2,930.00' S= 0.0235 '/' Cc= 0.900
n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=21.10 cfs @ 11.96 hrs HW=2,936.95' (Free Discharge)
└─**1=Culvert** (Inlet Controls 21.10 cfs @ 6.72 fps)

HydroCAD Analysis for Pre-developed Condition
(10 – Year Storm Event)

Subcatchment 1S: Drainage Area-1

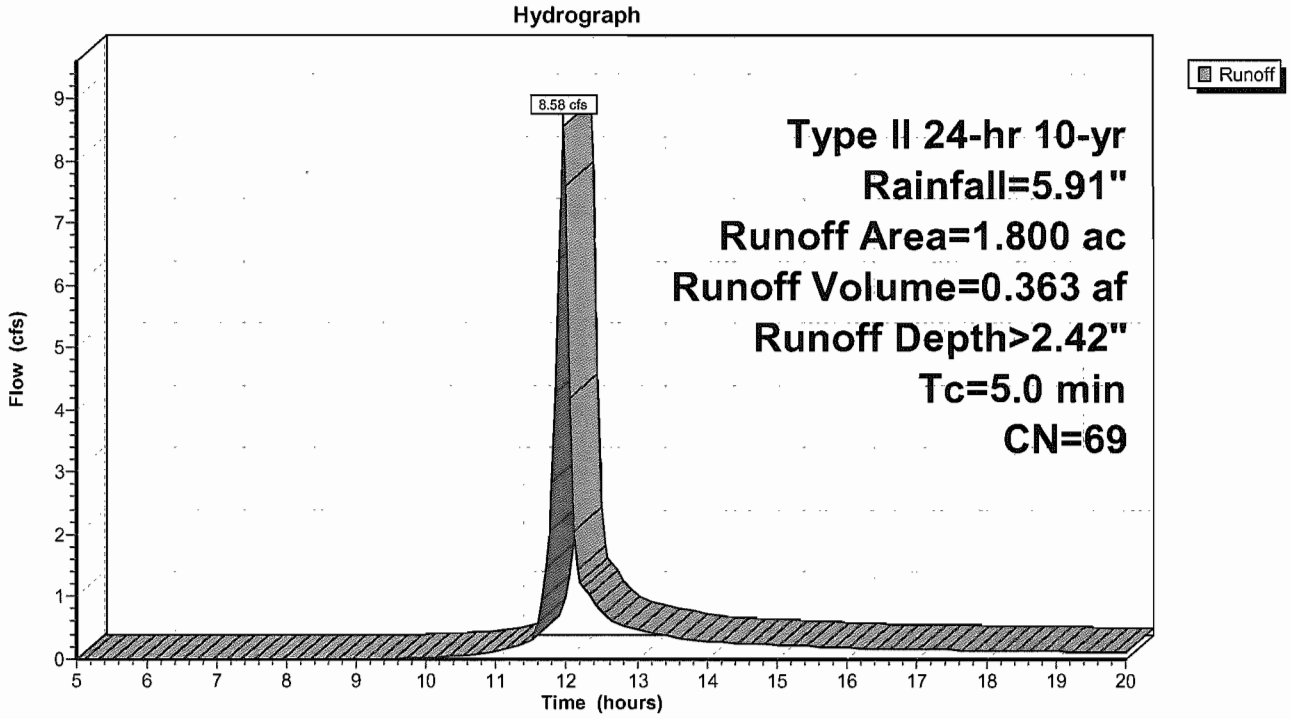
Runoff = 8.58 cfs @ 11.96 hrs, Volume= 0.363 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
1.800	69	50-75% Grass cover, Fair, HSG B
1.800		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Drainage Area-1



Subcatchment 2S: Drainage Area -2

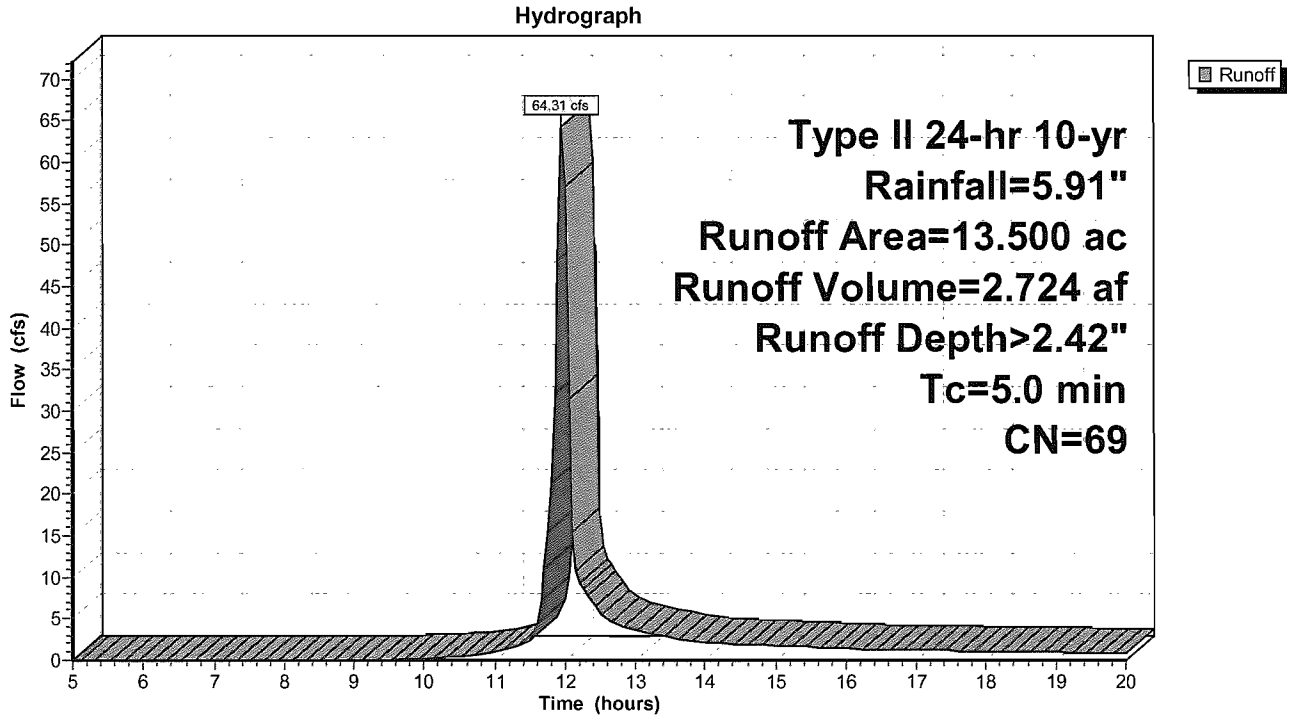
Runoff = 64.31 cfs @ 11.96 hrs, Volume= 2.724 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.91"

Area (ac)	CN	Description
13.500	69	50-75% Grass cover, Fair, HSG B
13.500		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: Drainage Area -2



Cascade Analysis

PROJECT Avery County C&D Landfill

SUBJECT Cascade Analysis

JOB NO. AVERY-08-1
DATE 9/4/08
COMPUTED BY TBM
CHECKED BY

Objective

To design cascades (i.e., stepped rock chutes) to handle stormwater flow from the design storm(s). The main design criteria will be to ensure that all cascades will be able to accommodate the peak discharge from the design storm without overtopping and without exceeding the allowable shear stress and/or velocity of the selected channel lining.

Comments

The cascade is a hybrid between an artificial rock chute and a natural stepped-bed high-gradient stream. The stepped-bed configuration is used to: i) dissipate energy and thus maintain stability of the channel lining under high-gradient flow conditions; and ii) create turbulent and nappe flows to achieve evaporative cooling and increase dissolved oxygen during warm months (rendering the outflow suitable for discharge to cold water streams). The cascade is not designed to become aquatic habitat. It is designed to prepare sediment basin outflow to be suitable for discharge to cold water streams.

References

See all references cited under Drainage Channels.

Chanson, Hubert (2000), "Hydraulics of Stepped Spillways," *Journal of Hydraulic Engineering,* 126:9, 636-637.

Thomas, D.B., S.R. Abt, R.A. Mussetter, M.D. Harvey (2000), "A Design Procedure for Sizing Step-Pool Structures," *Proceedings of the Joint Conference on Water Resource Engineering and Water Resources Planning and Management.*

Analysis

The following approach is used in the design of cascades:

1. The reaches between steps are analyzed as riprap-lined channels. The riprap size is selected to be stable for peak flow from the design storm based on the slope of the reach. This analysis is performed using the DRAINAGE CHANNEL spreadsheet. The selected slope should generally not exceed 10 percent in order to achieve stability without unmanageably large riprap.It is assumed that the energy from the steep drops at steps is dissipated in the nappe flow/impact/hydraulic jump at the steps.
2. The independent variable in the design process is the step height. A step height of 2 feet has been selected based on the observed maximum step height of 1.5 to 2 feet in natural steep streams. The steps are constructed of boulders having maximum dimensions of 2 to 3 feet, which is the pattern found in natural steep streams.
3. Based on the ground slope along the alignment of the cascade, the lengths of the reaches between the steps are selected.
4. Based on the selected step heights and lengths, a calculation is performed to verify that flow is in the nappe regime and not the skimming flow regime. Based on typical design conditions for sediment basin outflow, skimming flow is very unlikely.

Calculations

- Number of Steps:

$$n = \frac{(\Delta y - S\Delta x)}{H}$$

where:
n = number of steps (dimensionless)
Δy = vertical height of cascade alignment (ft)
Δx = horizontal length of cascade alignment (ft)
S = slope of reaches (dimensionless)
H = step height (ft)

- Length of Reaches Between Steps:

$$L = \frac{\Delta x}{n+1}$$

where:
L = step length (also called reach length) (ft)
n = number of steps (dimensionless)
Δx = horizontal length of cascade alignment (ft)

- Conditions for Nappe Flow:

$$\frac{d_c}{H} = 0.09\left(\frac{H}{L}\right)^{-13}$$

where:
d_c = critical depth (ft)
H = step height (ft)
L = step length (also called reach length) (ft)

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

SHEET: 2A, 5
JOB #: AVERY-07-1
DATE: 9/9/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Drainage Channel Analysis (Rip Rap Lined)

Channel No. SB-1 outlet cascade

Design Parameters:

PEAK DISCHARGE, Q25 = 6.9 ft^3/s Source: HydroCAD 100-Yr 24-Hr

Bottom Width, B = 4.0 ft
Left Side Slope, z_1 = 2.0 horizontal :1 vertical
Right Side Slope, z_2 = 2.0 horizontal :1 vertical
Minimum Freeboard = 0.1 ft

Rip Rap Lining:
D_{50} = 1.00 ft
V_{allow} = 13.0 ft/sec
τ_{allow} = 4.0 lb/ft^2

Maximum Channel Slope, S_{max} = 0.100 ft/ft
Minimum Channel Slope, S_{min} = 0.010 ft/ft

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:													
0.55	0.108	2.81	6.46	0.43	6.20	0.45	2.50	7.0	0.66	**3.4**	S	1.2	**O.K.**
Minimum Slope:													
0.86	0.077	4.92	7.85	0.63	7.44	0.66	1.41	6.9	0.31	**0.5**	V	9.2	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.42	0.148	2.03	5.88	0.35	5.68	0.36	1.22	6.9	3.39	1.00	0.466	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
0.65	6.60	**0.96**	**7.84**

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SHEET: 3 / 5
JOB #: AVERY-07-1
DATE: 9/3/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Drainage Channel Analysis (Rip Rap Lined)

Channel No. SB-2 outlet cascade

Design Parameters:

PEAK DISCHARGE, $Q25$ = 23.2 ft^3/s Source: HydroCAD 100-Yr 24-Hr

Bottom Width, B = 12.0 ft
Left Side Slope, z_1 = 2.0 horizontal :1 vertical
Right Side Slope, z_2 = 2.0 horizontal :1 vertical

Minimum Freeboard = 0.5 ft

Maximum Channel Slope, S_{max} = 0.100 ft/ft
Minimum Channel Slope, S_{min} = 0.100 ft/ft

Rip Rap Lining:
D_{50} = 1.00 ft
V_{allow} = 13.0 ft/sec
τ_{allow} = 4.0 lb/ft^2

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:													
0.58	0.103	7.63	14.59	0.52	14.32	0.53	2.98	22.7	0.72	**3.6**	S	1.1	**O.K.**
Minimum Slope:													
0.58	0.103	7.63	14.59	0.52	14.32	0.53	2.98	22.7	0.72	**3.6**	S	1.1	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.47	0.127	6.08	14.10	0.43	13.88	0.44	4.03	22.8	3.76	1.00	0.317	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
1.08	16.32	**1.08**	**16.32**

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Raleigh, NC 27603 Fax: 919-828-3899

SHEET: 4 / 5
JOB #: AVERY-07-1
DATE: 9/3/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Drainage Channel Analysis (Rip Rap Lined)

Channel No. SB-3 outlet cascade

Design Parameters:

PEAK DISCHARGE, $Q25$ = 18.0 ft^3/s Source: HydroCAD 100-Yr 24-Hr

Bottom Width, B = 12.0 ft
Left Side Slope, z_1 = 2.0 horizontal :1 vertical
Right Side Slope, z_2 = 2.0 horizontal :1 vertical
Minimum Freeboard = 0.5 ft

Rip Rap Lining:
D_{50} = 1.00 ft
V_{allow} = 13.0 ft/sec
τ_{allow} = 4.0 lb/ft^2

Maximum Channel Slope, S_{max} = 0.050 ft/ft
Minimum Channel Slope, S_{min} = 0.050 ft/ft

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:													
0.61	0.098	8.06	14.73	0.55	14.44	0.56	2.27	18.3	0.53	**1.9**	V	5.7	**O.K.**
Minimum Slope:													
0.61	0.098	8.06	14.73	0.55	14.44	0.56	2.27	18.3	0.53	**1.9**	V	5.7	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.40	0.159	5.12	13.79	0.37	13.60	0.38	3.14	17.8	3.48	1.00	0.516	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
1.11	16.44	**1.11**	**16.44**

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SHEET: 5 / 5
JOB #: Avery 07-1
DATE: 9/9/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Analysis of Cascade Geometry

Geometric Constants: Step height (H) = 2 ft **The recommended step height is 2 ft.**

Calculated Geometry: **Do not select S > 10%.**

Cascade I.D.	Reach I.D.	dx (ft)	dy (ft)	Interstep Slope (S) (%)	Req. No. of Steps	Rounded Number (n)	Typical L (ft)	Calculated dx	Calculated dy	Ave. Slope of Ground
SB-1 OUTLET		24	12	0%	6.0	6	3.4	24	12.0	50.0%
SB-2 OUTLET	UPPER	115	25	10%	6.8	7	14	115	25.5	21.7%
	LOWER	150	28	10%	6.5	7	19	150	29.0	18.7%
SB-3 OUTLET		125	40	5%	16.9	17	7	125	40.3	32.0%

Check for Nappe Flow:

Cascade I.D.	Reach I.D.	d_c (ft)	H (ft)	L (ft)	d_c / H	$0.09*(H/L)^{-13}$	Flow Regime
SB-1 OUTLET		0.42	2	3.4	0.2	9.9E+01	Nappe
SB-2 OUTLET	UPPER	0.47	2	14.4	0.2	1.2E+10	Nappe
	LOWER	0.47	2	18.8	0.2	3.9E+11	Nappe
SB-3 OUTLET		0.40	2	6.9	0.2	9.6E+05	Nappe

Note: Critical depth (d_c) is calculated using the DRAINAGE CHANNEL spreadsheet with Q_{100}.

Side Slope Swale Analysis

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SHEET: /
JOB #: Avery 07-1
DATE: 5/29/08
BY: KBS
CHKD BY: GGM

Avery C&D Landfill
Drainage Channel Analysis (TRM Lined)

Channel No. Side Slope Swale Analysis

Design Parameters:

PEAK DISCHARGE, Q25 = 8.6 ft^3/s Source: Rational Method

Bottom Width, B = 0.0 ft
Left Side Slope, z_1 = 1.5 horizontal :1 vertical
Right Side Slope, z_2 = 3.0 horizontal :1 vertical

Minimum Freeboard = 0.5 ft

Maximum Channel Slope, S_{max} = 0.040 ft/ft
Minimum Channel Slope, S_{min} = 0.020 ft/ft

Turf Reinforcement Matting (TRM) Lining:
Grass Retardance = D
K = 34.6
TRM Product Name = Propex - Landlok TRM 435, or equal
τ_{allow} = 5.0 lb/ft^2

Max^m Inflow Area for Grass Swale = 1.70 Acres
As per Rational Method,
Q = CIA (for 25-yr storm)
= 0.6 x 8.4 in/hr x 1.7 Acres
= 8.6 ft^3/s

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Factor of Safety τ_{allow}/τ_d	Comment
Maximum Slope:												
1.10	0.059	2.70	5.44	0.50	4.93	0.55	3.14	8.5	0.75	**2.7**	1.8	**O.K.**
Minimum Slope:												
1.28	0.063	3.72	6.38	0.58	5.78	0.64	2.32	8.6	0.51	**1.6**	3.1	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.99	0.057	2.18	4.89	0.45	4.43	0.49	1.53	8.7	3.98	1.00	0.068	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
1.60	7.18	**1.78**	**8.03**

Downpipe Analysis

PROJECT Avery County C&D Landfill

SUBJECT Down Pipe Analysis

JOB NO. AVERY 07-1
DATE 7/9/08
COMPUTED BY KBS
CHECKED BY GGM

Objective To design down pipes to handle the peak discharge from the design storm.

Reference Debo, T.N., and Reese, A.J. (1995), Municipal Storm Water Management, Lewis Publishers, Boca Raton, FL.

Malcom, H. Rooney (1989 & 2003 Supplement), Elements of Urban Stormwater Design, NC State Univ., Raleigh, NC.

Analysis The following approach is used in the design of down pipes:

1. Determine the peak discharge from the design storm(s). Use the Rational Method.

2. For each pipe size, determine the maximum area (A), to handle the predicted peak discharge (Q) with an added factor of safety. Analyze down pipes based on partial flow to determine flow depth and velocity then compare the full flow capacity of each pipe size with the calculated peak flow rate to verify the desired factor of safety. Analyze down pipe inlets as a culverts under inlet control.

Calculations

- Down Pipe Inlets (Inlet Control):

Determine Q_{max}:

For $Z \leq D$:

$$Q_{\max} = 0.372 C_d D (Z)^{3/2}$$ (Malcom Equation III-13)

For $Z > D$:

$$Q_{\max} = 0.0437 C_d D^2 \left(Z - \frac{D}{24} \right)^{1/2}$$ (Malcom Equation III-13)

where:
Q_{max} = flow capacity of inlet (cfs)
Z = height of water above pipe invert (ft)
= allowable headwater depth (HW)
C_d = coefficient of discharge
D = inside diameter of pipe (in)

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Determine Factor of Safety (FS):

$$FS = \frac{Q_{\max}}{Q}$$

Iterate the drainage area (A) to each inlet such that $Q_{max}/Q \geq$ the desired factor of safety.

- Down Pipes:

Determine Flow Capacity of Pipe:

$$Q_{\max} = \frac{0.463 D^{8/3} S^{1/2}}{n} \qquad \text{(D\&R Equation 8.24)}$$

where:
Q_{max} = flow capacity of pipe (cfs)
D = inside diameter of pipe (ft)
S = pipe slope (ft/ft)
n = Manning's roughness coefficient

Determine Factor of Safety (FS):

$$FS = \frac{Q_{\max}}{Q}$$

Iterate the drainage area (A) to each drainage structure such that $Q_{max}/Q \geq$ the desired factor of safety.

Determine Flow Depth:

$$h = \frac{1}{2}\left(1 - \cos\left(\frac{\theta}{2}\right)\right) D \qquad \text{(D\&R Equation 8.29)}$$

where:
h = flow depth (inches)
θ = central angle

$$\theta = \frac{3\pi}{2}\left[1 - \left(1 - (\pi K)^{1/2}\right)^{1/2}\right]^{1/2} \qquad \text{(D\&R Equation 8.28)}$$

K = constant

$$K = 0.673QnD^{-8/3}S^{-1/2}$$ (D&R Equation 8.27)

Determine Flow Velocity:

$$V = \frac{Q}{A} = \frac{Q}{D^2 \frac{(\theta - \sin\theta)}{8}}$$ (D&R Equation 8.30 for "A")

where: V = flow velocity (ft/sec)
A = cross-sectional area of flow (ft^3)

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SHEET: 3A/3
JOB #: Avery 07-1
DATE: 5/29/07
BY: KBS
CHKD BY: TM

Avery County C&D Landfill
Down Pipe Analysis (HDPE Pipe)

Input Parameters:

Manning's Rougness Coefficient =	**0.009**	--> HDPE Pipe
Runoff Coefficient =	**0.50**	
Rainfall Intensity =	**8.28**	IN/HR ---> 25 YR - 5 MIN STORM
Allowable Headwater Depth (Above Pipe Invert) (Down Pipe Inlets) =	**2.0**	FEET
Orifice Coef. Of Discharge (Down Pipe Inlets) =	**0.6**	TYPICAL

Down Pipe Inlets

ID	Drainage Area (AC)	Runoff Volume (Q) (CFS)	Pipe I.D. (SDR 26) (IN)	X-Sectional Area (SF)	Flow Capacity (Q_{max}) (CFS)	Factor of Safety (>/= 1.10)
Max. Area - 12"	**0.90**	3.73	**11.8**	0.76	4.48	1.20
Max. Area - 14"	**1.10**	4.55	**12.9**	0.91	5.28	1.16
Max. Area - 16"	**1.43**	5.92	**14.8**	1.19	6.75	1.14
Max. Area - 18"	**1.80**	7.45	**16.6**	1.50	8.26	1.11
Max. Area - 24"	**2.80**	11.59	**22.2**	2.69	13.40	1.16

Down Pipes

ID	Drainage Area (AC)	Runoff Volume (Q) (CFS)	Pipe I.D. (SDR 26) (IN)	Pipe Slope (%)	Flow Capacity (Q_{max}) (CFS)	Factor of Safety (>/= 1.10)	K (CONSTANT)	θ (< 265°)	Flow Depth (IN)	Flow Area (SF)	Flow Velocity (FPS)
Max. Area - 12"	**4.50**	18.63	**11.8**	**18**	20.87	1.12	0.278	233	8.53	0.59	31.68
Max. Area - 14"	**5.75**	23.81	**12.9**	**18**	26.47	1.11	0.280	234	9.38	0.71	33.66
Max. Area - 16"	**8.00**	33.12	**14.8**	**18**	38.18	1.15	0.270	229	10.47	0.90	36.64
Max. Area - 18"	**11.00**	45.54	**16.6**	**18**	51.85	1.14	0.274	231	11.86	1.15	39.66
Max. Area - 24"	**24.00**	99.36	**22.2**	**18**	112.57	1.13	0.275	231	15.91	2.06	48.18

Pipe Dimensions

Standard Dimension Ratio (SDR) of Pipe = **26**

Nominal Pipe Size (IN)	Pipe O.D. (IN)	Min. Wall Thickness (IN)	Pipe I.D. (IN)
12	**12.75**	0.490	11.8
14	**14**	0.538	12.9
16	**16**	0.615	14.8
18	**18**	0.692	16.6
24	**24**	0.923	22.2

Drop Inlet Analysis

PROJECT Avery County C&D Landfill	**SHEET** 1 **OF** 1
	JOB NO. AVERY 07-1
	DATE 4/11/2008
SUBJECT Drop Inlet Analysis	**COMPUTED BY** KBS
	CHECKED BY FGM

Objective To design the weir inlet structure for a drop inlet..

Reference 1. "Elements of Urban Storm water Design" by H.Rooney Malcolm, P.E.

Analysis

- Determine Peak Flow Rate to Drop Inlet:

  Use Rational Method ($Q_P = CIA$)

- Weir-Type Inlet ⇒ Use the Weir Equation:

$$Q = C_w L H^{3/2}$$

where:
- Q = Discharge (cfs)
- C_w = Weir Coefficient (=3.0 for Free Overfall)
- L = Length of Weir (ft)
- H = Driving Head (ft) (=Allowable Height of Water above Crest of Weir)

DROPINLET.WPD

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SHEET: /
JOB #: Avery 07-1
DATE: 7/9/08
BY: KBS
CHKD BY: GGM

Avery County C&D Landfill
Drop Inlet Analysis - Drop Inlet Dimensions (Weir-Type)

General Design Parameters:

Min. Outlet Pipe Invert to Bottom of Box (in) = 6.0
Thickness of Base of Box (in) = 6.0

Drop Inlet	Base of Box EL = (A)	Outlet Pipe Invert EL = (B)	Inlet Pipe 1 Invert EL = (C)	Top of Box EL = (E)	Height of Box (ft) (H)
DI-3A	3,012.5	3,013.0	N/A	3,016.0	4.0
DI-3B	2,969.5	2,970.0	2,973.0	2,976.0	7.0
DI-3C	2,933.5	2,934.0	2,939.0	2,942.0	9.0

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SHEET: /
JOB #: Avery 07-1
DATE: 7/9/08
BY: KBS
CHKD BY: FG-M

Avery County C&D Landfill
Drop Inlet Analysis

Drop Inlet Box (ID)	Peak Flow, Qp from HydrCAD - 25 yr storm (cfs)	Remark	Weir Discharge Coefficient, Cw	Length (Perimeter), L (ft)	Assumed Driving Head, H (ft)	Maximum design Flow, Qmax (cfs)	Factor of Safety Q_{all}/Q_p
DI-3A	7	Flow from Side Slope Swale	3	16	1	48.00	6.9
DI-3B	20	Flow from Side Slope Swale	3	16	1	48.00	2.4
DI-3C	30	Flow from Side Slope Swale	3	16	1	48.00	1.6

Sediment Basin Analysis

Objective To design a sediment basin(s) to satisfy erosion and sediment control requirements and to handle the flow from the design storm.

References

American Concrete Pipe Association (1996), "Design Data 41 - Manhole Floatation", ACPA, Irving, TX.

Malcom, H. Rooney (1989 & 2003 Supplement), Elements of Urban Stormwater Design, NC State Univ., Raleigh, NC.

North Carolina Division of Land Resources (2006), North Carolina Erosion & Sediment Control Planning & Design Manual, Raleigh, NC.

Virginia Department of Conservation and Recreation (1992), Virginia Erosion & Sediment Control Handbook, Third Edition, Richmond, VA.

Analysis The following approach is used to properly size and evaluate each sediment basin:

1. Design for Wet (If Applicable) and Dry Storage.
2. Route Design Storm.
3. Design Outlet Structures (Design Riser/Barrel Structures and Perform Riser Base Calculations, Anti-Seepage Collar Calculations, & Emergency Spillway Calculations).

Calculations

- Design for Wet (If Applicable) and Dry Storage:

  - Determine required wet (if applicable) and dry storage volumes based on applicable erosion and sedimentation control requirements.

  - If applicable, calculate the desired surface area at the principal spillway. For some locations:

$$A = 0.01 Q_P$$

where: A = desired surface area (acres)
Q_P = peak discharge from design storm (cfs)
(NC - Use 10-yr 24-hr storm; GA - Use 2-yr 24-hr storm)

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- Set up a stage-storage relationship for the proposed basin as shown below. Based on this relationship and the required volume(s) and/or desired surface area, determine the required wet storage (if applicable) and dry storage elevations. Alternatively the elevation(s) can be determined from a graphical stage-storage relationship.

$$S = K_S Z^b \qquad \text{(Malcom Eq. III-7)}$$

where:
S = storage volume (ft^3)
K_S, b = linear regression constants describing the stage-storage relationship
Z = stage referenced to the bottom elevation included in the analysis (ft)

- Set sediment basin cleanout elevation.

- Size the outlet device to release the dry storage volume (WQ_V) over the desired drawdown period (typically this is a minimum of 24 hours). Use the following equation:

$$A_O = \frac{A_S\sqrt{2h}}{TC_d(20{,}428)}$$

where:
A_o = surface area of dewatering hole(s) (ft^2)
A_s = surface area of basin (at principal spillway) (ft^2)
h = average head of water above hole (= (elev. of principal spillway - elev. of wet storage or (if not applicable) bottom of basin)/2) (ft)
C_d = coefficient of contraction (=0.60)
T = detention time (hrs.) (vary over recommended limits)

Select a standard pipe size and number of holes. Verify that the projected drawdown period is within the recommended limits.

- Size a drain for the basin for maintenance (and emergency situations). The drain should dewater the basin (to principal spillway) within 24 hours. Use the above equation to determine A_o of the basin drain. The inlet of the drain should be protected from the sediment storage zone.

- Evaluate basin shape. Compare with the recommended length to width ratio. If this ratio is not achieved, the basin should be modified or baffles should be added as required.

- Route Design Storm:

  - Route the design storm through the basin and determine the maximum pool elevation and the peak discharge (via HydroCAD, spreadsheet methods, or other). Depending on local requirements, multiple design storms may need to be considered and the peak discharge may need to be compared with the pre-development value.

  - Based on the peak stage of the design storm, check settling efficiency of the design particle. The design particle is typically 40 microns (0.04 mm) (within silt size criteria).

    - Settling Velocity of Design Particle

$$V_O = \frac{g}{18}\left[\frac{(S_S - 1)}{\nu}\right]d^2 \qquad \text{(Malcom Eq. IV-3)}$$

where:
V_o = settling velocity (ft/s) - convert from (m/s)
g = gravitational acceleration (m/s^2)
S_s = specific gravity of design particle
υ = kinematic viscosity of the fluid (m^2/s)
(= 1.14 x 10^{-6} m^2/s @ 15°C Ref. Streeter, 1975)
d = diameter of design particle (m)

    - Surface Area

$$A_S = bK_S Z^{(b-1)} \qquad \text{(Malcom Eq. IV-7)}$$

where:
A_S = surface area at given stage (Z) (ft)
K_S, b = linear regression constants describing the stage-storage relationship

    - Settling Efficiency

$$E = 1 - \left[1 + \frac{V_O A_S}{NQ}\right]^{-N} \qquad \text{(Malcom Eq. IV-1)}$$

where:
E = settling efficiency (decimal fraction - convert to %)
A_S = surface area at given stage (Z) (ft)
N = number of effective cells (N = 2 with forebay)
Q = discharge at given stage (Z) (cfs)

- Design of Outlet Structures:

  - Design riser/barrel structures based on information used in routing the design storm.

  - Design base for riser structure to resist design uplift force. Base must have a buoyant weight of at least the design uplift force. If a concrete riser structure is used, the buoyant weight of the riser can be accounted for in the calculations.

    - Design Uplift Force (↑F)

$$\uparrow F = (FS)V_{Riser}\gamma_{H2O} - W_{Riser} - W_{Top} - W_{Soil} - R_{soil}$$

where:
$\uparrow F$ = design uplift force (lbs)
FS = factor of safety (use 1.25)
V_{Riser} = interior volume of the riser (ft^2)
γ_{H2O} = density of water (62.4 pcf)
W_{Riser} = buoyant weight of riser (not including base or top) (lbs)
W_{Top} = buoyant weight of riser top (lbs)
W_{Soil} = buoyant weight of soil backfill around riser (above base projection) (lbs)
R_{Soil} = sliding resistance of soil backfill around riser (lbs)*

* See American Concrete Pipe Association Design Data 41 for more information.

    - Volume of Concrete for Base

$$V_{Conc} = \frac{\uparrow F}{W_{Conc,B}} = \frac{\uparrow F}{(150 - 62.4)}$$

where:
V_{Conc} = volume of concrete (ft^2)
$W_{Conc,B}$ = buoyant weight of concrete (150 - 62.4 = 87.6 lbs)

  - Determine anti-seepage collar requirements based on the following equation. Alternatively, a filter diaphragm may be designed.

$$L_S = y(z+4)\left[1 + \frac{s}{(0.25 - s)}\right]$$ (VA E&SC Handbook p. III-102)

where:
L_S = length of pipe in the saturated zone (ft)
y = distance from barrel invert to riser crest (ft)
z = slope of upstream embankment (zH:1V)
s = pipe slope (ft/ft)

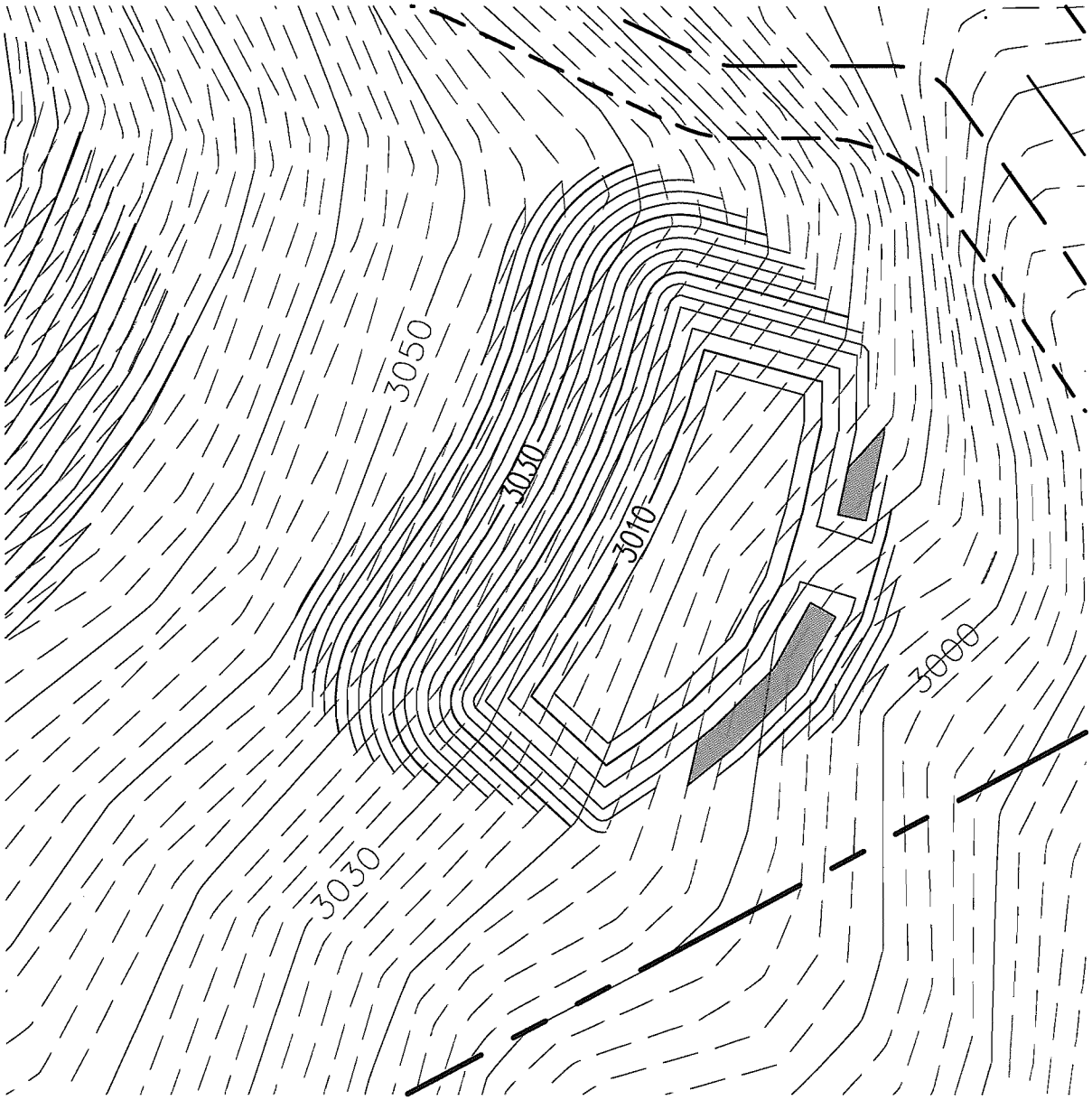
Determine L_S and use design chart to determine anti-seepage collar requirements. If more than one collar is used, the spacing between collars should be 14 times the projection (P) of the collar above the barrel. The first collar should be set at 2P from the riser or a minimum length to bury collar in slope.

- Design crest length of emergency spillway to handle flow from the design storm using the following equation. Determine peak flow from stormwater routing program. If applicable, design outlet channel as a drainage channel or rock chute.

$$Q_P = C_W L H^{3/2} \qquad \text{(Malcom Eq. I-6)}$$

where:

Q_P = peak discharge from design storm (cfs)
C_w = weir coefficient (=3.0 for free overfall)
L = length of weir (ft)
H = driving head (ft) (= allowable headwater above crest of weir or calculated value from stormwater routing program)



BASIN NO. 1 1"=60'

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SHEET: 7 of 25
JOB #: AVERY-07-1
DATE: 5/29/08
BY: KBS
CHKD BY: GGM

Avery County Landfill
Sediment Basin Analysis

Basin No.: Basin-1

DESIGN FOR WET (IF APPLICABLE) AND DRY STORAGE:

Areas Draining Into Basin:

Drainage Area	Area (acres)
A1. Landfill Slopes	3.7
A2. Other Areas	0.0
Total =	3.7 Acres

Basin Requirements:

Wet Storage:

Required Storage Capacity (ft^3/Ac.) =	0	**Enter "0" if Not Applicable.**
Required Storage Capacity (ft^3) =	0	
Required Depth of Wet Storage (ft) =	0.0	**Enter "0" if Not Applicable.**

Dry Storage:

Required Storage Capacity (ft^3/Ac.) =	1,800	**To Crest of Principal Spillway**
Required Storage Capacity (ft^3) =	6,714	
Multiplier (X) for Desired Surface Area (Qp x X) =	0.01	**At Crest of Principal Spillway**
Peak Discharge into Basin (Qp) (cfs) =	17.0	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Desired Surface Aree (Ac) =	0.17	
Desired Surface Area (ft^3) =	7,405	

Determine Stage-Storage Function:

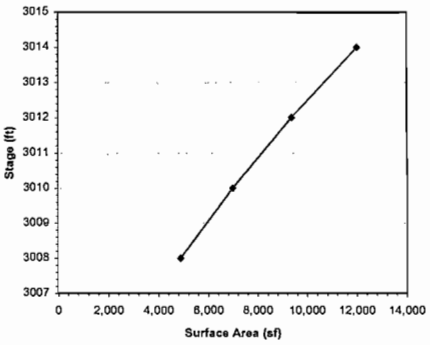
Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
3,008	4,888	0.11		0	0			
3,010	6,992	0.16	11,880	11,880	2	9.38	0.69	2.00
3,012	9,365	0.21	16,357	* 28,237	4	10.25	1.39	4.00
3,014	12,000	0.28	21,365	49,602	6	10.81	1.79	6.00

Linear Regression Constants:

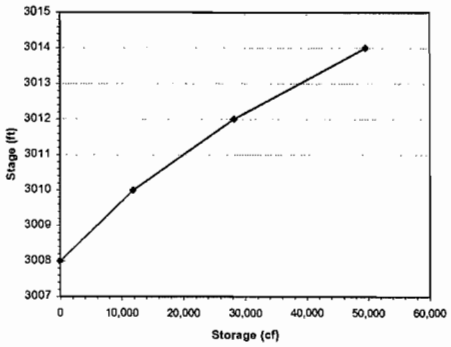
Ks = 4,799 Storage = 4799 z^1.3
b = 1.30

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



SHEET:	8/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	GGM

Basin Design Elevations:

Elev. of Bottom of Basin =	3008.0	

Wet Storage:

Required Storage Capacity (ft^3) =	0	
Min. Elev. of Wet Storage (Permanent Pool) =	3008.0	
Selected Elev. of Wet Storage (Permanent Pool) =	3008.0	O.K.
Actual Wet Storage Volume (ft^3) =	0	O.K.

Dry Storage:

Required Storage Capacity (ft^3) =	6,714	= Required Dry Storage + Actual Wet Storage
Min. Elev. of Principal Spillway =	3009.3	
Selected Elev. of Principal Spillway =	3011.5	O.K.
Actual Total Storage Volume (ft^3) =	24,315	O.K.
Desired Surface Area (ft^3) =	7,405	
Actual Surface Area at Principal Spillway (ft^2) =	8,999	O.K.

Cleanout:

Cleanout Requirement (% of Wet Storage) =	0	Enter "0" if Not Applicable
Cleanout Requirement (% of Total Storage) =	33	
Basin Cleanout Volume (ft^3) =	8,024	Based on 33% of Total Storage Volume
Basin Cleanout Elevation =	3009.5	

Dewatering of Dry Storage:

Average Head (ft) =	1.6	
Surface Area at Principal Spillway (ft^2) =	8,999	
Coef. of Contraction =	0.6	
Min. Drawdown Period (hrs) =	48	
Max. Drawdown Period (hrs) =	120	
Max. Area of Dewatering Hole (ft^2) =	0.03	Based on Min. Detention Time
Max. Diameter of Dewatering Hole (in) =	2.3	
Min. Area of Dewatering Hole (ft^2) =	0.01	Based on Max. Detention Time
Min. Diameter of Dewatering Hole (in) =	1.4	
Selected Diameter of Dewatering Hole(s) (in) =	2.0	
Number of Dewatering Holes =	1	
Actual Area of Dewatering Hole(s) (ft^2) =	0.02	
Actual Drawdown Period (hrs) =	63	O.K.

Basin Drain Calculations:

Average Head (ft) =	1.8	
Surface Area at Principal Spillway (ft^2) =	8,999	
Coef. of Contraction =	0.6	
Desired Drawdown Period (hrs) =	24	
Min. Area of Dewatering Hole (ft^2) =	0.06	Based on Max. Detention Time
Min. Diameter of Dewatering Hole (in) =	3.2	
Selected Diameter of Dewatering Hole (in) =	4	
Actual Area of Dewatering Hole (ft^2) =	0.09	
Actual Drawdown Period (hrs) =	16	O.K.

SHEET:	9125
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	GGM

ROUTE DESIGN STORM: Use HydroCAD or Other Method.

Design Parameters:

Design Storm:	25-Yr, 24-Hr
Design Storm Rainfall (in) =	6.25
Rainfall Distribution:	Type II
Runoff Method:	SCS TR-20

Results:

Maximum Pool Elevation =	3011.8
Surface Area at Maximum Pool (ft^2) =	9,206
Peak Discharge (cfs) =	2.4

Check Settling Efficiency:

Particle Data:

Diam. (microns) =	40	
Specific Gravity =	2.65	
Settling Veloc. (ft/s) =	0.004140	
Reynolds No. (<0.5) =	0.044284	O.K.

Efficiency Data:

Desired Efficiency (%) =	80	
No. of Effective Cells =	2	
Settling Efficiency (%) =	98.7	O.K.

DESIGN OUTLET STRUCTURES:

Design Riser/Barrel Structures:

Riser Design:

Type of Riser:	CPP-Circular
Riser Base Elevation =	3008.0
Riser Top Elevation =	3011.5
Riser Height (ft) =	3.5

Outlets:

Outlet No. 1 (for Dewatering Dry Storage):	Size:	2" Diam. Orifice (x1)	**From Above - Dewatering of Dry Storage**
	Invert Elevation:	3010.0	**May Vary For Multiple Holes**
Outlet No. 2 (Principal Spillway):	Size:	18" Diam. Orifice (x1)	
	Invert Elevation:	3011.5	

Barrel Design:

Type of Barrel:	CPP
Diameter (in) =	15
Inv. In Elevation =	3008.0
Inv. Out Elevation =	2992.0
Length (ft) =	75.0
Slope (ft/ft) =	0.213

SHEET:	10/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	TBM

Riser Base Calculations:

Design Uplift Force:

Factor of Safety =	1.25	
F (unadjusted) (lbs) =	482	
	0	
	0	
	0	
	0	
Buoyant Wt. of Riser Top (lbs) =	0	
Buoyant Wt. of Surrounding Soil Acting on Ext. Base (lbs) =	0	
Sliding Resistance of Surrounding Soil (lbs) =	0	
F (adjusted) (lbs) =	482	

Concrete Base:

Required Volume of Concrete (ft^3) =	5.5	
Length (ft) =	3.0	
Width (ft) =	3.0	
Thickness (ft) =	1.5	
Actual Volume of Concrete (ft^3) =	13.5	**O.K.**

Anti-Seepage Collar Calculations: (Alternatively - Design Filter Diaphragm)

Slope of Upstream Embankment (zH:1V) =	3	
Slope of Outlet Pipe (ft/ft) =	0.044	
Ls (ft) =	30	
Number of Collars:	2	
Length of Each Collar (ft) =	3.0	**From Design Chart Based on Ls and No. of Collars**
Width of Each Collar (ft) =	3.0	**From Design Chart Based on Ls and No. of Collars**
Collar Projection, P (ft) =	0.875	
Spacing of Subsequent Anti-Seep Collars (ft) =	12	**= 14P**

Emergency Spillway Calculations:

Crest Elev. (ft) =	3012.5	
Required Freeboard (ft) =	1.5	
Top of Berm Elev. (ft) =	3014.0	
Required Capacity (cfs) =	0.0	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Driving Head (ft) =	0	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Weir Coefficient =	3.0	
Length of Crest (ft) =	0.0	**Determine by Weir Equation***
Design Crest Length (ft) =	20	

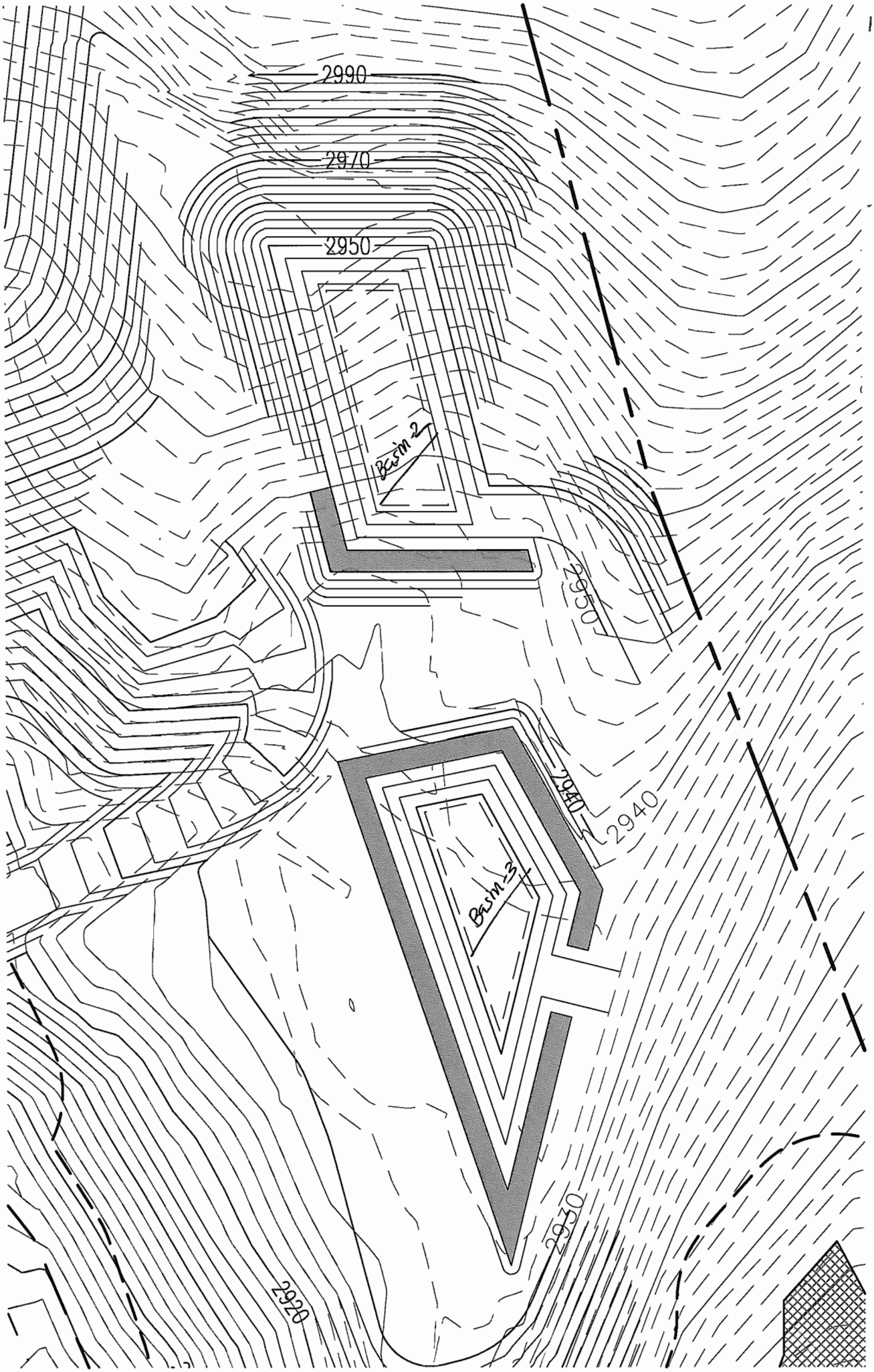
*** Length = 20 ft minimum.**

SUMMARY DATA:

Basin No.: Basin-1

Elev. of Bottom of Basin =	3008.0	
Cleanout Elev. (ft) =	3009.5	
Elev. of Wet Storage (Permanent Pool) =	NA	
Elev. of Principal Spillway =	3011.5	**See Above for Riser and Other Design Information.**
Emergency Spillway Elev. (ft) =	3012.5	
Top of Berm Elev. (ft) =	3014.0	
Top of Berm Width (ft) =	10	
Barrel Diameter (in) =	15	
Barrel Slope (%) =	4.4	

11/25



1"=60'

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

SHEET: 12/25
JOB #: AVERY-07-1
DATE: 5/29/08
BY: KBS
CHKD BY: GGM

Avery County Landfill
Sediment Basin Analysis

Basin No.: Basin - 2

DESIGN FOR WET (IF APPLICABLE) AND DRY STORAGE:

Areas Draining Into Basin:

Drainage Area	Area (acres)
A1. Landfill Slopes	5.7
A2. Other Areas	0.0
Total =	5.7 Acres

Basin Requirements:

Wet Storage:

Required Storage Capacity (ft^3/Ac.) =	0	**Enter "0" if Not Applicable.**
Required Storage Capacity (ft^3) =	0	
Required Depth of Wet Storage (ft) =	0.0	**Enter "0" if Not Applicable.**

Dry Storage:

Required Storage Capacity (ft^3/Ac.) =	1,800	**To Crest of Principal Spillway**
Required Storage Capacity (ft^3) =	10,260	
Multiplier (X) for Desired Surface Area (Qp x X) =	0.01	**At Crest of Principal Spillway**
Peak Discharge into Basin (Qp) (cfs) =	26.0	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Desired Surface Area (Ac) =	0.26	
Desired Surface Area (ft^3) =	11,326	

Determine Stage-Storage Function:

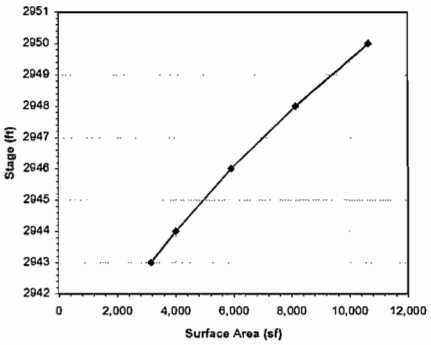
Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
2,943	3,153	0.07		0	0			
2,944	4,001	0.09	3,577	3,577	1	8.18	0.00	1.00
2,946	5,919	0.14	9,920	13,497	3	9.51	1.10	3.00
2,948	8,134	0.19	24,270	27,847	5	10.23	1.61	5.00
2,950	10,647	0.24	43,944	47,521	7	10.77	1.95	7.00

Linear Regression Constants:

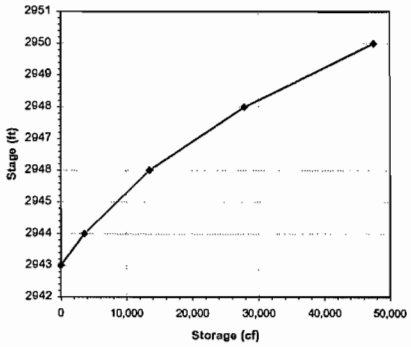
Ks = 3,441 Storage = 3441 z^1.32
b = 1.32

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



SHEET:	13/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	GGM

Basin Design Elevations:

Elev. of Bottom of Basin =	2943.0	

Wet Storage:

Required Storage Capacity (ft^3) =	0	
Min. Elev. of Wet Storage (Permanent Pool) =	2943.0	
Selected Elev. of Wet Storage (Permanent Pool) =	2943.0	**O.K.**
Actual Wet Storage Volume (ft^3) =	0	**O.K.**

Dry Storage:

Required Storage Capacity (ft^3) =	10,260	**= Required Dry Storage + Actual Wet Storage**
Min. Elev. of Principal Spillway =	2945.3	
Selected Elev. of Principal Spillway =	2948.0	**O.K.**
Actual Total Storage Volume (ft^3) =	28,582	**O.K.**
Desired Surface Area (ft^3) =	11,326	
Actual Surface Area at Principal Spillway (ft^2) =	8,134	**O.K. Close to desire surface area**

Cleanout:

Cleanout Requirement (% of Wet Storage) =	0	**Enter "0" if Not Applicable**
Cleanout Requirement (% of Total Storage) =	33	
Basin Cleanout Volume (ft^3) =	9,432	**Based on 33% of Total Storage Volume**
Basin Cleanout Elevation =	2945.2	

Dewatering of Dry Storage:

Average Head (ft) =	2.5	
Surface Area at Principal Spillway (ft^2) =	8,134	
Coef. of Contraction =	0.6	
Min. Drawdown Period (hrs) =	48	
Max. Drawdown Period (hrs) =	120	
Max. Area of Dewatering Hole (ft^2) =	0.03	**Based on Min. Detention Time**
Max. Diameter of Dewatering Hole (in) =	2.4	
Min. Area of Dewatering Hole (ft^2) =	0.01	**Based on Max. Detention Time**
Min. Diameter of Dewatering Hole (in) =	1.5	
Selected Diameter of Dewatering Hole(s) (in) =	2.0	
Number of Dewatering Holes =	1	
Actual Area of Dewatering Hole(s) (ft^2) =	0.02	
Actual Drawdown Period (hrs) =	68	**O.K.**

Basin Drain Calculations:

Average Head (ft) =	2.5	
Surface Area at Principal Spillway (ft^2) =	8,134	
Coef. of Contraction =	0.6	
Desired Drawdown Period (hrs) =	24	
Min. Area of Dewatering Hole (ft^2) =	0.06	**Based on Max. Detention Time**
Min. Diameter of Dewatering Hole (in) =	3.4	
Selected Diameter of Dewatering Hole (in) =	6	
Actual Area of Dewatering Hole (ft^2) =	0.20	
Actual Drawdown Period (hrs) =	8	**O.K.**

SHEET:	14/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	

ROUTE DESIGN STORM: **Use HydroCAD or Other Method.**

Design Parameters:

Design Storm:	25-Yr, 24-Hr
Design Storm Rainfall (in) =	6.25
Rainfall Distribution:	Type II
Runoff Method:	SCS TR-20

Results:

Maximum Pool Elevation =	2948.8
Surface Area at Maximum Pool (ft^2) =	7,896
Peak Discharge (cfs) =	8.0

Check Settling Efficiency:

Particle Data:

Diam. (microns) =	40	
Specific Gravity =	2.65	
Settling Veloc. (ft/s) =	0.004140	
Reynolds No. (<0.5) =	0.044284	O.K.

Efficiency Data:

Desired Efficiency (%) =	80	
No. of Effective Cells =	2	
Settling Efficiency (%) =	89.3	O.K.

DESIGN OUTLET STRUCTURES:

Design Riser/Barrel Structures:

Riser Design:

Type of Riser:	CPP- Circular
Riser Base Elevation =	2943.0
Riser Top Elevation =	2948.0
Riser Height (ft) =	5.0

Outlets:

Outlet No. 1 (for Dewatering Dry Storage):	Size:	2" Diam. Orifice (x1)	**From Above - Dewatering of Dry Storage**
	Invert Elevation:	2945.5	**May Vary For Multiple Holes**
Outlet No. 2 (Principal Spillway):	Size:	18" Diam. Orifice (x1)	
	Invert Elevation:	2948.0	

Barrel Design:

Type of Barrel:	CPP
Diameter (in) =	15
Inv. In Elevation =	2943.0
Inv. Out Elevation =	2942.0
Length (ft) =	150.0
Slope (ft/ft) =	0.007

SHEET:	15/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	TBM

Riser Base Calculations:

Design Uplift Force:

Factor of Safety =	1.25	
F (unadjusted) (lbs) =	689	
	0	
	0	
	0	
	0	
Buoyant Wt. of Riser Top (lbs) =	0	
Buoyant Wt. of Surrounding Soil Acting on Ext. Base (lbs) =	0	
Sliding Resistance of Surrounding Soil (lbs) =	0	
F (adjusted) (lbs) =	689	

Concrete Base:

Required Volume of Concrete (ft^3) =	7.9	
Length (ft) =	3.0	
Width (ft) =	3.0	
Thickness (ft) =	1.5	
Actual Volume of Concrete (ft^3) =	13.5	**O.K.**

Anti-Seepage Collar Calculations: (Alternatively - Design Filter Diaphragm)

Slope of Upstream Embankment (zH:1V) =	3	
Slope of Outlet Pipe (ft/ft) =	0.007	
Ls (ft) =	36	
Number of Collars:	2	
Length of Each Collar (ft) =	3.5	**From Design Chart Based on Ls and No. of Collars**
Width of Each Collar (ft) =	3.5	**From Design Chart Based on Ls and No. of Collars**
Collar Projection, P (ft) =	1.125	
Spacing of Subsequent Anti-Seep Collars (ft) =	16	**= 14P**

Emergency Spillway Calculations:

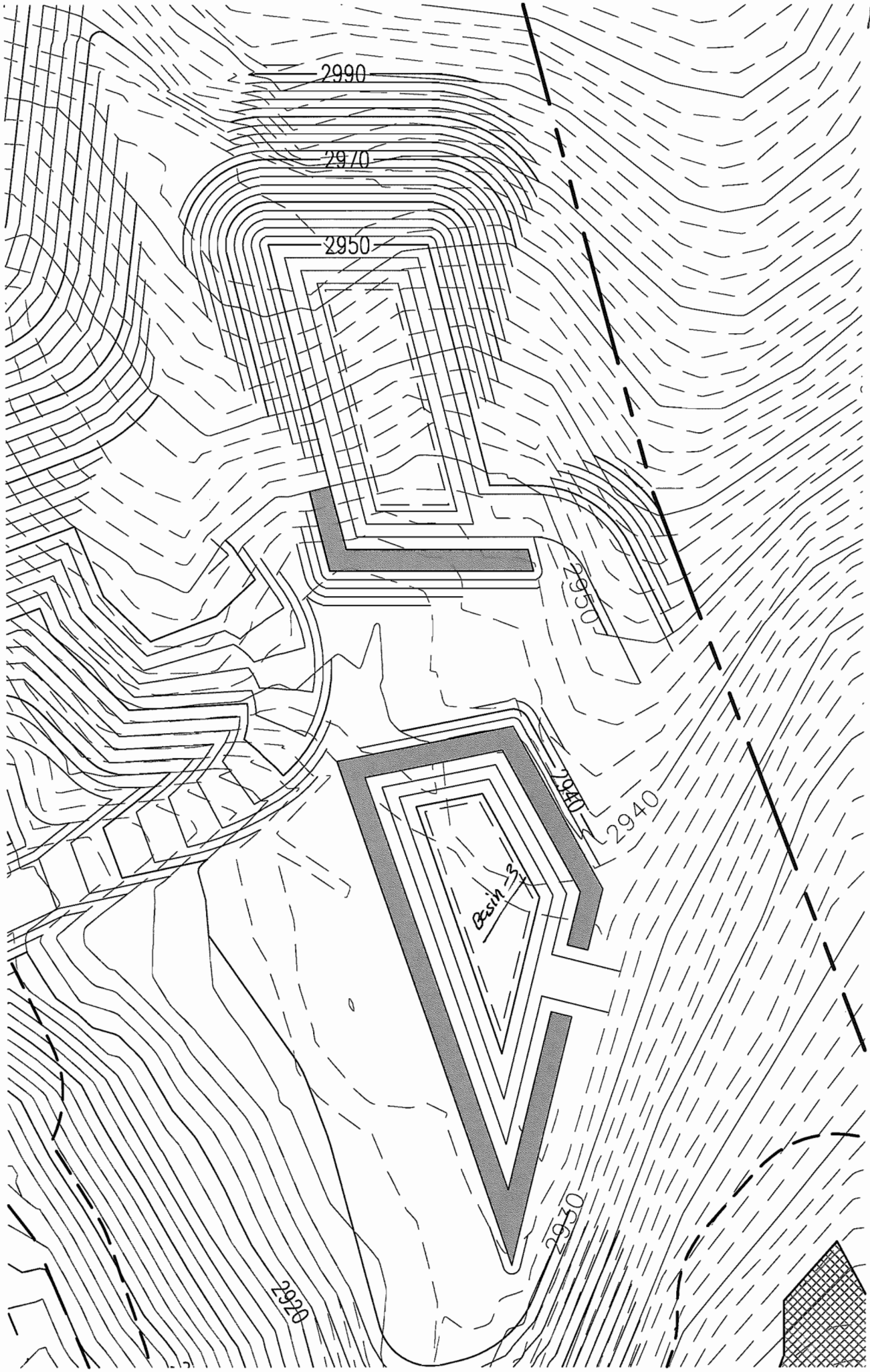
Crest Elev. (ft) =	2949.0	
Required Freeboard (ft) =	1.0	
Top of Berm Elev. (ft) =	2950.0	
Required Capacity (cfs) =	13.3	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Driving Head (ft) =	0.41	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Weir Coefficient =	3.0	
Length of Crest (ft) =	16.9	**Determine by Weir Equation***
Design Crest Length (ft) =	20	

*** Length = 20 ft minimum.**

SUMMARY DATA:

Basin No.: Basin - 2

Elev. of Bottom of Basin =	2943.0	
Cleanout Elev. (ft) =	2945.2	
Elev. of Wet Storage (Permanent Pool) =	NA	
Elev. of Principal Spillway =	2948.0	**See Above for Riser and Other Design Information.**
Emergency Spillway Elev. (ft) =	2949.0	
Top of Berm Elev. (ft) =	2950.0	
Top of Berm Width (ft) =	10	
Barrel Diameter (in) =	15	
Barrel Slope (%) =	0.7	


2990
2970
2950
2950
2940
2940
Basin 3
2930
2920
1"=60'

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

SHEET: 17 / 25
JOB #: AVERY-07-1
DATE: 7/9/08
BY: KBS
CHKD BY: GGM

Avery County Landfill
Sediment Basin Analysis

Basin No.: Basin - 3

DESIGN FOR WET (IF APPLICABLE) AND DRY STORAGE:

Areas Draining Into Basin:

Drainage Area	Area (acres)
A1. Landfill Slopes	5.1
Total =	5.1 Acres

Basin Requirements:

Wet Storage:

Required Storage Capacity (ft^3/Ac.) =	0	**Enter "0" if Not Applicable.**
Required Storage Capacity (ft^3) =	0	
Required Depth of Wet Storage (ft) =	0.0	**Enter "0" if Not Applicable.**

Dry Storage:

Required Storage Capacity (ft^3/Ac.) =	1,800	**To Crest of Principal Spillway**
Required Storage Capacity (ft^3) =	9,216	
Multipier (X) for Desired Surface Area (Qp x X) =	0.01	**At Crest of Principal Spillway**
Peak Discharge into Basin (Qp) (cfs) =	24.0	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Desired Surface Area (Ac) =	0.24	
Desired Surface Area (ft^3) =	10,454	

Determine Stage-Storage Function:

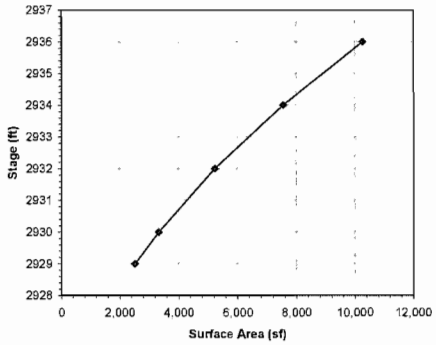
Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
2,929	2,524	0.06		0	0			
2,930	3,325	0.08	2,925	2,925	1	7.98	0.00	1.00
2,932	5,234	0.12	8,559	11,484	3	9.35	1.10	3.00
2,934	7,549	0.17	21,748	24,673	5	10.11	1.61	5.00
2,936	10,272	0.24	17,821	42,494	7	10.66	1.95	7.00

Linear Regression Constants:

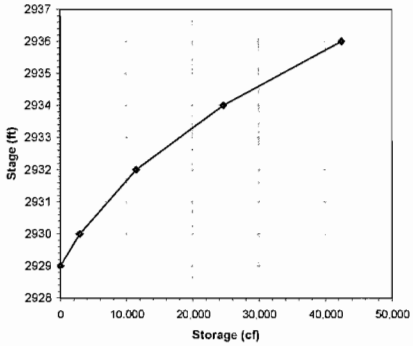
Ks = 2,805 Storage = 2805 z^1.36
b = 1.36

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



SHEET:	18 / 25
JOB #:	AVERY-07-1
DATE:	7/9/08
BY:	KBS
CHKD BY:	GGM

Basin Design Elevations:

Elev. of Bottom of Basin =	2929.0	

Wet Storage:

Required Storage Capacity (ft^3) =	0	
Min. Elev. of Wet Storage (Permanent Pool) =	2929.0	
Selected Elev. of Wet Storage (Permanent Pool) =	2929.0	**O.K.**
Actual Wet Storage Volume (ft^3) =	0	**O.K.**

Dry Storage:

Required Storage Capacity (ft^3) =	9,216	**= Required Dry Storage + Actual Wet Storage**
Min. Elev. of Principal Spillway =	2931.4	
Selected Elev. of Principal Spillway =	2934.0	**O.K.**
Actual Total Storage Volume (ft^3) =	25,155	**O.K.**

Cleanout:

Cleanout Requirement (% of Wet Storage) =	0	**Enter "0" if Not Applicable**
Cleanout Requirement (% of Total Storage) =	33	
Basin Cleanout Volume (ft^3) =	8,301	**Based on 33% of Total Storage Volume**
Basin Cleanout Elevation =	2931.2	

Dewatering of Dry Storage:

Average Head (ft) =	2.5	
Surface Area at Principal Spillway (ft^2) =	6,857	
Coef. of Contraction =	0.6	
Min. Drawdown Period (hrs) =	48	
Max. Drawdown Period (hrs) =	120	
Max. Area of Dewatering Hole (ft^2) =	0.03	**Based on Min. Detention Time**
Max. Diameter of Dewatering Hole (in) =	2.2	
Min. Area of Dewatering Hole (ft^2) =	0.01	**Based on Max. Detention Time**
Min. Diameter of Dewatering Hole (in) =	1.4	
Selected Diameter of Dewatering Hole(s) (in) =	2.0	
Number of Dewatering Holes =	1	
Actual Area of Dewatering Hole(s) (ft^2) =	0.02	
Actual Drawdown Period (hrs) =	57	**O.K.**

Basin Drain Calculations:

Average Head (ft) =	2.5	
Surface Area at Principal Spillway (ft^2) =	6,857	
Coef. of Contraction =	0.6	
Desired Drawdown Period (hrs) =	24	
Min. Area of Dewatering Hole (ft^2) =	0.05	**Based on Max. Detention Time**
Min. Diameter of Dewatering Hole (in) =	3.1	
Selected Diameter of Dewatering Hole (in) =	6	
Actual Area of Dewatering Hole (ft^2) =	0.20	
Actual Drawdown Period (hrs) =	6	**O.K.**

SHEET:	19/25
JOB #:	AVERY-07-1
DATE:	7/9/08
BY:	KBS
CHKD BY:	GGM

ROUTE DESIGN STORM: **Use HydroCAD or Other Method.**

Design Parameters:

Design Storm: 25-Yr, 24-Hr
Design Storm Rainfall (in) = 6.25
Rainfall Distribution: Type II
Runoff Method: SCS TR-20

Results:

Maximum Pool Elevation =	2934.8
Surface Area at Maximum Pool (ft^2) =	7,255
Peak Discharge (cfs) =	7.9

Check Settling Efficiency:

Particle Data:

Diam. (microns) =	40
Specific Gravity =	2.65
Settling Veloc. (ft/s) =	0.004140
Reynolds No. (<0.5) =	0.044284 **O.K.**

Efficiency Data:

Desired Efficiency (%) =	80
No. of Effective Cells =	2
Settling Efficiency (%) =	88.1 **O.K.**

DESIGN OUTLET STRUCTURES:

Design Riser/Barrel Structures:

Riser Design:

Type of Riser:	CPP-Circular
Riser Base Elevation =	2929.0
Riser Top Elevation =	2934.0
Riser Height (ft) =	5.0

Outlets:

Outlet No. 1 (for Dewatering Dry Storage): Size: 2" Diam. Orifice (x1)
Invert Elevation: 2931.5
Outlet No. 2 (Principal Spillway): Size: 18" Diam. Orifice (x1)
Invert Elevation: 2934.0

From Above - Dewatering of Dry Storage May Vary For Multiple Holes

Barrel Design:

Type of Barrel:	CPP
Diameter (in) =	15
Inv. In Elevation =	2929.0
Inv. Out Elevation =	2928.0
Length (ft) =	100.0
Slope (ft/ft) =	0.010

SHEET:	20/25
JOB #:	AVERY-07-1
DATE:	7/9/08
BY:	KBS
CHKD BY:	GGM

Riser Base Calculations:

Design Uplift Force:

Factor of Safety =	1.25
F (unadjusted) (lbs) =	689
	0
	0
	0
	0
Buoyant Wt. of Riser Top (lbs) =	0
Buoyant Wt. of Surrounding Soil Acting on Ext. Base (lbs) =	0
Sliding Resistance of Surrounding Soil (lbs) =	0
F (adjusted) (lbs) =	689

Concrete Base:

Required Volume of Concrete (ft^3) =	7.9
Length (ft) =	3.0
Width (ft) =	3.0
Thickness (ft) =	1.5
Actual Volume of Concrete (ft^3) =	13.5 **O.K.**

Anti-Seepage Collar Calculations: (Alternatively - Design Filter Diaphragm)

Slope of Upstream Embankment (zH:1V) =	3	
Slope of Outlet Pipe (ft/ft) =	0.010	
Ls (ft) =	36	
Number of Collars:	2	
Length of Each Collar (ft) =	3.5	**From Design Chart Based on Ls and No. of Collars**
Width of Each Collar (ft) =	3.5	**From Design Chart Based on Ls and No. of Collars**
Collar Projection, P (ft) =	1.125	
Spacing of Subsequent Anti-Seep Collars (ft) =	16	**= 14P**

Emergency Spillway Calculations:

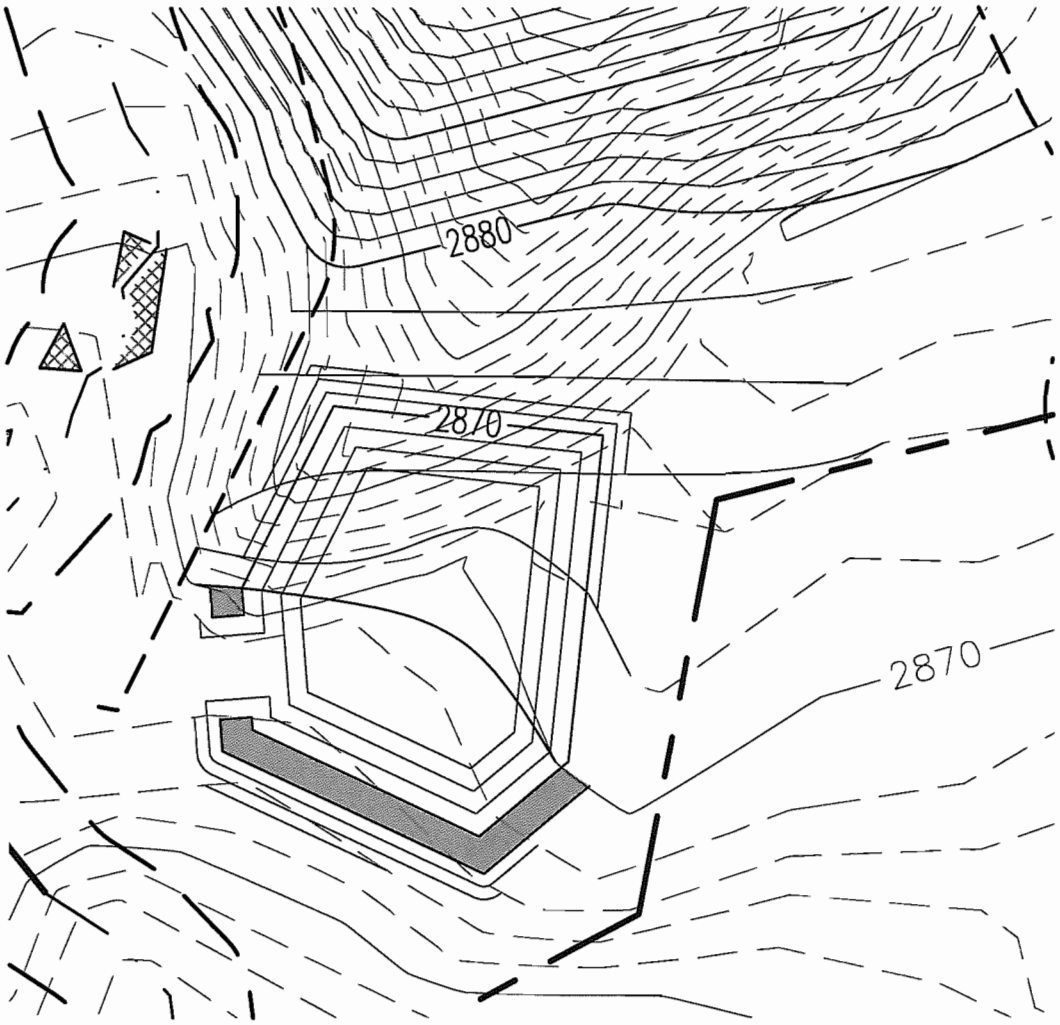
Crest Elev. (ft) =	2935.0	
Required Freeboard (ft) =	1.0	
Top of Berm Elev. (ft) =	2936.0	
Required Capacity (cfs) =	7.5	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Driving Head (ft) =	0.43	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Weir Coefficient =	3.0	
Length of Crest (ft) =	8.9	**Determine by Weir Equation***
Design Crest Length (ft) =	20	

*** Length = 20 ft minimum.**

SUMMARY DATA:

Basin No.: Basin - 3

Elev. of Bottom of Basin =	2929.0	
Cleanout Elev. (ft) =	2931.2	
Elev. of Wet Storage (Permanent Pool) =	NA	
Elev. of Principal Spillway =	2934.0	**See Above for Riser and Other Design Information.**
Emergency Spillway Elev. (ft) =	2935.0	
Top of Berm Elev. (ft) =	2936.0	
Top of Berm Width (ft) =	10	
Barrel Diameter (in) =	15	
Barrel Slope (%) =	1.0	



BASIN NO. 4

1" = 60'

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

SHEET: 22/25
JOB #: AVERY-07-1
DATE: 5/29/08
BY: KBS
CHKD BY: GGM

Avery County Landfill
Sediment Basin Analysis

Basin No.: Basin - 4

DESIGN FOR WET (IF APPLICABLE) AND DRY STORAGE:

Areas Draining Into Basin:

Drainage Area	Area (acres)
A1. Landfill Slopes	2.7
A2. Other Areas	1.2
Total =	3.9 Acres

Basin Requirements:

Wet Storage:

Required Storage Capacity (ft^3/Ac.) =	0	**Enter "0" if Not Applicable.**
Required Storage Capacity (ft^3) =	0	
Required Depth of Wet Storage (ft) =	0.0	**Enter "0" if Not Applicable.**

Dry Storage:

Required Storage Capacity (ft^3/Ac.) =	1,800	**To Crest of Principal Spillway**
Required Storage Capacity (ft^3) =	7,020	
Multiplier (X) for Desired Surface Area (Qp x X) =	0.01	**At Crest of Principal Spillway**
Peak Discharge into Basin (Qp) (cfs) =	18.0	**From HydroCAD - 10-Yr, 24-Hr. Storm**
Desired Surface Area (Ac) =	0.18	
Desired Surface Area (ft^3) =	7,841	

Determine Stage-Storage Function:

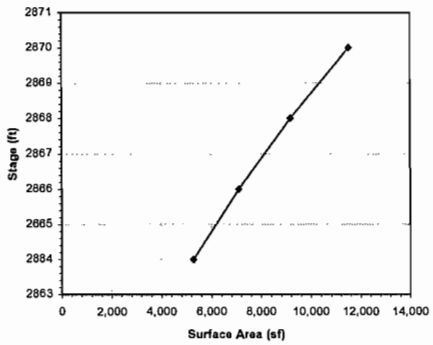
Contour	Area (ft^2)	Area (acres)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)	Stage (ft)	ln S	ln Z	Z est
2,864	5,293	0.12		0	0			
2,866	7,109	0.16	12,402	12,402	2	9.43	0.69	2.00
2,868	9,184	0.21	16,293	28,695	4	10.26	1.39	4.00
2,870	11,517	0.26	37,252	49,654	6	10.81	1.79	6.00

Linear Regression Constants:

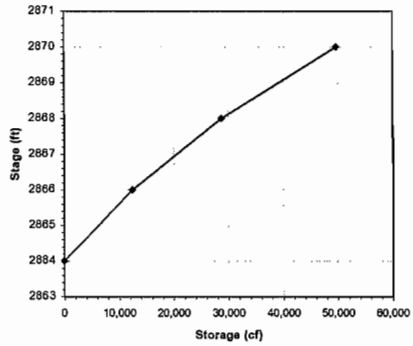
Ks = 5,144 Storage = 5144 z^1.28
b = 1.26

***CAUTION: CHECK INPUT FOR REGRESSION ANALYSIS!**

Stage-Surface Area Relationship



Stage-Storage Relationship



SHEET:	23/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	GGM

Basin Design Elevations:

Elev. of Bottom of Basin =	2864.0	

Wet Storage:

Required Storage Capacity (ft^3) =	0	
Min. Elev. of Wet Storage (Permanent Pool) =	2864.0	
Selected Elev. of Wet Storage (Permanent Pool) =	2864.0	O.K.
Actual Wet Storage Volume (ft^3) =	0	O.K.

Dry Storage:

Required Storage Capacity (ft^3) =	7,020	= Required Dry Storage + Actual Wet Storage
Min. Elev. of Principal Spillway =	2865.3	
Selected Elev. of Principal Spillway =	2867.0	O.K.
Actual Total Storage Volume (ft^3) =	20,467	O.K.
Desired Surface Area (ft^3) =	7,841	
Actual Surface Area at Principal Spillway (ft^2) =	8,576	O.K.

Cleanout:

Cleanout Requirement (% of Wet Storage) =	0	Enter "0" if Not Applicable
Cleanout Requirement (% of Total Storage) =	33	
Basin Cleanout Volume (ft^3) =	6,754	Based on 33% of Total Storage Volume
Basin Cleanout Elevation =	2865.2	

Dewatering of Dry Storage:

Average Head (ft) =	1.5	
Surface Area at Principal Spillway (ft^2) =	8,576	
Coef. of Contraction =	0.6	
Min. Drawdown Period (hrs) =	48	
Max. Drawdown Period (hrs) =	120	
Max. Area of Dewatering Hole (ft^2) =	0.03	Based on Min. Detention Time
Max. Diameter of Dewatering Hole (in) =	2.2	
Min. Area of Dewatering Hole (ft^2) =	0.01	Based on Max. Detention Time
Min. Diameter of Dewatering Hole (in) =	1.4	
Selected Diameter of Dewatering Hole(s) (in) =	2.0	
Number of Dewatering Holes =	1	
Actual Area of Dewatering Hole(s) (ft^2) =	0.02	
Actual Drawdown Period (hrs) =	56	O.K.

Basin Drain Calculations:

Average Head (ft) =	1.5	
Surface Area at Principal Spillway (ft^2) =	8,576	
Coef. of Contraction =	0.6	
Desired Drawdown Period (hrs) =	24	
Min. Area of Dewatering Hole (ft^2) =	0.05	Based on Max. Detention Time
Min. Diameter of Dewatering Hole (in) =	3.0	
Selected Diameter of Dewatering Hole (in) =	4	
Actual Area of Dewatering Hole (ft^2) =	0.09	
Actual Drawdown Period (hrs) =	14	O.K.

SHEET:	24/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	GGM

ROUTE DESIGN STORM: **Use HydroCAD or Other Method.**

Design Parameters:

Design Storm:	25-Yr, 24-Hr
Design Storm Rainfall (in) =	6.25
Rainfall Distribution:	Type II
Runoff Method:	SCS TR-20

Results:

Maximum Pool Elevation =	2887.5
Surface Area at Maximum Pool (ft^2) =	8,923
Peak Discharge (cfs) =	5.6

Check Settling Efficiency:

Particle Data:

Diam. (microns) =	40	
Specific Gravity =	2.65	
Settling Veloc. (ft/s) =	0.004140	
Reynolds No. (<0.5) =	0.044284	O.K.

Efficiency Date:

Desired Efficiency (%) =	80	
No. of Effective Cells =	2	
Settling Efficiency (%) =	94.6	O.K.

DESIGN OUTLET STRUCTURES:

Design Riser/Barrel Structures:

Riser Design:

Type of Riser:	CPP-Circular
Riser Base Elevation =	2864.0
Riser Top Elevation =	2867.0
Riser Height (ft) =	3.0

Outlets:

Outlet No. 1 (for Dewatering Dry Storage):	Size:	2"	**From Above - Dewatering of Dry Storage**
	Invert Elevation:	2865.5	**May Vary For Multiple Holes**
Outlet No. 2 (Principal Spillway):	Size:	18"	
	Invert Elevation:	2867.0	

Barrel Design:

Type of Barrel:	CMP
Diameter (in) =	15
Inv. In Elevation =	2864.0
Inv. Out Elevation =	2860.0
Length (ft) =	60.0
Slope (ft/ft) =	0.067

SHEET:	25/25
JOB #:	AVERY-07-1
DATE:	5/29/08
BY:	KBS
CHKD BY:	TBM

Riser Base Calculations:

Design Uplift Force:

Factor of Safety =	1.25	
F (unadjusted) (lbs) =	413	
	0	
	0	
	0	
	0	
Buoyant Wt. of Riser Top (lbs) =	0	
Buoyant Wt. of Surrounding Soil Acting on Ext. Base (lbs) =	0	
Sliding Resistance of Surrounding Soil (lbs) =	0	
F (adjusted) (lbs) =	413	

Concrete Base:

Required Volume of Concrete (ft^3) =	4.7	
Length (ft) =	3.0	
Width (ft) =	3.0	
Thickness (ft) =	2.0	
Actual Volume of Concrete (ft^3) =	18.0	**O.K.**

Anti-Seepage Collar Calculations: (Alternatively - Design Filter Diaphragm)

Slope of Upstream Embankment (zH:1V) =	3	
Slope of Outlet Pipe (ft/ft) =	0.067	
Ls (ft) =	29	
Number of Collars:	2	
Length of Each Collar (ft) =	3.0	**From Design Chart Based on Ls and No. of Collars**
Width of Each Collar (ft) =	3.0	**From Design Chart Based on Ls and No. of Collars**
Collar Projection, P (ft) =	0.875	
Spacing of Subsequent Anti-Seep Collars (ft) =	12	**= 14P**

Emergency Spillway Calculations:

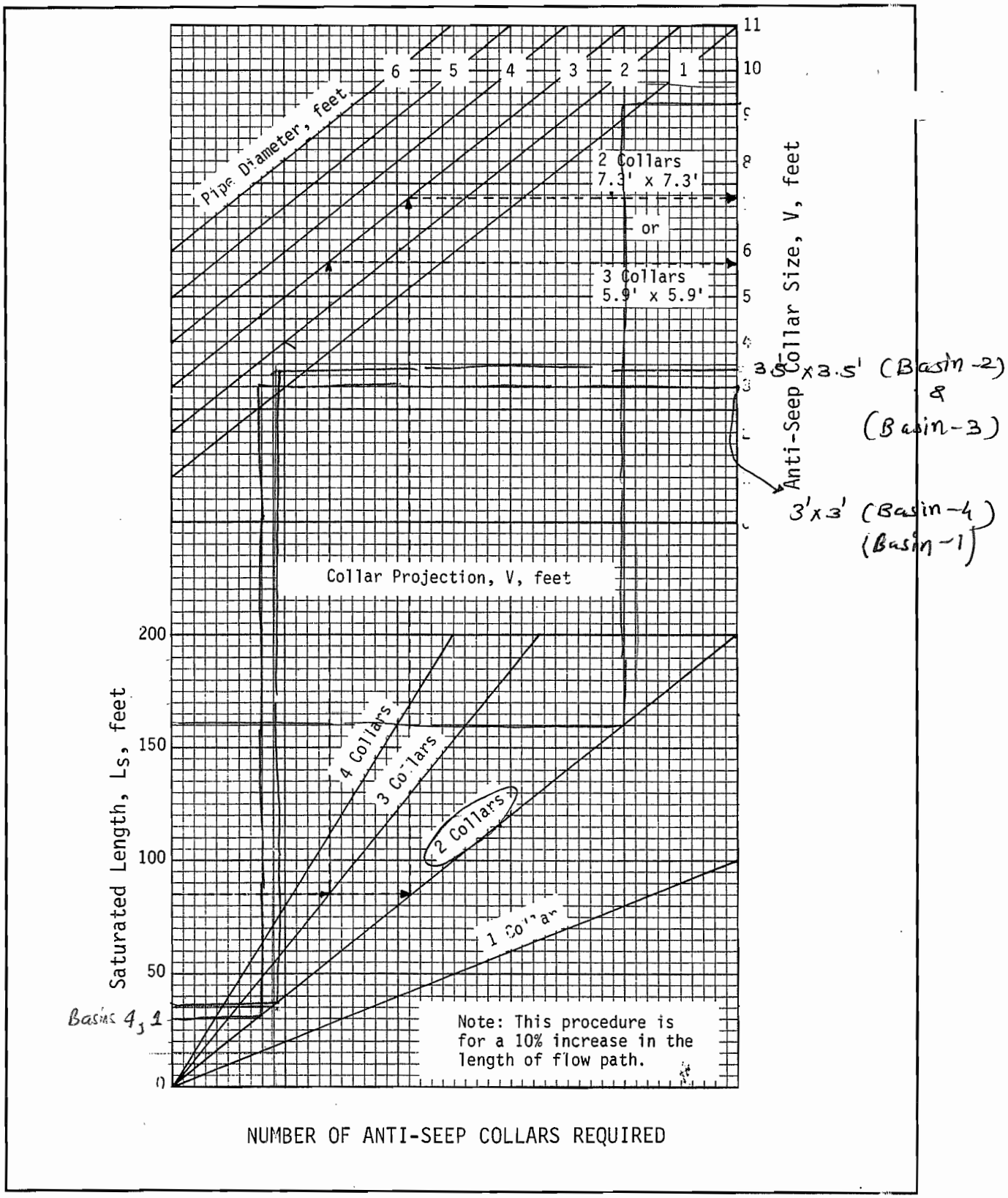
Crest Elev. (ft) =	2868.5	
Required Freeboard (ft) =	1.5	
Top of Berm Elev. (ft) =	2870.0	
Required Capacity (cfs) =	0.0	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Driving Head (ft) =	0	**From HydroCAD - 100-Yr, 24-Hr. Storm**
Weir Coefficient =	3.0	
Length of Crest (ft) =	0.0	**Determine by Weir Equation***
Design Crest Length (ft) =	20	

*** Length = 20 ft minimum.**

SUMMARY DATA:

Basin No.: Basin - 4

Elev. of Bottom of Basin =	2864.0	
Cleanout Elev. (ft) =	2865.2	
Elev. of Wet Storage (Permanent Pool) =	NA	
Elev. of Principal Spillway =	2867.0	**See Above for Riser and Other Design Information.**
Emergency Spillway Elev. (ft) =	2868.5	
Top of Berm Elev. (ft) =	2870.0	
Top of Berm Width (ft) =	10	
Barrel Diameter (in) =	15	
Barrel Slope (%) =	6.7	



Source: USDA-SCS

Plate 3.1-12

Outlet Protection Analysis

PROJECT Avery County C&D Landfill

SUBJECT Outlet Protection Analysis

JOB NO. Avery 07-1
DATE 7/10/08
COMPUTED BY KBS
CHECKED BY GGM

Objective To design outlet protection for culverts and/or drainage channels based on the maximum flow from the design storm. Rip rap aprons are applicable when the Froude Number (Fr) is less than or equal to 2.5 (Debo and Reese). For higher Froude Numbers, rip rap outlet basins, baffled outlets, and/or other methods are more appropriate.

Reference

Debo, T.N., and Reese, A.J. (1995), Municipal Storm Water Management, Lewis Publishers, Boca Raton, FL, Section 8.11 - pp. 289-290; Section 12.6 - pp. 523-526.

Federal Highway Administration (2000), Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular No. 14, FHWA EPD-86-110, Metric Ed., U.S. Dept. of Transportation, Washington, D.C.

North Carolina Division of Land Resources (2006), North Carolina Erosion & Sediment Control Planning & Design Manual, Raleigh, NC.

Analysis For each outlet, determine the Froude Number (Fr) based on the pipe Manning's number, diameter, slope, and design discharge. Use the methods described in Section 8.11 of Debo and Reese. Select the method of outlet protection, as appropriate, and perform design calculations.

Rip Rap Aprons:

If Fr $\leq$ 2.5, a rip rap apron may be used. The following design approach is based on Section 12.6 of Debo and Reese and Section 8.06 of the NC Erosion & Sediment Control Planning and Design Manual:

1. Determine the tailwater condition and select the appropriate design chart.
2. Using the appropriate design chart, determine the d_{50} rip-rap size and minimum apron length (La) based on the maximum design flow (Q), flow depth (d), and/or velocity (v) (depending on whether the pipe is flowing full or partially full).
3. Using the same chart, determine apron dimensions.
4. Determine the maximum stone diameter: $d_{max} = 1.5 \times d_{50}$
5. Determine the apron thickness:
   Thickness = $1.5 \times d_{max}$ (No Filter Geotextile)
   Thickness = $1.5 \times d_{50}$ (With Filter Geotextile)

Other Methods:

If Fr > 2.5, consider the use of a rip rap basin, baffled outlet, or other device. Design method according to FHA guidelines using HY8-Energy program (or other documented source).

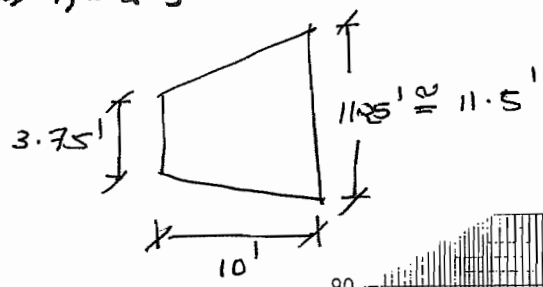
OUTLET PROTECTION.WPD

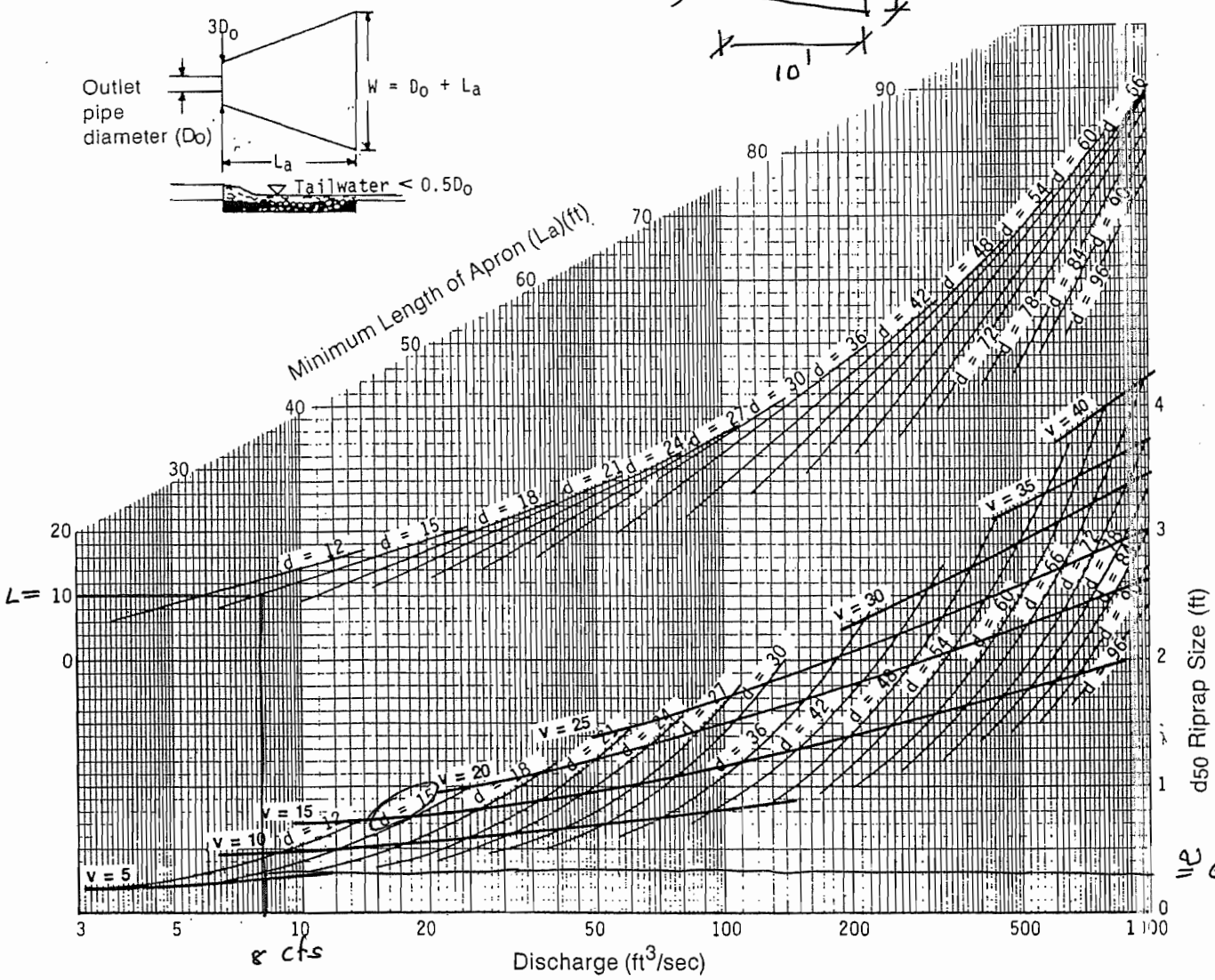
RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue, Raleigh, NC 27603
Telephone: (919) 828-0577

By: KBS
2/6 Appendices
OK GGM

Riprap Outlet Protection at the end of Basin - 1, 2, 3 & 4

Note: Cascades are used at Basins 1, 2 & 3



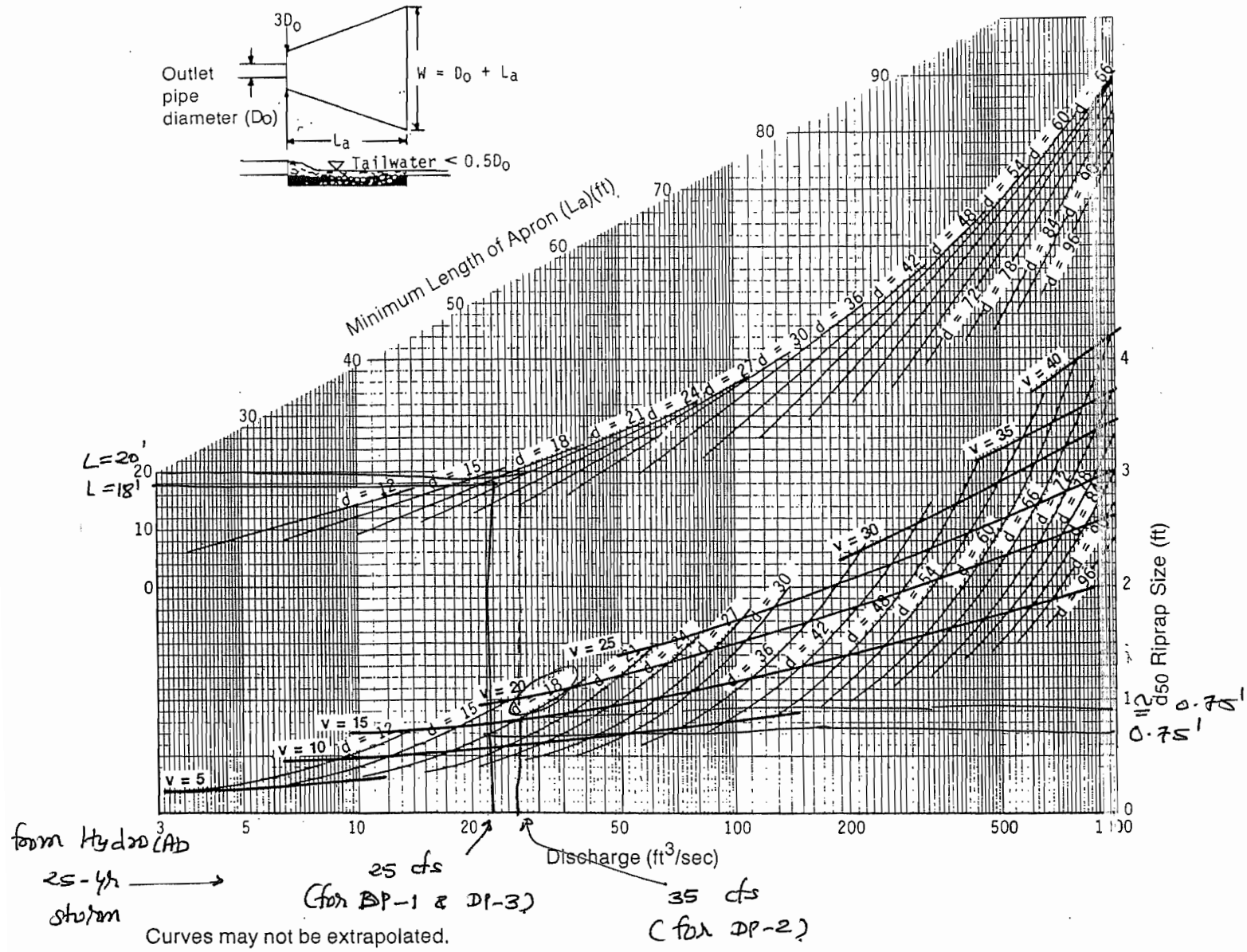


(From HydroCAD - 25 yr storm)

Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter)

Riprap Outlet Protection at the end of Down pipes.



from Hydro CAD 25-yr storm

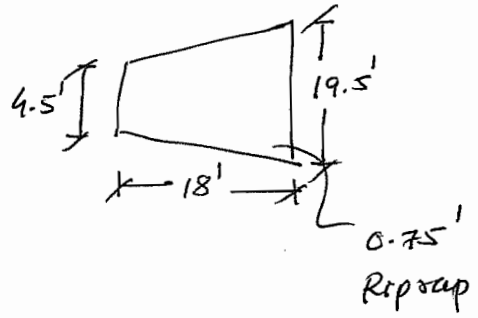
25 cfs (for DP-1 & DP-3)

35 cfs (for DP-2)

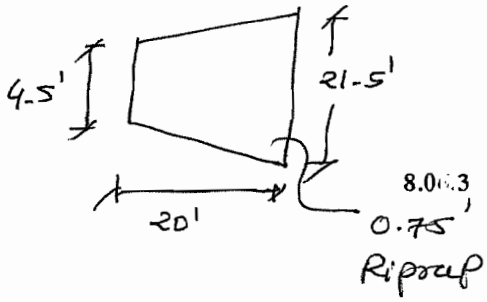
Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter)

For DP-1 & DP-3

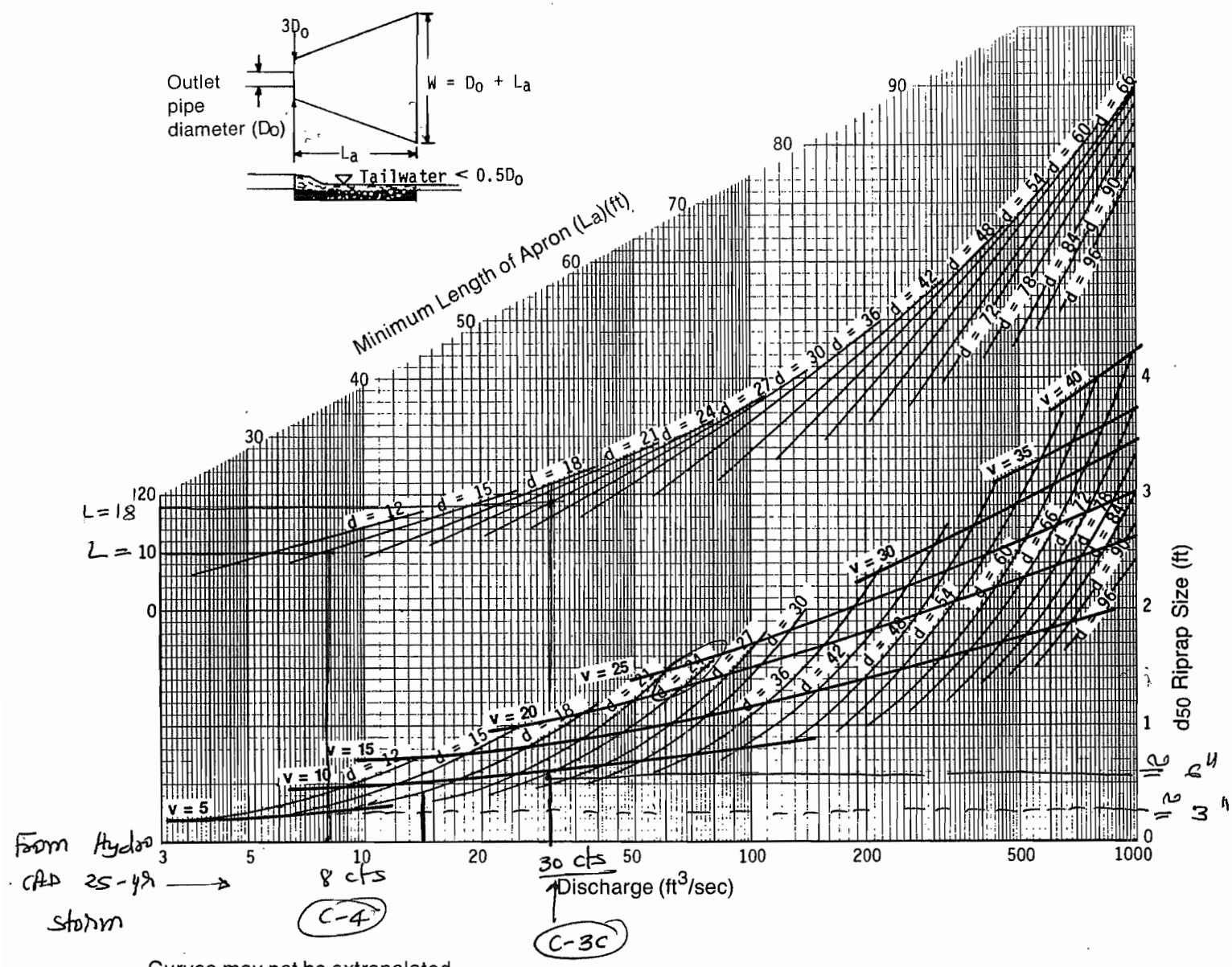


For DP-2



OK GGM

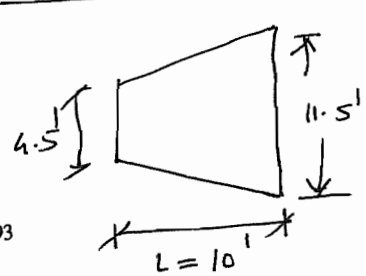
Riprap Outlet Protection at the end of C-3C & C-4



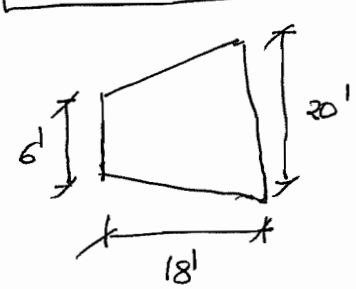
Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter).

For C-4



For C-3c



Riprap Outlet Protection at the end of channels.

OK
GGM

NEW YORK DOT DISSIPATOR METHOD FOR USE IN DEFINED CHANNELS

(Source: "Bank and channel lining procedures", New York Department of Transportation, Division of Design and Construction, 1971.)

Note: To use the following chart you must know:
(1) Q full capacity
(2) Q_{10}
(3) V full
(4) V_{10}

where Q = discharge in cfs and V = Velocity in FPS.

ESTIMATION OF STONE SIZE AND DIMENSIONS FOR CULVERT APRONS

Step 1) Compute flow velocity V_o at culvert or paved channel outlet.

Step 2) For pipe culverts D_o is diameter.
For pipe arch, arch and box culverts, and paved channel outlets, $D_o=A_o$, where A.= cross-sectional area of flow at outlet.

For multiple culverts, use $D_o=1.25xD_o$ of single culvert.

Step 3) For apron grades of 10% or steeper, use recommendations For next higher zone. (Zones 1 through 6).

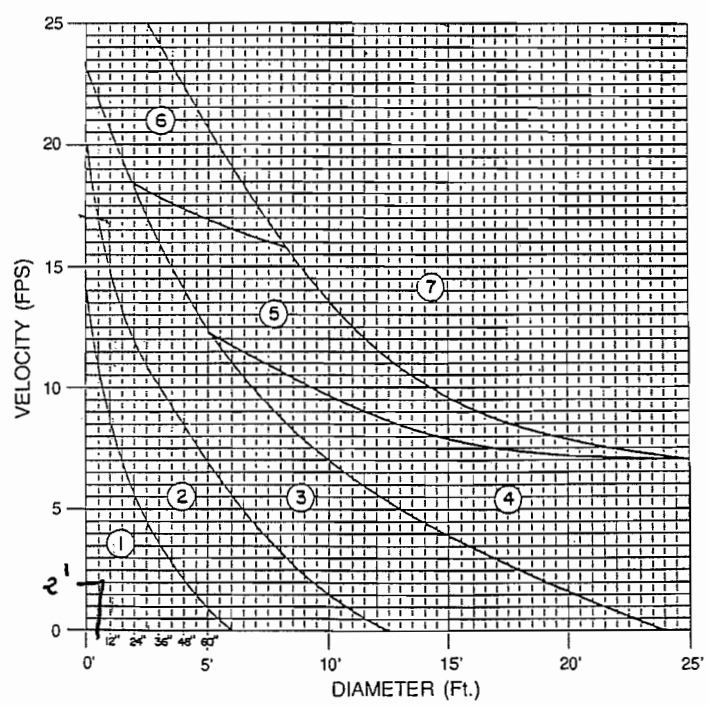
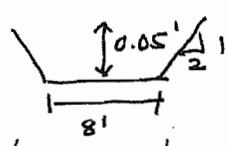


Figure 8.06.b.1

For DC-1 & DC-2 →



$A = \left(\frac{8+8.2}{2}\right)' \times 0.05' = 0.4$ SF

$\boxed{\text{Use } D_o = A_o = 0.5'}$

6/6

ZONE	APRON MATERIAL		LENGTH OF APRON: TO PROTECT CULVERT L1	LENGTH OF APRON: TO PREVENT SCOUR HOLE USE L2 ALWAYS L2
1	STONE FILLING (FINE)	CL. A	3 x Do	4 x Do
2	STONE FILLING (LIGHT)	CL. B	3 x Do	6 x Do
3	STONE FILLING (MEDIUM)	CL. 1	4 x Do	8 x Do
4	STONE FILLING (HEAVY)	CL. 1	4 x Do	8 x Do
5	STONE FILLING (HEAVY)	CL. 2	5 x Do	10 x Do
6	STONE FILLING (HEAVY)	CL. 2	6 x Do	10 x Do
7	SPECIAL STUDY REQUIRED (ENERGY DISSIPATORS, STILLING BASIN OR LARGER SIZE STONE).			

$L = 1.5'$
$\omega = 1.5'$

Fig. 8.06.b.2

Width = 3 times pipe dia. (min.)

DETERMINATION OF STONE SIXES FOR DUMPED STONE CHANNEL LININGS AND REVETMENTS

Step 1) Use figure 8.06.b.3 to determine maximum stone size (e.g. for 12 Fps=20" or 550 lbs.

Step 2) Use figure 8.06.b.4 to determine acceptable size range for stone (for 12 FPS it is 125-500 lbs. for 75% of stone, and the maximum and minimum range in weight should be 25-500 lbs.)

Note: In determining channel velocities for stone linings and revetment, use the following coefficients of roughness:

	Diameter (inches)	Mannin's "n"	Min. thickness of lining	(inches)
Fine	3	0.031	9	12
Light	6	0.035	12	18
Medium	13	0.040	18	24
Heavy	23	0.044	30 (Channels)	36 (Dissapators)

Outlet Velocity Analysis

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

SHEET: 1 / 4
JOB #: AVERY-07-1
DATE: 9/17/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Drainage Channel Analysis (Rip Rap Lined) **Check for V10<2fps** **Channel No. SB-1 outlet cascade**

Design Parameters:

PEAK DISCHARGE, $Q10$ = 0.5 ft^3/s Source: HydroCAD 10-Yr 24-Hr

Bottom Width, B = 4.0 ft
Left Side Slope, z_1 = 2.0 horizontal :1 vertical
Right Side Slope, z_2 = 2.0 horizontal :1 vertical
Minimum Freeboard = 0.1 ft

Rip Rap Lining:
D_{50} = 1.00 ft
V_{allow} = 13.0 ft/sec
τ_{allow} = 4.0 lb/ft^2

Maximum Channel Slope, S_{max} = 0.100 ft/ft
Minimum Channel Slope, S_{min} = 0.050 ft/ft

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:							< 2 fps						
0.27	0.468	1.23	5.21	0.24	5.08	0.24	0.38	0.5	0.14	**1.7**	S	2.4	**O.K.**
Minimum Slope:													
0.29	0.341	1.33	5.30	0.25	5.16	0.26	0.39	0.5	0.13	**0.9**	V	33.4	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.08	0.500	0.33	4.36	0.08	4.32	0.08	0.09	0.5	1.57	1.00	8.621	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
0.37	5.48	**0.39**	**5.56**

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

SHEET: 2 / 4
JOB #: AVERY-07-1
DATE: 9/17/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Drainage Channel Analysis (Rip Rap Lined) **Check for V10<2fps** **Channel No. SB-2 outlet cascade**

Design Parameters:

PEAK DISCHARGE, $Q10$ = 1.9 ft^3/s Source: HydroCAD 10-Yr 24-Hr

Bottom Width, B = 12.0 ft

Left Side Slope, z_1 = 2.0 horizontal :1 vertical

Right Side Slope, z_2 = 2.0 horizontal :1 vertical

Minimum Freeboard = 0.5 ft

Rip Rap Lining:

D_{50} = 1.00 ft

V_{allow} = 13.0 ft/sec

τ_{allow} = 4.0 lb/ft^2

Maximum Channel Slope, S_{max} = 0.100 ft/ft

Minimum Channel Slope, S_{min} = 0.050 ft/ft

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:							< 2 fps						
0.28	0.393	3.52	13.25	0.27	13.12	0.27	0.50	1.7	0.17	**1.7**	S	2.3	**O.K.**
Minimum Slope:													
0.30	0.302	3.78	13.34	0.28	13.20	0.29	0.48	1.8	0.16	**0.9**	V	27.4	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.09	0.500	1.10	12.40	0.09	12.36	0.09	0.33	1.9	1.69	1.00	8.168	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
0.78	15.12	**0.80**	**15.20**

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SHEET: 3 / 4
JOB #: AVERY-07-1
DATE: 9/17/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Drainage Channel Analysis (Rip Rap Lined) **Check for V10<2fps** **Channel No. SB-3 outlet cascade**

Design Parameters:

PEAK DISCHARGE, $Q10$ = 1.9 ft^3/s Source: HydroCAD 10-Yr 24-Hr

Bottom Width, B = 12.0 ft
Left Side Slope, z_1 = 2.0 horizontal :1 vertical
Right Side Slope, z_2 = 2.0 horizontal :1 vertical
Minimum Freeboard = 0.5 ft

Rip Rap Lining:
D_{50} = 1.00 ft
V_{allow} = 13.0 ft/sec
τ_{allow} = 4.0 lb/ft^2

Maximum Channel Slope, S_{max} = 0.100 ft/ft
Minimum Channel Slope, S_{min} = 0.050 ft/ft

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:							< 2 fps						
0.28	0.393	3.52	13.25	0.27	13.12	0.27	0.50	1.7	0.17	**1.7**	S	2.3	**O.K.**
Minimum Slope:													
0.30	0.302	3.78	13.34	0.28	13.20	0.29	0.48	1.8	0.16	**0.9**	V	27.4	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.09	0.500	1.10	12.40	0.09	12.36	0.09	0.33	1.9	1.69	1.00	8.168	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
0.78	15.12	**0.80**	**15.20**

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Raleigh, NC 27603 Fax: 919-828-3899

SHEET: 4 / 4
JOB #: AVERY-07-1
DATE: 9/17/08
BY: TBM
CHKD BY:

Avery County C&D Landfill
Drainage Channel Analysis (Rip Rap Lined) **Check for V10 < 2 fps** **Channel No. SB-4 riprap outlet protection (W=9.3')**

Design Parameters:

PEAK DISCHARGE, $Q10$ = 1.0 ft^3/s Source: HydroCAD 10-Yr 24-Hr

Bottom Width, B = 9.3 ft
Left Side Slope, z_1 = 1.0 horizontal :1 vertical
Right Side Slope, z_2 = 1.0 horizontal :1 vertical
Minimum Freeboard = 0.0 ft

Rip Rap Lining:
D_{50} = 0.25 ft
V_{allow} = 13.0 ft/sec
τ_{allow} = 1.0 lb/ft^2

Maximum Channel Slope, S_{max} = 0.160 ft/ft
Minimum Channel Slope, S_{min} = 0.100 ft/ft

Normal Depth

Depth of Flow (Norm. Depth) Y_n ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Average Velocity V_n ft/s	Flow Rate Q ft^3/s	Froude Number F_r (Normal) #	Maximum Shear Stress τ_d lb/ft^2	Allowable Velocity (V) or Sh. Stress (S) Used?	Factor of Safety V_{allow}/V_n or τ_{allow}/τ_d	Comment
Maximum Slope:							< 2 fps						
0.10	0.126	0.94	9.58	0.10	9.50	0.10	**1.00**	0.9	0.56	**1.0**	S	1.0	**O.K.**
Minimum Slope:													
0.11	0.110	1.04	9.61	0.11	9.52	0.11	0.97	1.0	0.52	**0.7**	S	1.5	**O.K.**

Critical Depth

Depth of Flow (Crit. Depth) Y_c ft	Manning's Roughness Coefficient n	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius $R=A/P$ ft	Top Width T ft	Hydraulic Depth $D=A/T$ ft	Section Factor $Z=AD^{1/2}$ $ft^{2.5}$	Flow Rate Q ft^3/s	Average Velocity V_c ft/s	Froude Number F_r (Critical) #	Uniform-Flow Critical Slope S_c ft/ft	Comment
0.07	0.312	0.66	9.50	0.07	9.44	0.07	0.17	1.0	1.50	1.00	3.459	**Flow is Stable.**

Determination of Minimum Channel Depth & Top Width

Maximum Slope		Minimum Slope	
Minimum Channel Depth ft	Minimum Top Width T ft	Minimum Channel Depth ft	Minimum Top Width T ft
0.10	9.50	**0.11**	**9.52**

Appendix B

Technical Specifications

Technical Specifications

Avery County
Newland, North Carolina

Prepared for:

Avery County
Newland, North Carolina 28657

July 2008

RICHARDSON SMITH GARDNER
& ASSOCIATES
ENGINEERING & GEOLOGICAL
SERVICES

Avery County C&D Landfill

TECHNICAL SPECIFICATIONS

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SECTION 02110

SITE PREPARATION

Site Preparation: Site Preparation includes clearing, grubbing, and stripping operations which precede the proposed construction.

A. DESCRIPTION

1. General:

a. The Contractor shall furnish all labor, material, and equipment to complete Site Preparation in accordance with the Contract Drawings and these Specifications.

b. Principal items of work include:

1. Notifying all authorities owning utility lines running to or on the property. Protect and maintain all utility lines to remain and cap those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.

2. Clearing the site within the clearing limits, including removal of grass, brush, shrubs, trees, loose debris, and other encumbrances except for trees to remain.

3. Boxing and protecting all areas to be preserved.

4. Removing all topsoil from designated areas and stockpiling on site where directed by the Engineer for future use.

5. Disposing from the site all debris resulting from work under this Section.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223

B. MATERIALS Not Used.

C. SUBMITTALS Not Used.

D. CONSTRUCTION

1. Clearing of the Site:

a. Clearing limits, as shown on the Contract Drawings, shall be established by the Contractor's Surveyor. Once established, the clearing limits shall be inspected and approved by the Engineer prior to clearing the affected areas.

b. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shown on the Contract Drawings shall be cleared and grubbed.

c. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, fencing, and other perishable and objectionable material.

Should it become necessary to remove a tree, bush, brush, or other plants outside the clearing limits, the Contractor shall do so only after permission has been granted by the Engineer.

d. Excavation resulting from the removal of trees, roots, and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02223, Embankment, of these Specifications.

e. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, they are too close to the work to be maintained or have become damaged due to the Contractor's operations.

2. Stripping and Stockpiling Existing Topsoil:

a. Existing topsoil and sod on the site within areas designated on the Contract Drawings shall be stripped to whatever depth it may occur, and stored in locations directed by the Engineer.

b. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling.

c. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

3. Grubbing:

a. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks, and other perishable materials to a depth of at least 6 inches below ground surfaces.

b. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

4. Disposal of Cleared and Grubbed Material:

All trees, stumps, roots, and bushes shall be disposed of by burning (Only if allowed by the Owner and local zoning) or shall be removed from the site and disposed of by the Contractor. The Contractor shall receive written authorization from the Owner prior to burning. Any material other than plant growth shall not be burned. On-site and off-site disposal areas are subject to approval by the Engineer. Ashes and residue from burning operations shall be removed from the site and disposed of by the Contractor. The Contractor shall also obtain all of the required permits for his burning operations, as applicable.

END OF SECTION

SECTION 02222

EXCAVATION

Excavation: Excavation includes excavating, sealing, hauling, scraping, undercutting, removal of accumulated surface water or ground water, stockpiling, and all necessary and incidental items as required for bringing the landfill and related structures to the specified lines and grades.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment required to complete Excavation of the project area in accordance with the Contract Drawings and these Specifications, except as noted below:

a. Clearing and grubbing and removal of topsoil is addressed in Section 02110, Site Preparation, of these Specifications.

b. Removal of rock is addressed in Section 02229, Rock Removal, of these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Site Preparation	02110
Embankment	02223
Erosion and Sedimentation Control	02270
Roadway Work	02500
CQA Manual	Attached

3. Quality Assurance:

Quality Assurance during Excavation will be provided by the Owner as described in the accompanying Project CQA Manual.

4. Definitions:

a. Excavation: shall consist of the removal and satisfactory disposal and/or stockpiling of materials located with the limits of construction including

widening cuts and shaping of slopes necessary for the preparation of roadbeds, landfill slope areas, cutting of any ditches, channels, waterways, entrances, and other work incidental thereto.

b. Borrow: shall consist of approved on-site material required for the construction of embankments/fills or for other portions of the work.

c. Select Borrow: shall consist of approved off-site material required for the construction of embankments/fills, roadway subgrade, backfilling, or for other portions of the work as shown on Contract Drawings or in these Specifications. The Contractor shall make his own arrangements for obtaining select borrow and pay all costs involved.

d. Unsuitable Material: is any in-place or excavated material which contains undesirable materials, or is in a state which is not appropriate; in the opinion of the CQA Engineer, for the intended use or support of planned structures, embankment, or excavation. This may include but not be limited to organic material, waste/refuse, soft, or wet material not meeting required specifications, etc.

e. Unsuitable Materials Excavation (Overexcavation): shall consist of the removal and satisfactory disposal of all unsuitable material located within the limits of construction. Where excavation to the finished grade section shown results in a subgrade or slopes of unsuitable material, the Contractor shall overexcavate such material to below the grade shown on the Contract Drawings or as directed by the Engineer and CQA Engineer.

B. MATERIALS

Excavation shall include the removal of all soil, weathered rock, boulders, conduits, pipe, and all other obstacles encountered and shown on the Contract Drawings or specified herein.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

1. Plans of open cut excavations showing side slopes and limits of the excavation at grade.

2. List of disposal site(s) for waste and unsuitable materials.

3. Descriptive information on Excavation equipment to be used.

D. CONSTRUCTION

1. The Contractor shall conduct Excavation activities in such a manner that erosion of disturbed areas and off site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.

2. The Contractor shall excavate to the lines and grades shown on the Contract Drawings and stockpile all suitable excavated materials. As the excavation is made, the materials will be examined and identified to the CQA Engineer.

   The Contractor will perform all surveys necessary to establish and verify lines and grades for all Excavation, including pipe excavations, soil overexcavation, and anchor trenches.

3. Stockpiling:

   The Contractor shall stockpile the materials in appropriate stockpiles as approved by the CQA Engineer. The Contractor shall use equipment and methods as necessary to maintain the moisture content of soils stockpiled (excluding topsoil) at or near their optimum moisture content.

   Stockpiles shall be properly sloped and the surfaces sealed by the Contractor at the end of each working day, or during the day in the event of heavy rain, to the satisfaction of the Engineer.

4. The Contractor shall protect all existing facilities and structures including, but not limited to, existing utilities, monitoring wells, signs, grade stakes, etc. during the grading and stockpiling operations.

5. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such sheeting, timbering, pumping, and drainage as may be required.

6. The Contractor shall be responsible for control of surface ans subsurface water, when necessary.

7. Excavation slopes shall be flat enough to avoid sloughs and slides that will cause disturbance of the subgrade or damage of adjacent areas. Slides and overbreaks which occur due to negligence, carelessness, or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as directed by the Engineer at no additional cost to the Owner.

8. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded. All protruding roots and other vegetation shall be removed from slopes.

9. The bottom of all excavations for structures and pipes shall be examined by the CQA Engineer for bearing value and the presence of unsuitable material. If, in the opinion of the CQA Engineer, additional Excavation is required due to the low bearing value of the subgrade material, or if the in-place materials are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted structural fill, or material directed by the CQA Engineer. No payment will be made for subgrade disturbance caused by inadequate Dewatering or improper construction methods.

10. Any areas excavated below design subgrade elevations by the Contractor, unless directed by the CQA Engineer, shall be brought back to design elevations at no cost to the Owner. The Contractor shall place and compact such material in accordance with Section 02223, Embankment, of these Specifications.

11. The Contractor shall dispose of excess or unsuitable excavation materials on-site at location(s) approved by the Owner.

12. The Contractor shall properly level-off bottoms of all excavations. Proof-rolling shall be conducted with appropriate equipment.

13. Upon reaching subgrade elevations shown in excavation areas, the Contractor shall scarify subgrade soils to a minimum depth of 6" and obtain the CQA Engineer's approval of quality. If unsuitable materials are encountered at the subgrade elevation, perform additional excavations as approved by the CQA Engineer to remove unsuitable materials.

14. <u>Overexcavation and Backfill:</u>

    Where subgrade materials are determined to be unsuitable, such materials shall be removed by the Contractor to the lengths, widths and depths approved by the CQA Engineer and backfilled with suitable material in accordance with Section 02223, Embankment, of these Specifications unless further excavation or earthwork is required. No additional payment will be made for such excavation and backfill 1 foot or less than the finished subgrade. Unsuitable material excavation greater than 1 foot beneath the finished subgrade shall be made on a unit price basis for excavation and backfill, only as approved by the Engineer and CQA Engineer prior to the work. Unit price for overexcavation and backfill greater than 1 foot in depth shall include disposal of unsuitable materials.

15. All cuts shall be brought to the grade and cross section shown on the Contract Drawings, or established by the Engineer, prior to final inspection.

16. The Contractor shall protect finished lines and grades of completed excavation against excessive erosion, damage from trafficking, or other causes and shall repair any damage at no additional cost to the Owner.

17. Trench Excavation:

a. All pipe Excavation and trenching shall be done in strict accordance with these Specifications, all applicable parts of the OSHA Regulations, 29 CFR 1926, Subpart P, and other applicable regulations. In the event of any conflicts in this information, safe working conditions as established by the appropriate OSHA guidelines shall govern.

b. The minimum trench widths shall be as indicated on the Contract Drawings. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Contract Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing.

c. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

d. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, obstructions, or structures.

e. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet.

f. Pipe Bedding: All pipe bedding shall be as shown on the Contract Drawings, unless otherwise specified herein.

18. Sheeting and Bracing:

a. The Contractor shall furnish, place, and maintain such sheeting and bracing which may be required to support sides of Excavation or to protect pipes and structures from possible damage and to provide safe working conditions in accordance with current OSHA requirements. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the sole expense of the Contractor. The Contractor shall be responsible for the adequacy of all sheeting and bracing used and for all damage resulting from sheeting and bracing failure or from placing, maintaining, and removing it.

b. The Contractor shall exercise caution in the installation and removal of sheeting to insure that excessive or unusual loadings are not transmitted to

any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to sheeting installation or removal.

c. All sheeting and bracing shall be removed upon completion of the work.

19. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed at the Contractor's sole expense.

END OF SECTION

SECTION 02223

EMBANKMENT

Embankment: Embankment is the on-site compacted fill that provides the foundation and the berms for the containment area, the subgrade for some access roadways and structures, and backfill around structures and piping.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete Embankment including borrowing, hauling, screening, discing, drying, compaction, control of surface and subsurface water, final grading, sealing, and all necessary and incidental items as detailed or required to complete the Embankment, all in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Erosion and Sedimentation Control	02270
Roadway Work	02500
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. Quality Assurance:

Quality Assurance during placement of Embankment will be provided by the Owner as described in the accompanying Project CQA Manual.

5. Definitions:

a Embankment: Shall include construction of all site earthwork including roadways, subgrade, perimeter berm embankments, including preparation of the areas upon which materials are to be placed. Embankment may also be referred to as structural and/or controlled fill. All Embankment materials may be either (off-site) Select Borrow or (on-site) Borrow unless otherwise noted on Contract Drawings or specified by the Engineer.

b. Prepared Subgrade: The ground surface after clearing, grubbing, stripping, excavation, scarification, and/or compaction, and/or proof rolling to the satisfaction of the CQA Engineer.

c. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters. Well-graded is used to define a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

d. Unclassified Fill: The nature of materials to be used is not identified or described herein but must be approved by the Engineer prior to use.

B. MATERIALS

1. Embankment materials shall consist of clean well-graded natural soil classified as SW, SM, SM-SC, SC, ML, CL-ML, or CL (ASTM D 2488) containing no topsoil or other deleterious material. Other material classifications may be approved by the Engineer.

2. Stones or rock fragments shall not exceed one half the maximum lift thickness as compacted in any dimension. Isolated rocks shall be a maximum of 24-inches in any dimension.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer before approval is given to proceed:

1. Descriptive information on compaction equipment to be used for construction of Embankment.

2. Descriptive information on the location and source of any off-site borrow material to be used for Embankment, where applicable. Information shall include Standard Proctor curves (ASTM D698) for each borrow material.

D. CONSTRUCTION

1. The Contractor shall conduct Embankment activities in such a manner that erosion of disturbed areas and off-site sedimentation is absolutely minimized as outlined in Section 02270, Erosion and Sedimentation Control, of these Specifications.

2. All placement and compaction of Embankment shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.

3. Embankment shall be placed and compacted to the lines and grades shown on the Contract Drawings. Placement of Embankment outside the construction limits shall occur only as directed and approved by the Engineer.

   The Contractor will perform all surveys necessary to establish and verify lines and grades for all Embankment.

4. The Contractor shall protect all existing facilities including, but not limited to, utilities and monitoring wells.

5. Subgrade Preparation:

   a. The CQA Engineer shall inspect the exposed subgrade prior to placement of Embankment to assure that all rocks, topsoil, vegetation, roots, debris, or other deleterious materials have been removed.

   b. Prior to placement of Embankment, the exposed subgrade shall be proofrolled using a static smooth-drum roller, loaded tandem axle dump truck, or other suitable equipment in the presence of the CQA Engineer. Any soft or unsuitable materials revealed before or during the in-place compaction shall be removed as directed by the CQA Engineer and replaced with suitable Embankment.

6. Surfaces on which Embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the Embankment with the existing surface.

7. The Contractor shall be responsible for preparing the materials for the Embankment, including but not limited to, in-place drying or wetting of the soil necessary to achieve the compaction criteria of these Specifications.

8. The Contractor shall be responsible for control of surface and subsurface water, when necessary.

9. Embankment materials shall be placed in a manner permitting drainage and in continuous, approximately horizontal layers.

10. Compaction Requirements:

    a. The Contractor shall compact Embankment in accordance with the requirements shown in Table 1 of this section. If Embankment does not meet the specified requirements, the Contractor shall rework the material, as may be necessary and continue compaction to achieve these requirements, or remove and replace the material to achieve the specified requirements, at Contractor's expense.

    b. Each lift shall be compacted prior to placement of succeeding lifts. In confined areas, mechanical equipment, suitable for small areas and capable of achieving the density requirements, shall be required.

    c. Lift compaction shall be performed with an appropriately heavy, properly ballasted, penetrating-foot or smooth-drum vibratory compactor depending on soil type. Compaction equipment shall be subject to approval by the CQA Engineer.

11. Embankment that becomes excessively eroded, soft, or otherwise unsuitable shall be removed or repaired by the Contractor as directed by the CQA Engineer, at no cost to the Owner.

12. The exposed surface of Embankment shall be rolled with a smooth-drum roller at the end of each work day to protect from adverse weather conditions.

13. Where Embankment is to be placed and compacted on slopes that are steeper than 3:1, the subgrade shall be benched to a minimum depth of 6 inches and the Embankment shall be placed in horizontal lifts.

14. Backfilling for Structures and Piping:

    a. All structures, including manholes and pipes shall be backfilled with Embankment as shown in the Contract Drawings and as described in these Specifications.

    b. Where sheeting is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when sheeting is removed. If significant volumes of soil cannot be prevented from clinging to the extracted sheets, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that sheeting will be driven in similar soil conditions or employ other appropriate means to prevent loss of support.

    c. When backfilling around structures, do not backfill until concrete has sufficiently cured (as determined by the CQA Engineer) and is properly supported. Place backfill in a manner to avoid displacement or damage of structures.

TABLE 1: REQUIRED EMBANKMENT PROPERTIES

ITEM	Required % Standard Proctor (ASTM D698)[2]	Required Moisture Content[3]	Maximum Lift Thickness (Compacted) (inches)
Embankment	95	As Required for Compaction	8
Embankment Beneath Structures and Roads[1]	98		8
Backfill Around Structures	95		8
Backfill in Pipe Trenches	95		6
Unclassified Fill	N/A	N/A	N/A

Notes:

1. Embankment beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope. Embankment beneath roads shall be considered to include all embankment placed within 2 vertical feet of the final wearing surface and shall also include shoulders.
2. Determine field density using ASTM D 6938, ASTM D 1556, ASTM D 2167, or ASTM D 2937.
3. Determine field moisture content using ASTM D 6938, ASTM D 2216, ASTM D 4643, or ASTM D 4959.
4. The Engineer may allow exceptions to the above criteria for areas outside of the containment area which are not subject to significant long-term loads.

END OF SECTION

SECTION 02240

GEOTEXTILES

Geotextiles: For the proposed construction, a Type GT-S (Separator/Filter) Geotextile is specified. The Type GT-S Geotextile will be placed between soil subgrade and aggregate in access roads, and in some erosion control and drainage applications.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Geotextiles including all necessary and incidental items as detailed or required for the Contractor to complete the installation in accordance with the Contract Drawings and these Specifications, except as noted below:

a. Geotextiles used as a Silt Fence is covered under Section 02270, Erosion and Sedimentation Control, of these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Erosion and Sedimentation Control	02270
Roadway Work	02500
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO) are hereby made a part of these specifications.

ASTM D 3786 — Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.

ASTM D 4355 — Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
AASHTO M 288	Standard Specification for Geotextiles.

4. Quality Assurance:

Quality Assurance during installation of Geotextiles will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. General:

The materials supplied under these Specifications shall consist of new, first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes.

Labels on each roll of Geotextile shall identify the length, width, lot and roll numbers, and name of Manufacturer.

2. The Type GT-S Geotextile shall be a nonwoven spunbonded or nonwoven needlepunched synthetic fabric consisting of polyester or polypropylene manufactured in a manner approved by the Engineer. Woven fabrics may be used in certain applications if approved in advance by the Engineer.

3. All Geotextiles shall conform to the properties listed in Table 1 of this section.

C. SUBMITTALS

Prior to the installation of Geotextiles, the Contractor shall submit the following to the CQA Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each type of Geotextile attesting that the Geotextiles meet the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of each Geotextile to be used. The samples shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.

3. Seaming Procedures:

   Submit proposed seaming procedures including proposed method and equipment.

4. Quality Control Certificates: For Geotextiles delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided which represent every roll of each type of Geotextile supplied. Each certificate shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and frequency of testing shall be as shown in Table 2 of this section.

5. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

   All Geotextiles shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Failing CQA Material Control Tests:

   Geotextiles that are rejected upon testing shall be removed from the project site and replaced at Contractor's cost. Sampling and CQA testing of Geotextiles supplied as replacement for rejected material shall be performed by the CQA Engineer at Contractor's cost.

3. Installation:

a. The surface receiving the Geotextiles shall be prepared to a relatively smooth condition, free of obstructions, standing water, excessive depressions, debris, and very soft, excessively wet, and/or loose pockets of soil. This surface shall be approved by the CQA Engineer prior to Geotextile placement.

b. Geotextiles shall be placed to the lines and grades shown on the Contract Drawings. At the time of installation, Geotextiles shall be rejected by the CQA Engineer if they have defects, rips, holes, flaws, evidence of deterioration, or other damage.

c. The Geotextiles shall be placed smooth and free of excessive wrinkles.

d. On slopes, Geotextiles shall be anchored at the top and unrolled down the slope. In the presence of wind, all Geotextiles shall be weighted with sandbags or other material as approved by the CQA Engineer. Geotextiles uplifted by wind may be reused upon approval by the CQA Engineer.

4. Seams:

a. All Geotextile seams shall be continuously sewn or heat bonded with methods approved by the Engineer. Overlapping of seams may also be allowed if approved in advance by the Engineer. All seams must be approved by the CQA Engineer.

b. On slopes of 6H:1V or steeper, all seams shall be oriented parallel to (in the direction of) the slope unless otherwise approved by the Engineer.

c. Seams to be sewn shall be sewn using a Type 401 stitch. One or two rows of stitching may be used. Each row of stitching shall consist of 4 to 7 stitches per inch. The minimum distance from the geotextile edge to the stitch line nearest to that edge (seam allowance) shall be 1.5 inches if a Type SSa (prayer or flat) seam is used. The minimum seam allowance for all other seam types shall be 1.0 inches.

d. Seams to be heat bonded shall be bonded using hot plate, hot knife, ultrasonic, or other approved devices.

5. Repair Procedures:

a. Any Geotextile that is torn, punctured, or otherwise damaged shall be repaired or replaced, as directed by the CQA Engineer, by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of Geotextile placed over the failed areas and shall overlap

the existing Geotextile a minimum of 18 inches from any point of the rupture. Patches shall be spot sewn or heat bonded so as not to shift during cover placement.

b. Slopes Flatter Than 6H:1V: Damaged areas of a size exceeding 10 percent of the roll width shall be removed and replaced across the entire roll width with new material. Damaged areas of a size less than 10 percent of the roll width may be patched.

c. Slopes of 6H:1V or Steeper: Geotextile panels which require repair shall be removed and replaced with new material. Replacement material shall be sewn as previously described in this specification.

6. Cover Placement:

Placement of cover over Geotextiles shall be performed in a manner as to ensure that the Geotextiles or underlying materials are not damaged. Cover material shall be placed such that excess tensile stress is not mobilized in the Geotextile.

TABLE 1: REQUIRED GEOTEXTILE PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE[1]	
			TYPE GT-S	TYPE GT-C
Geotextile Construction (NW = Nonwoven) (W = Woven)	----------	----------	NW[2] or W[3]	NW[2] Needle-punched
Mass per Unit Area (Unit Weight)	ASTM D 5261	oz/yd^2	N/A	12
Ultraviolet Resistance (500 hrs)	ASTM D 4355	%	70	70
Strength Class[4]	AASHTO M 288	Class	2	1
Tensile Properties:	ASTM D 4632			
Grab Strength		lbs	160 (NW) 250 (W)	205
Grab Elongation		%	$\geq$ 50 (NW) < 50 (W)	$\geq$ 50
Puncture Resistance	ASTM D 4833	lbs	55 (NW) 90 (W)	80
Trapezoidal Tear Strength	ASTM D 4533	lbs	55 (NW) 90 (W)	80
Burst Strength	ASTM D 3786	psi	200 (NW) 400 (W)	255
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	70+	N/A
Permittivity	ASTM D 4491	sec^{-1}	1.0	N/A

Notes:

1. Minimum Average Roll Value (MARV).
2. Nonwoven geotextiles that have been heat calendered are not acceptable, unless approved by the Engineer in advance.
3. Woven geotextiles shall be approved in advance by the Engineer. Woven geotextiles formed exclusively with slit film fibers are not acceptable.
4. AASHTO M 288 criteria includes the above listed requirements for: Tensile Properties, Puncture Resistance, Trapezoidal Tear Strength, and Burst Strength.

TABLE 2: REQUIRED MANUFACTURER QUALITY CONTROL TESTS

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
Mass per Unit Area (Unit Weight)	ASTM D 5261	200,000 ft^2
Ultraviolet Resistance (500 hrs)	ASTM D 4355	Periodic
Tensile Properties	ASTM D 4632	200,000 ft^2
Burst Strength (Diaphragm Methods)	ASTM D 3786	200,000 ft^2
Apparent Opening Size (AOS)	ASTM D 4751	Periodic
Permittivity	ASTM D 4491	Periodic
Puncture Resistance	ASTM D 4833	200,000 ft^2
Trapezoidal Tear Strength	ASTM D 4533	200,000 ft^2

END OF SECTION

SECTION 02258

VEGETATIVE SOIL LAYER

Vegetative Soil Layer (VSL): The Vegetative Soil Layer (VSL) is placed in the final cover system in order to support permanent vegetative cover. This section includes the topsoil to be placed as the upper 6 inches of the VSL.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of the VSL (including topsoil) for the landfill cover, including borrowing, hauling, spreading, and final grading and all necessary and incidental items as detailed or required to complete the VSL, all in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
HDPE Pipe	02614
Revegetation	02930
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM D 422	Standard Test Method for Particle Size Analysis of Soils.
ASTM D 2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

4. Quality Assurance:

Quality Assurance during placement of Vegetative Soil Layer will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

Soil that meets all of the following requirements shall be classified as select soil fill for use in construction of the VSL.

1. Soil shall be classified according to the Unified Soil Classification System (USCS) as SM, SC, CL-ML, or CL(ASTM D 2487) Alternatives to these requirements must be approved in advance by the Engineer.

2. Select soil fill materials shall be reasonably free of gypsum, ferrous, and/or calcareous concretions and nodules, refuse, roots, or other deleterious substances.

3. Continuous and repeated visual inspection of the materials being used will be performed by the Contractor to ensure proper soils are being used. In addition, the CQA Engineer shall make frequent inspections of the placement operations and materials, and will consult with the Engineer.

4. The VSL shall be uniform, smooth, and free of debris, rock, plant materials, and other foreign material larger than 3 inches in diameter. The material should contain no sharp edges. This material must be capable of supporting growth of vegetative cover.

5. Topsoil: The upper 6 inches of VSL shall be natural or blended soil material capable of supporting the growth of vegetative cover. Topsoil shall contain a minimum of 2% by weight of organics evenly blended into the material in order to support the growth of vegetative cover. Also, the topsoil shall contain 10% by weight gravel size particles (1½ inch maximum particle size) to aid in the prevention of excess wind erosion.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Before approval is given to proceed, the Contractor shall submit descriptive information on placement equipment to be used in construction of the VSL.
2. Survey Results:

After completion of a segment of VSL, survey results shall be submitted for review prior to VSL acceptance.

D. CONSTRUCTION

1. All placement and compaction of VSL shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.

2. VSL shall be placed as specified below:

   a. VSL shall be placed and compacted to the lines and grades shown on the Contract Drawings with the exception that a 0.15 foot overbuild at Contractor's expense is allowed. The Contractor will perform all surveys necessary to establish and verify lines and grades for all VSL.

   b. VSL shall be compacted by tracking the final lift with tracked equipment.

3. After the specified thickness has been achieved and verified, the Contractor shall proceed immediately with seeding.

4. <u>Surveying:</u>

   After completion of a segment of VSL, the VSL shall be surveyed on 100 foot centers and at slope breaks (including all tops and toes of slope, points of grade change, etc.) to ensure:

   a. The specified thickness has been achieved. A hand auger or similar method may be used to check for thickness at each location.

   b. The top of the VSL slopes at grades specified on the Contract Drawings; and

   c. VSL placed more than 0.15 feet beyond the limits of the lines and grades as shown on the Contract Drawings will not be accepted and must be removed at the Contractor's sole expense if required by the Engineer.

   This work shall be performed at the Contractor's cost by a registered surveyor.

END OF SECTION

SECTION 02270

EROSION AND SEDIMENTATION CONTROL

Erosion and Sedimentation Control: Erosion and Sedimentation Control is a system of construction and engineered measures (devices, structures, practices, etc.) which act to minimize surface water induced erosion of disturbed areas and the resulting off-site sedimentation.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of and maintain Erosion and Sedimentation Control measures and related work in accordance with the Contract Drawings and these Specifications.

All Erosion and Sedimentation Control work shall be in accordance with the latest edition of the North Carolina Erosion and Sediment Control Planning and Design Manual as well as applicable regulations.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Geotextiles	02240
Rip Rap	02271
Rolled Erosion Control Products	02275
Precast Concrete Structures	02608
HDPE Pipe	02614
Storm Water Systems	02720
Revegetation	02930
Concrete Work	03310

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 3786 — Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

B. MATERIALS

1. Permanent Sediment or Detention Basins:

Permanent sediment or detention basins shall be constructed as shown on the Contract Drawings.

2. Permanent Drainage Channels, Diversions, Swales, and Ditches:

Permanent drainage channels, diversions, swales, and ditches shall be constructed as shown on the Contract Drawings.

3. Silt Fence:

Silt fences shall be constructed as shown on the Contract Drawings and as needed, based on the Contractor's discretion and Engineer's approval. The silt fence is a permeable barrier erected within and downgradient of small disturbed areas to capture sediment from sheet flow. It is made of filter fabric buried at the bottom, stretched, and supported by posts and wire mesh backing. Silt fence shall conform to the following properties:

a. Posts: Posts shall be 3 feet long "U" or "T"-type steel posts.
b. Filter Fabric: Filter fabric shall be a woven geotextile made specifically for sediment control. Filter fabric shall conform to the properties listed in Table 1 of this section.

4. Geotextiles:

Geotextiles shall conform to the requirements of Section 02240, Geotextiles, of these Specifications.

5. Down Pipes:

Down pipes shall be constructed as shown on the Contract Drawings.

6. Rip Rap:

Rip Rap shall conform to the requirements of Section 02271, Rip Rap, of these Specifications.

7. Rolled Erosion Control Products (RECPs):

Rolled Erosion Control Products (RECPs) shall conform to the requirements of Section 02275, Rolled Erosion Control Products, of these Specifications.

8. Other Work:

In addition to the Erosion and Sedimentation Control measures shown on the Contract Drawings, the Contractor shall provide adequate means to prevent any sediment from entering any storm drains, drop inlets, ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of off-site areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed. All paved areas shall be scraped and swept as necessary to prevent the accumulation of dirt and debris. Work associated with this provision shall be considered incidental to the project and no separate payment will be made.

9. Temporary and Permanent Ground Cover:

The Contractor shall provide temporary or permanent ground cover (or other acceptable measure(s)) adequate to restrain erosion on erodible slopes or other areas within twenty-one (21) calendar days following completion of any phase of grading.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all Erosion and Sedimentation Control materials manufactured for the project have been produced in accordance with these Specifications.

2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. Establishment of Erosion and Sedimentation Control Measues:

a. All Erosion and Sedimentation Control measures will be constructed according to the Contract Drawings and these Specifications.

b. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the Erosion and Sedimentation Control measures may need to be adjusted on several occasions to reflect the current phase of construction.

c. Erosion and Sedimentation Control measures shall be established prior to the work in a given area. Where such practice is not feasible, the Erosion and Sedimentation Control measure(s) shall be established immediately following completion of the clearing operation.

d. The construction schedule adopted by the Contractor will impact the placement and need for specific measures required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and prevent or correct the discharge of sediment outside the limits of construction (unless controlled by other on-site measure(s)).

e. The location and extent of Erosion and Sedimentation Control measures shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from construction areas. All deviations from the control provisions shown on the Contract Drawings shall have the prior approval of the Engineer.

2. Inspection and Maintenance of Erosion and Sedimentation Control Measures:

a. The Contractor shall furnish the labor, material, and equipment required for the inspection and maintenance of all Erosion and Sedimentation Control measures. Maintenance shall be scheduled as required for a particular measure to maintain the removal efficiency and intent of the measure.

b. All Erosion and Sedimentation Control measures shall be inspected at least once every seven calendar days and within 24 hours after any storm event of greater than 0.5 inches of rain per 24 hour period and appropriate maintenance conducted. A rain gauge shall be maintained on the site and a record of the rainfall amounts and dates shall be kept properly.

c. Maintenance shall include, but not be limited to:

(1) The removal and satisfactory disposal of trapped or deposited sediments from basins, traps, barriers, filters, and/or drainage features/devices;

(2) Replacement of filter fabrics used for silt fences upon loss of efficiency; and

(3) Replacement of any other components which are damaged or cannot serve the intended use.

d. The Contractor shall accept and maintain any existing sediments that are included in existing sediment traps or basins that accept or will accept stormwater flow and or sediment accumulation from all areas within the Contractor's limits of construction.

e. Sediments removed from Erosion and Sedimentation Control measures shall be disposed of in locations that will not result in off-site sedimentation as approved by the Engineer.

f. All Erosion and Sedimentation Control measures shall be maintained to the satisfaction of the Engineer until the site has been stabilized.

3. Graded Slopes and Fills:

The angle for graded slopes and fills shall be no greater than the angle that can be retained by vegetated cover or other adequate measures.

4. Finish Grading:

All disturbed areas outside of the containment area shall be uniformly graded to the lines, grades, and elevations shown on the Contract Drawings. Finished surfaces shall be reasonably smooth, compacted, and free from irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from either blade or scraper operations. Areas shall be finished to a smoothness suitable for application of topsoil.

5. Revegetation:

Revegetation shall conform to the requirements of Section 02930, Revegetation, of these Specifications.

6. Cleanup:

a. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.

b. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

TABLE 1: REQUIRED SILT FENCE FILTER FABRIC PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE[1]
Grab Tensile Strength[2]	ASTM D 4632	lbs	100 x 100
Grab Elongation	ASTM D 4632	%	20 (Max.)
Trapezoidal Tear Strength[2]	ASTM D 4533	lbs	65 x 65
Burst Strength	ASTM D 3786	psi	300
Puncture Resistance	ASTM D 4833	lbs	65
Ultraviolet Resistance (500 hrs)	ASTM D 4355	%	80
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	30+
Permittivity	ASTM D 4491	sec^{-1}	0.05

Notes:
1. Minimum Average Roll Value (MARV).
2. Values for machine and cross machine direction (MD x XD), respectively.

END OF SECTION

SECTION 02275

ROLLED EROSION CONTROL PRODUCTS

Rolled Erosion Control Products: Rolled Erosion Control Products (RECPs) include turf reinforcement mats (TRM) placed on side slope swales.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of all RECPs in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Erosion and Sedimentation Control	02270
Revegetation	02930

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
ASTM D 6475	Standard Test Method for Measuring Mass per Unit Area of Erosion Control Blankets.
ASTM D 6524	Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats.
ASTM D 6525	Standard Test Method for Measuring Nominal Thickness of Permanent Erosion Control Products.
ASTM D 6566	Standard Test Method for Measuring Mass per Unit Area of Turf Reinforcement Mats.

ASTM D 6818 Standard Test Method for Ultimate Tensile Properties of Turf Reinforcement Mats.

B. MATERIALS

1. General:

The materials supplied under these Specifications shall consist of new, first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes.

Labels on each RECP shall identify the length, width, product name, and name of Manufacturer.

2. Turf Reinforcement Mat (TRM) (Type 1):

TRM (Type 1) shall consist of a dense web of crimped and interlocking polypropylene fibers positioned between two biaxially oriented nets and mechanically bound together by parallel stitching with polypropylene thread. TRM (Type 1) shall be designed to accelerate seedling emergence, exhibit high resiliency, and possess strength and elongation properties to limit stretching in a saturated condition. TRM (Type 1) shall be stabilized against chemical and UV degradation which are normally found in a natural soil environment and shall have no biodegradable components. TRM (Type 1) shall also conform to the properties listed in Table 1 of this section. TRM (Type 1) shall be LANDLOK TRM 435, as manufactured by Propex Fabrics, or approved equal.

3. Anchors: Anchors for RECPs shall consist of machine made staples of No. 8 gauge new steel wire formed into a “U” shape. The size when formed shall be not less that 8 inches in length with a throat of not less than 1 inch in width. Longer anchors may be required for loose soils. Other anchors, such as metal pins or plastic pegs, may also be used if approved in advance by the Engineer.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Mill Certificate and Sample: Prior to shipping to the site, the Contractor shall submit a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each RECP attesting that each RECP meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of each RECP to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

2. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.

3. Installation Guidelines/Instructions: The Manufacturer's guidelines/instructions for installation shall be submitted for review.

4. Furnish copies of delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

D. CONSTRUCTION

1. Shipping, Handling, and Storage:

All RECPs shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. Installation - General:

a. Placing of RECPs shall be done immediately following seeding. Seeding shall be performed in accordance with Section 02930, Revegetation, of these Specifications.

b. RECPs shall be placed to the lines and grades shown on the Contract Drawings. The earth surface shall be smooth and free from stones, clods, or debris which will prevent the contact of the RECP with the soil. Care shall be taken to preserve the required line, grade, and cross section of the area.

c. RECPs shall be unrolled in the direction of the flow of water and shall be applied without stretching so that it will lie smoothly but loosely on the soil surface.

d. At the time of installation, RECPs shall be rejected, if they have defects, rips, holes, flaws, evidence of deterioration, or other damage.

e. The Engineer may require adjustments in the installation requirements to fit individual conditions.

3. Installation - Slopes:

RECPs installed on slopes shall be oriented in vertical strips and anchored. Subsequent rolls shall be installed outward to the edge(s) of the original roll and be lapped to allow installation of a common row of anchors. RECP ends shall be shingled. Refer to the Contract Drawings and/or the Manufacturer’s installation guidelines/instructions for installation details.

4. Maintenance:

Maintenance of RECPs shall be in accordance with Section 02270, Erosion and Sedimentation Control, of these Specifications.

TABLE 1: REQUIRED ROLLED EROSION CONTROL PRODUCT PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE[1]
Turf Reinforcement Mat (TRM) (Type 1)			
Mass per Unit Area	ASTM D 6566	oz/yd^2	8
Thickness	ASTM D 6525	inches	0.35
Tensile Strength[1]	ASTM D 6818	lbs/ft	225 x 175
Tensile Elongation	ASTM D 6818	%	50 (max.)
Resiliency	ASTM D 6524	%	80
UV Resistance (1,000 Hours)	ASTM D 4355	%	80
Maximum Permissible Shear Stress (Long-Term Vegetated)	Large Scale	lb/ft^2	5

Notes:

1. Values for machine and cross machine direction (MD x XD), respectively.

END OF SECTION

SECTION 02500

ROADWAY WORK

Roadway Work: Roadway Work refers to the construction of paved and gravel road surfaces.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment required to complete construction of all Roadway Work including gravel roads and asphalt concrete pavement in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223
Geotextiles	02240
Concrete Work	03300

3. Reference Standards:

The latest revision of the following standards of the North Carolina Department of Transportation (NCDOT) are hereby made a part of these Specifications:

NCDOT Standard Specifications for Roads and Structures.

B. MATERIALS

1. Geotextiles:

Geotextiles shall conform to the requirements outlined in Section 02240, Geotextiles, of these Specifications.

2. Aggregate Base Course (ABC):

All work, including materials, associated with ABC shall be in accordance with NCDOT Section 520, Aggregate Base Course, except that Articles 520-7

(Contractor Furnished Laboratory), 520-12 (Method of Measurement), and 520-13 (Basis of Payment) shall be deleted. Type "A" or "B" aggregate will be acceptable for this project.

3. Aggregate Stabilization:

All work, including materials, associated with aggregate stabilization shall be in accordance with NCDOT Section 510, Aggregate Stabilization, except that Articles 510-6 (Method of Measurement), and 510-7 (Basis of Payment) shall be deleted.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all materials for Roadway Work have been produced in accordance with these Specifications.

2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. General:

All Roadway Work including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses, and types as shown on the Contract Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt or gravel, depending upon the material encountered, unless otherwise indicated.

2. Earthwork:

The earthwork for all Roadway Work shall be completed in accordance with Section 02222, Excavation, and Section 02223, Embankment, of these Specifications and as shown on the Contract Drawings.

3. Geotextiles:

Geotextiles shall be placed as shown on the Contract Drawings and in accordance with Section 02240, Geotextiles, of these Specifications. If overlapped seams are used, overlaps shall be a minimum of 12 inches.

4. Aggregate Stabilization:

Subgrade not overlain by a geotextile, where shown on the Contract Drawings, shall be aggregate stabilized by the addition and mixing of coarse aggregate with the top 3 inches of subgrade in accordance with NCDOT Section 510. Aggregate stabilization shall be applied to the subgrade at a rate of 300 lbs/yd^2. Following the application of stabilizer aggregate, the subgrade shall be shaped and compacted in accordance with NCDOT Section 510.

5. Aggregate Base Course:

ABC shall be constructed in accordance with NCDOT Section 520.

6. Underground Utility Lines:

Where an underground utility line is beneath the Roadway Work, backfilling shall be carried out with special care, and the final consolidation shall be accomplished by a vibratory roller. Construction of Roadway Work over the trench shall be deferred as long as practicable.

END OF SECTION

SECTION 02608

PRECAST CONCRETE STRUCTURES

Precast Concrete Structures: Precast Concrete Structures are used in the storm water.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of Precast Concrete Structures in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223
Erosion and Sedimentation Control	02270
HDPE Pipe	02614
Storm Water Systems	02720
Concrete Work	03310
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these Specifications.

ASTM A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
ASTM C 443	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
ASTM C 478	Standard Specification for Precast Reinforced Concrete Manhole Sections.
ASTM C 497	Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
ASTM C 1433	Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Strom Drains, and Sewers.

4. Quality Control:

The Contractor shall perform leak testing of Precast Concrete Structures as described in this section.

5. Quality Assurance:

Quality Assurance during placement of Precast Concrete Structures will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. Precast Concrete Boxes: All precast concrete boxes shall be constructed from non-shrink, 4,000 psi compressive strength concrete in conformance with ASTM C 1433 and as detailed on the Contract Drawings.

2. Joints: All joints shall be sealed with preformed plastic gaskets in conformance with ASTM C 990 or rubber gaskets in conformance with ASTM C 443.

3. Steps: All steps shall be constructed of 0.5 inch reinforcing rod completely encased in corrosion-resistant rubber or plastic. The upper surfaces of each step shall have a traction tread of self cleaning rubber cleats and guide lugs on both sides to prevent slippage.

4. Frames and Covers: Frames and covers shall consist of cast iron frames and covers (Vulcan Foundry, or equal) equipped with steel handles and shall be of the opening size as indicated on the Contract Drawings. Markings on the covers shall indicate the intended use of the structure and shall be acceptable to the Owner.

5. Markings: All Precast Concrete Structures shall include markings clearly identifying the date of manufacture, the name of the manufacturer, and any other pertinent information.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. The Contractor shall submit shop drawings for Precast Concrete Structures for approval at least 4 weeks prior to construction. Shop drawings shall show complete design, installation, and construction information in such detail as to enable the Engineer to determine the adequacy of the proposed units for the intended purpose. Details of steel reinforcement size and placement shall be included. The shop drawings shall include a schedule which will list the size and type of precast structure at each location where the precast structures are to be used.

2. Submit a certification and summary of all required test results, prior to installation, that all Precast Concrete Structures have been produced in accordance with these Specifications.

D. CONSTRUCTION

1. The Precast Concrete Structures shall be installed at the locations and to the elevations indicated on the Contract Drawings. The Contractor shall give the CQA Engineer sufficient notice so he may observe the field location and installation activities.

2. The Precast Concrete Structures will be bedded and backfilled as indicated on the Contract Drawings.

3. Precast Concrete Structures which are damaged or become damaged will be rejected or shall be repaired in a manner approved by the Engineer at the Contractor's sole expense.

END OF SECTION

SECTION 02614

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

High Density Polyethylene (HDPE) Pipe: HDPE Pipe is used in the storm water.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete installation of HDPE Pipe in accordance with the Contract Drawings and these Specifications. The Contractor shall also clean and test pipelines where required.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223
Precast Concrete Structures	02608
Concrete Work	03310
CQA Manual	Attached

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.

ASTM D 2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
ASTM D 3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
ASTM D 3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
ASTM F 412	Standard Terminology Relating to Plastic Piping Systems.
ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ASTM F 1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
ASTM F 1473	Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.
ASTM F 2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.

4. Quality Control:

   The Contractor shall perform pressure testing of HDPE Pipe as described in this section.

5. Quality Assurance:

   Quality Assurance during placement of HDPE Pipe will be provided by the Owner as described in the accompanying Project CQA Manual.

B. MATERIALS

1. All HDPE Pipe shall be manufactured from new materials meeting the physical requirements shown in Table 1 of this section.

2. All HDPE Pipe shall have smooth interior walls and the DR (dimension ratio) and diameter of the pipe shall be as shown on the Contract Drawings.

3. All HDPE Pipe having an outside diameter 3.5 inches and larger shall meet the requirements of ASTM F 714. All HDPE Pipe having an outside diameter less than 3.5 inches shall meet the requirements of ASTM D 3035.

4. Visible defects, such as cracks, creases, crazing, non-uniformly pigmented areas, or undispersed raw materials shall not be acceptable and will result in rejection of the pipe by the CQA Engineer.

5. Pipe Perforations: The perforations of the perforated HDPE Pipe shall be as shown on the Contract Drawings.

6. All HDPE Pipe fittings shall be in accordance with ASTM D 3261 and shall be manufactured by the Manufacturer of the HDPE Pipe supplied for the project and shall be pressure rated to match the system piping. The fittings shall be manufactured from the same materials as the pipe itself. The butt fusion outlets of fittings shall be machined to the same DR as the system piping to which they are to be fused.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all HDPE Pipe manufactured for the project has been produced in accordance with these Specifications.

2. Submit a copy of the HDPE Pipe Manufacturer's recommendations for shipping, handling, and storage of pipe.

3. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

4. Survey Results:

   After placement of HDPE Pipe, survey results shall be submitted for review prior to acceptance.

D. CONSTRUCTION

1. Shipping , Handling, and Storage:

   All HDPE Pipe shall be shipped, handled, and stored in strict accordance with the Manufacturer's recommendations.

2. HDPE Pipe Installation:

a. The Contractor shall install HDPE Pipe to the lines and grades shown on the Contract Drawings. Line and grade of piping shall be maintained with laser or approved equivalent. The Contractor shall give the CQA Engineer sufficient notice so that the he may observe field location and installation activities.

b. Excavation for leachate transmission lines shall be backfilled as directed by the Engineer as shown on the Contract Drawings. Sand backfill or approved soil backfill compacted to at least 95 percent of the Standard Proctor dry density (ASTM D 698) shall be used.

Sharp stones or other potentially damaging material shall be removed from the base of the trench prior to placement of the piping. A leveling course, as required, shall consist of sand or other approved material.

c. Pipe Connections: Joining of HDPE Pipe shall be as follows:

(1) General pipe sections shall be butt-fusion welded according to the Manufacturer's recommendations and shall be performed by a Manufacturer's authorized, trained fusion technician.

(2) Pipe ends to be butt-fusion welded shall be clean and dry at the time of welding. No welding shall occur during precipitation or excessive moisture.

(3) The Contractor shall grind burrs or other potentially damaging areas in the welds prior to placement of the pipe.

(4) Specified bolted pipe connections shall be made as specified on the Contract Drawings using stainless steel hardware and neoprene gaskets.

(5) Polyethylene stub ends and flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene.

(6) Properly executed electrofusion fittings may be used.

d. Perforated HDPE Pipe shall be placed during construction as shown on the Contract Drawings.

3. <u>Cleaning:</u>

a. All HDPE Pipe shall be cleaned of any accumulation of silt, debris, or foreign matter of any kind and shall be kept clear of such accumulation until final acceptance of the work.

4. Pressure Testing:

a. All solid piping where factory or field joints have been performed require pressure testing except as noted below.

(1) Any unjointed section of pipe showing visual signs of damage or that is of questionable quality may be required to be pressure tested as directed by the CQA Engineer.

(2) Cleanout risers within the containment areas do not require pressure testing.

c. Pressure testing shall be conducted by the Contractor in a manner approved by the Engineer. Such testing shall be observed by the CQA Engineer.

5. Surveying:

The Contractor shall survey all HDPE Pipe on 100 foot centers and at bends to ensure the proper location and grade of the piping.

TABLE 1: REQUIRED HDPE PIPE PROPERTIES

PROPERTY	TEST METHOD	UNITS	VALUE[1]
Material Designation	ASTM D 412	----------	PE 3408
Cell Classification	ASTM D 3350	----------	345464 C
Density	ASTM D 1505	g/cm^3	0.955
Melt Flow Index	ASTM D 1238	g/10 min	0.1
Flexural Modulus	ASTM D 790	psi	130,000
Tensile Strength @ Yield	ASTM D 638	psi	3,200
SCG (PENT)	ASTM F 1473	hrs.	> 100
Hydrostatic Design Basis at 73° F	ASTM D 2837	psi	1,600
UV Stabilizer	ASTM D 1603	% Carbon Black	2 - 3%

Notes:
1. Nominal Values.

END OF SECTION

SECTION 02720

STORM WATER SYSTEMS

Storm Water Systems: Storm Water Systems shall include all piping, pipe fittings, headwalls, flared end sections, drop inlets, and other appurtenances designated to convey stormwater.

A. DESCRIPTION

1. General:

The contractor shall furnish all labor, material, and equipment to complete installation of Storm Water Systems in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Excavation	02222
Embankment	02223
Erosion and Sedimentation Control	02270
Rip Rap	02271
Precast Concrete Structures	02608
HDPE Pipe	02614
Concrete Work	03310

3. Reference Standards:

The latest revision of the following standards of the American Society of Testing and Materials (ASTM), the American Association of State Highway and Transportation Officials (AASHTO), and the North Carolina Department of Transportation (NCDOT) are hereby made a part of these specifications.

ASTM C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
ASTM C 150	Standard Specification for Portland Cement.
ASTM D 1248	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials For Wire and Cable.

ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
AASHTO M 36	Specification for Corrugated Steel Pipe.
AASHTO M 252	Specification for Corrugated Polyethylene Drainage Tubing, 3 to 10 Inch Diameter.
AASHTO M 294	Specification for Corrugated Polyethylene Pipe, 12 to 36 Inch Diameter.
NCDOT	Standard Specifications for Roads and Structures and Roadway Standard Drawings.

B. MATERIALS

1. Reinforced Concrete Pipe (RCP):

   a. All reinforced concrete pipe shall be manufactured in accordance with ASTM C 76, Wall Type B or C, and shall be of the class that equals or exceeds the pipe class as shown on the Contract Drawings. All pipe shall be aged at the manufacturing plant for at least fourteen (14) days before delivery to the job site.

   b. Minimum pipe laying lengths shall be four (4) feet.

   c. Joints for reinforced concrete pipe shall have tongue and groove or bell and spigot ends with leak-resistant mastic joint sealant. Joint sealant shall be ConSeal type, or approved equal.

2. Corrugated Polyethylene (CPE) Pipe:

   CPE pipe and fittings shall be of the sizes and type shown on the Contract Drawings and shall conform to every aspect of AASHTO M 252 (3 to 10 inch diameters) or AASHTO M 294 (12 to 36 inch diameters). All Type S CPE pipe shall have watertight joints.

3. Flared End Sections:

   Flared end sections shall be reinforced and shall be fabricated from the same materials meeting the same requirements as the pipe to which they are connected. All reinforced concrete and corrugated metal flared end sections shall meet the

requirements of the NCDOT. Corrugated polyethylene flared end sections shall be as recommended by the pipe manufacturer.

4. Headwalls:

Headwalls shall be as described in the Contract Drawings.

5. Precast Concrete Structures:

Precast Concrete Structures shall be constructed as shown in the Contract Drawings and in accordance with Section 02608, Precast Concrete Structures, of these Specifications.

C. SUBMITTALS

The Contractor shall submit the following to the CQA Engineer:

1. Submit a certification and summary of all required test results, prior to installation, that all Storm Water Systems have been produced in accordance with these Specifications.

2. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into construction.

D. CONSTRUCTION

1. All piping shall be installed by skilled workmen and in accordance with the best standards for piping installation. Proper tools and appliances for the safe and convenient handling and installation of the pipe and fittings shall be used.

2. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be defective. If any defective piece should be discovered after having been installed, it shall be removed and replaced at the Contractor's expense.

3. Excavation and backfilling of pipe trenches shall be as described in Section 02222, Excavation and Section 02223, Embankment, respectively, of these Specifications.

4. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. No materials shall be dropped or dumped into the trench.

5. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fittings, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.

6. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade.

7. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation. No pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense.

8. The laying of reinforced concrete pipe shall conform to the current recommendations of the American Concrete Pipe Association for Installation Type 1 or 2.

END OF SECTION

SECTION 02930

REVEGETATION

Revegetation: Revegetation includes permanent Revegetation of all site areas disturbed by the Contractor whether inside the Contract Limits or not.

A. DESCRIPTION

1. General:

The Contractor shall furnish all labor, material, and equipment to complete Revegetation in accordance with the Contract Drawings and these Specifications.

2. Related Work:

Related Contract Work is described in the following sections of the Specifications:

Work	Section
Embankment	02223
Protective Cover	02256
Vegetative Soil Layer	02258
Erosion and Sedimentation Control	02270
Rolled Erosion Control Products	02275

3. Warranty:

The Contractor shall be responsible for the satisfactory establishment and growth of a permanent stand of vegetation for a period of one year following the final seeding as judged by the Engineer. During this period, the Contractor shall be responsible for the maintenance items described in Paragraph D.4 (Maintenance) of this Specification.

4. The Contractor shall be a licensed landscape contractor in the state of North Carolina as defined in Chapter 89D of the General Statutes of North Carolina. The certificate number shall be provided.

B. MATERIALS

1. Limestone: Unless otherwise defined by specific soil tests, supply agricultural grade ground limestone conforming to the current "Rules, Regulations, and Standards of the Fertilizer Board of Control."

2. Fertilizer: Unless otherwise defined by specific soil tests, supply commercial fertilizer of 10-20-10 analysis, meeting applicable requirements of State and Federal law. Do not use cyanamic compounds of hydrated lime. Deliver fertilizer in original containers labeled with content analysis.

3. Grass Seed: Supply fresh, clean, new-crop seed as specified in Table 1 of this section. Do not use seed which is wet, moldy, or otherwise damaged. Deliver seed in standard sealed containers labeled with producer's name and seed analysis, and in accord with US Department of Agriculture Rules and Regulations under Federal Seed Act.

4. Mulch: Supply clean, seed-free, threshed straw of oats, wheat, barley, rye, beans, or other locally available mulch material.

   a. Do not use mulch containing a quantity of matured, noxious weed seeds or other species that will be detrimental to seeding, or provide a menace to surrounding land.

   b. Do not use mulch material which is fresh or excessively brittle, or which is decomposed and will smother or retard growth of grass.

5. Binder: Supply emulsified asphalt or synthetic binder.

6. Water: Supply potable, free of substances harmful to growth.

C. SUBMITTALS

The Contractor shall submit the following to the Engineer:

1. Results of soil tests performed and proposed modifications, if any, to the specified requirements.

2. Certificates for each grass seed mixture, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed. Certify that each container of seed delivered is fully labeled in accordance with Federal Seed Act and equals or exceeds specification requirements.

3. Copies of invoices for fertilizer, showing grade furnished and total quantity applied.

D. CONSTRUCTION

1. The Contractor shall establish a smooth, healthy, uniform, close stand of grass from the specified seed. Prior to Revegetation, the Contractor shall adequately test the soils to be revegetated to ensure the adequacy of the specified requirements. Any modifications to these requirements deemed necessary after

the review of soil test results, shall be at the Contractor's sole expense. The Engineer will perform the observations to determine when successful Revegetation is achieved.

2. Soil Preparation:

a. Limit preparation to areas which will be planted soon after preparation.

b. Loosen surface to minimum depth of four (4) inches.

c. Remove stones, sticks, roots, rubbish and other extraneous matter over three (3) inches in any dimension.

d. Spread lime uniformly over designated areas at the rate specified in Table 1 of this section.

e. After application of lime, prior to applying fertilizer, loosen areas to be seeded with double disc or other suitable device if soil has become hard or compacted. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.

f. Distribute fertilizer uniformly over areas to be seeded at the rate specified in Table 1 of this section.

(1) Use suitable distributor.

(2) Incorporate fertilizer into soil to depth of a least two (2) inches.

(3) Remove stones or other substances which will interfere with turf development or subsequent mowing.

g. Grade seeded areas to smooth, even surface with loose, uniformly fine texture.

(1) Roll and rake, remove ridges and fill depressions, as required to meet finish grades.

(2) Fine grade just prior to planting.

3. Seeding:

a. Use approved mechanical power driven drills or seeders, mechanical hand seeders, or other approved equipment.

b. Distribute seed evenly over entire area at the rate specified in Table 1 of this section.

c. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds, excessive moisture, or other factors.

d. Resume work only when favorable condition develops, or as directed by the Engineer.

e. Lightly rake seed into soil followed by light rolling or cultipacking.

f. Immediately protect seeded areas against erosion by mulching or placing Rolled Erosion Control Products in accordance with Section 02275 of these Specifications, where applicable.

(1) Spread mulch in a continuous blanket at the rate specified in Table 1 of this section.

(2) Immediately following spreading mulch, secure with evenly distributed binder at the rate specified in Table 1 of this section.

4. Maintenance:

The Contractor shall be responsible for maintaining all seeded areas through the end of his warranty period. The Contractor shall provide, at his expense, protection of all seeded areas against damage at all times until acceptance of the work. Maintenance shall include, but not be limited to, the following items:

a. Regrade and revegetate all eroded areas until adequately stabilized by grass.

b. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.

c. Replant bare areas using same materials specified.

TABLE 1: SEEDING SCHEDULE

MATERIAL	SEED TYPE	APPLICATION RATE[1]
Lime	-----	4,000 lbs/acre
Fertilizer	10-10-10 Analysis	1,000 lbs/acre
Seed Permanent:	 Creeping Red Fescue Red Clover Kobe Lespedeza Seasonal Nurse Crop[2] Seasonal Nurse Crop[2]	 40 lbs/acre 10 lbs/acre 10 lbs/acre See Note 2 See Note 2
Mulch	-----	4,000 - 5,000 lbs/acre
Binder	Asphalt Emulsion	300 gallons/acre

Notes:

1. Application rates and/or chemical analysis shall be confirmed or established by a soil test(s).
2. Use seasonal nurse crop in accordance with seeding dates as stated below:

April 15 - August 15	10 lbs/acre German Millet or 15 lbs/acre Sudangrass
August 16 - April 14	25 lbs/acre Rye (grain).

END OF SECTION

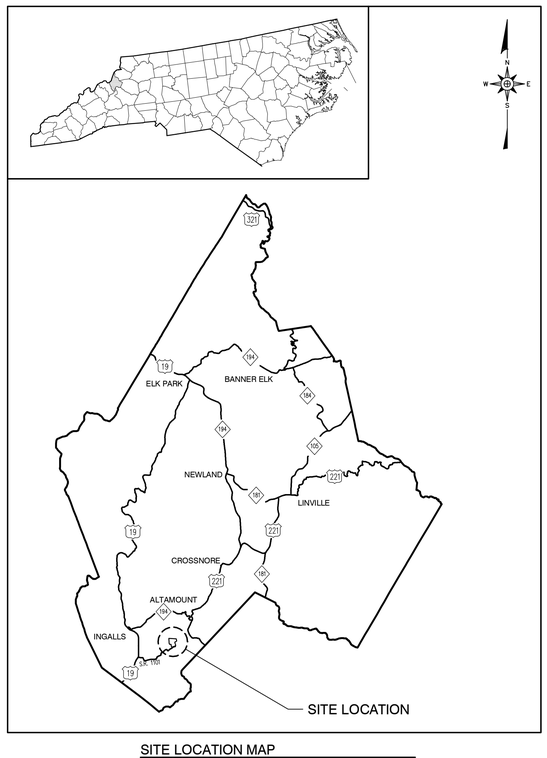
Appendix C

Engineering Drawings

AVERY COUNTY SOLID WASTE DEPARTMENT
AVERY COUNTY, NORTH CAROLINA

CONSTRUCTION & DEMOLITION LANDFILL STORMWATER MANAGEMENT PLAN

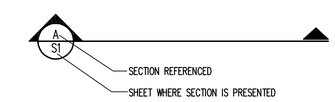
SEPTEMBER 2008



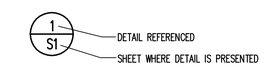
SITE LOCATION MAP
NOT TO SCALE

SHEET NO.	DRAWING NO.	TITLE
1		TITLE – COVER SHEET
2	S1	EXISTING CONDITIONS
3	S2	INITIAL GRADING PLAN
4	S3	STORMWATER MANAGEMENT PLAN
5	S4	RESTORATION PLAN
6	D1	UNDERDRAIN DETAILS
7	EC1	STORMWATER MANAGEMENT DETAILS (SHEET 1 OF 3)
8	EC2	STORMWATER MANAGEMENT DETAILS (SHEET 2 OF 3)
9	EC3	STORMWATER MANAGEMENT DETAILS (SHEET 3 OF 3)
10	EC4	CASCADE DETAILS

STANDARD SECTION LOCATION (SHEET AND DETAIL)



STANDARD DETAIL CALLOUT



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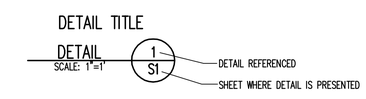

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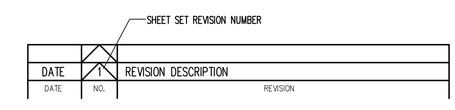

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FILE NAME
AVERY-D0042

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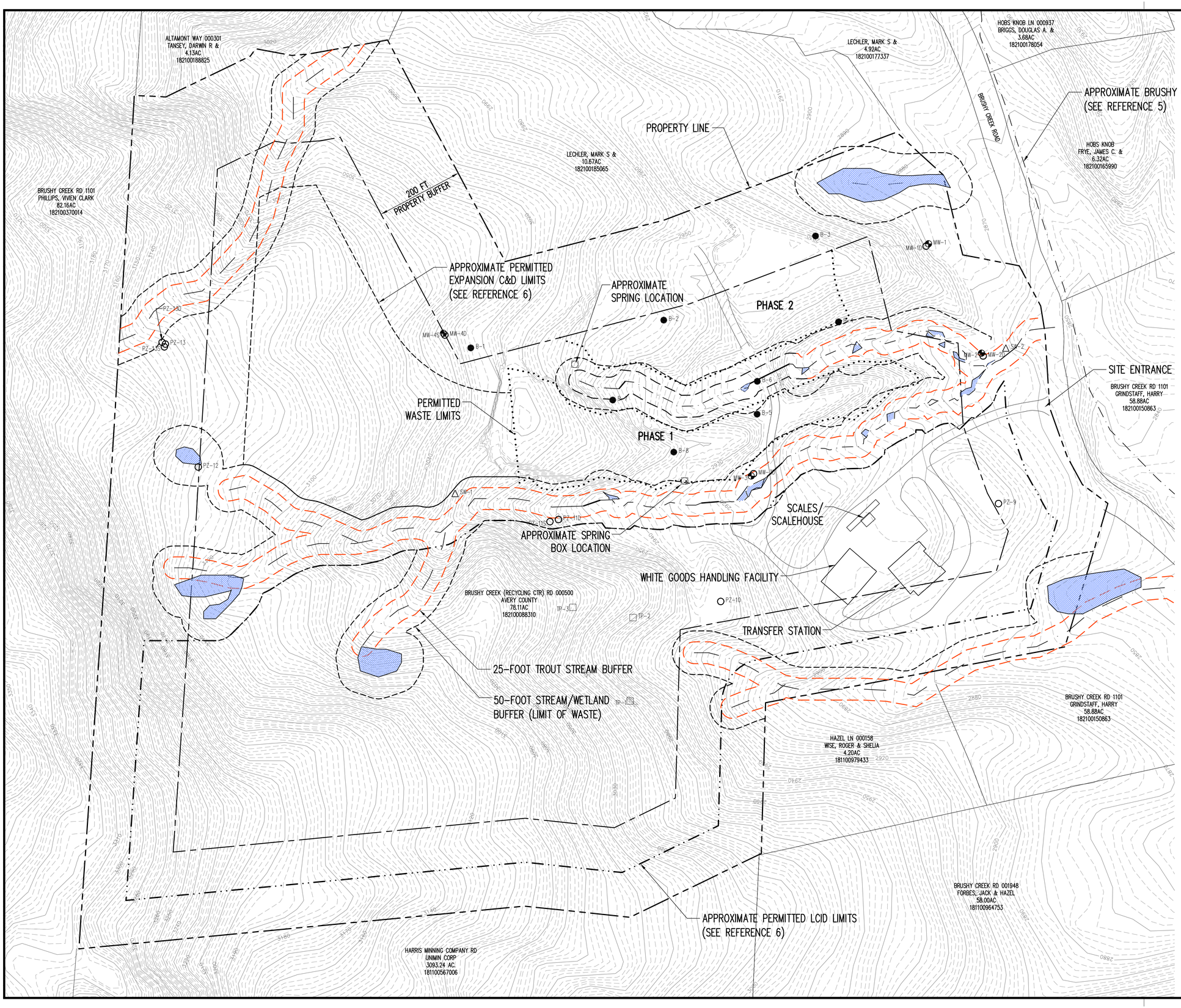

LEGEND

- EXISTING 10' CONTOUR (SEE REFERENCE 1)
- EXISTING 2' CONTOUR
- PROPERTY LINE (SEE REFERENCE 2)
- PERMITTED WASTE LIMITS
- PROPOSED SUBGRADE LIMITS
- APPROX. STREAM LOACTION (SEE REFERENCES 3, 4)
- WETLANDS (SEE REFERENCES 3, 4)
- 50-FOOT STREAM AND WETLAND BUFFER
- 25-FOOT TROUT STREAM BUFFER
- MONITORING WELL
- PIEZOMETER
- SURFACE WATER MONITORING POINT
- BORING

REFERENCES

1. OVERALL SITE TOPOGRAPHY FROM NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, DATA GENERATED FROM LIDAR DATED MARCH 2005, TOPO IN AREAS IN AND SURROUNDING PHASES 1 AND 2 FROM FIELD SURVEY DATED 9/07, BY SURVEYING SOLUTIONS, P.C.
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4. STREAMS AND WETLANDS NEAR PHASE 1 AND 2 FROM FIELD SURVEY DATED 2/18/08 BY SURVEYING SOLUTIONS, P.C.
5. BRUSHY CREEK LOCATION FROM AVERY COUNTY GIS DEPARTMENT.
6. DRAWING ENTITLED "CONCEPTUAL DESIGN, SHEET 1 OF 1", DATED 6/22/95, PREPARED BY MUNICIPAL ENGINEERING SERVICES, P.A.

NO.	DATE	REVISION

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SEAL

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PROJECT TITLE:
AVERY COUNTY
C&D LANDFILL
STORMWATER MANAGEMENT PLAN

DRAWING TITLE:
EXISTING CONDITIONS

DESIGNED BY: S.A.S.	DRAWN BY: J.A.L.
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME: AVERY-D0043	
SHEET NO. 2	DRAWING NO. S1

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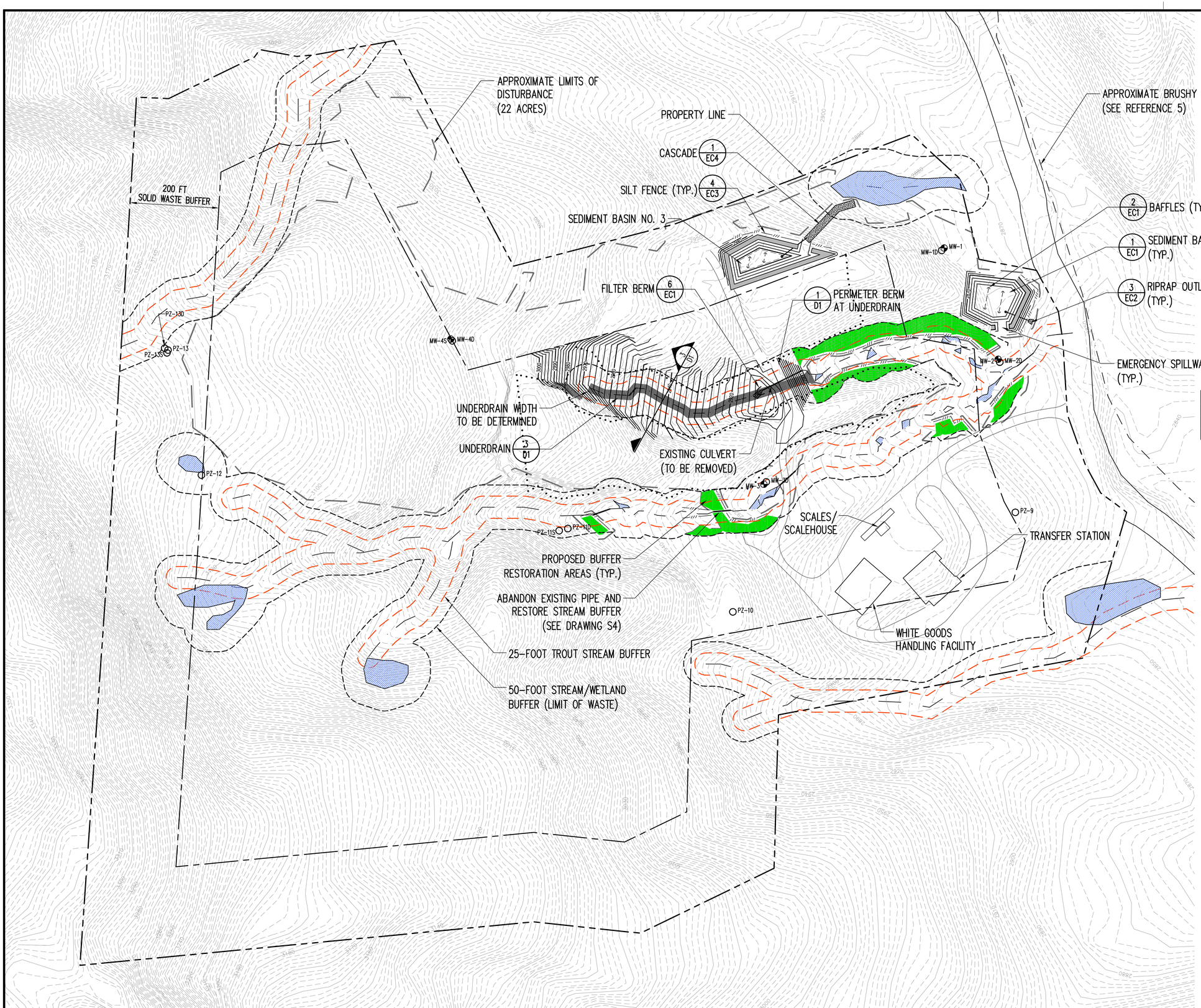

SUMMARY OF IMPACTS	
IMPACT	AREA / LENGTH
WETLANDS	174.2 S.F. (0.004 AC.)
STREAMS	408 L.F.

LEGEND

- 2840 — EXISTING 10' CONTOUR (SEE REFERENCE 1)
- EXISTING 2' CONTOUR
- 3000 — PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- PROPERTY LINE (SEE REFERENCE 2)
- 200-FOOT SOLID WASTE BUFFER
- PERMITTED WASTE LIMITS
- LIMITS OF DISTURBANCE
- SILT FENCE
- APPROX. STREAM LOCATION (SEE REFERENCE 3, 5)
- WETLANDS (SEE REFERENCE 3)
- 50-FOOT STREAM AND WETLAND BUFFER
- 25-FOOT TROUT STREAM BUFFER
- WETLAND IMPACT AREA
- PROPOSED BUFFER RESTORATION AREAS
- MONITORING WELL
- PIEZOMETER

REFERENCES

1. OVERALL SITE TOPOGRAPHY FROM NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, DATA GENERATED FROM LIDAR DATED MARCH 2005, TOPO IN AREAS IN AND SURROUNDING PHASES 1 AND 2 FROM FIELD SURVEY DATED 9/07, BY SURVEYING SOLUTIONS, P.C.
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4. STREAMS AND WETLANDS NEAR PHASE 1 AND 2 FROM FIELD SURVEY DATED 2/18/08 BY SURVEYING SOLUTIONS, P.C.
5. BRUSHY CREEK LOCATION FROM AVERY COUNTY GIS DEPARTMENT.

0 100' 200' 300'

NO.	DATE	REVISION

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SEAL

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PROJECT TITLE: AVERY COUNTY C&D LANDFILL STORMWATER MANAGEMENT PLAN

DRAWING TITLE: INITIAL GRADING PLAN

DESIGNED BY: S.A.S.	DRAWN BY: J.A.L.
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME: AVERY-D0050	
SHEET NO. 3	DRAWING NO. S2

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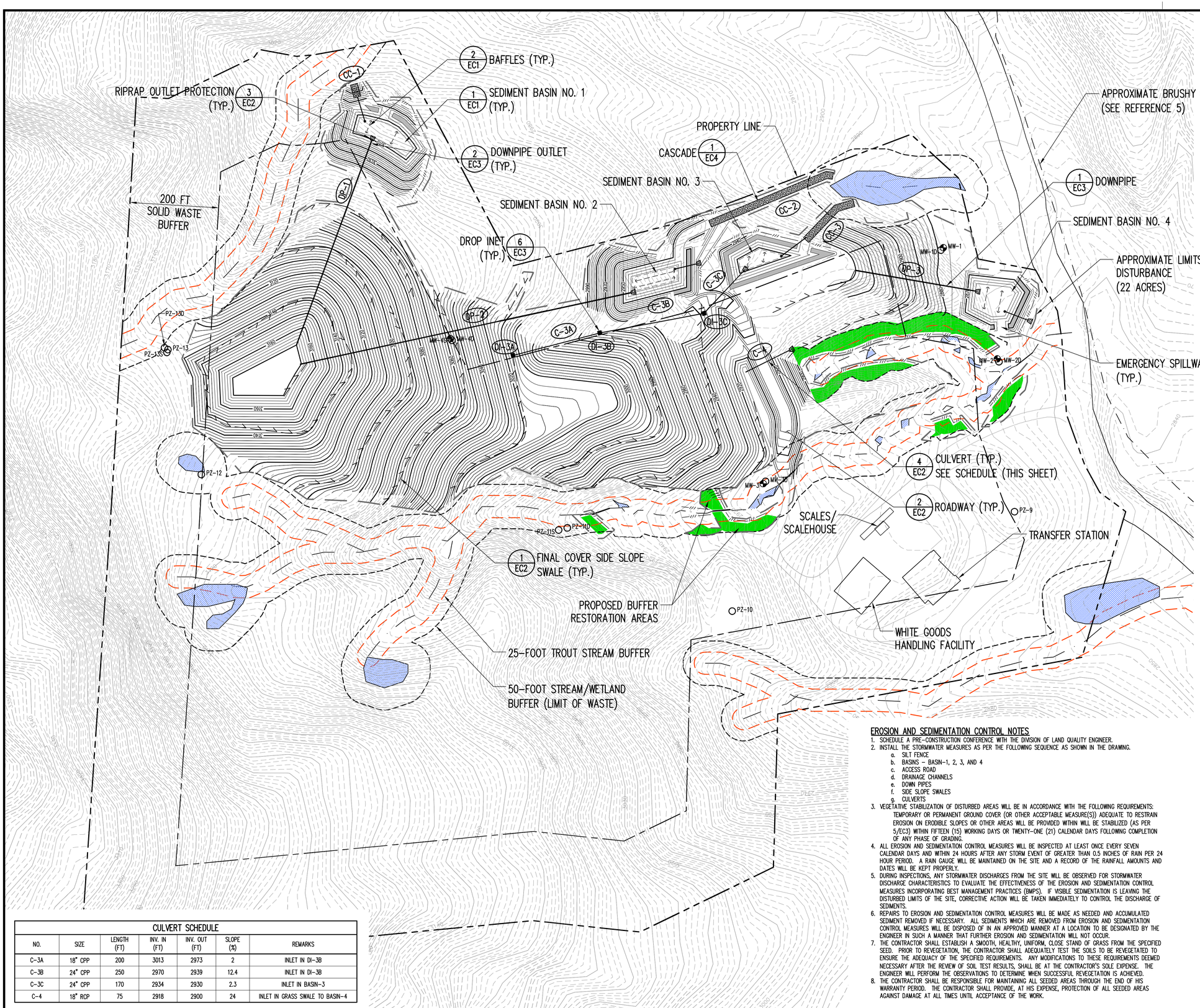

CULVERT SCHEDULE						
NO.	SIZE	LENGTH (FT)	INV. IN (FT)	INV. OUT (FT)	SLOPE (%)	REMARKS
C-3A	18" CPP	200	3013	2973	2	INLET IN DI-3B
C-3B	24" CPP	250	2970	2939	12.4	INLET IN DI-3B
C-3C	24" CPP	170	2934	2930	2.3	INLET IN BASIN-3
C-4	18" RCP	75	2918	2900	24	INLET IN GRASS SWALE TO BASIN-4

EROSION AND SEDIMENTATION CONTROL NOTES

1. SCHEDULE A PRE-CONSTRUCTION CONFERENCE WITH THE DIVISION OF LAND QUALITY ENGINEER.
2. INSTALL THE STORMWATER MEASURES AS PER THE FOLLOWING SEQUENCE AS SHOWN IN THE DRAWING.
   a. SILT FENCE
   b. BASINS – BASIN-1, 2, 3, AND 4
   c. ACCESS ROAD
   d. DRAINAGE CHANNELS
   e. DOWN PIPES
   f. SIDE SLOPE SWALES
   g. CULVERTS
3. VEGETATIVE STABILIZATION OF DISTURBED AREAS WILL BE IN ACCORDANCE WITH THE FOLLOWING REQUIREMENTS: TEMPORARY OR PERMANENT GROUND COVER (OR OTHER ACCEPTABLE MEASURE(S)) ADEQUATE TO RESTRAIN EROSION ON ERODIBLE SLOPES OR OTHER AREAS WILL BE PROVIDED WITHIN WILL BE STABILIZED (AS PER 5/EC3) WITHIN FIFTEEN (15) WORKING DAYS OR TWENTY-ONE (21) CALENDAR DAYS FOLLOWING COMPLETION OF ANY PHASE OF GRADING.
4. ALL EROSION AND SEDIMENTATION CONTROL MEASURES WILL BE INSPECTED AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY STORM EVENT OF GREATER THAN 0.5 INCHES OF RAIN PER 24 HOUR PERIOD. A RAIN GAUGE WILL BE MAINTAINED ON THE SITE AND A RECORD OF THE RAINFALL AMOUNTS AND DATES WILL BE KEPT PROPERLY.
5. DURING INSPECTIONS, ANY STORMWATER DISCHARGES FROM THE SITE WILL BE OBSERVED FOR STORMWATER DISCHARGE CHARACTERISTICS TO EVALUATE THE EFFECTIVENESS OF THE EROSION AND SEDIMENTATION CONTROL MEASURES INCORPORATING BEST MANAGEMENT PRACTICES (BMPS). IF VISIBLE SEDIMENTATION IS LEAVING THE DISTURBED LIMITS OF THE SITE, CORRECTIVE ACTION WILL BE TAKEN IMMEDIATELY TO CONTROL THE DISCHARGE OF SEDIMENTS.
6. REPAIRS TO EROSION AND SEDIMENTATION CONTROL MEASURES WILL BE MADE AS NEEDED AND ACCUMULATED SEDIMENT REMOVED IF NECESSARY. ALL SEDIMENTS WHICH ARE REMOVED FROM EROSION AND SEDIMENTATION CONTROL MEASURES WILL BE DISPOSED OF IN AN APPROVED MANNER AT A LOCATION TO BE DESIGNATED BY THE ENGINEER IN SUCH A MANNER THAT FURTHER EROSION AND SEDIMENTATION WILL NOT OCCUR.
7. THE CONTRACTOR SHALL ESTABLISH A SMOOTH, HEALTHY, UNIFORM, CLOSE STAND OF GRASS FROM THE SPECIFIED SEED. PRIOR TO REVEGETATION, THE CONTRACTOR SHALL ADEQUATELY TEST THE SOILS TO BE REVEGETATED TO ENSURE THE ADEQUACY OF THE SPECIFIED REQUIREMENTS. ANY MODIFICATIONS TO THESE REQUIREMENTS DEEMED NECESSARY AFTER THE REVIEW OF SOIL TEST RESULTS, SHALL BE AT THE CONTRACTOR'S SOLE EXPENSE. THE ENGINEER WILL PERFORM THE OBSERVATIONS TO DETERMINE WHEN SUCCESSFUL REVEGETATION IS ACHIEVED.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL SEEDED AREAS THROUGH THE END OF HIS WARRANTY PERIOD. THE CONTRACTOR SHALL PROVIDE, AT HIS EXPENSE, PROTECTION OF ALL SEEDED AREAS AGAINST DAMAGE AT ALL TIMES UNTIL ACCEPTANCE OF THE WORK.

LEGEND

- 2840 — EXISTING 10' CONTOUR (SEE REFERENCE 1)
- EXISTING 2' CONTOUR
- 3000 — PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- PROPERTY LINE (SEE REFERENCE 2)
- 200-FOOT SOLID WASTE BUFFER
- LIMITS OF DISTURBANCE
- SILT FENCE
- SIDE SLOPE SWALE
- APPROX. STREAM LOCATION (SEE REFERENCE 3, 5)
- WETLANDS (SEE REFERENCE 3)
- 50-FOOT STREAM AND WETLAND BUFFER
- 25-FOOT TROUT STREAM BUFFER
- PROPOSED BUFFER RESTORATION AREAS
- MONITORING WELL
- PIEZOMETER
- DP-1 — DOWN PIPE
- C-3A — CULVERT
- DI-3A — DROP INLET

REFERENCES

1. OVERALL SITE TOPOGRAPHY FROM NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, DATA GENERATED FROM LIDAR DATED MARCH 2005, TOPO IN AREAS IN AND SURROUNDING PHASES 1 AND 2 FROM FIELD SURVEY DATED 9/07, BY SURVEYING SOLUTIONS, P.C.
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5. BRUSHY CREEK LOCATION FROM AVERY COUNTY GIS DEPARTMENT.

0 100' 200' 300'

NO.	DATE	REVISION

SEAL

SEAL

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PROJECT TITLE: AVERY COUNTY C&D LANDFILL STORMWATER MANAGEMENT PLAN

DRAWING TITLE: STORMWATER MANAGEMENT PLAN

DESIGNED BY: S.A.S.	DRAWN BY: J.A.L.
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME: AVERY-D0044	
SHEET NO. 4	DRAWING NO. S3

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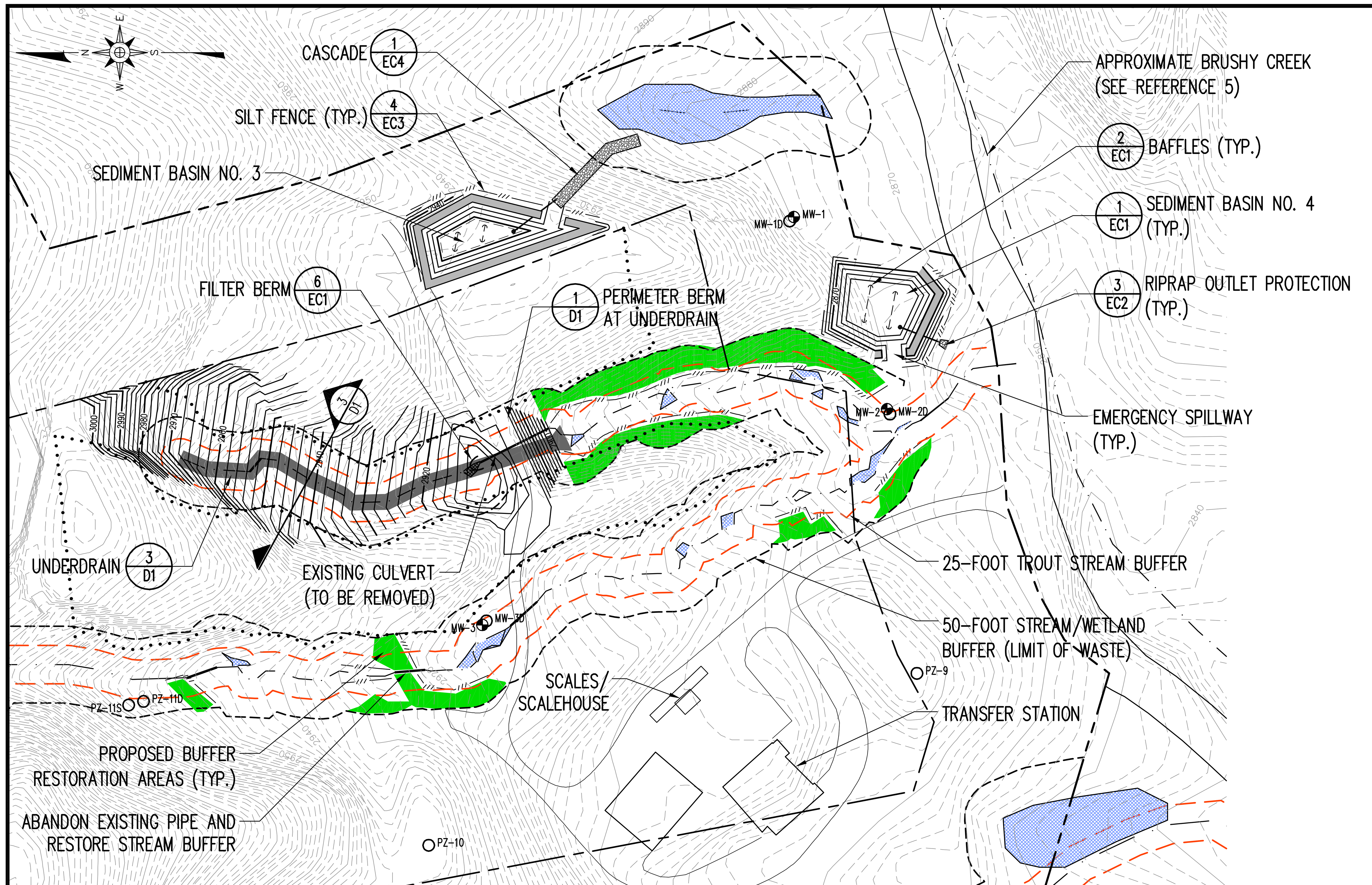

RESTORATION PLAN

LEGEND

2840	EXISTING 10' CONTOUR (SEE REFERENCE 1)
	EXISTING 2' CONTOUR
3000	PROPOSED 10' CONTOUR
	PROPOSED 2' CONTOUR
	PROPERTY LINE (SEE REFERENCE 2)
	200-FOOT SOLID WASTE BUFFER
	PERMITTED WASTE LIMITS
	SILT FENCE
	APPROX. STREAM LOCATION (SEE REFERENCE 3, 5)
	WETLANDS (SEE REFERENCE 3)
	50-FOOT STREAM AND WETLAND BUFFER
	25-FOOT TROUT STREAM BUFFER
	WETLAND IMPACT AREA
	PROPOSED BUFFER RESTORATION AREAS
	MONITORING WELL
	PIEZOMETER

REFERENCES

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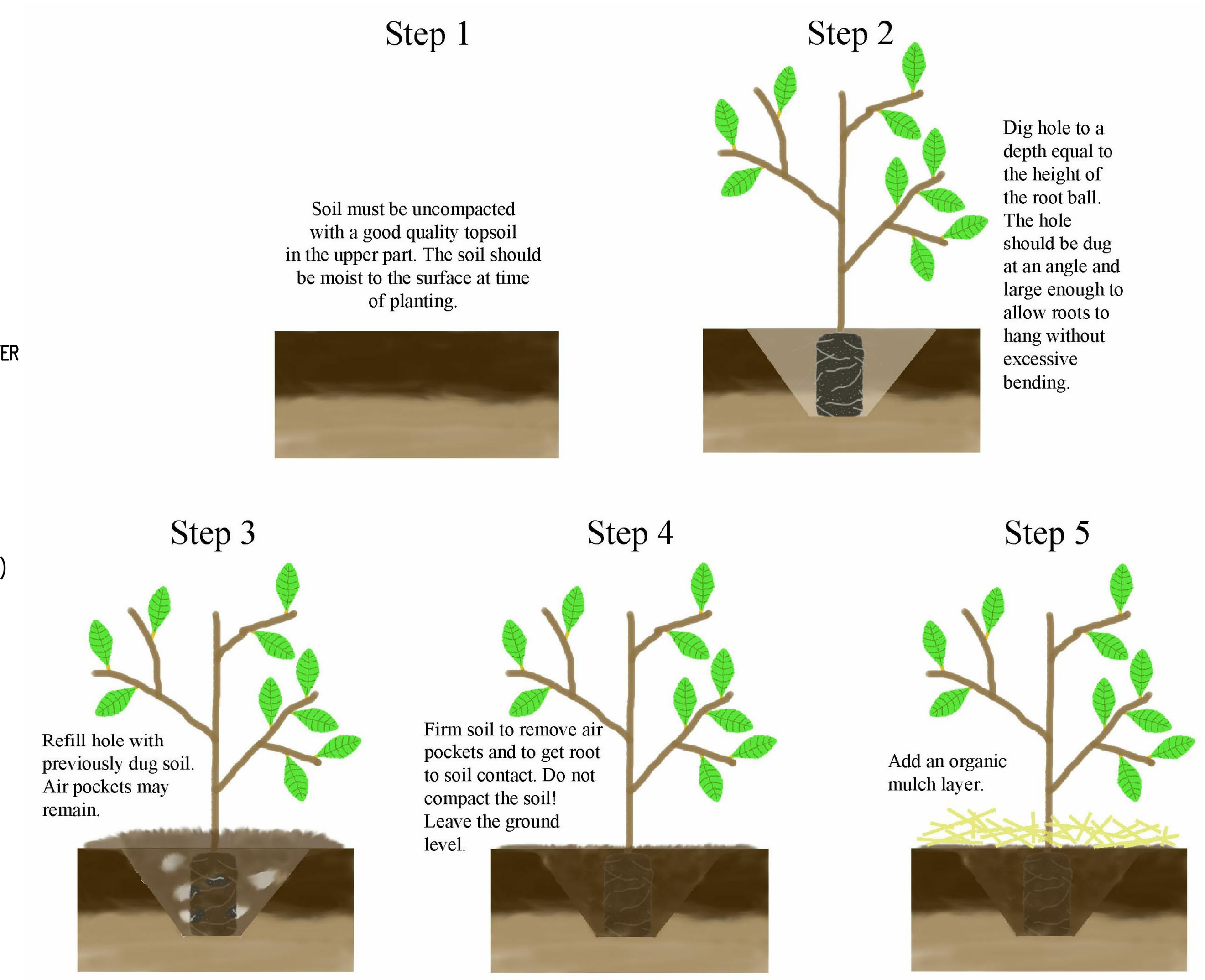

RESTORATION PLANTING DETAIL 1 S4
NOT TO SCALE

RESTORATION PLAN

Avery County Landfill
On-Site Mitigation Plan

This on-site mitigation plan has been developed based on the need to have a stable, healthy, and natural plant community established along the on-site streams where disturbance has occurred or waste will be removed. The site and surrounding area was investigated to determine existing conditions and to develop the target plant community to restore to these areas. It was determined that the Chestnut Oak Forest community type as described in *Classification of the Natural Communities of North Carolina – Third Approximation* was the appropriate target community for these stream buffer areas. This plan will provide for a stable stream buffer with plant species that should restore these areas to the natural plant communities that was likely here prior to their disturbance.

In addition, this plan addresses the remediation of previous impacts to the streams on site. This includes removal of sediment from the perennial channel between the landfill cells and removal of an existing 40' pipe in the channel to the west of the landfill. This work is intended to allow the aquatic habitat in the streams to recover, and to improve water quality in the streams and downstream trout habitat.

1.0 Stream Buffer Restoration Plan

1.1 Soil Preparation

The site will undergo large earth moving activities prior to the restoration efforts. These activities will likely result in compacted soil and subsoil. The areas to be restored as stream buffer will need to be properly prepared to ensure adequate growing conditions. If compaction or loss of topsoil has occurred, the following actions must be taken in the stream buffer restoration areas before final seedbed/woody planting preparation begins.

- All disturbed areas within the buffer restoration zones that have been compacted must be rip-tilled in such a manner as to allow plant root growth in the subsoil. All heavy equipment such as large excavators/bulldozers is prohibited from entering the restoration zone after the rip-tilling has been completed.
- In disturbed areas within the buffer restoration zones, final grade elevations shall be attained by the application of 6 to 10 inches of topsoil to all disturbed areas within the restoration zones.
- The topsoil shall be disked to ensure proper connection with the subsoil and prevention of surface compaction. This activity shall be done in dry weather conditions with satisfactory soil moisture.
- All erosion control/permanent seeding soil preparation criteria shall then be implemented. See **Erosion Control Notes** for details.

1.2 Stream Buffer Plant List

(SB): All disturbed areas denoted on plans as SB shall be planted with plants selected from the following list.

Scientific Name	Common Name	Layer	Spacing (ft) On-Center	Plant Size	Distribution
Pinus strobus	White Pine	Tree	8x8	Container	Random
Liriodendron tulipifera	Tulip Poplar	Tree	8x8	Container	Random
Quercus prinus	Chestnut Oak	Tree	8x8	Container	Random
Quercus rubra	Northern Red Oak	Tree	8x8	Container	Random
Quercus coccinea	Scarlet Oak	Tree	8x8	Container	Random
Fagus grandifolia	American Beech	Tree	8x8	Container	Random
Acer rubrum	Red Maple	Tree	8x8	Container	Random
Carpinus caroliniana	Ironwood	Tree	8x8	Container	Random
Kalmia latifolia	Mountain Laurel	Shrub	8x8	Container	Random
Rhododendron maximum	Great Laurel	Shrub	8x8	Container	Random

1.3 Planting Requirements

- **The Stream Buffer Zone shall be planted with at least six (6) of the above species.**
- **No species shall make up more than 30% of the total planted stems in each SB area.**
- **No species shall make up less than 10% of the total planted stems in each SB area.**
- **No plant substitutions beyond the list above are allowed.**

The following are the weather and soil conditions that must be present at the site during all planting of the stream buffer zones.

- **Temperature greater than 35^{0}F and less than 85^{0}F**
- **Relative Humidity greater than 30%**
- **Wind less than 10 miles/hour**
- **Soil is moist to the surface**
- **Soil surface is protected by an organic mulch layer or equivalent protection**
- **Soil has been ripped and disked such that compaction will not inhibit growth**

The stream buffer restoration areas should be adequately marked before planting commences.

The correct spacing of vegetation should be checked by the On-Site Supervisor on a regular basis.

1.3.1 Plant Distribution

Random Distribution – take all six (6) plant species selected for planting from the plant list in the proper percentages to meet the planting requirements. Mix the plants so that they are all planted randomly at the 8' spacing called for in this plan. If done properly, sometimes two or more of the same species will be planted adjacent to each other and other times there may only be one plant of a species completely surrounded by one or more other species.

1.3.2 Planting Method

The following describes the general planting techniques to be followed when installing the plants. However, these techniques may be modified if the contractor believes that other techniques will improve health and survival of the plants.

<u>Containerized Plants (equal to or larger than 16 cubic inches)</u>

i. Containerized plants must be robust healthy growing plants.
ii. The root system must be vigorous and dense enough to hold the shape of the container once removed.
iii. Container vegetation must always be handled by the container and never by the tops of the plants.
iv. Containerized plants must be stored in the shade and kept moist until installation.
v. If soil is compacted, the area of planting shall be loosened to a depth equal to that of the root ball for a radius of one (1) feet around each plant.
vi. Install containerized plants only when soil is moist and/or wet.
vii. Before installation, remove any damaged roots and loosen any circling or compacted roots.
viii. Install containerized plants using an appropriate implement such that a hole is created that will allow the plant to be inserted without any bending, binding, or breaking of roots.
ix. Container stock shall be planted in a vertical position with the root collar approximately 0.5 inches below the soil surface. The planting trench or hole shall be deep and wide enough to permit roots to spread out and down without J-rooting.
x. After planting, the soil shall be tamped firmly to eliminate air pockets.
xi. A 2 foot radius of a 3- to 4-inch layer of organic mulch such as straw must then be placed on the soil surface around the entire plant.
xii. If dry conditions occur following planting, a method to water the plants should be developed and implemented.

Plant spacing is called out on a grid basis such as 8 x 8, etc. This spacing refers to planting the plants 8 feet apart from each other in all directions within a planting zone. This spacing does not relate to planting distance from other zones or the planting distance at the zone boundary.

Planting shall begin 2' in from the planting zone boundary nearest to the stream. Planting will then proceed away from the stream on an 8' spacing. The plants will be planted along all other boundaries to within a distance of 4 feet or less from any boundary edge. This is likely to result in an outer row being planted closer than the designated 8' spacing.

Some existing stream buffer areas are to remain undisturbed. These areas should be protected from encroachment and no additional planting will be done in these areas. If some of these areas are impacted during construction activities, then the stream buffer restoration plan shall be implemented for those areas as well.

In addition to the woody plants to be planted in the stream buffer areas, the soil will be prepared, seeded and protected according to the temporary and permanent seeding requirements for the entirety of the site. However, no fescue, lespedeza, or other aggressive nonnative grasses are allowed to be planted in the stream buffer areas.

1.3.3 Planting Warranty

For all planted material, the contractor shall warrant an 80% survival rate against defects including mortality and poor growth, except for defects resulting from abuse by other parties and abnormal weather conditions.

2.0 Stream Daylighting and Remediation

2.1 Stream Daylighting

The approximate 40' pipe within the stream channel just west of the existing landfill, and within the proposed buffer restoration area, will be removed and the banks returned to natural conditions. This will be accomplished through the following steps:

- Removing the pipe during a dry period with low-flow conditions in the stream channel.
- Reestablishing the banks to match upstream and downstream contours.
- Stabilizing the stream banks with erosion control blanket down to, but not including, the bed of the stream.
- Planting the stream bank as described in Section 1.0 of this plan, along with the associated buffers.
- Appropriate sediment and erosion control measures will be used during this work.

2.2 Sediment Removal

The perennial channel between the two landfill cells, from the road crossing down to its confluence with the larger stream, will be enhanced through the removal of deposited sediment from within the channel. This will be accomplished in the following manner:

- Carolina Ecosystems, Inc. or other qualified personnel will inspect the stream channel prior to the start of the work, and place staking along the banks to indicate the areas and approximate depth of the sediment removal.
- Removal of the sediment will be performed by hand using shovels or other hand tools. No mechanized equipment will be used within the channel.
- Several staging areas for excavated materials will be established along the channel for deposition of the material. This material will then be moved by on-site equipment to an appropriate location with adequate sediment and erosion controls.
- The staging areas will be located in coordination with the buffer restoration and will be planted as described in Section 1.0 when work is completed. Each staging area will have silt fence placed on the downstream sides to prevent material from re-entering the channel.
- Sediment will be removed down to a depth just above the original bed of the stream in order to not disturb the channel dimensions.
- This work will be performed during a low-flow or dry period and appropriate sediment and erosion control measures will be implemented during this work.

3.0 Conclusions

This plan will be implemented in conjunction with the Avery County Landfill expansion. It will serve to provide compensation for the removal of 408 linear feet of intermittent channel that currently does not provide significant aquatic habitat, and to remediate previous secondary impacts from landfill operations. The result of this work will be a decrease in sedimentation of downstream trout habitat, an increase in the stability of temperature fluctuations within the channel, and a re-colonization of the affected stream channel by typical aquatic macrobenthos over the long term.

EROSION CONTROL BLANKET NOTE

1. FOLLOWING SEEDING, APPLY A 4' STRIP OF EROSION CONTROL BLANKET TO ALL DISTURBED STREAM BANKS. THE BLANKET WILL BEGIN AT THE TOE OF THE STREAM BANK AT THE MOST DOWNSTREAM POINT OF THE PROJECT (THIS IS SO THE OVERLAPS WILL GO WITH THE FLOW OF THE STREAM). THE BOTTOM EDGE SHOULD BE HEELED OR TACKED INTO THE SOIL SO AS TO PREVENT FLOATING. WHEN A NEW PIECE OF BLANKET IS USED, IT MUST BE PLACED ON TOP OF THE PREVIOUSLY INSTALLED BLANKET AND OVERLAPPED BY TWO OR MORE FEET. BRING THE BLANKET UP AND OVER THE TOP OF THE STREAM BANK AND HEEL IN THE TOP EDGE. APPLY DEGRADABLE BLANKET STAKES TO ENSURE GOOD CONTACT WITH THE SOIL. ALL OTHER SEEDED AREAS WILL BE PROPERLY COVERED WITH WHEAT STRAW TO PROTECT THE SOIL SURFACE.

REVISION | NO. | DATE

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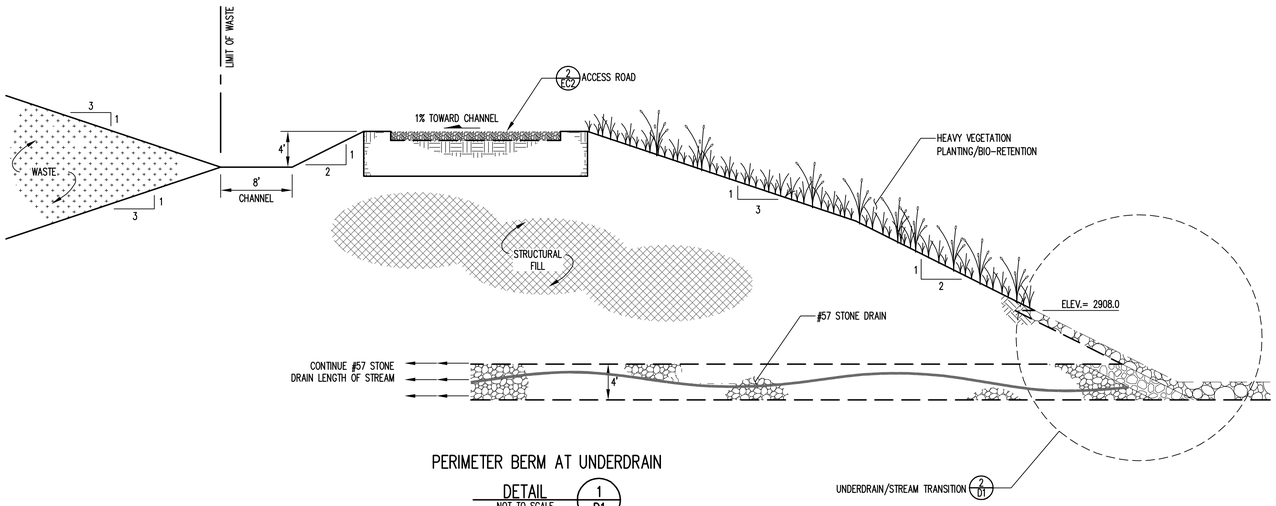
SEAL

SEAL

PROJECT TITLE: AVERY COUNTY C&D LANDFILL STORMWATER MANAGEMENT PLAN

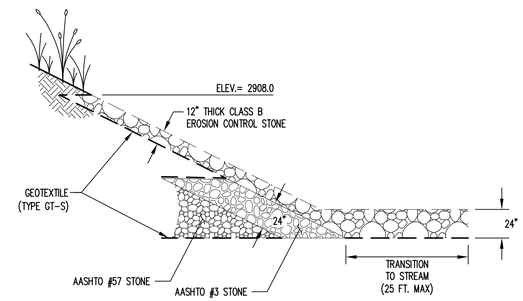
DRAWING TITLE: RESTORATION PLAN

DESIGNED BY: S.A.S.	DRAWN BY: J.A.L.
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME: AVERY-D0051	
SHEET NO. 5	DRAWING NO. S4



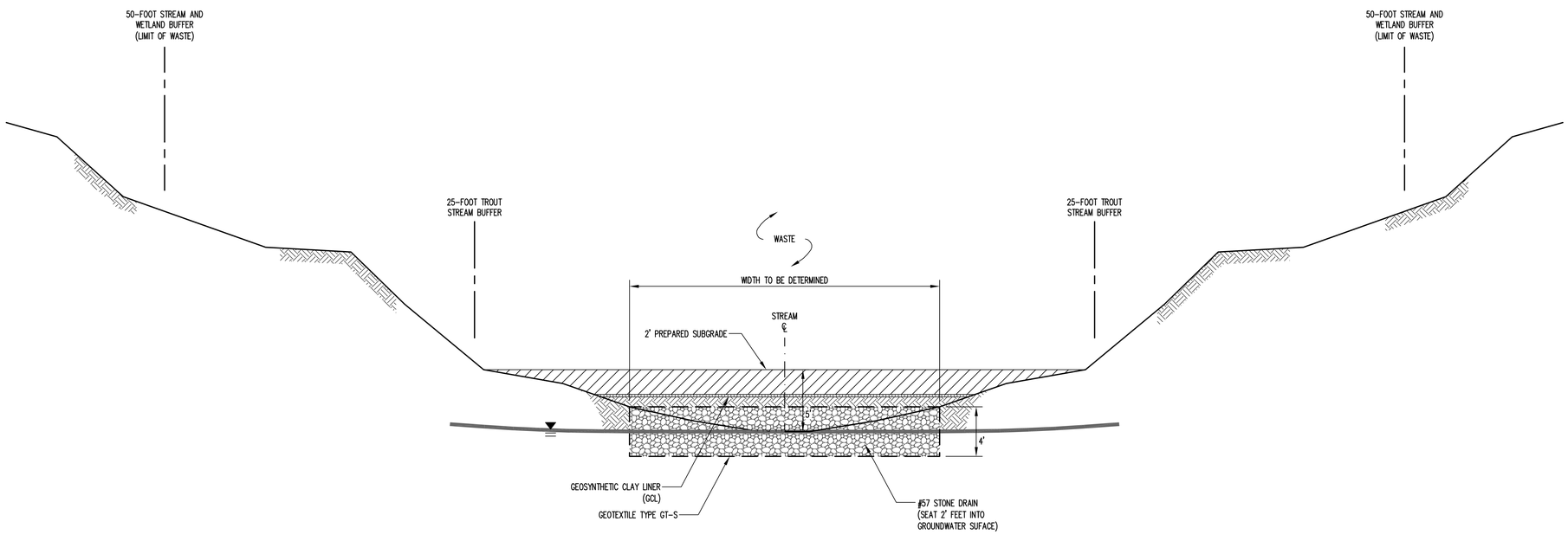
PERIMETER BERM AT UNDERDRAIN

DETAIL 1/D1
NOT TO SCALE



UNDERDRAIN – STREAM TRANSITION

DETAIL 2/D1
NOT TO SCALE



UNDERDRAIN – TYPICAL SECTION

DETAIL 3/D1
NOT TO SCALE

NO.	DATE	REVISION

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SEAL

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PROJECT TITLE:
AVERY COUNTY
C&D LANDFILL
STORMWATER MANAGEMENT PLAN

DRAWING TITLE:
UNDERDRAIN DETAILS

DESIGNED BY:	DRAWN BY:
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME AVERY-D0052	
SHEET NO. 6	DRAWING NO. D1

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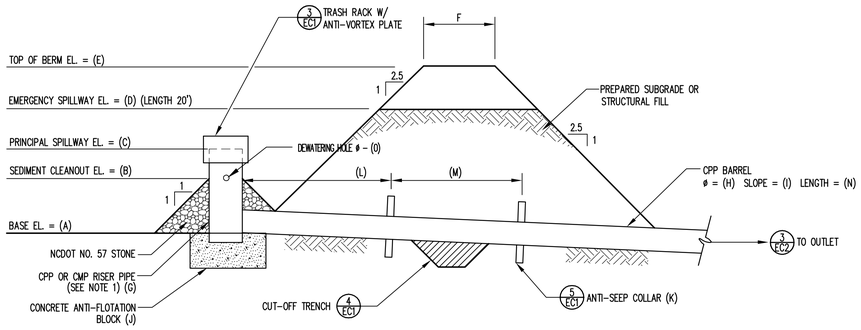
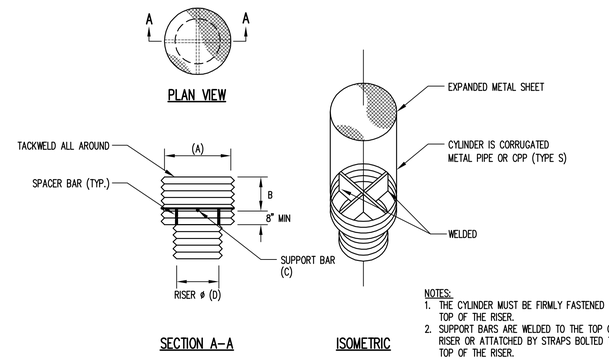


BASIN #	A (FT)	B (FT)	C (FT)	D (FT)	E (FT)	F (FT)	G (IN)	H (IN)	I (%)	J (FT²)	K (FT)	L (FT)	M (FT)	N (FT)	O (IN)
1	3,008.0	3,009.5	3,011.5	3,012.5	3,014.0	10.0	18	15	4.4	3.0x3.0x1.5	3.0x3.0	10	12	45	2
2	2,943.0	2,945.2	2,948.0	2,949.0	2,950.0	10.0	18	15	2.0	3.0x3.0x1.5	3.5x3.5	10	16	50	2
3	2,929.0	2,931.2	2,934.0	2,935.0	2,936.0	10.0	18	15	1.0	3.0x3.0x1.5	3.5x3.5	10	16	100	2
4	2,864.0	2,865.2	2,867.0	2,868.5	2,870.0	10.0	18	15	6.7	3.0x3.0x2.0	3.0x3.0	10	12	60	2

NOTE:
1. CPP/CMP RISER IS PERFORATED WITH 1/2" DIAMETER HOLES ON 4" CENTERS STARTING AT BASE ELEVATION UP TO SEDIMENT CLEANOUT ELEVATION.

TYPICAL SEDIMENT BASIN CROSS SECTION

DETAIL 1/EC1
NOT TO SCALE

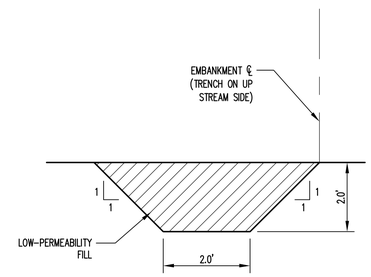


NOTES:
1. THE CYLINDER MUST BE FIRMLY FASTENED TO THE TOP OF THE RISER.
2. SUPPORT BARS ARE WELDED TO THE TOP OF THE RISER OR ATTATCHED BY STRAPS BOLTED TO THE TOP OF THE RISER.

TRASH RACK SCHEDULE				
BASIN	A (IN)	B (IN)	C (IN)	D (IN)
1	30	15	1/2	18
2	30	15	1/2	18
3	30	15	1/2	18
4	30	15	1/2	18

TRASH RACK ANTI-VORTEX

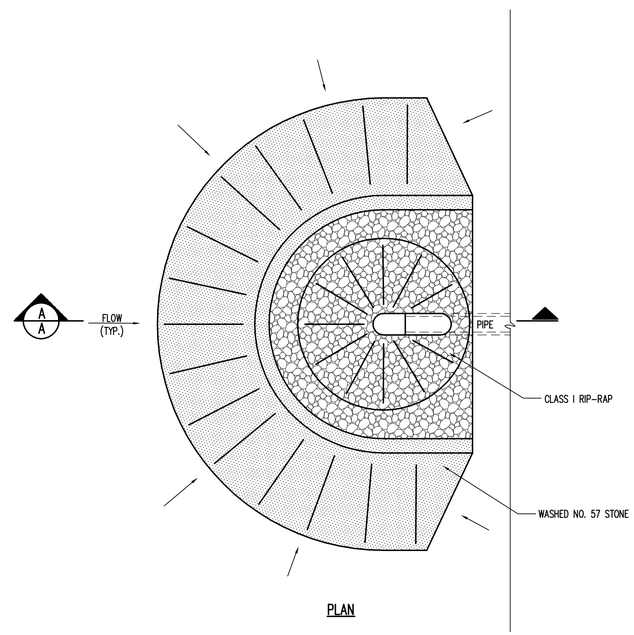
DETAIL 3/EC1
NOT TO SCALE

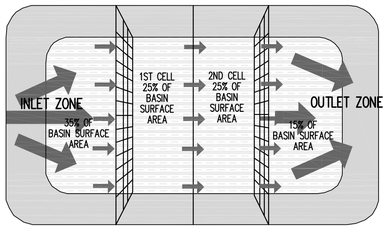


NOTES:
1. CUT-OFF TRENCH SHALL BE LOCATED IN UNDISTURBED SOIL.
2. CUT-OFF TRENCH SHALL BE EXTEND THE LENGTH OF THE EMBANKMENT TO THE PRINCIPAL SPILLWAY CREST ELEVATION AT EACH END.

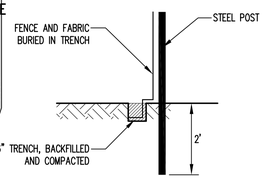
CUTOFF TRENCH

DETAIL 4/EC1
NOT TO SCALE

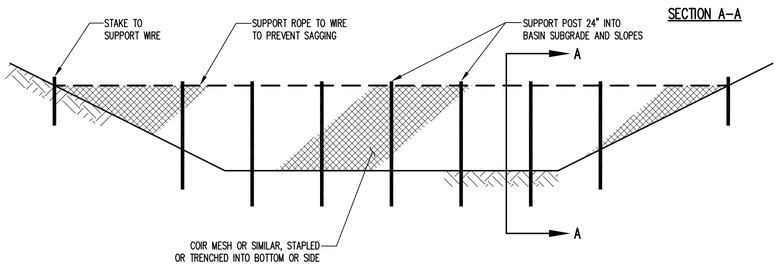




PLAN VIEW



SECTION A-A

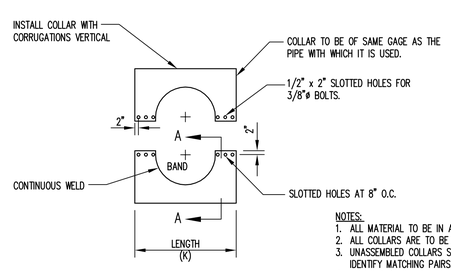


ELEVATION

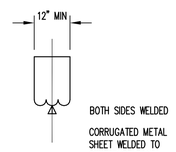
STANDARD BAFFLES

DETAIL 2/EC1
NOT TO SCALE

NOTES:
1. BAFFLE MATERIAL SHOULD BE SECURED AT THE BOTTOM AND SIDES USING STAPLES OR BY TRENCHING AS FOR SILT FENCE.
2. MOST OF THE SEDIMENT WILL ACCUMULATE IN THE FIRST BAY, WHICH SHOULD BE READILY ACCESSIBLE FOR MAINTENANCE.
3. PROVIDE 3 BAFFLES (USE TWO IF LESS THAN 20 FEET IN LENGTH).
4. BAFFLE SHALL BE 700 g/m² COIR EROSION BLANKET.
5. TOPS OF BAFFLES SHOULD BE 2 INCHES LOWER THAN THE TOP OF THE BERMS.
6. INSPECT BAFFLES FOR REPAIR ONCE A WEEK AND AFTER EACH RAINFALL.



ELEVATION OF UNASSEMBLED COLLAR

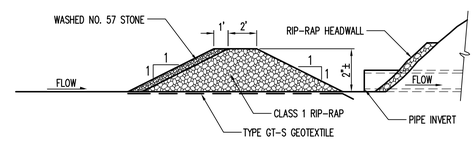


SECTION A-A

NOTES:
1. ALL MATERIAL TO BE IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
2. ALL COLLARS ARE TO BE ASPHALT COATED.
3. UNASSEMBLED COLLARS SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PAIRS.
4. THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE AND CONNECTING BAND SHALL BE CAULKED WITH ASPHALT MASTIC AT TIME OF INSTALLATION.
5. EACH COLLAR SHALL BE FURNISHED WITH TWO 1/2"ø RODS WITH STANDARD TANK LUGS FOR CONNECTING COLLARS TO PIPE

ANTI-SEEP METAL

DETAIL 5/EC1
NOT TO SCALE



SECTION A-A

FILTER BERM

DETAIL 6/EC1
NOT TO SCALE

REVISION | NO. | DATE

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PROJECT TITLE: AVERY COUNTY C&D LANDFILL STORMWATER MANAGEMENT PLAN

DRAWING TITLE: STORMWATER MANAGEMENT DETAILS (SHEET 1 OF 3)

DESIGNED BY: K.B.S.	DRAWN BY: J.A.L.
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME: AVERY-D0045	
SHEET NO. 7	DRAWING NO. EC1

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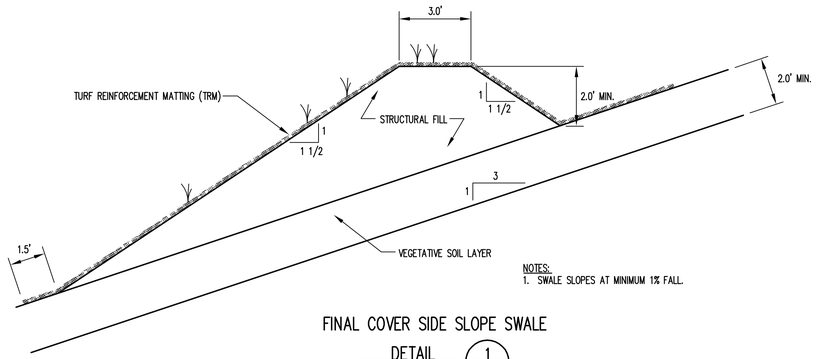
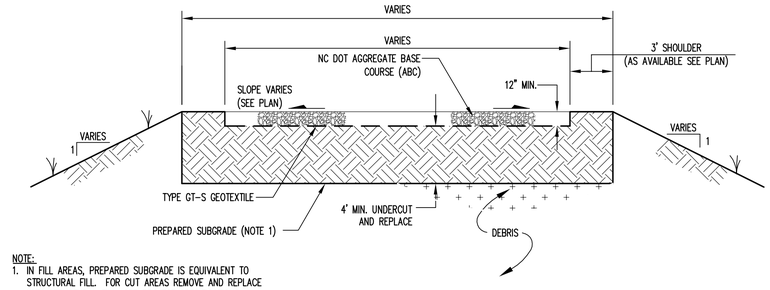


NOTES:
1. SWALE SLOPES AT MINIMUM 1% FALL.

FINAL COVER SIDE SLOPE SWALE

DETAIL 1 / EC2
NOT TO SCALE

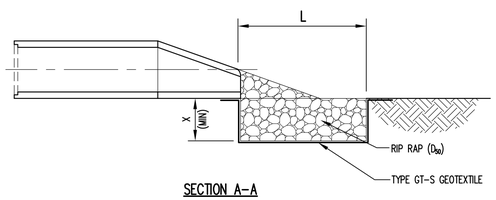


NOTE:
1. IN FILL AREAS, PREPARED SUBGRADE IS EQUIVALENT TO STRUCTURAL FILL. FOR CUT AREAS REMOVE AND REPLACE WITH STRUCTURAL FILL (SEE PROJECT SPECIFICATIONS.)

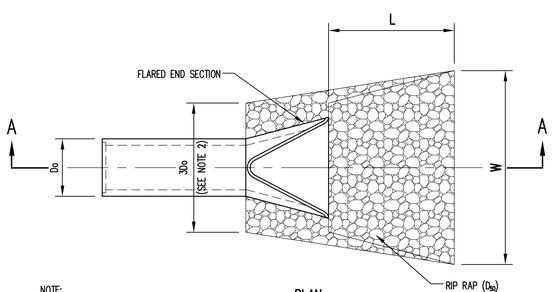
TYPICAL ROADWAY CROSS SECTION

DETAIL 2 / EC2
NOT TO SCALE

RIP RAP OUTLET PROTECTION SCHEDULE					
PIPE	D_O (IN)	L (FT)	W (FT)	D_{50} (FT)	X (FT)
BASIN-1	15	10	11.5	0.5	1.0
BASIN-2	15	10	11.5	0.5	1.0
BASIN-3	15	10	11.5	0.5	1.0
BASIN-4	15	10	11.5	0.5	1.0
DP-1	18	18	19.5	0.75	1.5
DP-2	18	20	21.5	0.75	1.5
DP-3	18	15	19.5	0.75	1.5
C-3C	24	18	20	0.5	1.0
C-4	18	10	11.5	0.25	0.5



SECTION A-A

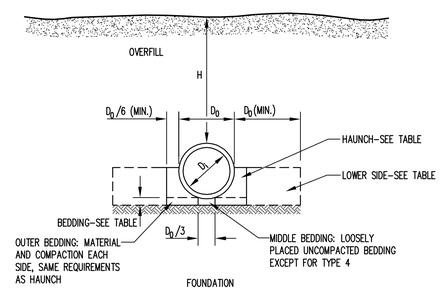


PLAN

NOTE:
1. D_{50} REFERS TO THE MINIMUM REQUIRED AVERAGE STONE SIZE
2. FOR MORE THAN ONE PIPE, EXTEND RIP RAP 1.0' MIN. BEYOND OUTSIDE EDGES OF PIPES.

RIP RAP OUTLET PROTECTION

DETAIL 3 / EC2
NOT TO SCALE



CONCRETE PIPE INSTALLATION

DETAIL 4 / EC2
NOT TO SCALE

(BASED ON AMERICAN CONCRETE PIPE ASSOCIATION RECOMMENDATIONS)

STANDARD EMBANKMENT INSTALLATION SOILS AND MINIMUM COMPACTION REQUIREMENTS			
INSTALLATION TYPE	BEDDING THICKNESS	HAUNCH AND OUTER BEDDING	LOWER SIDE
TYPE 1	D_O/24"(600mm) MINIMUM, NOT LESS THAN 3"(75mm). IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	95% SW, SP, GW, GP	90% SW, SP, GW, GP; 95% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 100% CL, MH, SC, GC, CH.
TYPE 2	D_O/24"(600mm) MINIMUM, NOT LESS THAN 3"(75mm). IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	90% SW, SP, GW, GP; OR 95% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE	85% SW, SP, GW, GP; 90% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 95% CL, MH, SC, GC, CH.
TYPE 3	D_O/24"(600mm) MINIMUM, NOT LESS THAN 3"(75mm). IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	85% SW, SP, GW, GP; 90% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 95% CL, MH, SC, GC, CH	85% SW, SP, GW, GP; 90% ML, SM, GM OR GC, SC WITH <20% PASSING NO.200 SIEVE; OR 95% CL, MH, SC, GC, CH.
TYPE 4	NO BEDDING REQUIRED, EXCEPT IF ROCK FOUNDATION, USE D_O/12"(300mm) MINIMUM, NOT LESS THAN 6"(150mm).	NO COMPACTION REQUIRED, EXCEPT IF CL, MH, SC, GC, CH USE 85%	NO COMPACTION REQUIRED, EXCEPT IF CL, MH, SC, GC, CH USE 85%

NOTES:
1. COMPACTION AND SOIL SYMBOLS (95% SW) REFER TO SW SOIL MATERIAL (USCS CLASSIFICATION) WITH A MINIMUM STANDARD PROCTOR COMPACTION (ASTM D 698) OF 95%.
2. SOIL IN THE OUTER BEDDING, HAUNCH, AND LOWER SIDE ZONES, EXCEPT WITHIN D_O/3 FROM THE PIPE SPRINGLINE, SHALL BE COMPACTED TO AT LEAST THE SAME COMPACTION AS THE MAJORITY OF THE SOIL IN THE OVERFILL ZONE.
3. SUBTRENCHES:
   - 3.1. A SUBTRENCH IS DEFINED AS A TRENCH WITH ITS TOP BELOW FINISHED GRADE BY MORE THAN 0.1H OR, FOR ROADWAYS, ITS TOP IS AT AN ELEVATION LOWER THAN 1'(0.3m) BELOW THE BOTTOM OF THE PAVEMENT BASE MATERIAL.
   - 3.2. THE MINIMUM WIDTH OF A SUBTRENCH SHALL BE 1.33 D_O OR WIDER IF REQUIRED FOR ADEQUATE SPACE TO ATTAIN THE SPECIFIED COMPACTION IN THE HAUNCH AND BEDDING ZONES.
   - 3.3. FOR SUBTRENCHES WITH WALLS OF NATURAL SOIL, ANY PORTION OF THE LOWER SIDE ZONE IN THE SUBTRENCH WALL SHALL BE AT LEAST AS FIRM AS AN EQUIVALENT SOIL PLACED TO THE COMPACTION REQUIREMENTS SPECIFIED FOR THE LOWER SIDE ZONE AND AS FIRM AS THE MAJORITY IF THE SOIL IN THE OVERFILL ZONE, OR SHALL BE REMOVED AND REPLACED WITH SOIL COMPACTED TO THE SPECIFIED LEVEL.

NO.	DATE	REVISION

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PROJECT TITLE:
AVERY COUNTY
C&D LANDFILL
STORMWATER MANAGEMENT PLAN

DRAWING TITLE:
STORMWATER MANAGEMENT
DETAILS
(SHEET 2 OF 3)

DESIGNED BY: K.B.S.	DRAWN BY: J.A.L.
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME: AVERY-D0046	
SHEET NO. 8	DRAWING NO. EC2

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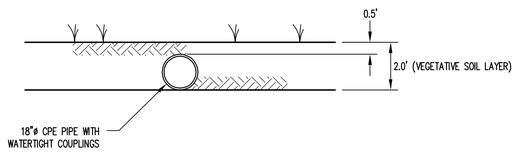
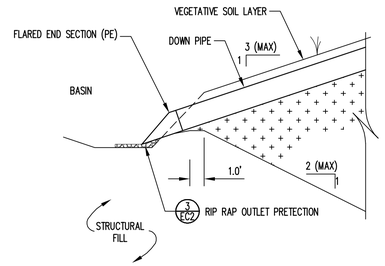


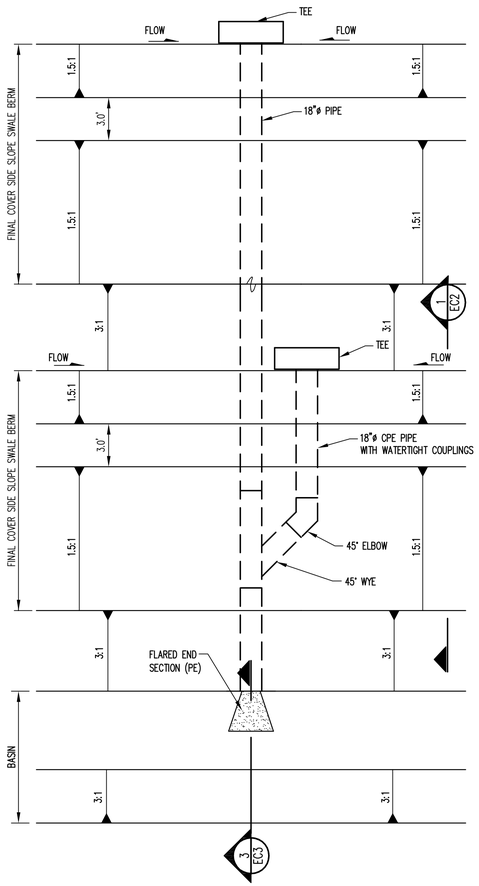
DOWN PIPE ON SLOPE

DETAIL 1/EC3
NOT TO SCALE



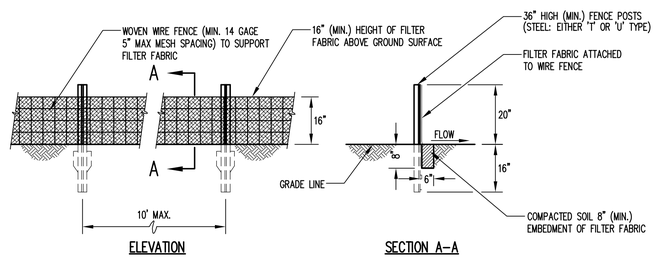
DOWN PIPE OUTLET

DETAIL 3/EC3
NOT TO SCALE



DOWN PIPE INLETS & OUTLETS

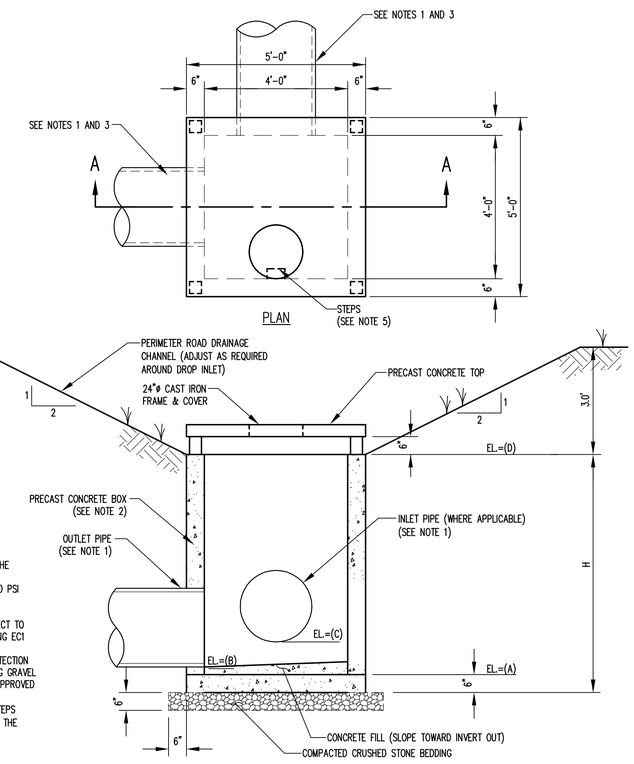
DETAIL 2/EC3
NOT TO SCALE



SILT FENCE

DETAIL 4/EC3
NOT TO SCALE

DROP INLET SCHEDULE					
DROP INLET	Base of Box EL=(A) FT	OUTLET PIPE INVERT EL=(B) FT	INLET PIPE INVERT EL=(C) FT	TOP of BOX EL=(D) FT	HEIGHT of BOX (FT) (H)
DI–3A	3,012.5	3,013.0	N/A	3,016.0	4.0
DI–3B	2,969.5	2,970.0	2,973.0	2,976.0	7.0
DI–3C	2,933.5	2,934.0	2,939.0	2,942.0	9.0



SEEDING SCHEDULE		
MATERIAL	SEED TYPE	APPLICATION RATE
LIME	–	4,000 LBS/ACRE
FERTILIZER	10–10–10 ANALYSIS	1,000 LBS/ACRE
SEED		
PERMANENT	CREEPING RED FESCUE RED CLOVER KOBE LESPEDEZA SEASONAL NURSE CROP	40 LBS/ACRE 10 LBS/ACRE 10 LBS/ACRE SEE NOTE 2
TEMPORARY	SEASONAL NURSE CROP	SEE NOTE 2
MULCH	–	4,000–5,000 LBS/ACRE
BINDER	ASPHALT EMULSION	300 GALLONS/ACRE

NOTES:
1. APPLICATION RATES AND/OR CHEMICAL ANALYSIS SHALL BE CONFIRMED OR ESTABLISHED BY A SOIL TEST.
2. USE SEASONAL NURSE CROP IN ACCORDANCE WITH SEEDING DATES AS STATED BELOW:
   APRIL 15 – AUGUST 15 — 10 LBS/ACRE GERMAN FOXTAIL OR BROWNTOP MILLET OR 15 LBS/ACRE SUDANGRASS
   AUGUST 16 – APRIL 14 — 25 LBS/ACRE RYE (GRAIN)
3. FROM SEPTEMBER 1 – MARCH 1, USE UNSCARIFIED SERICEA SEED.

SEEDING SCHEDULE

DETAIL 5/EC3
NOT TO SCALE

NOTES:
1. PROVIDE WATERTIGHT JOINTS ON ALL PIPING.
2. PRECAST CONCRETE BOXES SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:
   A. CONCRETE: COMPRESSIVE STRENGTH 4000 PSI
   B. REINFORCING: ASTM A–615, GRADE 60
   C. MEETS H–20 LOADING.
3. PIPES MAY BE ORIENTED DIFFERENTLY WITH RESPECT TO THE CHANNEL THAN DISPLAYED HERE. SEE DRAWING EC1 FOR PROPER ORIENTATION.
4. THE CONTRACTOR SHALL PROVIDE ADEQUATE PROTECTION FROM SEDIMENTATION FOR ALL DROP INLETS USING GRAVEL AND WIRE MESH FILTERS OR OTHER METHOD AS APPROVED BY THE ENGINEER.
5. PROVIDE STEPS FOR DROP INLETS WITH H>4.5'. STEPS SHALL HAVE A 16" SPACING THE FULL HEIGHT OF THE DROP INLET. START FIRST STEP 6" BELOW TOP.

DROP INLET

DETAIL 6/EC3
NOT TO SCALE

REVISION	DATE	NO.

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PROJECT TITLE:
AVERY COUNTY
C&D LANDFILL
STORMWATER MANAGEMENT PLAN

DRAWING TITLE:
STORMWATER MANAGEMENT DETAILS (SHEET 3 OF 3)

DESIGNED BY:	DRAWN BY:
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME: AVERY-D0047	
SHEET NO. 9	DRAWING NO. EC3

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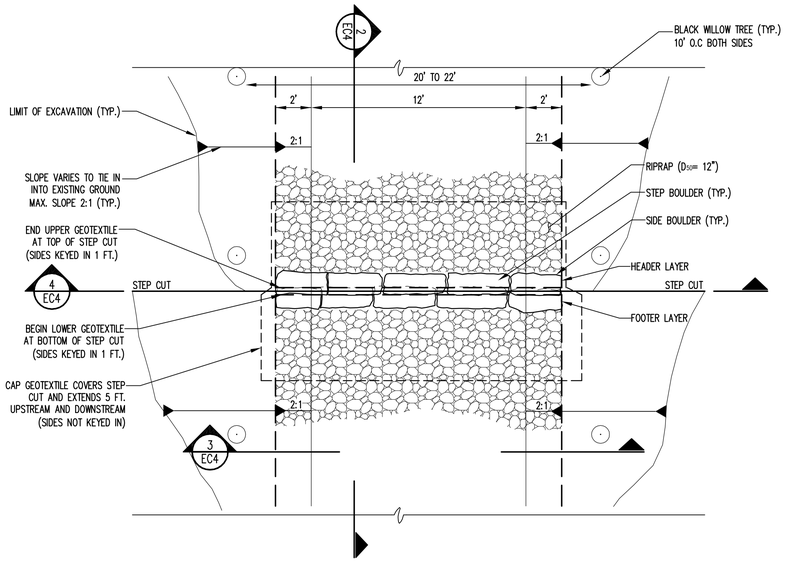
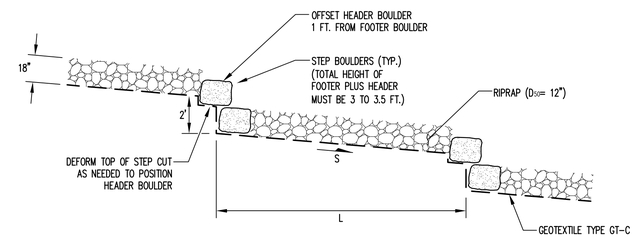


TYPICAL PLAN – CASCADE

DETAIL 1 EC4
NOT TO SCALE

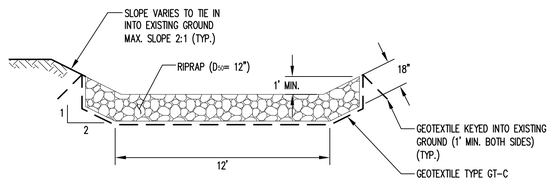


TYPICAL PROFILE – CASCADE

DETAIL 2 EC4
NOT TO SCALE

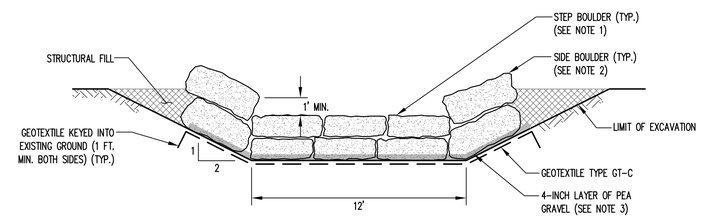
CASCADE STEP SCHEDULE				
STEP NO. FROM TOP DOWN	H (FEET)	TYPICAL L (FEET)	S (INTERSTEP SLOPE)	REMARKS
CASCADE I.D.: SB-1 OUTLET				
1-6	2	3.4	0%	AVERAGE GROUND SLOPE= 50.0%
CASCADE I.D.: SB-2 OUTLET				
1-7	2	14	10%	AVERAGE GROUND SLOPE= 21.7%
8-14	2	19	10%	AVERAGE GROUND SLOPE= 18.7%
CASCADE I.D.: SB-3 OUTLET				
1-17	2	7	5%	AVERAGE GROUND SLOPE= 32.0%

NOTES:
H= STEP HEIGHT; L= STEP LENGTH
1. FIELD ADJUST L TO MAINTAIN CHANNEL EXCAVATION BETWEEN 2.5 AND 4.5 FEET AND MATCH REQUIRED CASCADE LENGTH.
2. CONTRACTOR SHALL PERFORM WORK IN THE PRESENCE OF AND TO THE SATISFACTION OF THE CQA ENGINEER.
3. CONTRACTOR MUST OBTAIN APPROVAL OF THE CQA ENGINEER FOR EACH BOULDER PLACED.



TYPICAL SECTION – CASCADE

DETAIL 3 EC4
NOT TO SCALE



NOTES:
1. TOTAL HEIGHT OF FOOTER PLUS HEADER STEP BOULDERS MUST BE 3 TO 3.5 FT.
2. SIDE BOULDERS SHALL BE LARGER THAN STEP BOULDERS. TOTAL HEIGHT OF FOOTER PLUS HEADER SIDE BOULDERS MUST BE 3.5 TO 4.5 FT. AND MUST FORM A MIN. 1 FT. DEEP CHANNEL.
3. PLACE 4-INCH LAYER OF PEA GRAVEL ON GEOTEXTILE BEFORE SETTING BOULDERS IN PLACE. PEA GRAVEL IS NOT REQUIRED UNDER RIPRAP.

TYPICAL SECTION – STEP

DETAIL 4 EC4
NOT TO SCALE

NO.	DATE	REVISION

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SEAL

SEAL

PROJECT TITLE:
AVERY COUNTY
C&D LANDFILL
STORMWATER MANAGEMENT PLAN

DRAWING TITLE:
CASCADE DETAILS

DESIGNED BY: T.B.M.	DRAWN BY: C.T.J.
CHECKED BY:	PROJECT NO.: AVERY 07-1
SCALE: AS SHOWN	DATE: SEPT. 2008
FILE NAME AVERY-D0053	
SHEET NO. 10	DRAWING NO. EC4

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