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Prepared for:

Material Recovery, LLC
421 Raleigh View Road
Raleigh, North Carolina 27610

JEI PROJECT NO. 479.01, TASK 02

VOLUME TWO
CONSTRUCTION PLAN APPLICATION

MATERIAL RECOVERY, LLC BROWN-FIELD ROAD CONSTRUCTION AND DEMOLITION LANDFILL

WAKE COUNTY, NORTH CAROLINA

DECEMBER 2001

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
DATE 1/31/03 **BY** DAB

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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 17501 JOHN P. DRISCOLL

Prepared by:

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VOLUME TWO
TABLE OF CONTENTS

STATEMENT OF COMPLIANCE WITH ENGINEERING PLAN REQUIREMENTS

1.0 GENERAL 1
1.1 Existing Conditions 1
2.0 CONSTRUCTION PLAN 2
2.1 Proposed Development 2
2.2 Base Grades 2
2.3 Final Cover System 3
2.4 C&D Waste Stream 3
2.5 Landfill Capacity 3
2.6 Waste Management Procedures 4
3.0 OPERATION PLAN 4
3.1 General Operating Conditions 5
3.1.1 Facility Contact 5
3.1.2 Hours of Operation 5
3.1.3 Site Access and Safety 5
3.1.4 Waste Acceptance 5
3.1.5 Material Recovery 6
3.1.6 Prohibited Waste 6
3.1.7 Litter Control 7
3.1.8 Air Quality 7
3.1.9 Dust, Odor, Fire and Vector Control 7
3.1.10 Scavenging/Salvaging 8
3.2 Random Waste Screening Program 8
3.2.1 Authority 8
3.2.2 Random Selection 9
3.2.3 Record Keeping 9
3.2.4 Training 9
3.2.5 Location 9
3.2.6 Contingency/Action Plan 9
3.3 Waste Compaction And Equipment 10
3.3.1 Filling Operation Cell Progression 10
3.3.2 Landfill Equipment 11
3.3.3 Cover Material 11
3.4. Environmental Monitoring Program 11
3.4.1 Water Quality Monitoring 11
3.4.2 Landfill Gas 11
3.5 Erosion and Sediment Control Requirements 12
3.6 Record Keeping Requirements 12
3.7 Training 13
4.0 CLOSURE PLAN 13
4.1 General 13

TABLE OF CONTENTS (Continued)

4.2 Area To Receive Final Cover 13
4.3 Cap Design 13
4.3.1 Drainage and Erosion 14
4.3.2 Closure Plan Schedule 14
4.3.3 Cap Construction 15
4.3.4 Certification 15
5.0 POST-CLOSURE CARE 15
5.1 General 15
5.2 Contact 15
5.3 Security 15
5.4 Post-Closure Maintenance 16
5.5 Inspection Plan 16
5.6 Post-Closure Land Use 16
5.7 Environmental Monitoring 16

TABLES

Table 1 Phase 1 Projected Capacity and Life Estimate
Table 2 Soil Balance Calculations

FIGURE

Figure 1 Site Location Map

DRAWINGS

Drawing No. 0 Title Sheet
Drawing No. 1 Drawing Index, Notes and Legend
Drawing No. 2 Existing Conditions
Drawing No. 3 Site Development Plan
Drawing No. 4 Phase 1 Base Grading Plan
Drawing No. 5 Phase 1 Final Grading Plan
Drawing No. 6 Phase 1 Annual Phasing (Cells A-C)
Drawing No. 7 Phase 1 Annual Phasing
Drawing No. 8 Phase 1 Cross-Sections
Drawing No. 9 Project Details
Drawing No. 10 Erosion and Sediment Control Plan - Overview
Drawing No. 11 Erosion and Sediment Control Features for Phased Waste Progression (Stages 1 and 2)
Drawing No. 12 Erosion and Sediment Control Features for Phased Waste Progression (Stages 3 and 4)
Drawing No. 13 Erosion and Sediment Control Details
Drawing No. 14 Erosion and Sediment Control Details

TABLE OF CONTENTS (Continued)

APPENDICES

Appendix 1	Property Boundary Survey and Legal Description
Appendix 2	Random Waste Screening Forms 1. Waste Inspection Form 2. Refuse/Unidentified Waste Inspection Form 3. USEPA Hazardous Waste Inspection Decision Tree
Appendix 3	Seeding Specifications
Appendix 4	Erosion and Sediment Control Plan
Appendix 5	Post Closure Inspection Forms 1. Post Closure Maintenance Record 2. Groundwater Monitoring Well Maintenance Record

STATEMENT OF COMPLIANCE WITH CONSTRUCTION PLAN APPLICATION REQUIREMENTS

It is our opinion that the information and design described in this Construction Plan Application for the proposed Material Recovery LLC, Brown-Field Road Construction and Demolition Debris Landfill, meet the requirements of Rule .504 of the North Carolina Solid Waste Management Rules, 15A NCAC 13B.

Respectfully Submitted
JOYCE ENGINEERING, INC.

NORTH CAROLINA PROFESSIONAL SEAL 17501 JOHN P. DRISCOLL

John P. Driscoll, P.E.
Senior Technical Consultant

1.0 GENERAL

In accordance with the North Carolina Solid Waste Management Rules, 15A NCAC 13B, Section .0500, Material Recovery, LLC (MR) is submitting this Construction Plan Application to demonstrate compliance with the applicable requirements therein so that a permit to construct may be issued for the first five-year phase of the proposed Brown-Field Road Construction and Demolition Debris (C&D) Landfill located in Wake County, North Carolina.

The property is owned and will be operated by MR. The proposed C&D landfill facility property will consist of approximately 210 acres, of which 69 acres will be used for C&D waste disposal. The property is located on SR2553, Brown-Field Road, in eastern Wake County, North Carolina. The site is approximately 4 miles north west of Clayton and 5.5 miles south east of Raleigh.

Joyce Engineering, Inc. (JEI) has prepared this Construction Plan Application in accordance with the requirements of 15A NCAC 13B .0504(2). This report contains information pertinent to the construction and operation of the first five-year phase of the proposed C&D landfill. Section 2.0 describes the comprehensive development of the C&D landfill as required by Subsection .0504 of the Rules, and includes drawings, figures and tables. The Operations Plan, Section 3.0, describes the operational requirements for the C&D landfill as required by Subsection .0505 of the Rules. The Closure Plan and Post Closure Plan, Sections 4.0 and 5.0, describe the closure and post-closure requirements for the C&D landfill as required by Subsection .0510 of the Rules.

Information related to the landfill siting requirements is being submitted in conjunction with this Construction Plan Application as the Site Application within Volume One. References to Volume One are made as needed to clarify or support the design of the C&D landfill.

1.1 Existing Conditions

This section describes the site location, its physical layout, and current land usage. Geologic and hydrogeologic characteristics are discussed within Volume One, Section II.

The proposed site is located in the eastern portion of Wake County, North Carolina, just west of the Johnston County line, along SR2553 (Brown-Field Road). A site location map is provided as Figure 1. Access to the site will be from SR2553, approximately 0.25 miles south of the intersection of Brown-Field Road and Old Battle Bridge Road. The site is bounded on the east by SR2553, on the north by property owned by the City of Raleigh, on the west by properties owned by Horace Benton Heirs, Polly S. Quinn and MR, and on the south by properties owned by John and Marie Baucom, and Margaret Talton.

The site is characterized by gently sloping hillsides ranging in elevation from 180 to 295 feet above mean sea-level (MSL). This site has been used primarily in the past for agriculture purposes. Portions of the property have previously been logged and cleared, and used as sludge application fields by the City of Raleigh. Two man-made ponds exist on the property. These ponds will be buffered to avoid disturbance. Two residential structures used by the previous property owners currently exist on the site. The north structure and its water supply well will remain, and may be used as the landfill office, until the development of future landfill phases within the northern disposal area. The south structure will remain intact.

A 200-ft wide buffer will be maintained around the entire property boundary. 50-ft buffers will be maintained around intermittent streams and tributaries of the Neuse River.

Appendix 1 contains a boundary survey plat and legal description of the property. It should be noted that the protruding tract along the southernmost property line will not be part of the facility property boundary. The tract has been conveyed to a neighboring property owner. The property identified as Tract 2 within the legal description is not part of the proposed facility boundary and has been conveyed to the City of Raleigh. The existing conditions and surrounding topography are shown on the Drawing No. 2. The drawing also includes the locations of on-site benchmarks, soil borings and groundwater monitoring sites.

2.0 CONSTRUCTION PLAN

The purpose of this section is to satisfy the requirements of .0504 (2)(h), which calls for a written report that addresses the proposed development, the projected capacity and life, and general operating and waste management procedures of the first five-year phase, referred to hereinafter as "Phase 1", of the proposed C&D landfill.

2.1 Proposed Development

The Brown-Field Road C&D Landfill will be owned and operated by Material Recovery, LLC. The overall site development is expected to include two C&D disposal areas (identified as the north and south disposal areas), a main entrance road, access roads, scale and scale-house, maintenance shop, C&D reclamation pad, and erosion and sediment control features.

Phase 1 will be developed within the westernmost portion of the north disposal area. Phase 1 is approximately 19 acres in size and will consist of approximately 3 cells. The development of subsequent Phases (2-4) within the northern disposal area will progress from west to east adjacent to Phase 1. The limits of Phase 1 with respect to the northern disposal area are shown on Drawing No. 3.

2.2 Base Grades

The base grade of the proposed C&D landfill will consist of the existing underlying soils. Base grades have been designed to be at least four feet above the seasonal high groundwater table and bedrock elevations. The underlying soils, which will serve as the foundation for the landfill, are predominately silty sands, clayey sands, and sandy silts. If unsuitable soils are identified during preparation of the base grades, they will be removed and replaced with suitable compacted material. A land surveyor licensed in North Carolina will verify that the dimensions and elevations of the base grade are in accordance with the approved plans prior to submittal of an application for a Permit to Operate.

The proposed base grades, as well as the estimated seasonal high groundwater and bedrock elevations, are shown on Drawing No. 4. See Volume One, Section II for a detailed discussion of the hydrogeologic evaluation of this area. The base grade elevations within Phase 1 are generally governed by the estimated seasonal high groundwater elevations within Cells A, B and the majority of Cell C. A small area/ridge of bedrock governs the base grades in the southeastern section of Cell C. If it is found during the excavation of this area that the ridge is comprised of rippable rock and soil material, the Solid Waste Section will be notified, and a modification to the base grade elevations will be submitted for approval. In this case, the modified base grades will be designed to maintain a separation at least four feet above the estimated seasonal high groundwater elevations.

2.3 Final Cover System

Final grading contours for Phase 1 are shown on Drawing No. 5. Final contours have been designed with post-settlement surface slopes of at least five percent on top of the phase, and a maximum of 3 horizontal to 1 vertical (3H:1V) on the side slopes. Cross-sectional details of the proposed closure cap are provided on Drawing No. 9.

The cap system will consist of the following: a 12-inch intermediate cover and leveling course, an 18-inch compacted soil layer, and a 6-inch vegetative layer. The cap components are discussed in detail in Section 4.0 of this report.

2.4 C&D Waste Stream

Service Area: The landfill will serve Wake County and Johnston County and all municipalities contained therein. Additional counties that may also be served include, but are not limited to, Durham, Orange and Chatham.

Disposal Rates and Waste Stream: Material Recovery, LLC projects that the facility will initially accept approximately 650 tons of C&D waste material per day. The waste stream will consist of C&D waste that cannot be reclaimed at the company's affiliate, Material Reclamation, LLC, reclamation facility, located in Raleigh, North Carolina, as well as C&D material received from other third parties. Currently, 55% of all C&D waste brought to the reclamation center is reclaimed; the remaining 45% will be disposed at the proposed landfill. It is anticipated that of the 650 tons per day, approximately 400 tons will originate with other third parties, while approximately 250 tons would originate from the Raleigh reclamation facility.

Types of Waste Specified for Disposal: The facility will only accept construction and demolition (C&D) debris, and land-clearing and inert debris (LCID). All other waste is prohibited from disposal. Construction and demolition debris is waste or debris resulting solely from construction, remodeling, repair, or demolition operations on pavement, buildings, or other structures. Land clearing debris is waste that is generated solely through land clearing activities. Material Recovery and its affiliate, Material Reclamation, will also use the site to dispose of C&D wastes that cannot be reclaimed at their reclamation center in Raleigh, North Carolina.

2.5 Landfill Capacity

The projected waste capacity of Phase 1 is approximately 1,429,000 cubic yards or 964,000 tons. This volume does not include weekly cover soils or final cap material. At the current waste stream, Phase 1 has a life expectancy 5.2 years (see Table 1). The capacity was calculated using airspace volumes between the base and final grades obtained from Softdesk Civil\Survey software integrated with the construction drawings produced using AutoCAD, Release 2000.

The in-place ratio of waste to soil used to calculate the operating life and operating soil requirements was assumed to be 9 to 1. This is based on the assumption that a 6-inch lift of cover soil will be placed on the working face once per week. An in-place compaction density of 1,350 pounds per cubic yard was used in determining the projected life of the disposal area.

Approximately 598,000 cubic yards (cy) of soil will need to be excavated to achieve the Phase 1 subgrade elevations, as depicted on Drawing No. 4. Excavated material that is unsuitable for use as structural fill or for construction of the cap will be segregated for use as weekly cover. This will include sludge material that is encountered during excavation of the site. Approximately 100,000 cy of material will be needed as fill to construct the access roads. At a waste to soil ratio of 9:1, approximately 159,000 cy of material will be needed for weekly cover. The cap will require approximately 45,000 cy of soil material. The remainder of the soil, approximately 294,000 cy, will be available for future development of additional phases or other on-site needs. The on-site soil resources, usage, and balance for Phase 1 are provided in Table 2. A mining permit will be obtained if MR. elects to sell excess soil.

The data and assumptions used in projecting the capacity are consistent with the disposal rates discussed in the preceding section, and are representative of the operational requirements and conditions anticipated for the new facility.

2.6 Waste Management Procedures

During operating hours, traffic will be routed from the entrance gate and scalehouse to a road leading to the reclamation pad and disposal area. Phase 1 will be broken up into multiple cells. Cells will be constructed as needed. Appropriate CQA documentation, including as-built base grades, will be submitted to the Solid Waste Section for review prior to initiating landfill disposal operations. An approved Permit to Operate will be obtained prior to the disposal of waste.

Recoverable materials will be separated from the C&D waste stream for recycling. Much of this will occur at the Raleigh reclamation facility, but will also be carried out on the proposed reclamation pad at the proposed site. These procedures are described in more detail in the discussion of material recovery in Section 3.1.5 of this report. Section 3.2 contains information on the proposed waste-screening program to preclude the acceptance of unauthorized waste, as well as other operational issues.

3.0 OPERATION PLAN

This operation plan describes how the design and construction plans will be implemented during the life of the facility. The text, drawings, and appendices illustrate general operating conditions, cell progression, waste placement, daily operations, and special waste management.

3.1 General Operating Conditions

3.1.1 Facility Contact

The owner of the site is:

Material Recovery, LLC.

The facility contact for the site is:

Norbert Hector
421 Raleigh View Road
Raleigh, North Carolina 27610

Phone Number: (919) 835-3655
Fax Number: (919) 835-3622

3.1.2 Hours of Operation

The landfill will operate between 7:00 A.M. and 5:30 P.M., Monday thru Friday, and between 8:30 A.M. and 2:00 P.M. on Saturdays. The facility will be closed on the following major holidays: Thanksgiving and Christmas Day. If the facility will be closed during other holidays, third party haulers will be notified in advance.

3.1.3 Site Access and Safety

Access to the facility will be controlled through a single entrance road. A metal gate will prevent access after operating hours. A sign containing the information required in Rule .0505 (9) (i.e., acceptable wastes, hours, permit number, etc.) will be posted at the facility entrance. Waste collection vehicles will be weighed in (and out if tare weights are not available for that vehicle) at the scale house. Signs will be posted directing traffic to separate areas of the facility. Traffic will move from the scales to the landfill via a gravel haul road. The layout of haul roads may change as needed during the course of landfill development so that there is convenient access to active disposal areas. Access roads will be maintained to remain passable during most weather conditions. An attendant will remain on duty at the scale house during operating hours.

3.1.4 Waste Acceptance

Only construction/demolition waste and land clearing and inert debris are proposed for disposal at the C&D landfill. Construction and demolition debris is defined in NC General Statutes as waste or debris resulting solely from construction, remodeling, repair, or the demolition of pavement, buildings, or other structures. Land clearing and inert debris includes waste such as stumps, trees, limbs, leaves, brush, grass, brick, block and untreated wood.

In accordance with Division policy, other waste types may be proposed for disposal that are similar to waste typically found in land clearing-inert debris and construction/demolition waste streams. Examples might be roofing shingle waste from the shingle manufacturer, waste building materials from a mobile home/modular home manufacturer, or wooden pallets. If other wastes are proposed for disposal at this facility, requests for approval will be submitted in accordance with Division requirements.

On or before August 1 of each year, MR will report to the Solid Waste Section the amount of waste received in tons at this facility and disposed in the waste disposal areas. The reporting period shall be for the previous year beginning July 1 and ending on June 30. Data will be transmitted on forms prescribed by the Section. The report will include the following:

- The amount of waste received and landfilled in tons, compiled on a monthly basis by county or transfer station of origin, and by specific waste type if diverted to a specific unit within the permitted facility; and

- The completed report shall be forwarded to the Regional Waste Management Specialist for the facility. A copy of the completed report shall be forwarded to the County Manager of each county from which waste was received.

3.1.5 Material Recovery

Certain materials in the C&D waste stream will be recovered and transported off site for recycling. C&D waste with potential recyclable materials will be dumped on the reclamation pad for sorting. Recyclable material will be manually and/or mechanically separated from C&D waste that will be disposed in the landfill. Examples of recyclable materials that may be pulled from the waste stream include, but are not limited to: lumber, wood waste, pallets, drywall, cardboard, plastics, ferrous metals, non-ferrous metals, concrete, bricks, soils, asphalt, and de minimus amounts of other non-hazardous materials that are generated at construction and demolition projects. The type of recyclable material that will be sorted from the waste stream at any given time is market dependent. C&D waste received from the Raleigh reclamation facility will have been presorted and will be directed to the landfill.

3.1.6 Prohibited Waste

In accordance with Rule .0505(11)(b), no hazardous or liquid waste may be accepted for disposal. The C&D landfill will not accept:

- municipal solid waste (MSW), including household, commercial and industrial waste;

- hazardous waste as defined within 15A NCAC 13A, including hazardous waste from conditionally exempt small quantity generators;

- polychlorinated biphenyl (PCB) wastes as defined in 40 CFR 761;

- barrels and drums (except fiber drums containing asbestos), unless they are empty and sufficiently perforated;

- friable asbestos;
- yard trash defined as solid waste consisting solely of vegetative matter resulting from landscaping maintenance;
- other wastes specifically banned from landfill disposal by rule or statute, such as lead acid batteries, whole tires, used oil, or aluminum cans.

MR will notify the NC Division of Waste Management within 24 hours of attempted disposal of hazardous waste or other waste that the landfill is not permitted to receive. Municipal solid waste (MSW) that is received will be placed in containers and transported to a permitted Subtitle D MSW landfill. The waste-screening program is described later in Section 3.2.

3.1.7 Litter Control

Windblown litter is not anticipated to be a significant problem at the C&D landfill due to the heavy, bulky nature of this waste type. Prompt compaction of the waste at the working face will be conducted to minimize litter. Temporary fences may be constructed if needed to contain windblown material during operations. Also, landfill personnel will pick up windblown litter as needed along the access road and in the vicinity of the disposal area.

3.1.8 Air Quality

Open burning of waste, including yard waste and brush, is prohibited at the landfill.

3.1.9 Dust, Odor, Fire and Vector Control

Dusty road surfaces will be sprayed with water as needed during windy, dry weather.

Significant odors and disease vectors are not anticipated at the C&D landfill. The waste will be covered weekly.

Site operators will observe incoming waste loads for evidence of fire such as flames, smoke, or the odor of burning material. If evidence of fire exists, the landfill operator will evaluate the situation to determine whether the fire can be extinguished using fire extinguishers and/or other equipment at the site, or if off-site equipment is needed. If necessary, the local fire department will be called to render assistance in extinguishing the fire. Fires that occur at the landfill will be reported verbally to the NC Division of Waste Management within 24 hours, and in writing within 15 days.

If a fire occurs at the waste disposal area, waste that is burning will be removed or segregated from other waste in the disposal area, if possible. The situation will be evaluated to determine whether emergency personnel should be notified. If necessary, the local fire department will be called to render assistance and provide support in fighting fires that occur at this site. Station 2 of the Knightdale Fire Department services the fire district surrounding the site. Water in sedimentation ponds and nearby creeks can be used by firefighters to assist in extinguishing fires.

Fire extinguishers will be carried on each piece of landfill equipment on site, and will be used for small, localized fires. Equipment operators will be trained in the use of these extinguishers. A small stockpile of soil will be maintained near the working face to be used for extinguishing small surface fires that are too large to control with fire extinguishers.

3.1.10 Scavenging/Salvaging

The unauthorized removal of waste, or scavenging, is prohibited at the landfill. Landfill personnel may remove recyclable salvageable materials and process them through MR's recycling program.

3.2 Random Waste Screening Program

3.2.1 Authority

To prevent the acceptance of prohibited wastes, the following random waste screening program is proposed in accordance with the North Carolina's Solid Waste Management Regulations, Rule .1626(1)(f). The program is primarily used to detect hazardous waste that is mixed with MSW. However, the same methodology can be used to keep hazardous wastes and prohibited MSW from being disposed at the C&D landfill. Key elements of this rule are as follows:

- No hazardous or liquid wastes as defined in 15A NCAC 13A, municipal solid waste, or materials offering an undue hazard to landfill personnel or the landfill operations shall be accepted at the C&D landfill except as specifically authorized by the facility permit or by the Division. The owner or operator shall implement an inspection program to detect and prevent disposal of non-permitted wastes, hazardous and liquid wastes, and polychlorinated biphenyls (PCB). This program shall include, at a minimum:

- Random inspections of incoming loads, unless the owner or operator takes other steps to prohibit incoming loads containing municipal solid waste, regulated hazardous or liquid wastes, or PCB wastes;

- Records of any inspections;

- Training of facility personnel to recognize municipal solid waste, regulated hazardous or liquid wastes, or PCB wastes; and other non acceptable wastes;

- Development of a contingency/action plan to properly manage non-permitted or hazardous and/or liquid wastes that are identified.

3.2.2 Random Selection

Random selection of vehicles to be inspected will be conducted on a regular basis, depending on personnel available. At least one vehicle per week, but not less than one percent by weight of the waste stream (based on the previous week's total) will be randomly selected at the working face by the personnel conducting the inspection. A random truck number and time will be selected (i.e., the tenth load after 10:00 a.m.) on the day of inspections.

3.2.3 Record Keeping

The Waste Inspection Form and, if applicable, the Refuse / Identified Waste Inspection Form (included in Appendix 2) will be completed at each inspection. Reports and resulting correspondence will be maintained at the landfill office for the life of the landfill and during the post-closure period.

3.2.4 Training

Inspections will be supervised by the operator or by support personnel trained to identify and manage C&D waste, municipal solid waste, and hazardous and liquid waste.

3.2.5 Location

Inspections will be conducted at or near the working face of the landfill.

3.2.6 Contingency/Action Plan

The following action plan details the procedures to follow for conducting random waste inspections.

1) Dump single load in prepared area and hold truck and driver until inspection is completed.

2) Spread waste with a loader, as appropriate. Loads that include large closed containers will be handled carefully to avoid possible rupturing of the containers. Have appropriate safety equipment present. Minimum safety equipment will include:

- Rubber gloves;
- Rubber boots;
- Safety glasses; and
- Long handled hoe.

3) Examine waste for excluded waste and/or safety hazards:

- Municipal solid waste (MSW);
- Containers labeled hazardous;
- Excessive or unusual moisture;
- Biomedical (red bag) waste;

- Powders, dusts, smoke, vapors, or chemical odors;
- Sludges, pastes, slurries, or bright colors (such as dyes); and
- Unauthorized out-of-County waste.

4) Take Action: One or more as appropriate:

   a) Incorporate acceptable waste into working face;
   b) Remove MSW to a permitted Subtitle D MSW landfill or transfer facility for disposal;
   c) Hold suspect waste for identification by on-site personnel and confirmation by others, if necessary, such as:

      - contract laboratory;
      - state authority; and/or
      - federal regulator.

   d) Interview driver and hauler to identify the waste source;
   e) Remove hazardous or liquid waste (In Priority Order):

      - Hold rejected hazardous or liquid waste for generator;
      - Arrange for hazardous or liquid waste collection by licensed collector.

   f) Use the USEPA Hazardous Waste Inspection Decision Tree. (See Appendix 2)

5) Document Actions:

   a) Record Inspection;
   b) Retain Reports;
   c) Report hazardous liquid, or PCB wastes to Solid Waste Section - DENR.

3.3 Waste Compaction And Equipment

3.3.1 Filling Operation Cell Progression

The method of filling will be in accordance with the filling sequence shown on Drawing Nos. 6 and 7. Operations within Phase 1 will start at the north end of the disposal area, and progress southward. The projected annual phasing plan throughout the life of Phase 1 is also shown on Drawing Nos. 6 and 7. Cross-sections through the operational areas are shown on Drawing No. 8.

The size of the working face will be maintained as small as possible to minimize contact with stormwater. The width of the working face will vary, depending on the rate of waste acceptance on a given day and weather conditions.

The waste will be dumped in the active cell as closely as possible to the working face, and then pushed if necessary to the desired area. The length of the daily working face will be maintained at approximately 100 feet to provide space for several trucks to dump at the same time. The debris shall be spread and compacted by a self-propelled landfill compactor. At least 4 to 6 passes in orthogonal directions shall be made by the compactor prior to the placement of another layer of debris.

Inactive portions of the cells that have not received waste will be separated from the active area by the use of temporary diversion berms to segregate uncontaminated and contaminated runoff. As filling progresses, the diversion berms will be relocated to allow for continued filling within the cell. As subsequent cells are opened in the planned sequence, uncontaminated stormwater will be diverted around the active portions of cells for collection and removal.

The second cell (Cell B) will be located immediately to the south of the first cell (Cell A). The third cell (Cell C) will be located south of Cell B, and will complete the Phase 1 footprint. When the entire floor of the cell has received its first lift of waste, filling will continue upward until the final proposed grade is met.

Inactive areas of the various cells that have received waste will be covered with an intermediate soil layer. Uncontaminated runoff from these areas will be routed through channels or pumped into stormwater channels that will convey the flow to the on-site sediment basin.

3.3.2 Landfill Equipment

MR will purchase typical landfill operating equipment to run the C&D landfill. Equipment such as, but not limited to, excavators, loaders and compactors, will be used to conduct the day-to-day operations of the facility.

3.3.3 Cover Material

At the end of each week's operation, the compacted waste in the current lift shall be covered with cover soil. At least 2 to 3 passes of heavy equipment will be made over the area to compact the soil. Whenever a subsequent lift of waste will not be placed for at least 12 months, additional soil shall be placed over the cover material already in place to provide a minimum 12 inches of intermediate cover. Provisions for a vegetative ground cover to restrain erosion shall be accomplished within 120 calendar days upon completion of each phase of development.

3.4. Environmental Monitoring Program

3.4.1 Water Quality Monitoring

The Water Quality Monitoring program for groundwater and surface water is described in Volume One, Section II.

3.4.2 Landfill Gas

Landfill gas is not expected to be a significant by-product from the disposal of C&D waste.

3.5 Erosion and Sediment Control Requirements

As required, the operator shall not cause a discharge of pollutants into waters of the United States, including wetlands, that violates requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, pursuant to Section 402, or cause the discharge of a non-point source of pollution to waters of the United States, including wetlands, that violates requirement of an area-wide or Statewide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended.

Embankment slopes will be inspected regularly for erosion. The vegetation on these slopes will be mowed at least once per year. These slopes will be maintained by reseeding, the application of fertilizers, and other means necessary to promote a healthy stand of vegetation. Recommended seeding specifications are located in Appendix 3. All vegetative and structural erosion and sediment control devices will be maintained according to the North Carolina Erosion and Sediment Control Planning and Design Manual. Channels and basins will be kept free of debris and sediment.

The text for the Erosion and Sediment Control Plan (E&S Plan) for Phase 1, and supporting calculations for stormwater conveyance channels, sediment traps, and sediment basins for both the north and south disposal areas, are located in Appendix 4 of this report. The E&S Plan with attachments (supporting documentation) for the Phase 1 development has been submitted to the Wake County Department of Environmental Services, Erosion, Flood and Stormwater Division, Wake County Office Building, P.O. Box 550, 336 Fayetteville Street Mall, Raleigh, NC 27602.

3.6 Record Keeping Requirements

The following records will be maintained in the Operating Record at the landfill office:

- The landfill's Permit to Construct, Permit to Operate and pertinent correspondence and other permits;
- Operation Plan;
- Inspection records, waste determination records, and waste screening programs;
- Amounts by weight of construction/demolition debris received at the facility, including the source of generation;
- Water Quality Monitoring Plan and any demonstration, certification, finding, monitoring, testing, or analytical data required by the approved water quality monitoring program at the site;

3.7 Training

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

A qualified firm will conduct groundwater and surface water monitoring, and a certified environmental laboratory will conduct laboratory analysis.

4.0 CLOSURE PLAN

4.1 General

The site will be closed incrementally as landfilling progresses. The landfill is designed so that closure can occur in stages when final contours are reached in a given area. Once an area has reached the elevations where it can logically be closed, closure activities will be carried out according to the criteria below. Ultimately, a final cover system will be constructed over the entire footprint (Phases 1-6) to minimize the infiltration of stormwater, and provide for the establishment of a vegetative cover.

4.2 Area To Receive Final Cover

The proposed Phase 1 footprint with projected final grades on the north, south and east slopes is shown on Drawing No. 5. The slope depicted on the east side is an intermediate slope prior to the construction of Phase 2, and would represent final grades only in the event that Phase 2 is not constructed. Assuming that the north, south and west slopes are capped independently of the remainder of Phase 1, the cap would approximately 8.8 acres in area.

4.3 Cap Design

Final contours have been designed with post-settlement surface slopes of at least five percent on top of the cell. Final side slope grades will be limited to a maximum of 3H:1V. A cross-sectional detail of the proposed closure cap is provided on Drawing No. 9. The following components are proposed as shown on the detail:

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

b. Compacted Soil Layer and Vegetative Layer: A compacted soil layer of unspecified permeability, at least 18 inches thick, will be constructed on top of the intermediate cover. A layer of topsoil material or organically amended local soil at least 6 inches in thickness will be placed on top of the compacted layer. The 6-inch layer will constitute a vegetative layer for the establishment of a vegetative cover on top of the landfill cap. The vegetative layer will not be heavily compacted so that vegetative growth will be promoted.

c. Vegetative Cover: After placement of the vegetative layer, the area that has been closed will be seeded with a grass and/or wildflower mixture. Recommendations regarding soil amendments and seeding mixtures will be obtained and incorporated into the seeding specifications. Mulch and erosion matting will be used as needed to control erosion.

4.3.1 Drainage and Erosion

A combination of drainage ditches, diversion berms, slope drains and permanent vegetative cover will be used to control stormwater runoff and erosion. Sediment control features will be provided to minimize the transport of sediment off-site. All erosion and sediment control features will be designed in accordance with applicable criteria of the Wake County Department of Environmental Services, and the North Carolina Erosion and Sediment Control Planning and Design Manual.

4.3.2 Closure Plan Schedule

The projected operating life of Phase 1 is approximately 5 years. However, the landfill is designed so that it can be closed incrementally as final contours are reached in various areas. Prior to beginning closure of any portion of the facility, MR will notify the Division that a notice of intent to close the facility has been placed in the operating record.

An itemized list of closure milestones and a proposed schedule follow. Closure activities are proposed to begin within 30 days of final receipt of waste in the area to be closed. Construction of the closure cap is to be completed within 180 days following the initiation of closure activities. The total length of the proposed closure period is 210 days following the final receipt of waste.

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

Proposed Closure Milestones and Schedule

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

4.3.3 Cap Construction

Once final grades are established, a detailed design for the closure cap and associated stormwater control structures will be provided. Plans and specifications will be prepared, as well as a construction quality assurance plan. Borrow soil for cap construction has not been specifically identified at this time. If there is an insufficient quantity of suitable soil on-site, then the owner will locate an off-site source of suitable soil, and haul the material to the landfill for use in cap construction.

4.3.4 Certification

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

5.0 POST-CLOSURE CARE

5.1 General

The C&D Landfill cap maintenance and environmental monitoring will be conducted for at least five years following closure of the landfill. The length of the period can be increased or decreased in accordance with Division directives.

5.2 Contact

Material Recovery, LLC will handle questions and/or problems that might occur during the post-closure care period.

CONTACT PERSON:	Mr. Norbert Hector
OWNER:	Material Recovery, LLC
ADDRESS:	421 Raleigh View Road Raleigh, North Carolina 27610
PHONE NUMBER:	(919) 835-3655

5.3 Security

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

5.4 Post-Closure Maintenance

Post-closure maintenance and monitoring will be conducted at the C&D landfill for at least five years after final closure. Monitoring will include semi-annual sampling of groundwater and surface water, and monthly inspection of the final cover. Maintenance needs identified through the monitoring program will be initiated no later than 60 days after the discovery, and within 24 hours if a danger or eminent threat to human health or the environment is indicated. Minor cap maintenance may be deferred until there is a sufficient amount of work to justify the mobilization of equipment and personnel. Unusual or extreme maintenance needs due to calamities or vandalism might require the implementation of emergency contract service procedures established by Material Recovery, LLC.

5.5 Inspection Plan

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

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

Post-closure maintenance and groundwater monitoring well maintenance inspection forms have been prepared for use during each inspection (see Appendix 5). The owner will keep completed copies of the inspection forms; copies will be forwarded to the Division for its records.

5.6 Post-Closure Land Use

The primary land use for the site after closure of the landfill will be open dormant green space.

5.7 Environmental Monitoring

Semiannual groundwater and surface water monitoring will continue to be conducted as outlined in the approved Water Quality Monitoring Plan for a period of time to be determined by the NC Division of Waste Management.

[End]

TABLES

ENGINEERING, INC.

Job:	Material Recovery, LLC.
Job Number:	479.0
Calculated By:	SDF — Date: 12/1/01
Checked By:	Date:
Subject:	Capacity Calculations
Sheet:	1 of 2

Determine the total airspace available for waste in Phase 1.

Total airspace for waste, cover soil and cap (V_t)	=	1,632,050 cy	volume from AutoCadd
Airspace consumed by the final cover (V_f)	=	44,722 cy	(V_f=$Area_f$ x dcap)
Airspace consumed by weekly cover (V_s)	=	158,733 cy	(V_s=V_t-V_f x %soil)
Total airspace available for waste (V_w)	**=**	***1,428,596 cy***	(V_w=V_t-V_f-V_s)

Determine the estimated life of Phase 1.

Total waste volume (V_w)	=	1,428,596 cy	
Total waste mass volume (M_w)	=	964,302 tons	(M_w=V_w x D/2000)
Projected remaining life of the the disposal unit	**=**	***5.2 years***	

Landfill Parameters:

Wa	=	average daily waste acceptance rate	=	650 tons/day
		(based on a 5.5 day work week)	or	3575 tons/week
D	=	average inplace density of waste	=	1350 lbs/yd^3
%soil	=	waste to soil ratio (9:1)	=	10 %
$Area_f$	=	area of final cover	=	8.8 acres
		(area includes 3:1 sideslopes)	=	402,494 sf
dcap	=	depth of cap (final and intermediate cover)	=	3 ft

Table 2

JOYCE ENGINEERING, INC.

Job:	Material Recovery, LLC.		
Job Number:	479.0		
Calculated By:	SDF	Date:	12/1/01
Checked By:		Date:	
Subject:	Capacity Calculations		
Sheet:	2 of 2		

Determine the overall soil balance for Phase 1.

Total cut resulting from the construction of the Phase 1 (base grades, perimeter road, main access road and sed. basin)	=	598,492 cy	volume from AutoCadd
Total fill needed to develop Phase 1 (base grades, perimeter road, main access road and sed. basin)	=	99,648 cy	volume from AutoCadd
Soil needed for weekly cover	=	158,733 cy	
Soil needed for the final cover	=	44,722 cy	
Soil balance	=	295,390 cy	
Total soil available	=	598,492 cy	
Total soil needed	=	303,102 cy	
Total soil balance	**=**	**295,390 cy**	

Landfill Parameters:

%soil	=	waste to soil ratio (9:1)	=	10 %
dcap	=	depth of cap (final and intermediate cover)	=	3 ft

DRAWINGS

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

BROWN-FIELD ROAD
C&D LANDFILL

CONSTRUCTION PLAN APPLICATION

L:\Material Recovery Facility LLC\dwg\Task 01-02 Construction Plan Application\CP00-TITLE SHEET.dwg

PREPARED FOR:

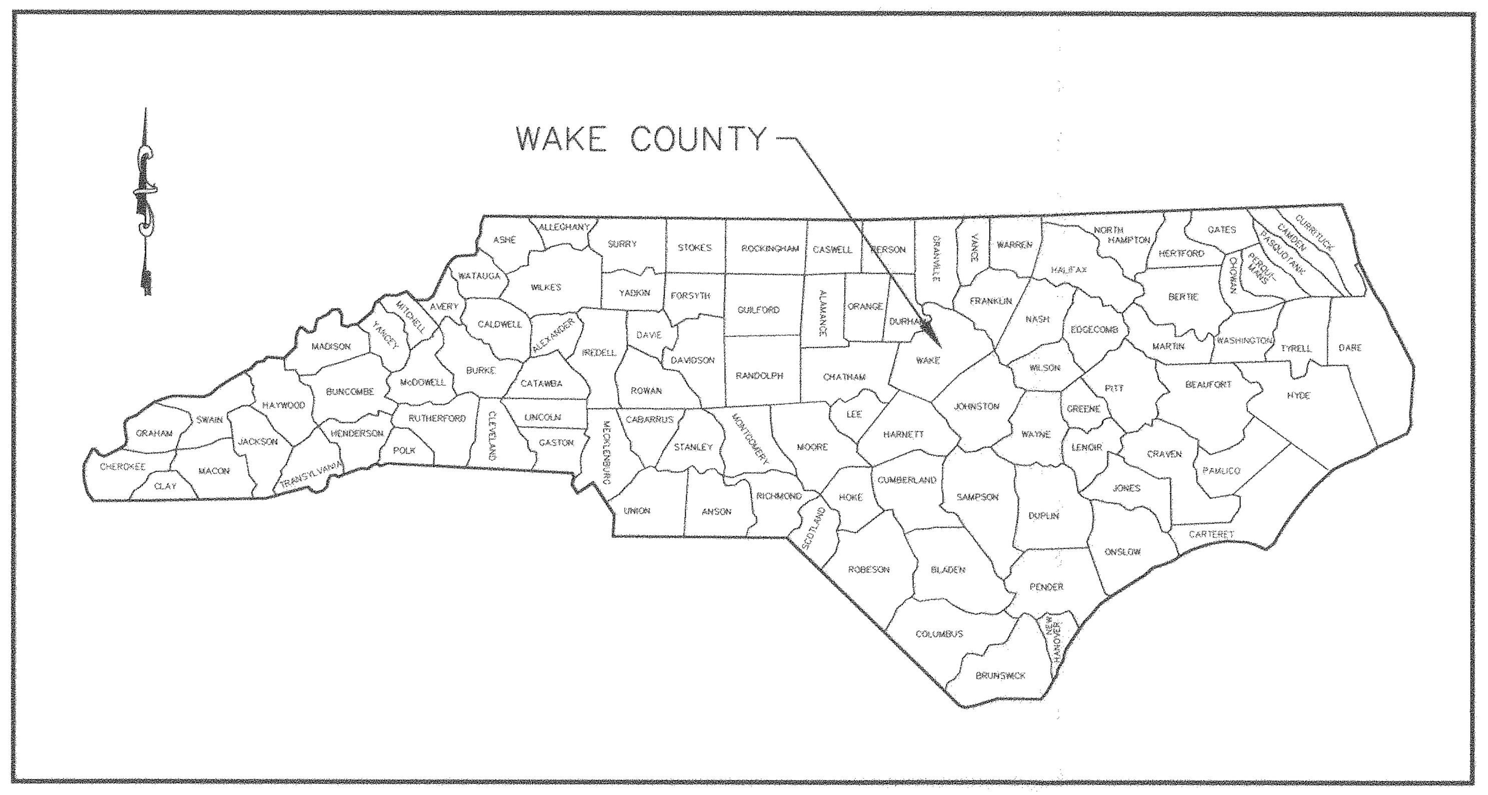
MATERIAL RECOVERY, LLC
421 RALEIGH VIEW ROAD
RALEIGH, NORTH CAROLINA 27610

DECEMBER 2001

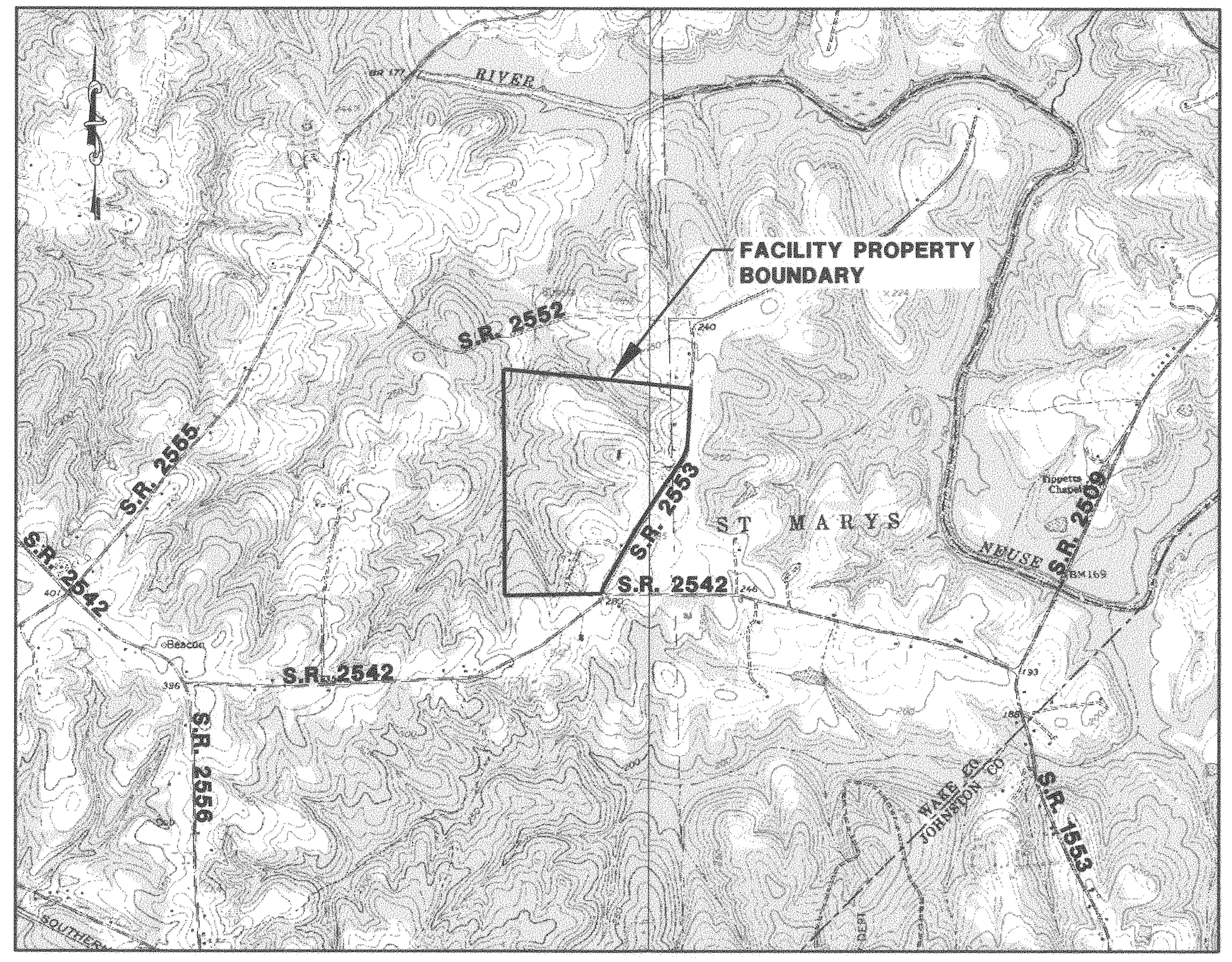
PREPARED BY:

JOYCE ENGINEERING, INC.
2301 WEST MEADOWVIEW ROAD, SUITE 203
GREENSBORO, NORTH CAROLINA 27407
(336) 323-0092 FAX: (336) 323-0093

FOR PERMITTING ONLY



NORTH CAROLINA
COUNTY LOCATION MAP



VICINITY MAP
1"=2000'

DRAWING INDEX

SHEET	DESCRIPTION
0	TITLE SHEET
1	DRAWING INDEX, NOTES AND LEGEND
2	EXISTING CONDITIONS
3	SITE DEVELOPMENT PLAN
4	PHASE 1 BASE GRADING PLAN
5	PHASE 1 FINAL GRADING PLAN
6	PHASE 1 ANNUAL PHASING (CELLS A, B AND C)
7	PHASE 1 ANNUAL PHASING
8	PHASE 1 CROSS-SECTIONS
9	PROJECT DETAILS
10	EROSION AND SEDIMENT CONTROL PLAN – OVERVIEW
11	EROSION AND SEDIMENT CONTROL FEATURES FOR PHASED WASTE PROGRESSION (STAGES 1 AND 2)
12	EROSION AND SEDIMENT CONTROL FEATURES FOR PHASED WASTE PROGRESSION (STAGES 3 AND 4)
13	EROSION AND SEDIMENT CONTROL DETAILS
14	EROSION AND SEDIMENT CONTROL DETAILS

LEGEND

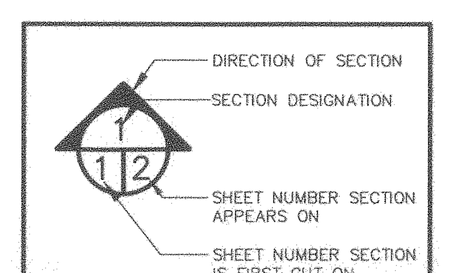
EXISTING 10 FT. CONTOUR	– – – 240 – – –
EXISTING 2 FT. CONTOUR	
PROPOSED 10 FT. CONTOUR	—— 240 ——
PROPOSED 2 FT. CONTOUR	
PROPERTY LINE	— – – ℄ – – —
STREAM	
EXISTING TREELINE	
PROPOSED TREELINE	
EXISTING ROAD	
LIMITS OF WASTE (APPROXIMATE LOCATION)	— — — —
PROPOSED PHASE LIMITS	
BORING LOCATION	△ B-7
PIEZOMETER LOCATION	PZ-15
TEST PIT LOCATION	T-7
CORE LOCATION	□ C-5
TEST WELLS AND WELLS (CITY OF RALEIGH)	WELL 28
BENCHMARK	BM-1
SEDIMENT BASIN	SB
SILT FENCE	
TEMPORARY DIVERSION BERM	TD—TD—TD—TD—TD

NOTES

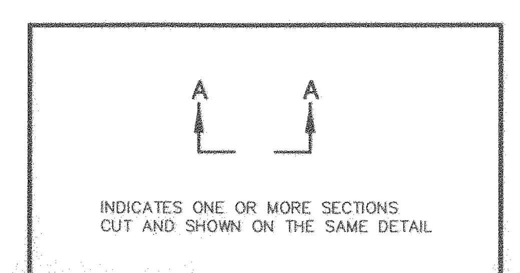
1. DIGITAL MAPPING PROVIDED BY SPATIAL DATA CONSULTANTS, INC., OF HIGH POINT, NORTH CAROLINA. DATE OF AERIAL FLYOVER WAS MARCH 27, 2001.
2. DIGITAL ORTHOPHOTO PROVIDED BY WAKE COUNTY GIS DEPARTMENT. DATE OF AERIAL FLYOVER WAS FEBRUARY, 1999.
3. FACILITY PROPERTY LINE INFORMATION FROM A SURVEY BY WILLIAMS – PEARCE AND ASSOC., P.A., ON JUNE 23, 1995. ADDITIONAL PROPERTY LINES PROVIDED BY WAKE COUNTY GIS DEPARTMENT.
4. VICINITY MAP FROM U.S.G.S. 7.5 MINUTE TOPOGRAPHIC QUADRANGLES FOR CLAYTON AND GARNER, NORTH CAROLINA.

BENCH MARK INFORMATION:

POINT	NORTHING	EASTING	ELEVATION
MARIAH	701369.9036	2146838.4520	361.69
BM-1	713853.47	2148693.87	268.75
BM-2	711371.57	2147318.46	278.32



SECTION DESIGNATION



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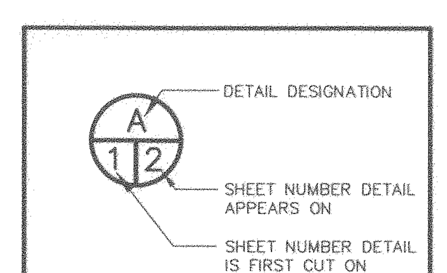
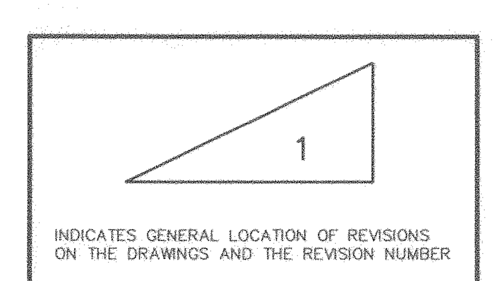


DETAIL DESIGNATION



REVISION DESIGNATION

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CKAPP

L:\Material Recovery Facility LLC\dwg\Task 01-02 Construction Plan Application\CP01-LEGEND.dwg

DESIGNED SF/JD
DRAWN CADD/BY/SY/TH
CHECKED SF
APPROVED JD
DATE 12/28/01

SCALE AS SHOWN

PROJECT NO. 47901.02

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C. 27407
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

DRAWING INDEX, NOTES AND LEGEND

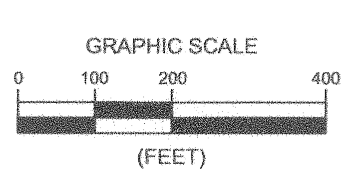
DRAWING NO. 1

NOTES:

1. DIGITAL MAPPING PROVIDED BY SPATIAL DATA CONSULTANTS, INC., OF HIGH POINT, NORTH CAROLINA. DATE OF AERIAL FLYOVER: MARCH 27, 2001.
2. FACILITY PROPERTY LINE REFERENCE: SURVEY BY WILLIAMS – PEARCE AND ASSOC., P.A., DATED JUNE 23, 1995. ADDITIONAL PROPERTY LINES PROVIDED BY WAKE COUNTY GIS DEPARTMENT.

BENCH MARK INFORMATION:

POINT	NORTHING	EASTING	ELEVATION
NCGS MARIAH	701369.9036	2146838.4520	361.69
BM–1	713853.47	2148693.87	268.75
BM–2	711371.57	2147318.46	278.32



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DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP

DESIGNED SF/JD
DRAWN CADD/BY/SY
CHECKED SF
APPROVED JD
DATE 12/28/01

SCALE
1"=200'

PROJECT NO.
47901.02

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

EXISTING CONDITIONS

DRAWING NO.
2

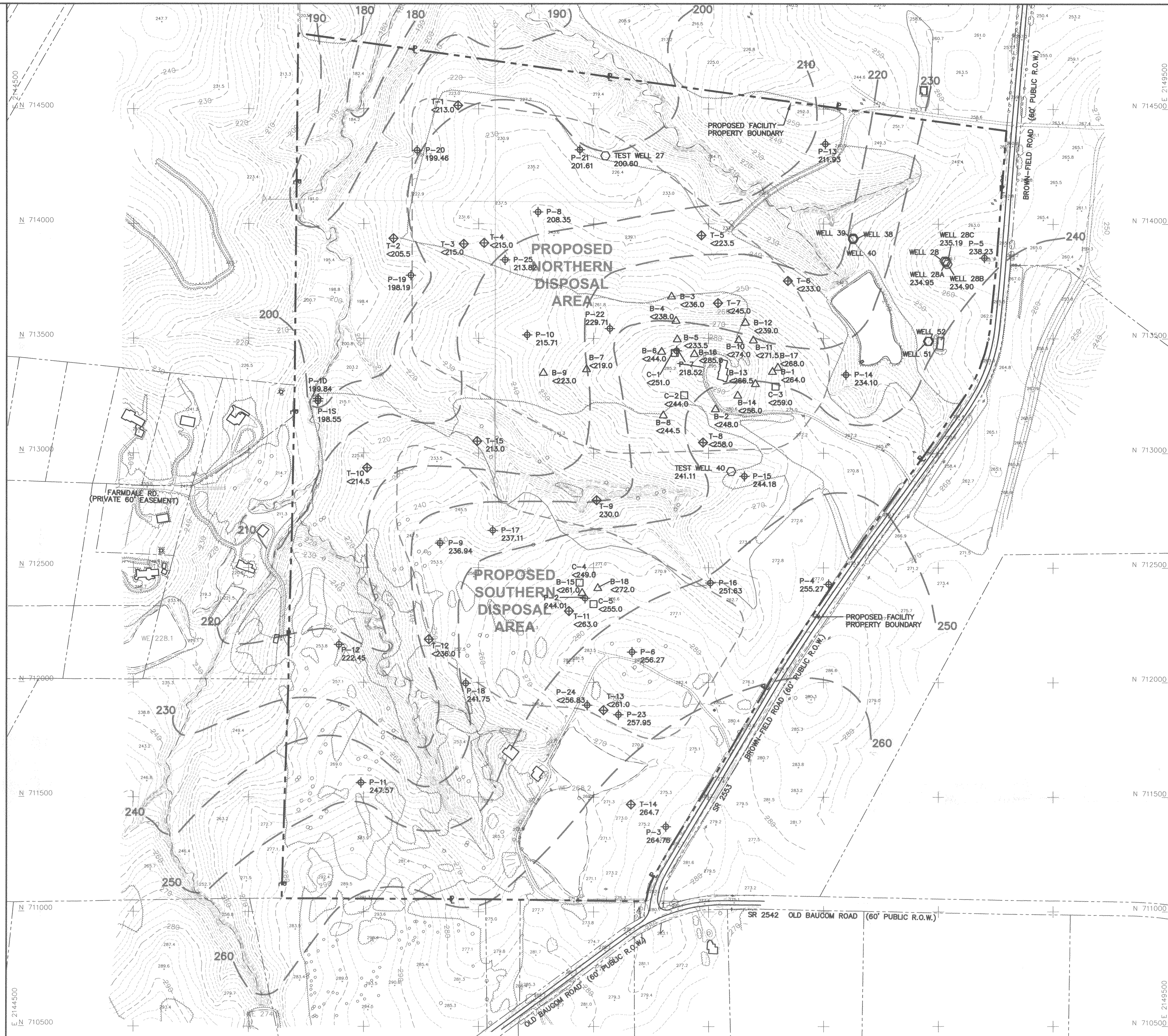
NOTES:

1. TOPOGRAPHIC CONTOUR INTERVAL = 2 FEET.
2. GROUNDWATER SURFACE CONTOUR INTERVAL = 10 FEET.
3. STATIC WATER LEVELS FOR ALL PIEZOMETERS AND CITY OF RALEIGH MONITORING WELLS MEASURED ON 10/03/01. SUPPLEMENTAL DATA FOR CONSTRUCTION OF GROUNDWATER CONTOURS TAKEN FROM TEST PITS ON 08/28-30/01, BORINGS B-1 THROUGH B-15 ON 10/01-02/01, AND CORE LOCATIONS C-1 THROUGH C-5 AND BORINGS B-16 THROUGH B-18 MEASURED ON 11/13-15/01.
4. THE LOCATIONS OF TEST PITS, BORINGS, CORE LOCATIONS, AND WELL 28B ARE APPROXIMATE.
5. THE COORDINATES FOR ALL "WELLS" AND "TEST WELLS" WERE TAKEN FROM WATER RESOURCES RESEARCH INSTITUTE SPECIAL REPORT SERIES NO. 20 (JANUARY 2000). HOWEVER, THE GIVEN LOCATION FOR WELL 28B DID NOT MATCH THE FIELD LOCATION AND THE PLOTTED WELL LOCATION WAS MOVED TO THE APPROPRIATE APPROXIMATE LOCATION.
6. THE GROUNDWATER ELEVATION FOR P-7 IS CONSIDERED ANOMOLOUS AS DESCRIBED IN THE TEXT OF THE REPORT AND WAS NOT USED IN THE CONSTRUCTION OF GROUNDWATER CONTOURS.
7. GROUNDWATER CONTOURS BASED ON LINEAR INTERPOLATION BETWEEN AND EXTRAPOLATION FROM KNOWN DATUM, TOPOGRAPHIC CONTOURS, AND KNOWN FIELD CONDITIONS. THEREFORE, GROUNDWATER CONTOURS MAY NOT REFLECT ACTUAL GROUNDWATER CONDITIONS.

GRAPHIC SCALE

0 100 200 400

(FEET)



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DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP

DESIGNED RK/BY
DRAWN CADD/BY
CHECKED RK
APPROVED DM
DATE 12/28/01

SCALE 1"=200'

PROJECT NO. 47902.01

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

POTENTIOMETRIC SURFACE MAP
OCTOBER 3, 2001

DRAWING NO. 3

NOTES

1. DIGITAL MAPPING PROVIDED BY SPATIAL DATA CONSULTANTS, INC., OF HIGH POINT, NORTH CAROLINA. DATE OF AERIAL FLYOVER: MARCH 27, 2001.
2. THE LANDFILL PERIMETER ROAD WILL BE BUILT IN STAGES CONCURRENT WITH THE SEQUENCE OF CONSTRUCTION OF CELLS A–C.

BENCH MARK INFORMATION:

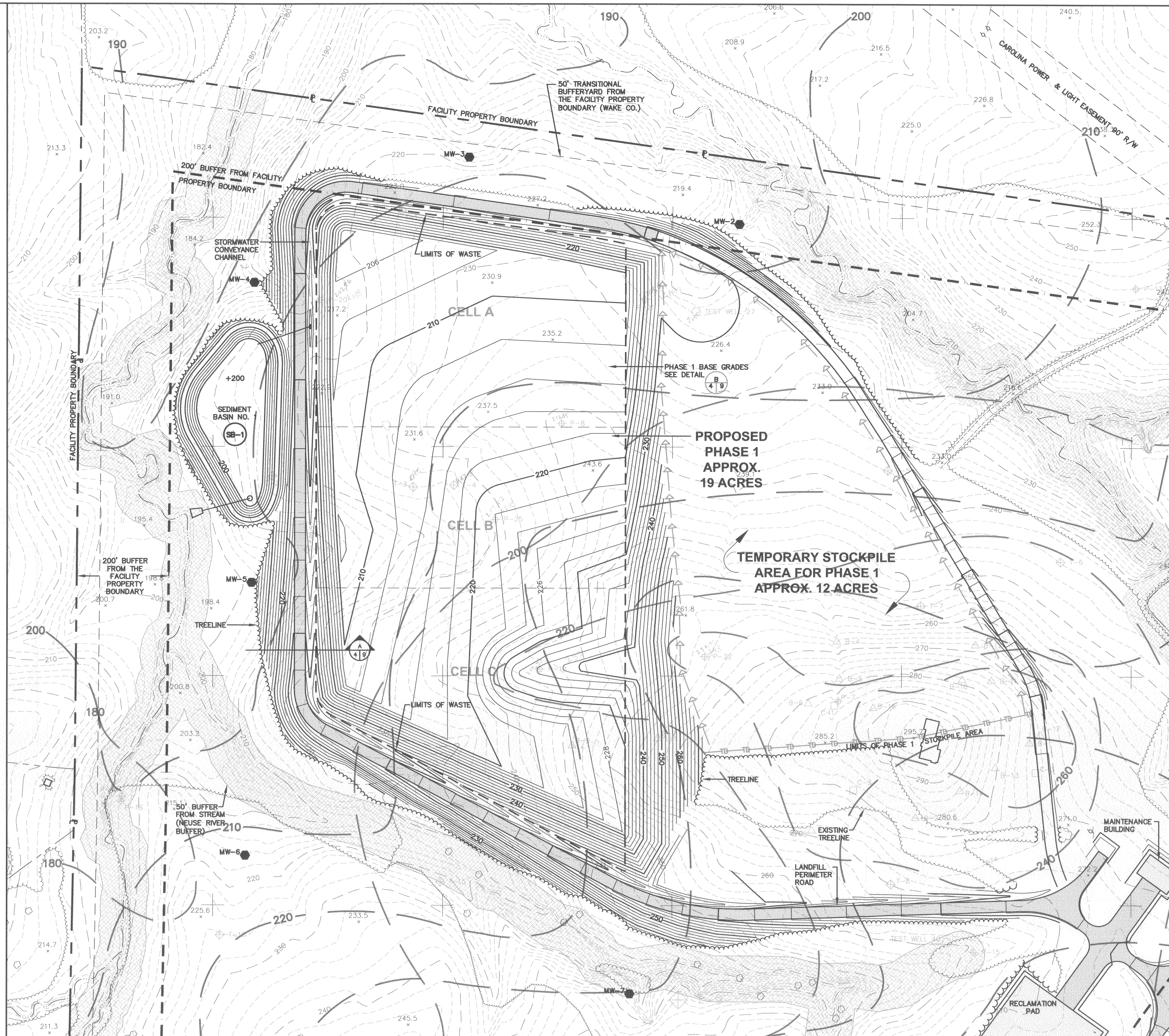
POINT	NORTHING	EASTING	ELEVATION
NCGS MARIAH	701369.9036	2146838.4520	361.69
BM–1	713853.47	2148693.87	268.75
BM–2	711371.57	2147318.46	278.32

LEGEND:

BEDROCK CONTOUR (APPROXIMATE) 20 FT. CONTOUR INTERVAL —— ——240

GROUNDWATER CONTOUR (APPROXIMATE) 10 FT. CONTOUR INTERVAL — — — —240

GRAPHIC SCALE 0 50 100 200 (FEET)



REVISIONS AND RECORD OF ISSUE

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP

DESIGNED SF/JD
DRAWN CADD/BY/SV/TH
CHECKED SF
APPROVED JD
DATE 12/28/01

SCALE 1"=100'

PROJECT NO. 47901.01

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

PHASE 1
BASE GRADING PLAN

DRAWING NO. 4

NOTES

1. DIGITAL MAPPING PROVIDED BY SPATIAL DATA CONSULTANTS, INC., OF HIGH POINT, NORTH CAROLINA. DATE OF AERIAL FLYOVER: MARCH 27, 2001.
2. THE LANDFILL PERIMETER ROAD WILL BE BUILT IN STAGES CONCURRENT WITH THE SEQUENCE OF CONSTRUCTION OF CELLS A–C.

BENCH MARK INFORMATION:

POINT	NORTHING	EASTING	ELEVATION
NCGS MARIAH	701369.9036	2146838.4520	361.69
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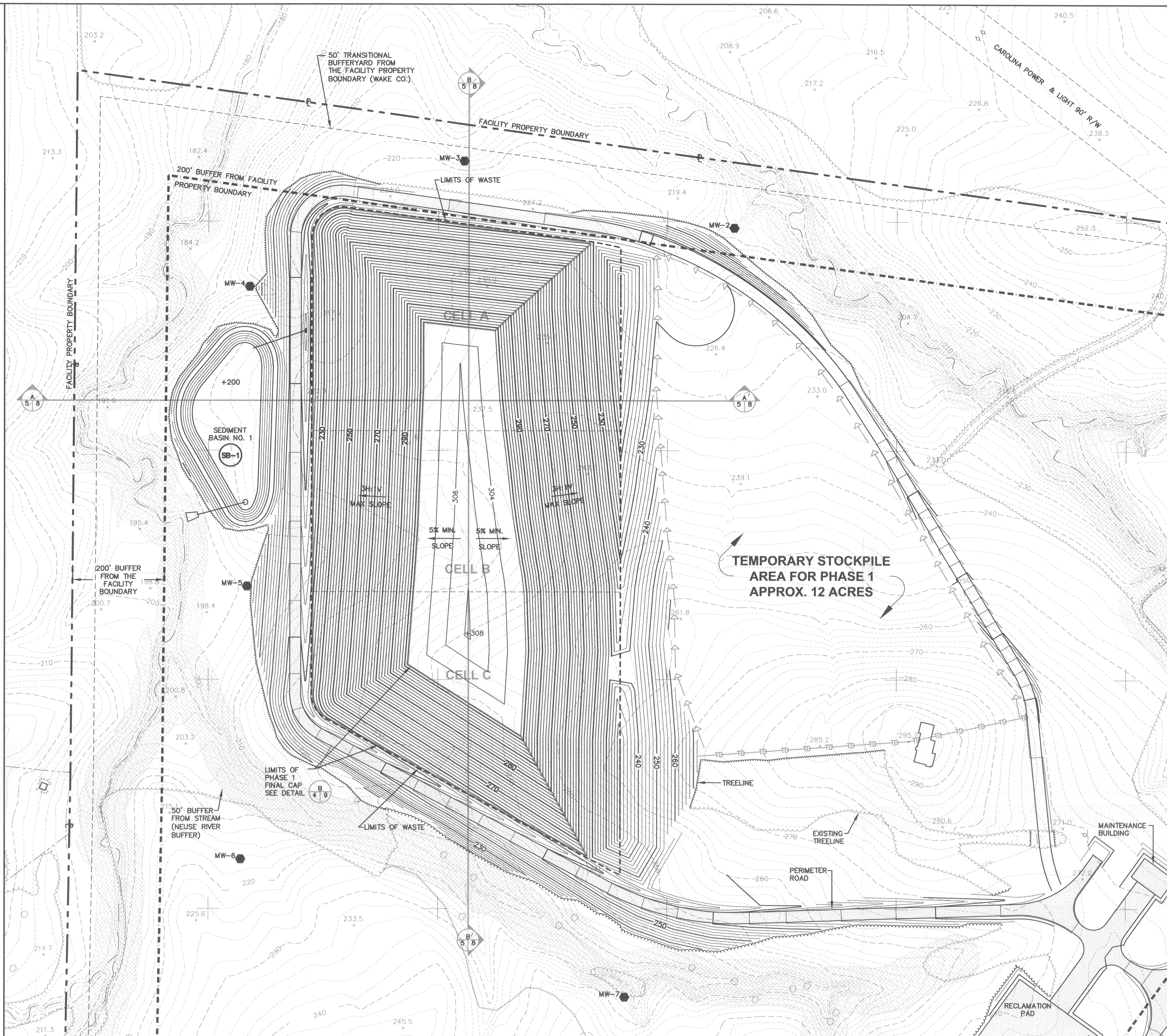
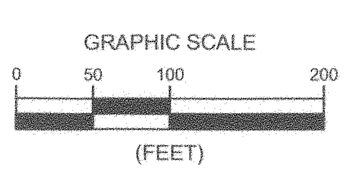




DESIGNED SF/JD
DRAWN CADD/BY/SY/TH
CHECKED SF
APPROVED JD
DATE 12/28/01

SCALE 1"=100'

PROJECT NO. 47901.01

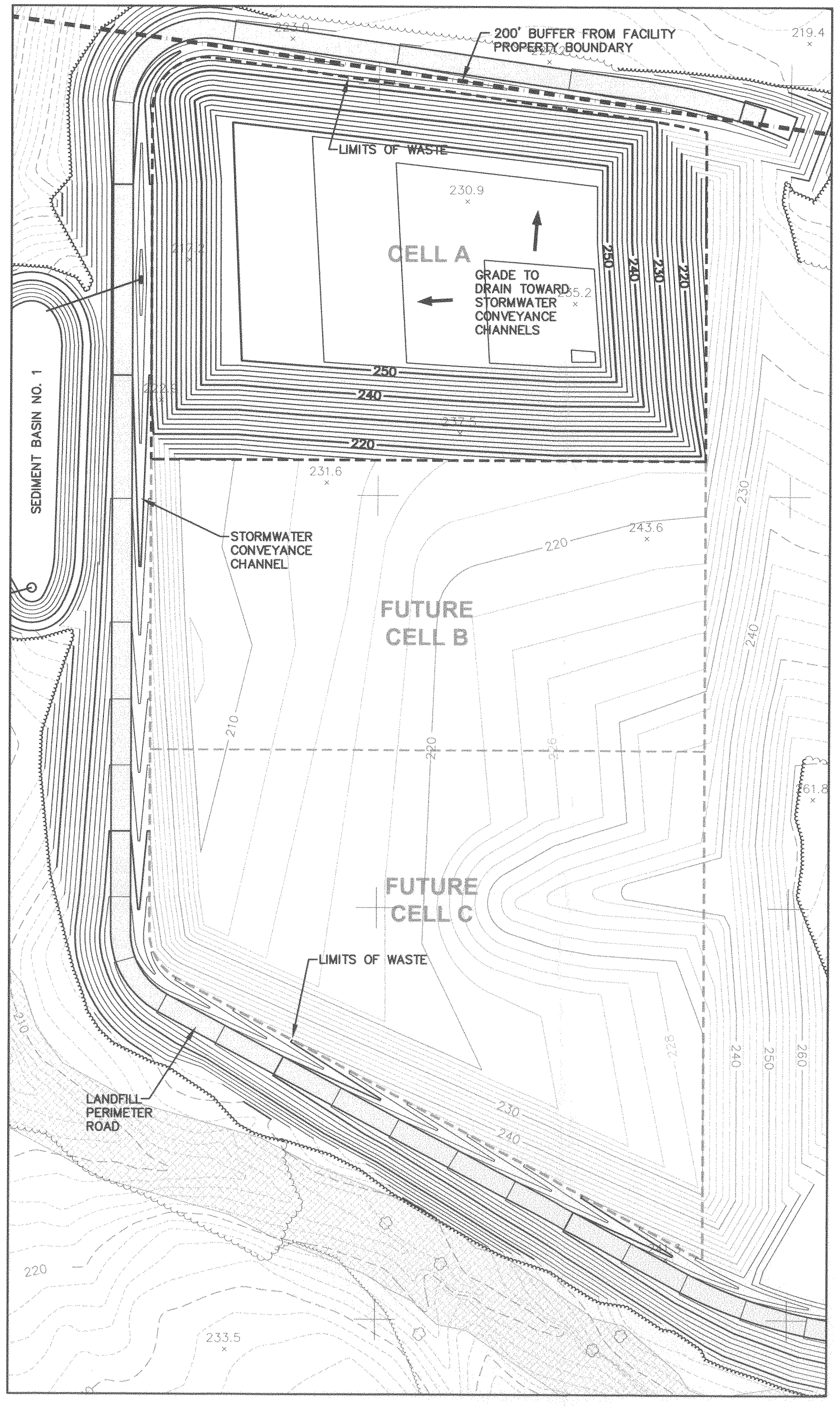
JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

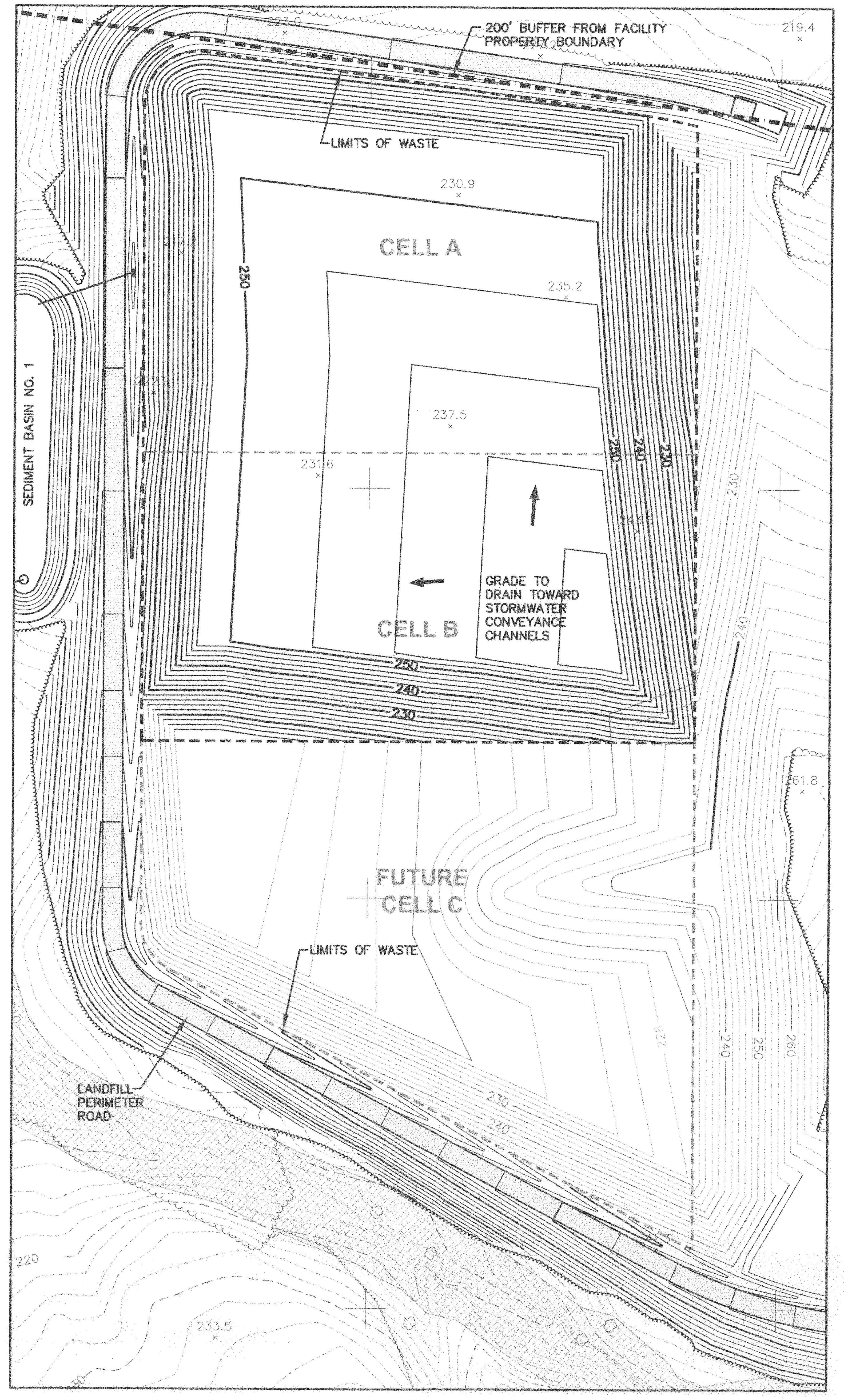
PHASE 1
FINAL GRADING PLAN

DRAWING NO. 5

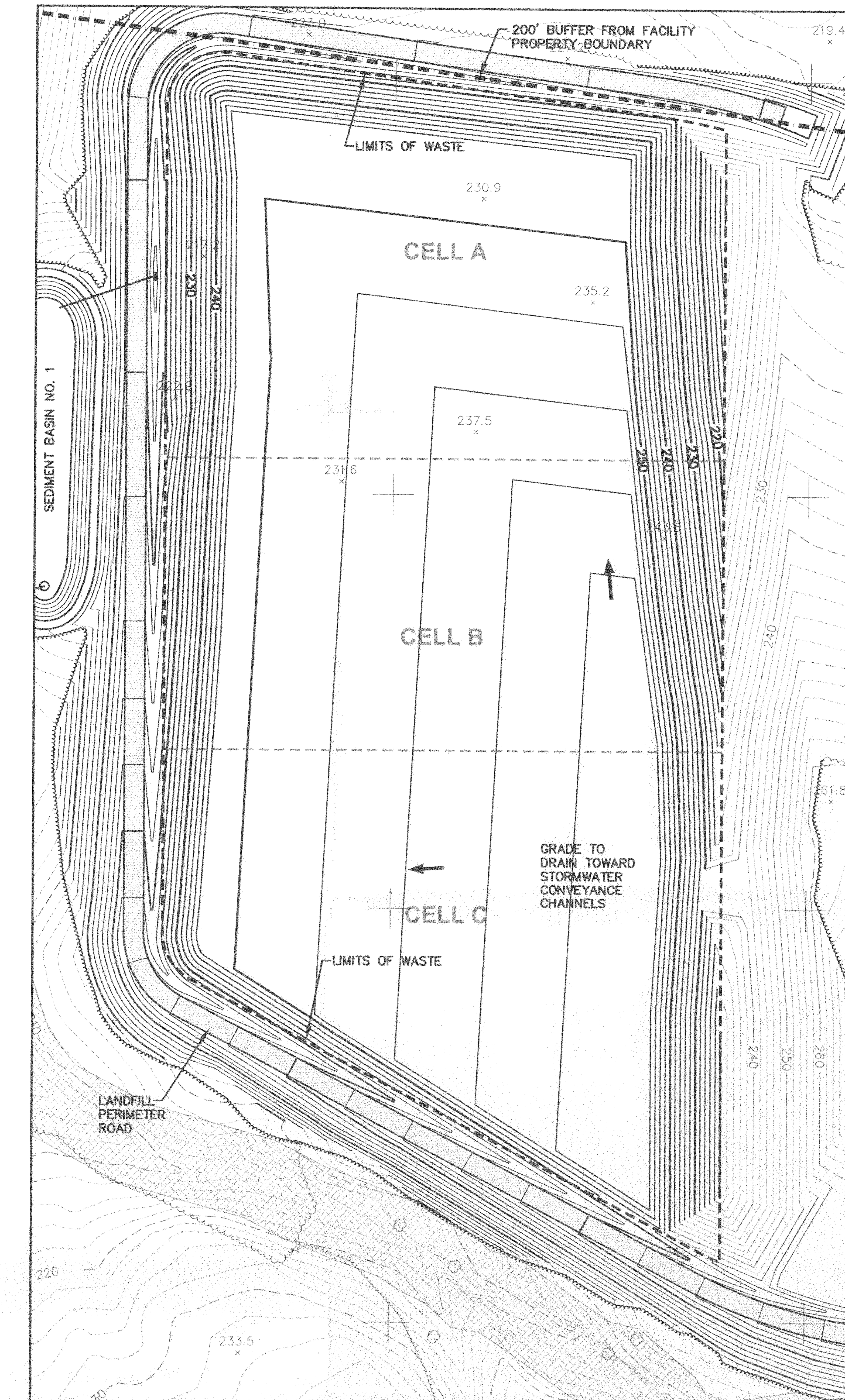
DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP



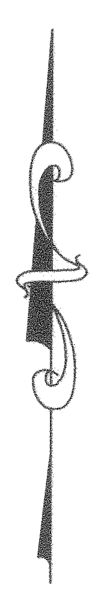
YEAR 1 – CELL A



YEAR 2 – CELLS A AND B

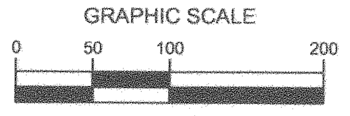


YEAR 3 – CELLS A, B AND C



NOTE:
THE LANDFILL PERIMETER ROAD WILL BE BUILT IN STAGES CONCURRENT WITH THE SEQUENCE OF CONSTRUCTION OF CELLS A–C.

GRAPHIC SCALE



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NO	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE

DESIGNED	SF/JD
DRAWN	CADD/BY/SY/TH
CHECKED	SF
APPROVED	JD
DATE	12/28/01

SCALE 1"=100'

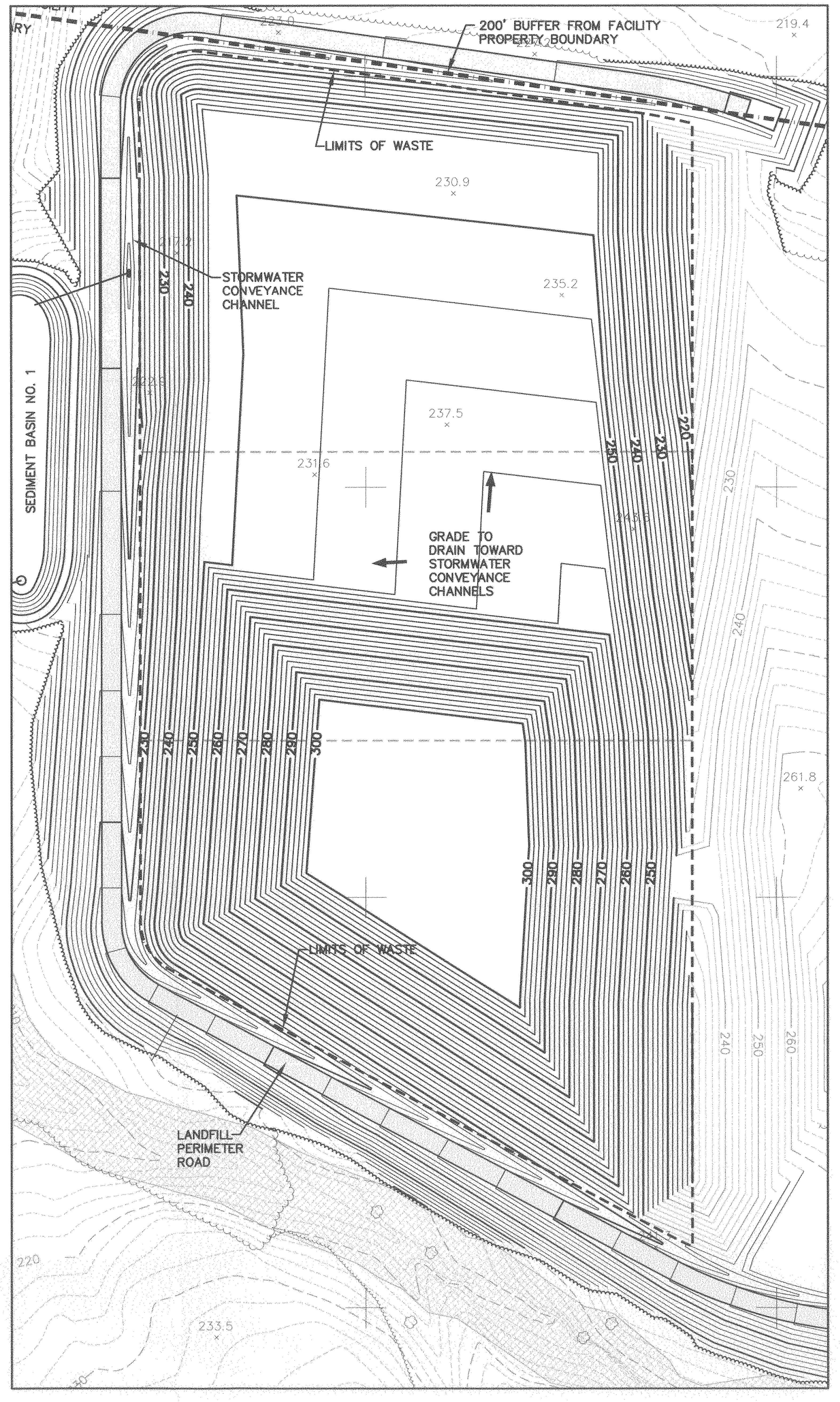
PROJECT NO. 47901.01

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

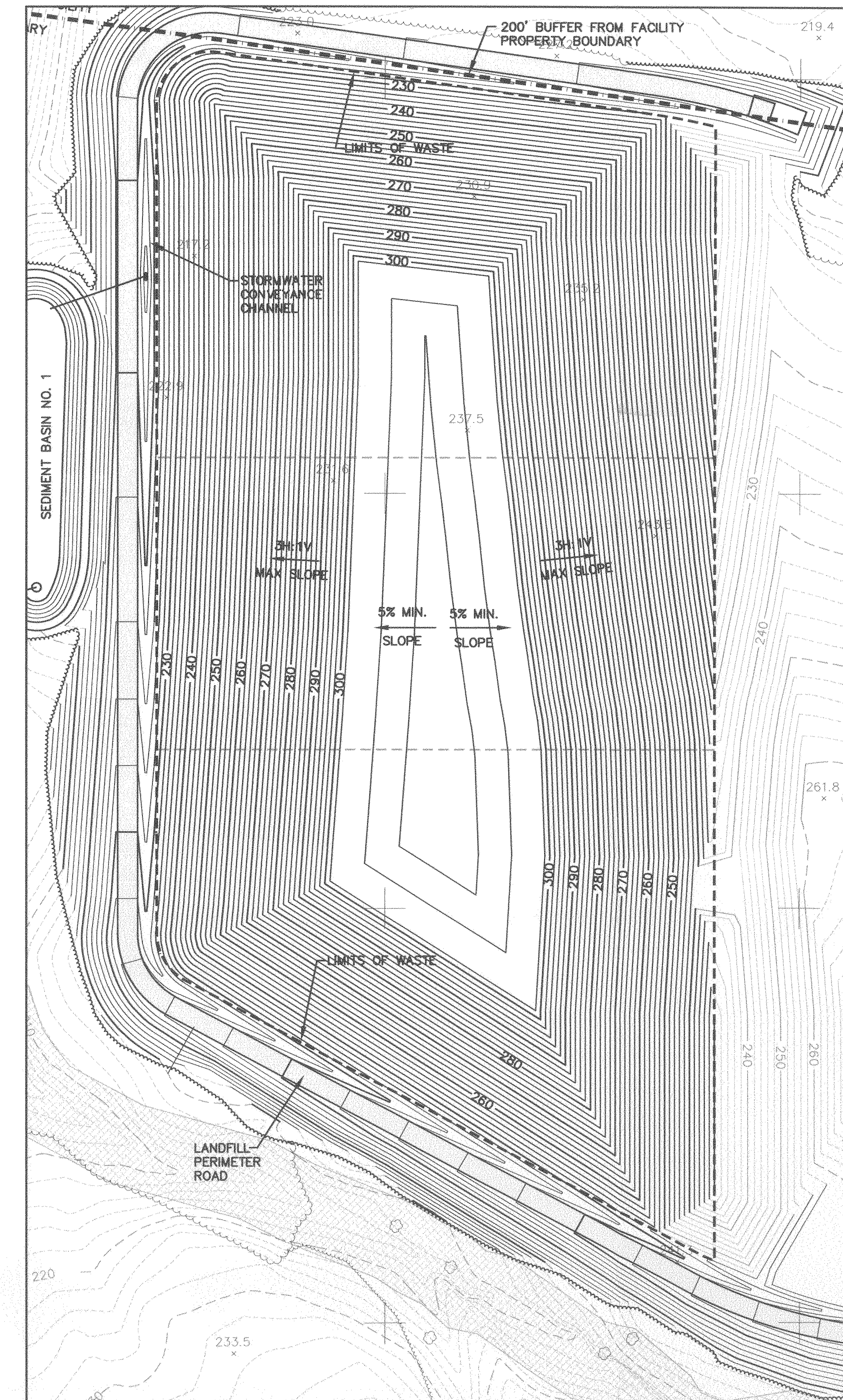
MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

PHASE 1
ANNUAL PHASING
(CELLS A, B AND C)

DRAWING NO. 6



YEAR 4



YEAR 5

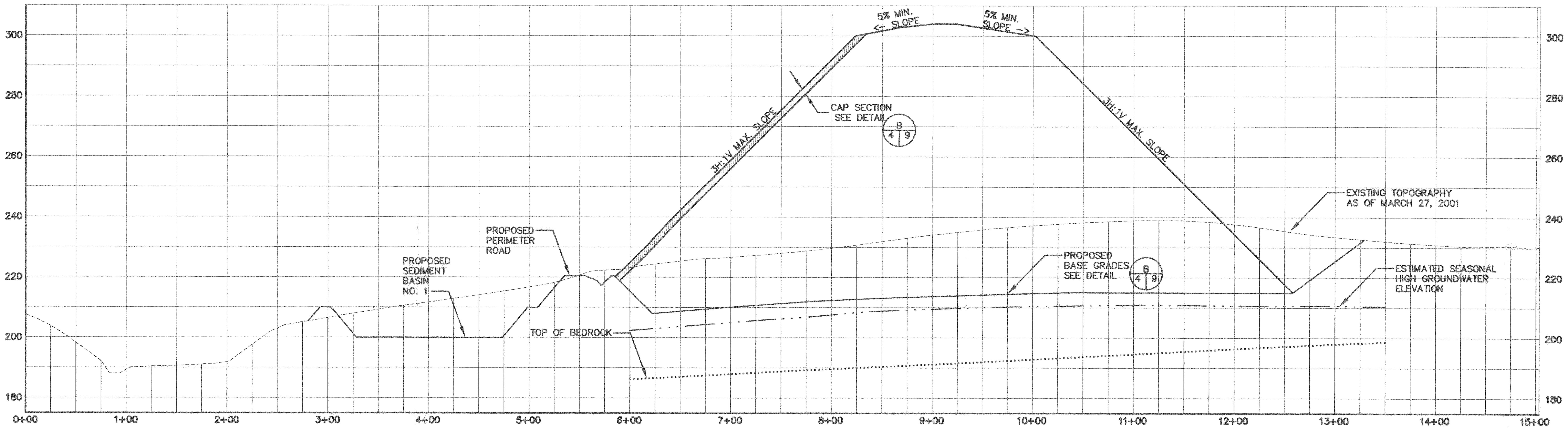
GRAPHIC SCALE

0 50 100 200

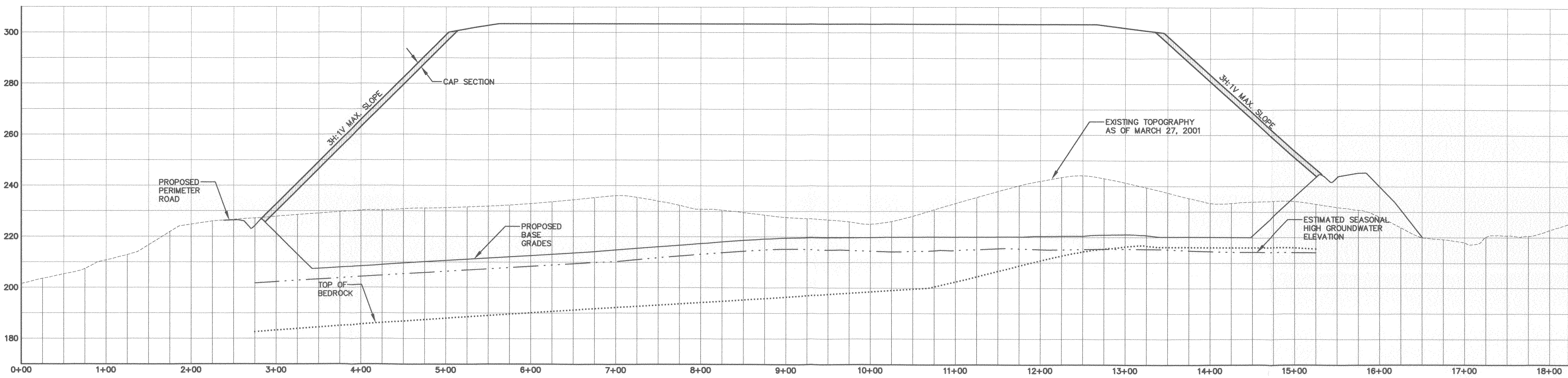
(FEET)

DRAWING NO.	7
	MATERIAL RECOVERY, LLC WAKE COUNTY, NORTH CAROLINA
	PHASE 1 ANNUAL PHASING
	JOYCE ENGINEERING, INC. 2301 W. MEADOWVIEW RD. GREENSBORO, N.C. PHONE: (336) 323-0092
SCALE	1"=100'
PROJECT NO.	47901.01
DESIGNED	SF/JD
DRAWN	CADD/BY/SY/TH
CHECKED	SF
APPROVED	JD
DATE	12/28/01

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP



SECTION A–A'
SCALE: H: 1"=60'
V: 1"=20'
A
5 | 8



SECTION B–B'
SCALE: H: 1"=60'
V: 1"=20'
B
5 | 8

DATE | REVISIONS AND RECORD OF ISSUE | NO | BY | CK | APP

DESIGNED SF/JD
DRAWN CADD/BY/SY
CHECKED SF
APPROVED JD
DATE 12/28/01

SCALE
H: 1"=60'
V: 1"=20'

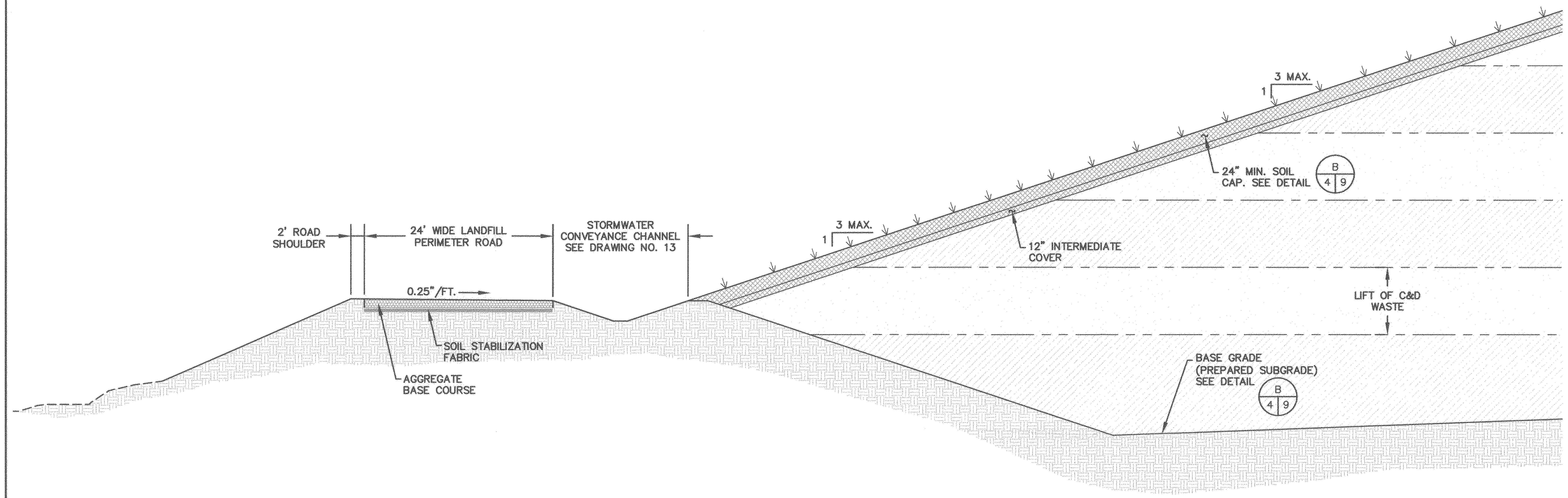
PROJECT NO.
47901.01

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

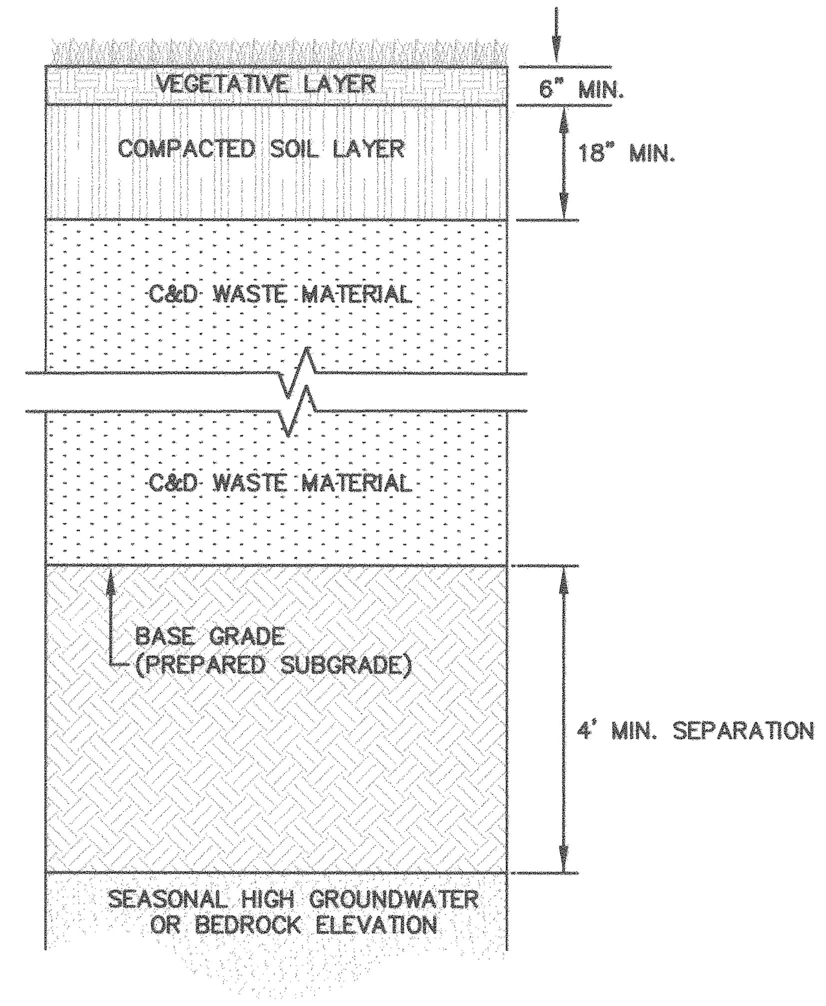
MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

PHASE 1
CROSS-SECTIONS

DRAWING NO.
8



SECTION A–A' (TYPICAL) A 4 9
N.T.S.



DETAIL B 4 9
N.T.S.

L:\Material Recovery Facility LLC\dwg\Task 01-02 Construction Plan Application\CP09-DETAILS.dwg

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP

DESIGNED	SF / JD
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CHECKED	SF
APPROVED	JD
DATE	12/28/01

SCALE
N.T.S

PROJECT NO.
47901.02

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

PROJECT DETAILS

DRAWING NO.
9


PROPERTY BOUNDARY
200' BUFFER FROM FACILITY PROPERTY BOUNDARY
SCC-10
SCC-8
ST-6
SCC-7
LIMITS OF WASTE
CELL A
CELL B
CELL C
+200
SEDIMENT BASIN NO. 1
SB-1
SILT FENCE
SCC-1
ST-1
200' BUFFER FROM THE FACILITY BOUNDARY
SCC-2
SCC-3
ST-2
SCC-9
SCC-4
SCC-5
ST-3
SCC-6
50' BUFFER FROM STREAM (NEUSE RIVER BUFFER)
TEMPORARY STOCKPILE AREA FOR PHASE 1 APPROX. 12 ACRES
LIMITS OF PHASE 1 STOCKPILE AREA
PROPOSED TREELINE
EXISTING TREELINE
PROPOSED PERIMETER ROAD
SILT FENCE
PROPOSED FACILITY PROPERTY BOUNDARY
CAROLINA POWER & LIGHT EASEMENT
PROPOSED FACILITY ENTRANCE
90' R/W
PROPOSED PARKING
SILT FENCE
PROPOSED TRUCK SCALE
PROPOSED SCALE HOUSE AND OFFICE
WE 239.9
TEMPORARY DIVERSION BERM TO REMAIN IN PLACE DURING CONSTRUCTION OF ROADWAY NORTH OF THE BERM. REMOVE BERM AS NECESSARY FOR CONSTRUCTION OF STREAM CROSSING.
TEMPORARY DIVERSION BERM TO REMAIN IN PLACE DURING CONSTRUCTION OF ROADWAY SOUTH OF THE BERM. REMOVE BERM AS NECESSARY FOR CONSTRUCTION OF STREAM CROSSING.
ST-5
ST-4
PROPOSED MAINTENANCE BUILDING
PROPOSED RECLAMATION PAD
NOTE: STORMWATER CHANNELS AND SEDIMENT TRAPS AT OUTSIDE TOE OF EMBANKMENTS ARE TEMPORARY. FOLLOWING STABILIZATION OF ROADWAY EMBANKMENTS, REMOVE TEMPORARY TRAPS AND CHANNELS. RESTORE DENSE VEGETATION IN DISTURBED AREAS OF THE BUFFER.
GRAPHIC SCALE
0 50 100 200
(FEET)
MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA
EROSION AND SEDIMENT CONTROL PLAN OVERVIEW
DRAWING NO. 10
SCALE 1"=100'
PROJECT NO. 47901.01
JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092
DESIGNED SF/JD
CHECKED SF
APPROVED JD
DATE 12/28/01
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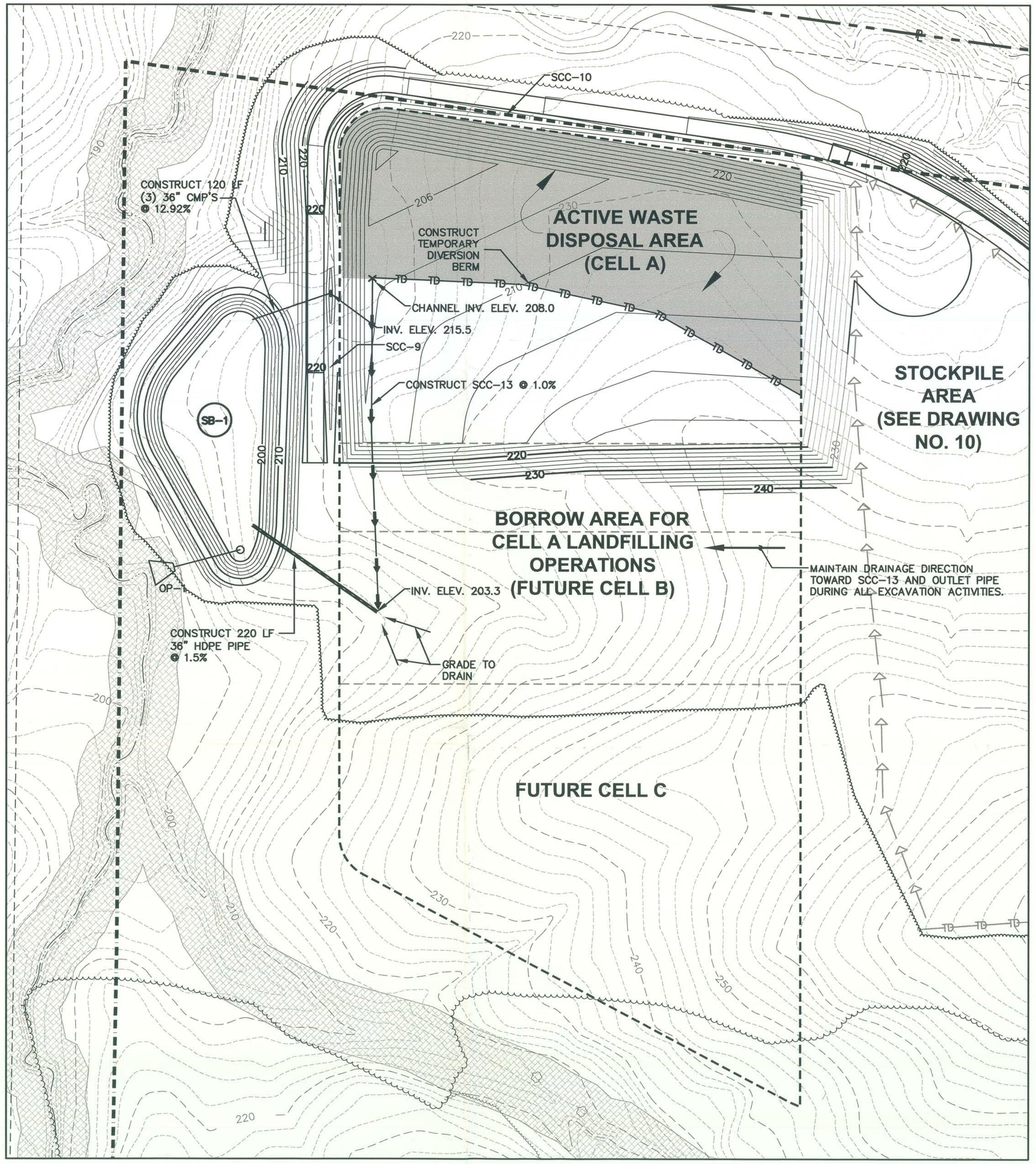
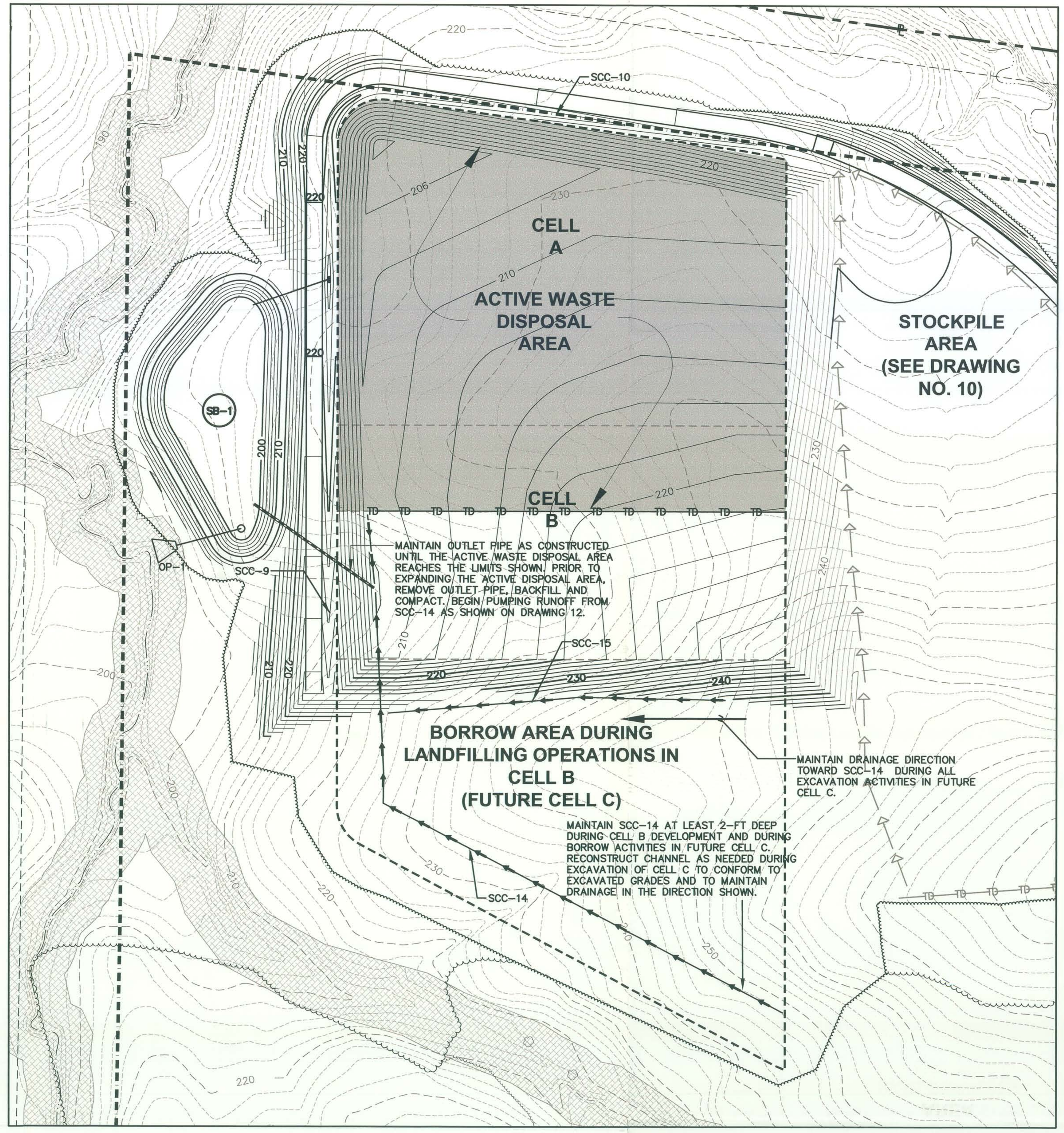
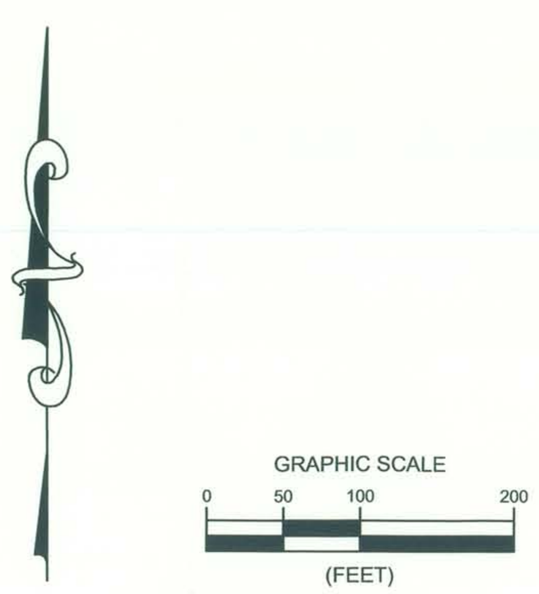
REVISIONS AND RECORD OF ISSUE
NO BY CK APP DATE



STAGE 1



STAGE 2



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DRAWN CADD/BY/SY/TH
CHECKED SF
APPROVED JD
DATE 12/28/01

SCALE 1"=100'

PROJECT NO. 47901.01

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
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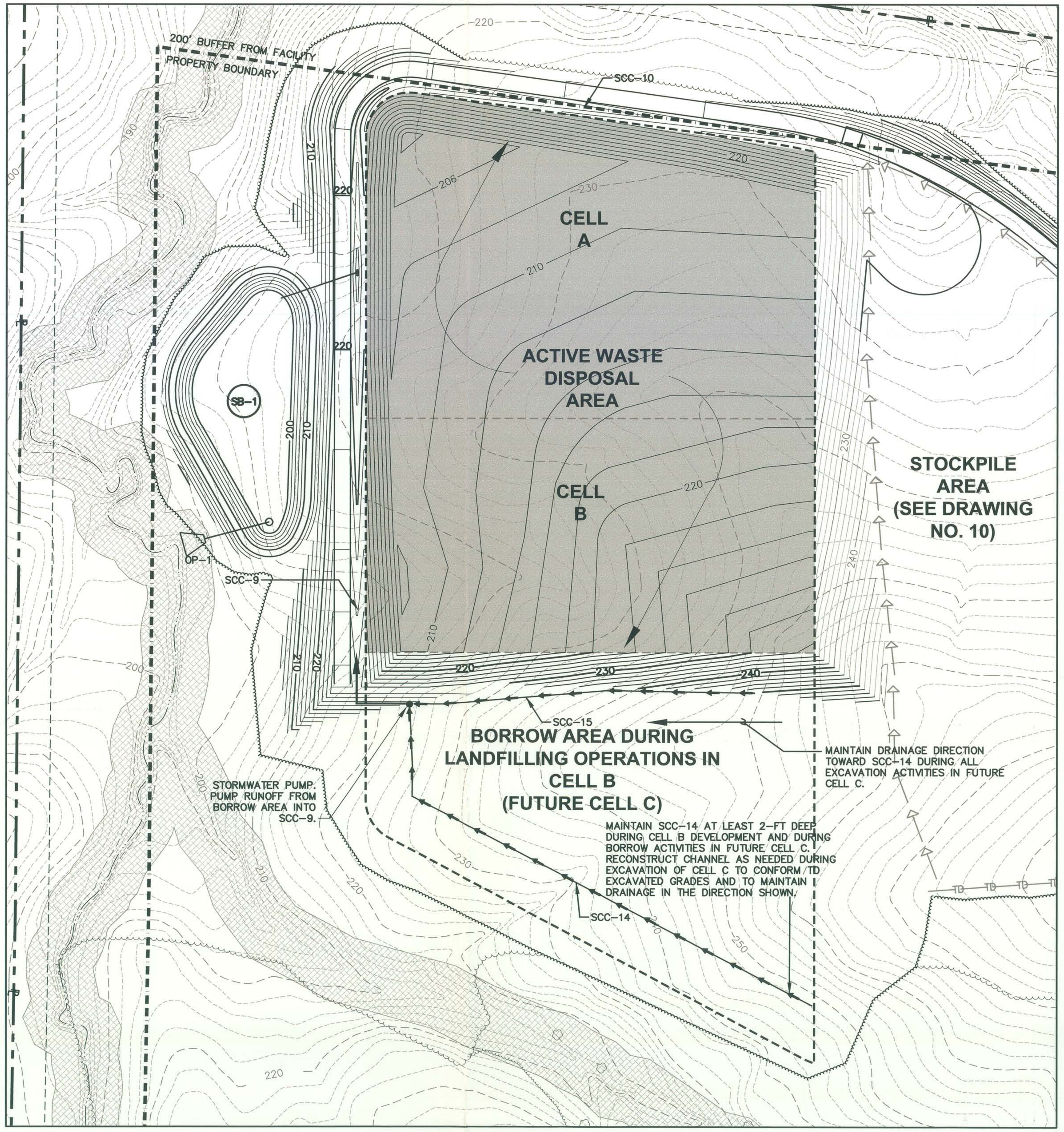
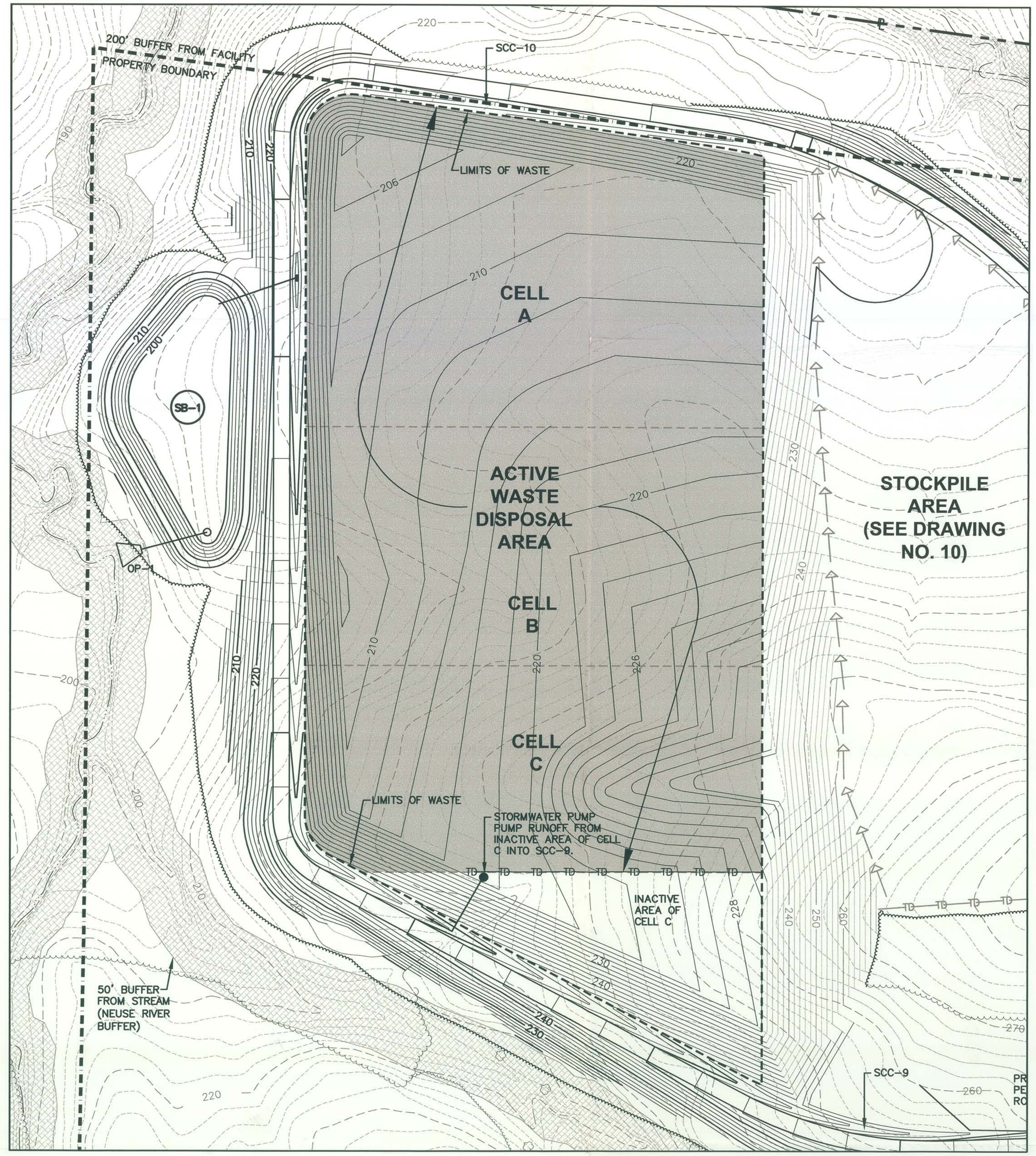
MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

EROSION AND SEDIMENT CONTROL FEATURES FOR PHASED WASTE PROGRESSION (PROGRESSION STAGES 1 & 2)

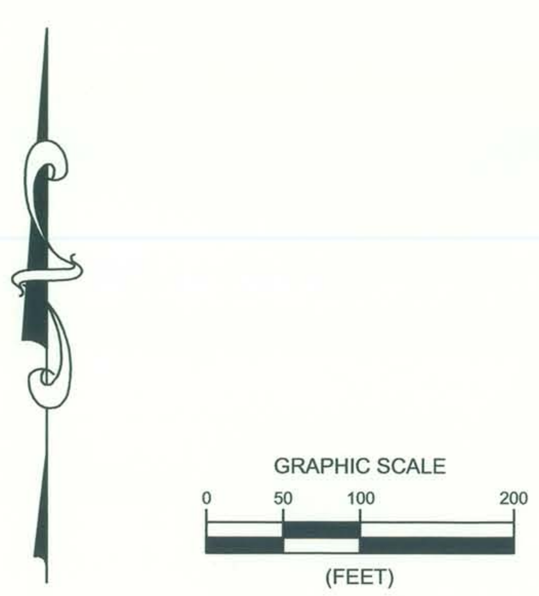
DRAWING NO. 11



STAGE 3



STAGE 4



NO	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE

DESIGNED	SF/JD
DRAWN	CADD/BY/SYTH
CHECKED	SF
APPROVED	JD
DATE	12/28/01

SCALE 1"=100'

PROJECT NO. 47901.01

JOYCE ENGINEERING, INC.
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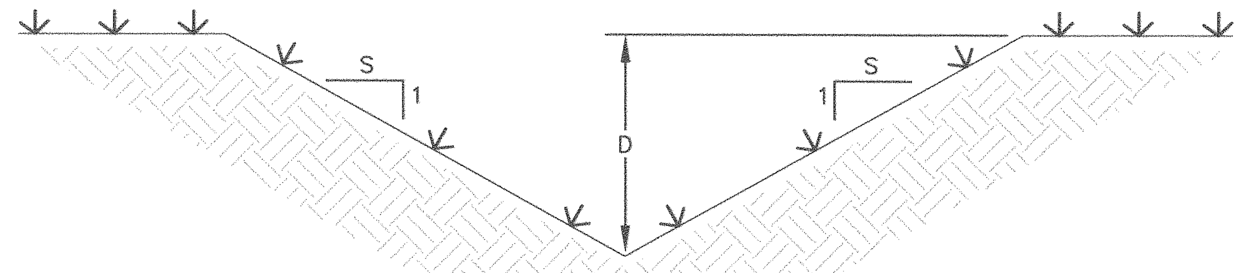
GREENSBORO, N.C.
PHONE: (336) 323-0092

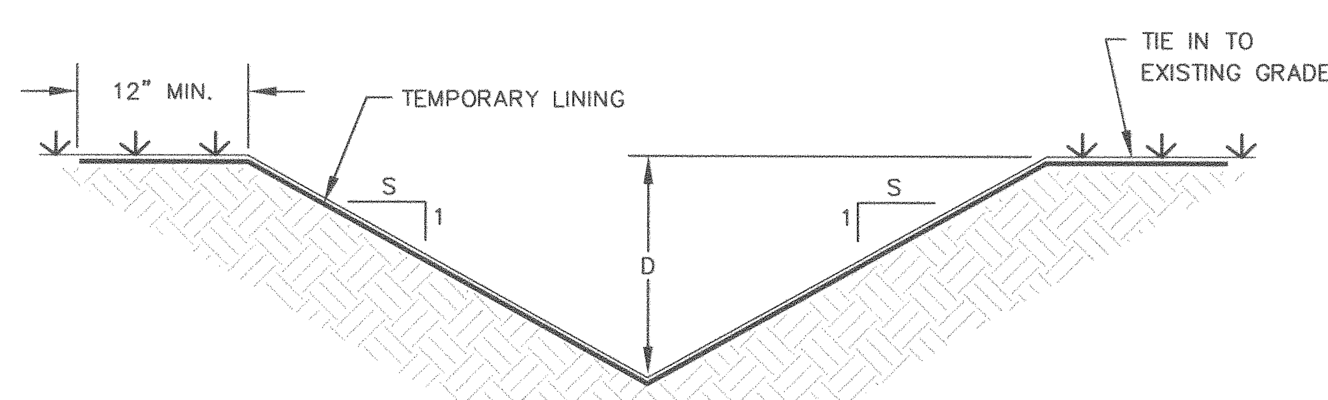
MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

EROSION AND SEDIMENT CONTROL FEATURES FOR PHASED WASTE PROGRESSION (PROGRESSION STAGES 3 & 4)

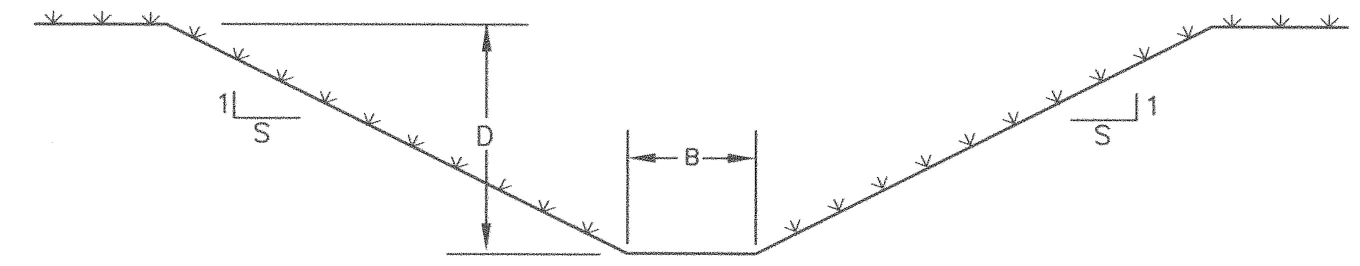
DRAWING NO. 12



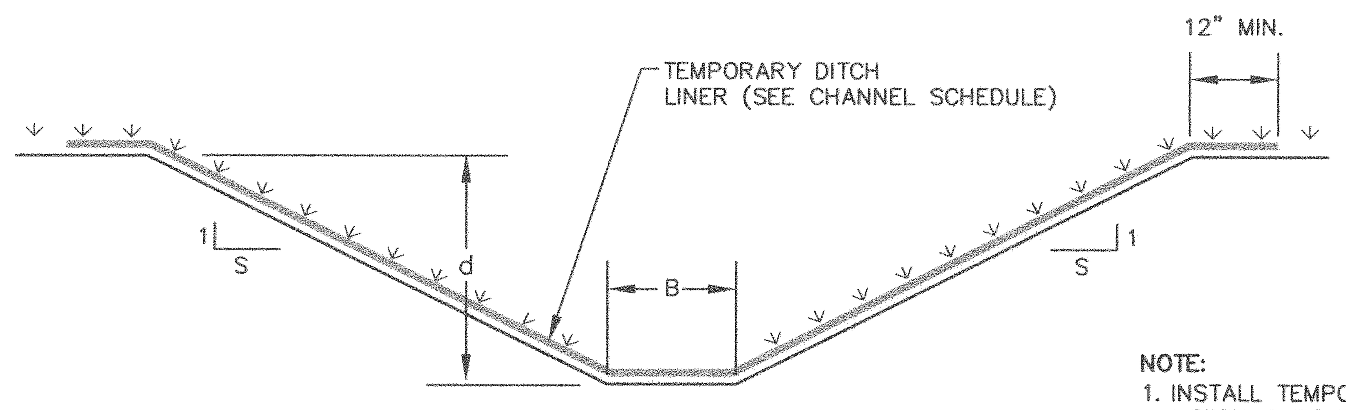
GRASS–LINED TRIANGULAR CHANNEL



GRASS–LINED TRIANGULAR CHANNEL WITH TEMPORARY LINING



GRASS LINED TRAPEZOIDAL CHANNEL

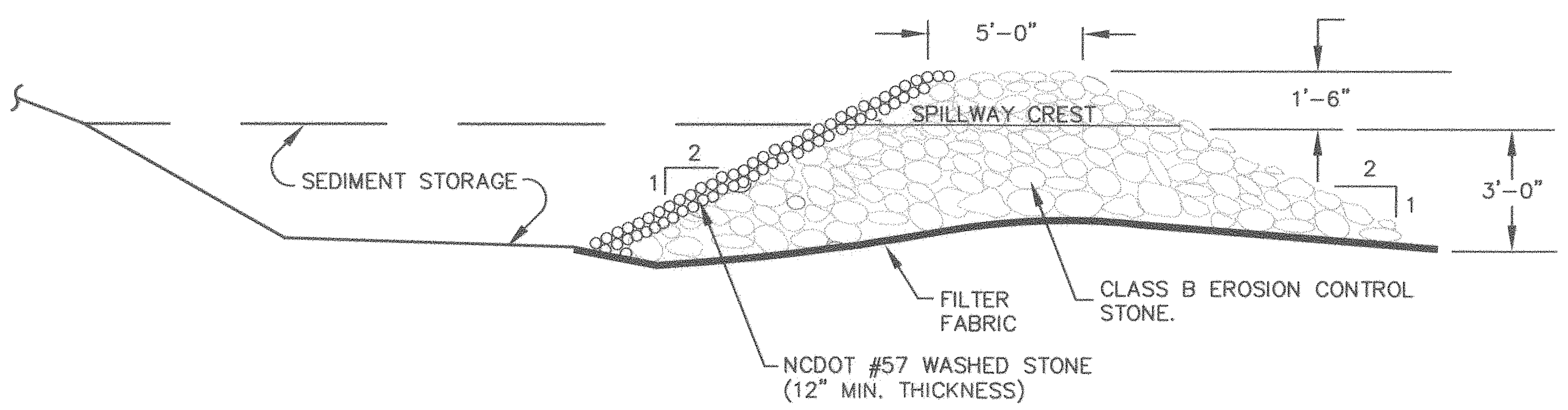


GRASS–LINED TRAPEZOIDAL CHANNEL WITH TEMPORARY LINING

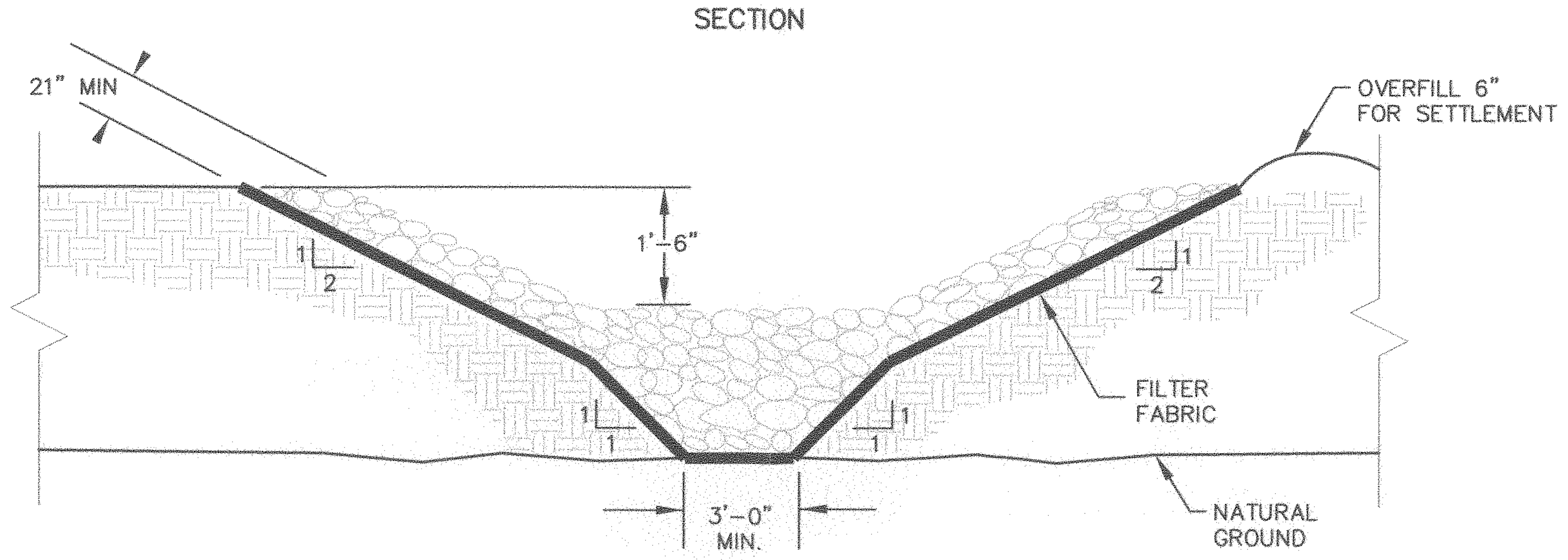
NOTE:
1. INSTALL TEMPORARY LINING IN ACCORDANCE WITH NORTH CAROLINA'S EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL, SECTION 6.14, INSTALLATION OF NETTING AND MATTING.

STORMWATER CONVEYANCE CHANNEL SCHEDULE					
CHANNEL SECTION	CHANNEL DEPTH (D) (FT)	BOTTOM WIDTH (B) (FT)	SIDE SLOPE (S)	CHANNEL SLOPE (%)	TEMPORARY CHANNEL LINING
SCC–1	2'–0"	1'–0"	3	11.0	SYNTHETIC MAT
SCC–2	2'–0"	2'–0"	3	5.0	STRAW W/ NET
SCC–3	2'–0"	1'–0"	3	12.0	NONE
SCC–4	2'–0"	2'–0"	3	3.9	STRAW W/ NET
SCC–5	2'–0"	0	3	4.5	NONE
SCC–6	2'–0"	1'–0"	3	6.0	JUTE NET
SCC–7	2'–0"	0	3	17.0	SYNTHETIC MAT
SCC–8	2'–0"	2'–0"	3	6.0	STRAW W/ NET
SCC–9A	2'–0"	2'–0"	3	2.25	STRAW W/ NET
SCC–9B	2'–0"	2'–0"	3	2.55	SYNTHETIC MAT
SCC–9C	2'–0"	2'–0"	3	2.40	SYNTHETIC MAT
SCC–9D	2'–0"	2'–0"	3	1.29	STRAW W/ NET
SCC–10A	2'–0"	2'–0"	3	2.40	STRAW W/ NET
SCC–10B	2'–0"	2'–0"	3	2.48	STRAW W/ NET
SCC–10C	2'–0"	2'–0"	3	1.16	STRAW W/ NET
SCC–10D	2'–0"	2'–0"	3	1.0	STRAW W/ NET
SCC–10E	2'–0"	2'–0"	3	1.55	STRAW W/ NET
SCC–11A	2'–0"	2'–0"	3	1.16	STRAW W/ NET
SCC–11B	2'–0"	2'–0"	3	2.64	STRAW W/ NET
SCC–11C	2'–0"	2'–0"	3	1.72	STRAW W/ NET
SCC–12A	2'–0"	2'–0"	3	2.36	STRAW W/ NET
SCC–12B	2'–0"	2'–0"	3	3.05	SYNTHETIC MAT
SCC–12C	2'–0"	2'–0"	3	1.08	STRAW W/ NET
SCC–13	2'–0"	0	3	VARIES	NONE
SCC–14	2'–0"	0	3	VARIES	NONE
SCC–15	2'–0"	0	3	VARIES	NONE
SCC–16	2'–0"	0	3	VARIES	NONE
SCC–17	2'–0"	0	3	VARIES	NONE

STORMWATER CONVEYANCE CHANNEL (SCC) SCHEDULE
N.T.S.



SECTION

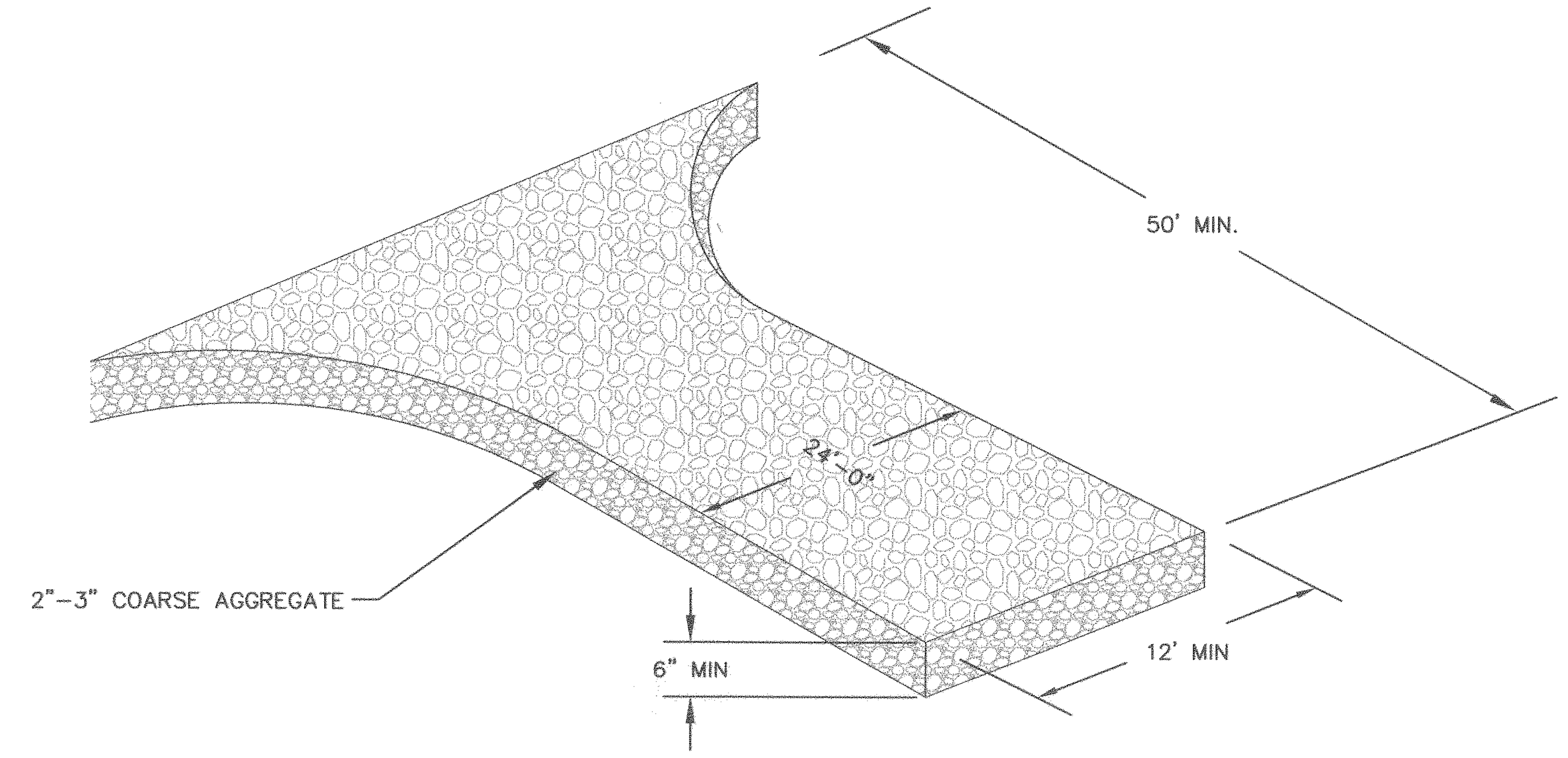


SPILLWAY

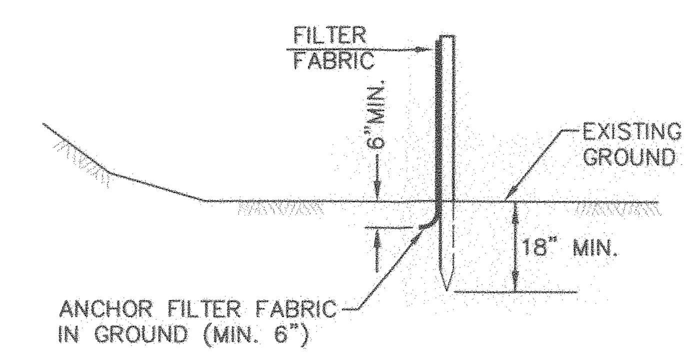
SEDIMENT TRAP DETAIL
N.T.S.

SEDIMENT TRAP SCHEDULE

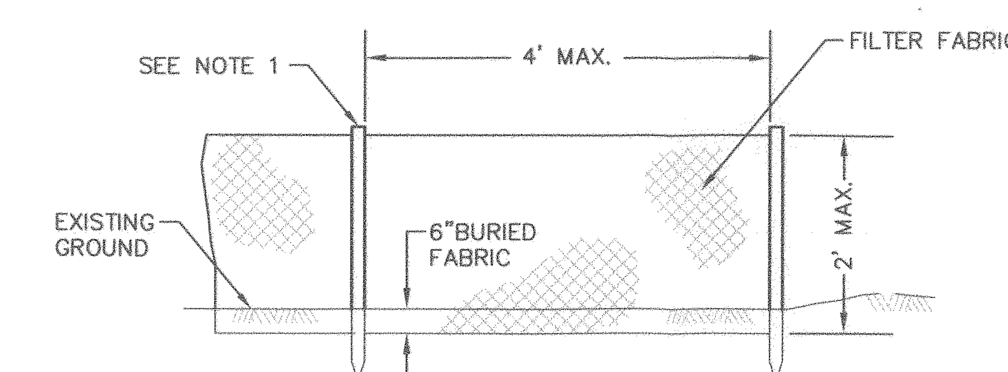
SEDIMENT TRAP	REQUIRED MIN. STORAGE CAPACITY (FT^3)	WEIR LENGTH (FT)
ST–1	2,700	6
ST–2	2,250	4
ST–3	2,250	4
ST–4	4,200	6
ST–5	5,400	8
ST–6	1,500	4



TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/ EXIT DETAIL
N.T.S.



SECTION



ELEVATION

SEDIMENT FENCE DETAIL
N.T.S.
B 2 3

NOTE:
1. POSTS SHALL BE 4" DIA. PINE, 2" DIA. OAK, OR 1.33 LB/L.F. STEEL WITH MAX. LENGTH OF 6 FT.
2. LOCATE SEDIMENT FENCE AS SHOWN ON PLANS, AND AT A SUFFICIENT DISTANCE FROM PROPOSED WORK ACTIVITIES SO THAT IT WILL NOT INTERFERE WITH THE WORK.
3. IF THE SEDIMENT FENCE LOCATION SHOWN ON THE PLANS WILL INTERFERE WITH PROPOSED WORK BY THE CONTRACTOR, OBTAIN ENGINEER'S APPROVAL BEFORE INSTALLING.

DATE | REVISIONS AND RECORD OF ISSUE | NO | BY | CK | APP

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CHECKED SF
APPROVED JD
DATE 12/28/01

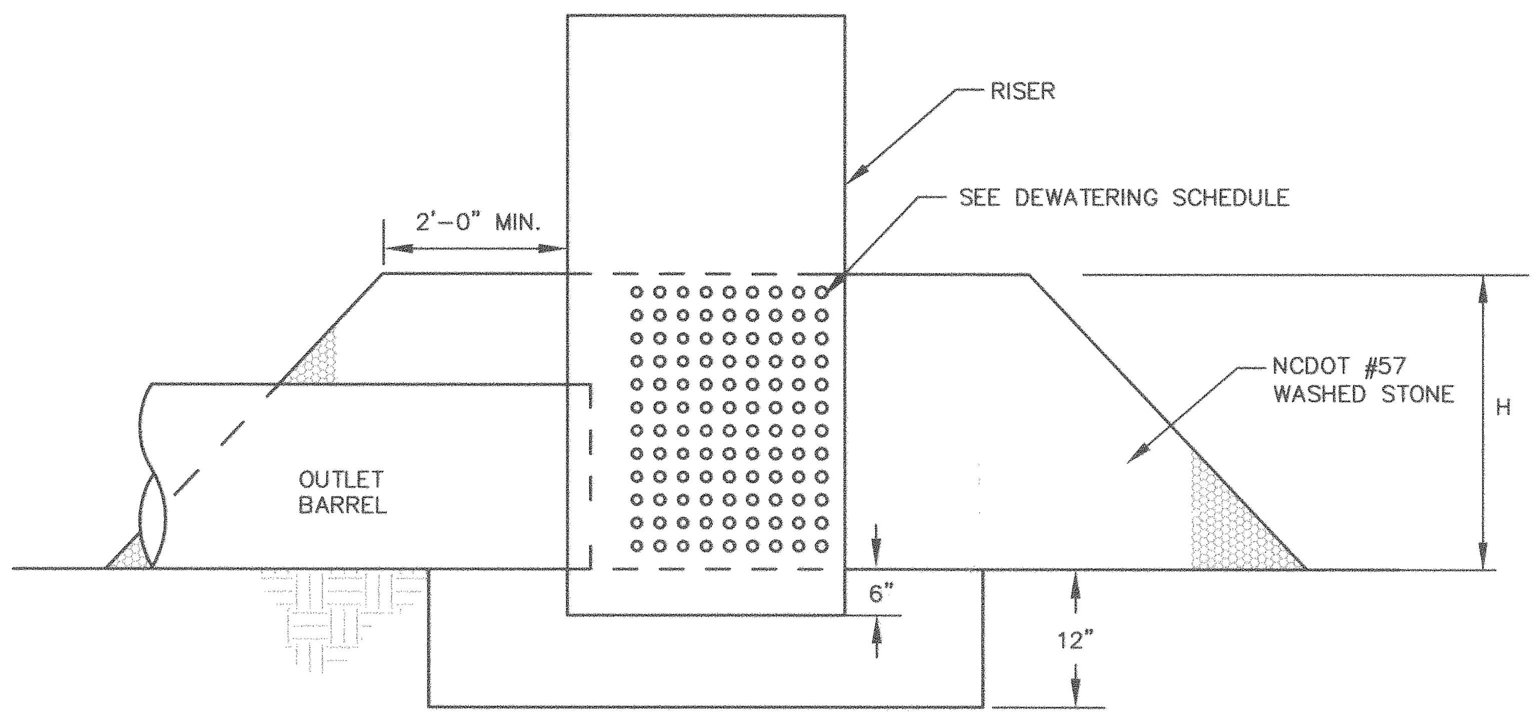
SCALE N.T.S.
PROJECT NO. 47901.02

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

EROSION AND SEDIMENT CONTROL PLAN DETAILS

DRAWING NO. 13

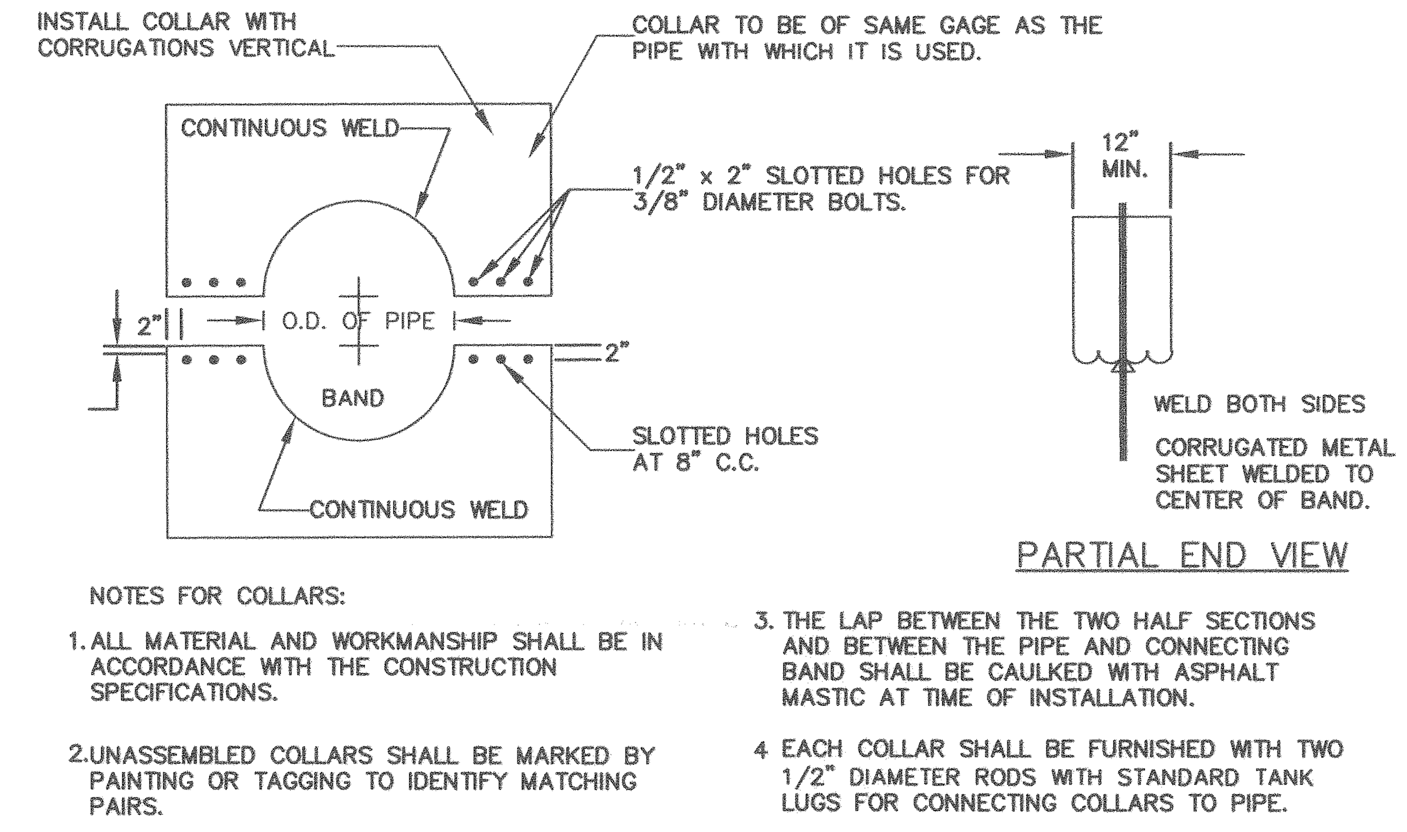


RISER

NOTE: SPACE HOLES THREE INCHES APART IN EACH OUTSIDE PIPE VALLEY IN LOWER HALF OF RISER.

RISER	HOLE SIZE	H (FT)
SB-1	1/2"	3.25'
SB-2	1/2"	2.1'

DEWATERING SCHEDULE



NOTES FOR COLLARS:

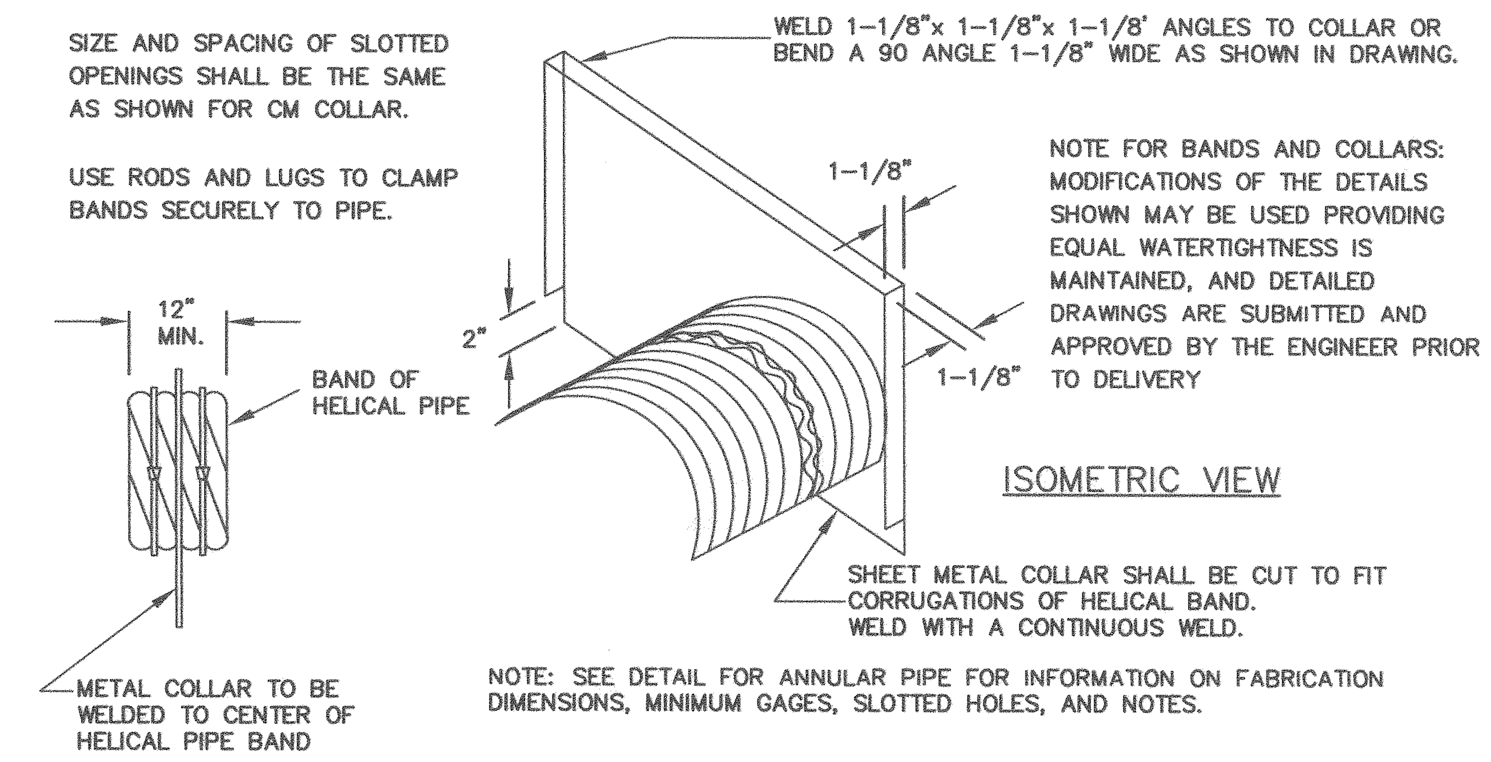
1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS.
2. UNASSEMBLED COLLARS SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PAIRS.
3. THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE AND CONNECTING BAND SHALL BE CAULKED WITH ASPHALT MASTIC AT TIME OF INSTALLATION.
4. EACH COLLAR SHALL BE FURNISHED WITH TWO 1/2" DIAMETER RODS WITH STANDARD TANK LUGS FOR CONNECTING COLLARS TO PIPE.

ANNULAR CMP PIPE ANTI-SEEP COLLAR

N.T.S.

SIZE AND SPACING OF SLOTTED OPENINGS SHALL BE THE SAME AS SHOWN FOR CM COLLAR.

USE RODS AND LUGS TO CLAMP BANDS SECURELY TO PIPE.

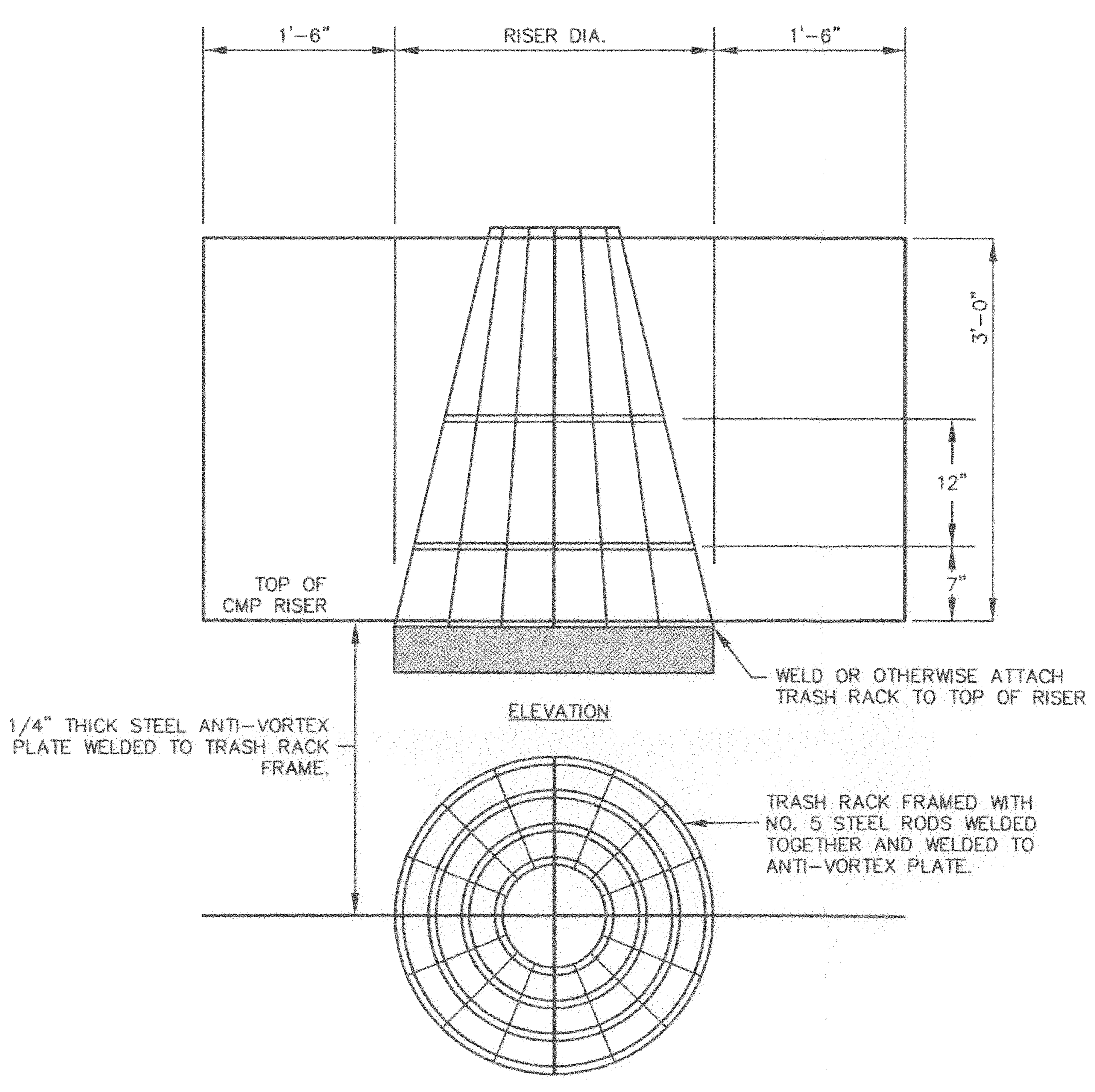


NOTE FOR BANDS AND COLLARS: MODIFICATIONS OF THE DETAILS SHOWN MAY BE USED PROVIDING EQUAL WATERTIGHTNESS IS MAINTAINED, AND DETAILED DRAWINGS ARE SUBMITTED AND APPROVED BY THE ENGINEER PRIOR TO DELIVERY

NOTE: SEE DETAIL FOR ANNULAR PIPE FOR INFORMATION ON FABRICATION DIMENSIONS, MINIMUM GAGES, SLOTTED HOLES, AND NOTES.

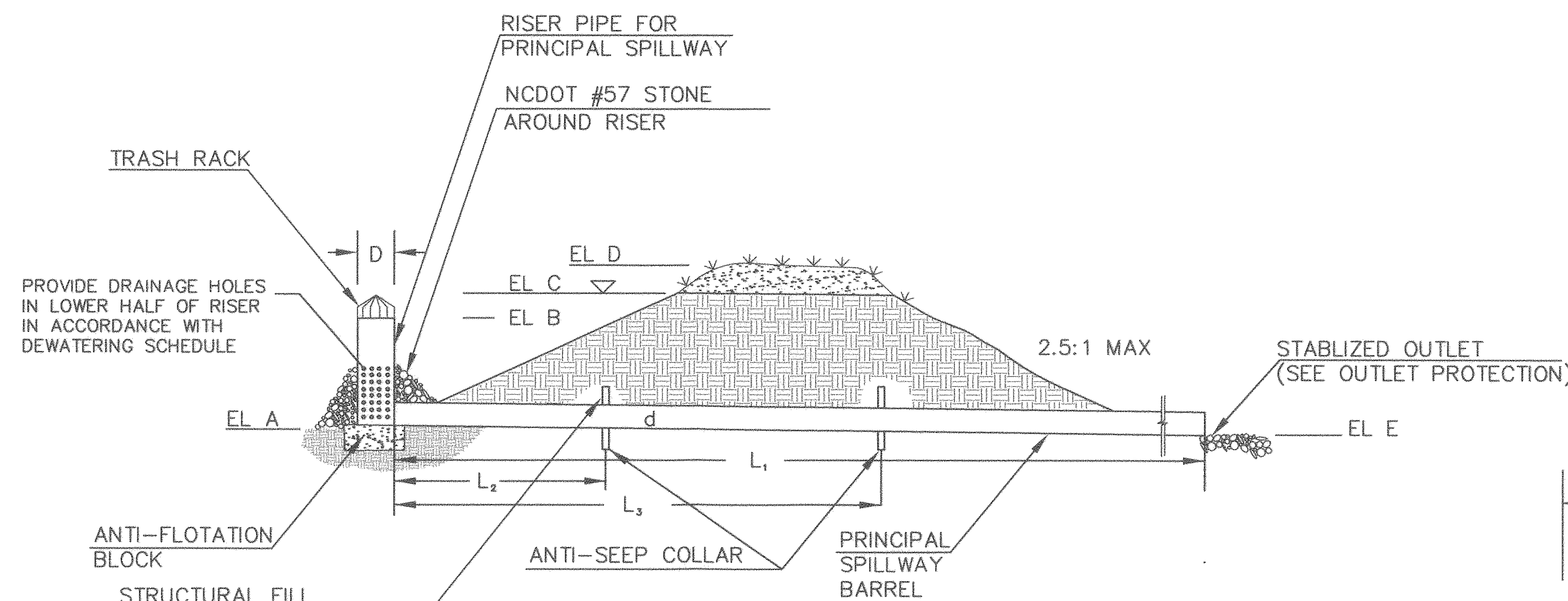
HELICAL CMP PIPE ANTI-SEEP COLLAR

N.T.S.



TYPICAL TRASH RACK DETAIL

N.T.S.



	SB-1	SB-2
EL A	200.0	214.0
EL B	206.5	218.2
EL C (25-yr HIGH WATER ELEV.)	208.0	219.4
EL D	210.0	221.0
EL E	194.0	204.0
D (IN)	60"	60"
d (IN)	48"	48"
CLEANOUT ELEVATION	203.25	216.1
L_1 (FT.)	100	160
L_2 (FT.)	16	17
L_3 (FT.)	32	N/A
ANTI-FLOTATION BLOCK (FT.)	7'-8"x7'-8"x12"	7'-0"x7'-0"x12"
ANTI-SEEP COLLAR	(2) 7'-2"x7'-2"	(1) 7'-8"x7'-8"

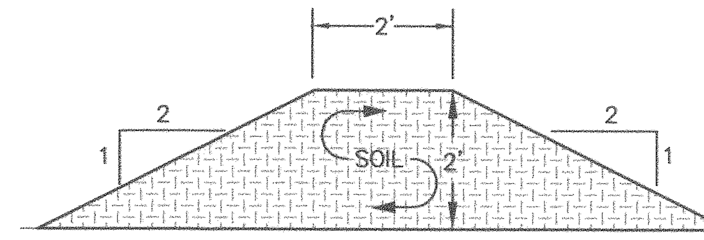
SB-1= PROPOSED SEDIMENT BASIN LOCATED NORTHWEST OF THE PROPOSED LANDFILL.
SB-2= PROPOSED SEDIMENT BASIN LOCATED SOUTH OF THE PROPOSED LANDFILL.
L= LENGTH OF DISCHARGE BARREL

NOTE:

SEDIMENT BASINS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE NORTH CAROLINA EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL AND PROJECT SPECIFICATIONS.

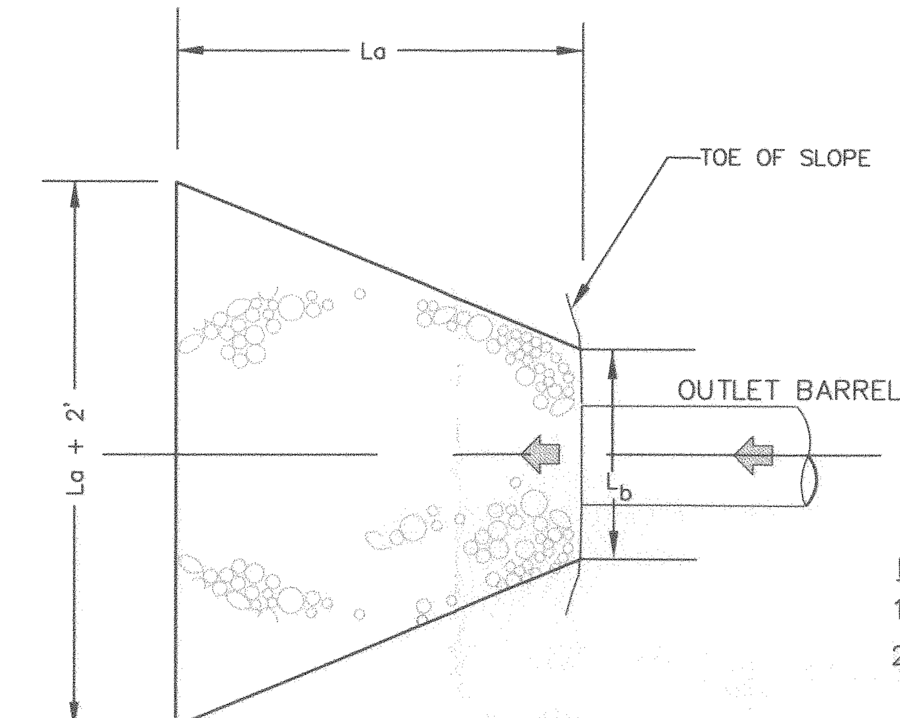
SEDIMENT BASIN DETAIL

N.T.S.



TEMPORARY STORMWATER DIVERSION BERM DETAIL

N.T.S.



NOTES:

1. APRON THICKNESS = 18" MIN.
2. INSTALL FILTER FABRIC BETWEEN THE RIPRAP AND THE SOIL FOUNDATION.

	OP-1	OP-2
La	34'	22'
L_b	12'	12'
d_{50}	12"	12"

OUTLET PROTECTION DETAIL

N.T.S.

L:\Material Recovery Facility LLC\dwg\Task 01-02 Construction Plan Application\CP14-E&S DETAILS.dwg

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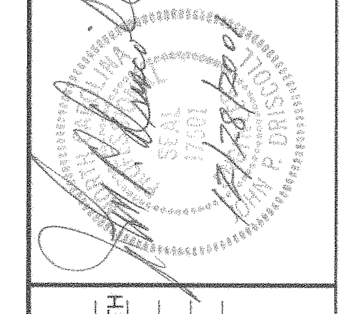

DESIGNED SF/JD
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SCALE N.T.S.

PROJECT NO. 47901.02

JOYCE ENGINEERING, INC.
2301 W. MEADOWVIEW RD.
GREENSBORO, N.C.
PHONE: (336) 323-0092

MATERIAL RECOVERY, LLC
WAKE COUNTY, NORTH CAROLINA

EROSION AND SEDIMENT CONTROL PLAN DETAILS

DRAWING NO. 14

APPENDIX 1

Property Boundary Survey and Legal Description

EXHIBIT B

BK6555PG0646

000484

PRESENTED FOR REGISTRATION

95 JUN -9 PM 3:32

KENNETH C. WILKINS
REGISTER OF DEEDS
WAKE COUNTY

Excise Tax 00

Recording Time, Book and Page

Tax Lot No. .... Parcel Identifier No. 0004648 & 0004649

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

by ....

Mail after recording to R. Dannette Underwood
PO Box 141, Clayton, NC 27520

This instrument was prepared by R. Dannette Underwood

Brief description for the Index: Lot 1 & 2, 163.43 Ac. St. Mary's Twnshp

NORTH CAROLINA GENERAL WARRANTY DEED

THIS DEED made this 9 day of June, 19 95, by and between

GRANTOR	GRANTEE
ASHLEY TURNER BUILDING CO., INC.	WILLIAM ASHLEY TURNER and wife, DEBRA C. TURNER 3700 Shotwell Road Clayton, NC 27520

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 .... St. Mary's Township, Wake County, North Carolina and more particularly described as follows:

SEE ATTACHED EXHIBIT A FOR DESCRIPTION

The property hereinabove described was acquired by Grantor by instrument recorded in ....

Deed Book 6477 Page 925, Wake Coutny Registry

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:

Restrictions and easements of record.

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.

ASHLEY TURNER BUILDING CO., INC. ....(SEAL)
(Corporate Name)

By: ....(SEAL)

..............................President ....(SEAL)

ATTEST: ....

..............................Secretary (Corporate Seal) ....(SEAL)

ASHLEY TURNER BUILDING CO. INC. NORTH CAROLINA CORPORATE SEAL

USE BLACK INK ONLY

SEAL-STAMP

NORTH CAROLINA, ...County.

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

.... Grantor,

personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this .... day of ...., 19......

My commission expires: .... Notary Public

Use Black Ink

SEAL-STAMP

NORTH CAROLINA, Johnston County.

I, a Notary Public of the County and State aforesaid, certify that Barbara Bailey personally came before me this day and acknowledged that S he is .... Secretary of Ashley Turner Building Co., Inc. 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 her as its .... Secretary.

Witness my hand and official stamp or seal, this 9 day of June, 19 95

BEVERLY LEONA WALLACE
NOTARY PUBLIC
JOHNSTON COUNTY, N.C.

My commission expires: July 27, 1998 .... Notary Public

Use Black Ink

The foregoing Certificate(s) of Beverly Leona Wallace

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.

KENNETH C. WILKINS REGISTER OF DEEDS FOR Wake COUNTY

By .... Deputy/Assistant - Register of Deeds

EXHIBIT A

Tracts 1 & 2, 163.43 Acres

TRACT 1

BEGINNING at a point 70.65 feet North of the intersection of NCSR 2542 and NCSR 2553, having a line from NCSR 2542 to the point of Beginning of South 03 degrees 54' 58" 70.65 feet, thence from said point North 89 degrees 34' 18" West 578.19 feet to an existing iron pipe, thence from the existing iron pipe South 00 degrees 15' 03" West 449.24 feet to an existing iron pipe, thence from the existing iron pipe South 00 degrees 15' 03" West 36.92 feet to the center of NCSR 2542, thence from the center of NCSR 2542 South 53 degrees 15' 50" West 172.61 feet along NCSR 2542, thence from this center point of NCSR 2542 North 00 degrees 59' 07" West 36.56 feet to an existing iron pipe, thence from the existing iron pipe N 00 degrees 59' 07" West 552.64 feet to an existing iron pipe, thence from the existing iron pipe South 89 degrees 54' 28" West 888.40 feet to an existing iron pipe, thence from the existing iron pipe North 01 degrees 28' 05" East 959.90 feet to an existing iron pipe, thence from the existing iron pipe N 01 degrees 28 ' 17" East 314.90 feet to an existing iron pipe, thence from the existing iron pipe North 00 degrees 46' 02" East 959.50 feet to an existing iron pipe thence from the existing iron pipe South 87 degrees 55' 55" East 2879.54 feet to a new iron pipe, thence from the new iron pipe South 87 degrees 55' 55" East 35.68 feet to the center of NCSR 2553, thence from the center of NCSR 2553, traversing along the same road at the following coordinates: North 34 degrees 51' 54" East 62.67 feet, North 35 degrees 35' 00" East 601.74 feet, North 35 degrees 25' 33" East 122.54, North 34 degrees 46' 39" east 103.54 feet, North 34 degrees 25' 54" 115.25 feet, North 33 degrees 42' 51" East 122.91 feet, North 33 degrees 34' 14"

Exhibit A
Continued Page 2

East 109.37 feet, North 32 degrees 51' 31" East 104.44 feet, North 31 degrees 20' 44" East 105.20 feet, North 30 degrees 38' 28" east 914.06 feet, North 28 degrees 24' 19" East 53.84 feet, North 21 degrees 50' 36" East 51.26 feet, and North 10 degrees 10' 37" East 58.49 feet, which includes the 60 feet right of way reserved by DOT on NCSR 2553, to the point and place of BEGINNING, containing 113.55 gross acres, according to the plat of same prepared by Williams-Pearce & Associates, P.A., Registered Land Surveyors, dated March 21, 1995 and recorded in Plat Book 1995, Page 456, of the Wake County Registry.

TRACT 2

BEGINNING at the same point as did Tract 1 above and traversing along NCSR 2553 with those same coordinates as set forth above in Tract 1, those being as follows: North 10 degrees 10' 37" east 58.49 feet, North 21 degrees 50' 36" East 51.26 feet, North 28 degrees 24' 19" East 53.84 feet, North 30 degrees 38' 28" East 914.06 feet, North 31 degrees 20' 44" east 105.20 feet, North 32 degrees 51' 31" east 104.44 feet, North 33 degrees 34' 14" East 109.37 feet, North 33 degrees 42' 51" 122.91 feet, North 34 degrees 25' 54" East 115.25 feet, North 34 degrees 46' 39" East 103.54 feet, North 35 degrees 25' 33" East 122.54 feet, North 35 degrees 35' 00" East 601.74 feet, North 34 degrees 51' 54" East 62.67 feet, North 33 degrees 47' 21" east 92.11 feet, North 28 degrees 21' 05" east 55.62 feet, North 24 degrees 14' 24" East 56.47 feet, North 19 degrees 07' 50" Est 70.27 feet, North 14 degrees 27' 54" East 55.00 feet, North 10 degrees 22' 09" East 52.22 feet, North 06 degrees 52' 39" East 76.00 feet, North 05 degrees 41' 37" East 113.61 feet and North 04 degrees 39' 47" 102.92 feet to a new PK nail in

Exhibit A Continued
Page 3

the center of NCSR 2553, thence from said new PK nail North 89 degrees 23' 26" east 30.13 feet to a new iron pipe, thence from said new iron pipe North 89 degrees 23' 26" East 229.08 feet to an existing iron pipe, thence form said existing iron pipe South 52 degrees 46' 34" East 600.84 feet to an existing iron pipe, thence from said existing iron pipe South 00 degrees 02' 37" 311.54 feet to an existing iron pipe, thence from said existing iron pipe South 00 degrees 12' 23" West 580.92 feet to an existing iron pipe, thence from said existing iron pipe South 89 degrees 25' 55" West 731.89 feet to an existing iron pipe thence from said existing iron pipe South 28 degrees 23' 31" West 1687.75 feet to an existing iron pipe, thence from said existing iron pipe South 28 degrees 23' 31" WEst 33.90 feet to the center of NCSR 2542, thence from this center point North 89 degrees 34' 18" West 703.21 feet, which includes the 60 feet right of way reserved by DOT on NCSR 2542, to the point and place of BEGINNING, containing 49.88 gross acres, according to the plat of same prepared by William-Pearce and Associates, P.A., Registered Land Surveyor, dated March 21, 1995 and recorded in Plat Book 1995, Page 456, of the Wake County Registry.

EXHIBIT C

BK8310PG1316

000536

PRESENTED FOR REGISTRATION

99 MAY 11 PM 1:48

LAURA M. RIDDICK
REGISTER OF DEEDS
WAKE COUNTY

WAKE COUNTY
05/11/1999
$2400.00
STATE OF NORTH CAROLINA
Real Estate Excise Tax

Excise Tax $2,400.00

Recording Time, Book and Page

Tax Lot No. .... Parcel Identifier No. 1741.04 73 2924 ....
Verified by .... County on the ..... day of ...., 19.....
by ....

Mail after recording to R. Dannette Underwood, P. O. Box 141, Clayton, North Carolina 27520

This instrument was prepared by Charles L. Fulton of Manning, Fulton & Skinner, P.A.

Brief description for the Index: 97.52 acres, SR 2553 — T-17288

NORTH CAROLINA GENERAL WARRANTY DEED

THIS DEED made this 11th day of May, 1999, by and between

GRANTOR	GRANTEE
CYLESTER P. GINN, widow	ASHLEY TURNER ENTERPRISES, INC. P. O. Box 160 Clayton, North Carolina 27520

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~~ near the City of Garner, St. Mary's Township, Wake County, North Carolina and more particularly described ~~as follows:~~

on Exhibit A attached hereto and incorporated herein by this reference thereto.

12

The property hereinabove described was acquired by Grantor by instrument recorded in ....

Deed Book 1726, page 588, Wake County Registry

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:

1999 taxes, a 90' CP&L easement crossing the northeast corner of the property and other easements of record, and the right of way of SR 2553.

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.

USE BLACK INK ONLY

.... (Corporate Name)

By: ....

.... President

ATTEST:

....

.... Secretary (Corporate Seal)

Cylester P. Ginn ....(SEAL)
Cylester P. Ginn

....(SEAL)

....(SEAL)

....(SEAL)

SEAL-STAMP

DORIS B. MARSH
NOTARY PUBLIC
WAKE COUNTY, N.C.
My Commission Expires 9-10-2000

Use Black Ink

NORTH CAROLINA, ...Wake.................. County.

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

.......Cylester P. Ginn, widow.. Grantor,

personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this *11th* day of ....May.................., 1999...

My commission expires: *9-10-2000* ....*Doris B. Marsh*......... Notary Public

SEAL-STAMP

Use Black Ink

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 .... 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 ....*DORIS B. MARSH*..

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.

..............LAURA M. RIDDICK.............................. REGISTER OF DEEDS FOR..........WAKE.................... COUNTY

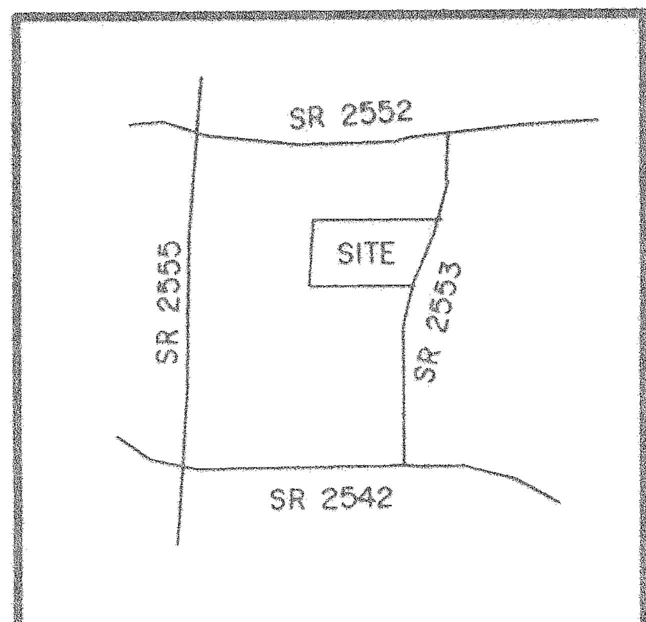
By ....*[signature]*.............. Deputy/Assistant - Register of Deeds

N.C. Bar Assoc. Form No. 3 © 1976, Revised © 1977
Printed by Agreement with the N.C. Bar Association — 1981 • Long Printing Co. • PO Box 58493 • Raleigh, NC 27658-8493

EXHIBIT A TO DEED FROM CYLESTER P. GINN, WIDOW, TO ASHLEY TURNER ENTERPRISES, INC.

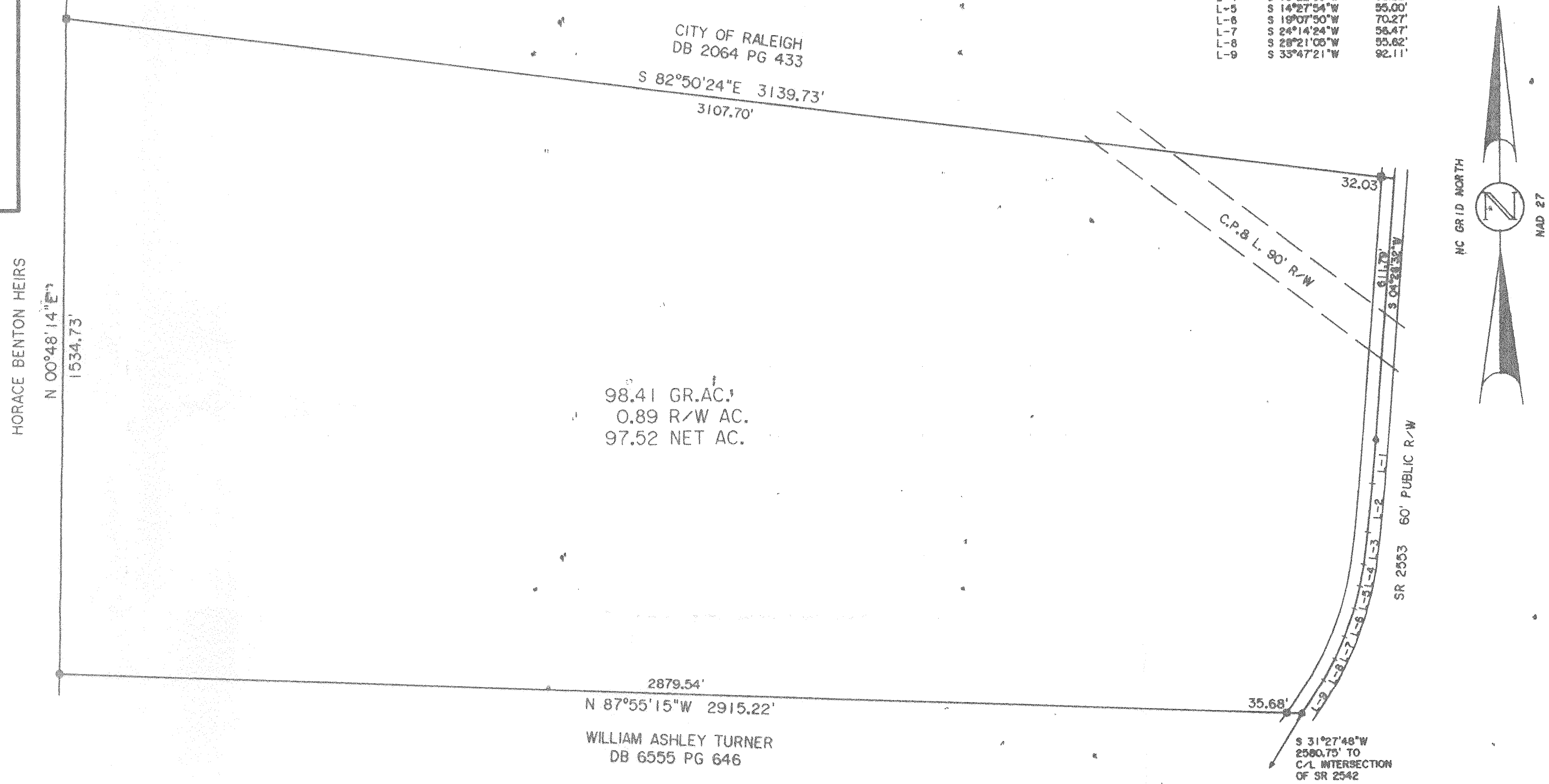
BEGINNING at an existing PK nail located in the centerline of SR 2553 (a 60' public right-of-way), said nail being distant North 31° 27' 48" East 2580.75 feet from the centerline intersection of SR 2542, said nail marking the northeast corner of the property owned now or formerly by William Ashley Turner as described in Deed Book 6555, page 646, Wake County Registry; runs thence along and with the northern line of the Turner property (now or formerly) North 87° 55' 15" West 35.68 feet to an existing iron pipe located in the western right-of-way line of said SR 2553 and North 87° 55' 15" West 2879.54 feet to an existing iron pipe in the eastern line of the property owned now or formerly by Horace Benton Heirs; runs thence along and with said eastern line of the Benton Heirs property (now or formerly) North 00° 48' 14" East 1534.73 feet to an existing concrete monument, said concrete monument marking the southwest corner of the property owned now or formerly by the City of Raleigh as described in Deed Book 2064, page 433, Wake County Registry; runs thence along and with the southern line of the property of the City of Raleigh (now or formerly) South 82° 50' 24" East 3107.70 feet to an existing concrete monument located in the western right-of-way line of said SR 2553 and South 82° 50' 24" East 32.03 feet to a point in the centerline of said SR 2553; runs thence along and with said centerline of SR 2553 the following ten courses and distances; (1) South 04° 28' 32" West 611.79 feet to an existing PK nail; (2) South 04° 39' 47" West 102.91 feet to point; (3) South 05° 41' 37" West 113.61 feet to point; (4) South 06° 52' 39" West 76.00 feet to point; (5) South 10° 22' 09" West 52.22 feet to point; (6) South 14° 27' 54" West 55.00 feet to point; (7) South 19° 07' 50" West 70.27 feet to point; (8) South 24° 14' 24" West 56.47 feet to point; (9) South 28° 21' 05" West 55.62 feet to point; and (10) South 33° 47' 21" West 92.11 feet to the POINT AND PLACE OF BEGINNING, containing 98.41 gross acres, including 0.89 acres within the right-of-way of said SR 2553, all according to plat of survey dated April 27, 1999 and revised May 5, 1999 entitled "Property Survey for Ashley Turner Enterprises" prepared by Clyde T. Pearce, Professional Land Surveyor, of Williams – Pearce & Assoc., P.A.

The above-described tract being the property conveyed to Harvey D. Ginn and wife, Cylester P. Ginn by deed recorded in Book 1726, page 588, Wake County Registry. See also Estate File of Harvey D. Ginn found in 96 E 209, Wake County Clerk of Superior Court.



VICINITY MAP

COURSE	BEARING	DISTANCE
L-1	S 04°39'47"W	102.91'
L-2	S 05°41'37"W	113.61'
L-3	S 08°52'39"W	76.00'
L-4	S 10°22'09"W	52.22'
L-5	S 14°27'54"W	55.00'
L-6	S 19°07'50"W	70.27'
L-7	S 24°14'24"W	56.47'
L-8	S 28°21'05"W	55.62'
L-9	S 33°47'21"W	92.11'



NOTE: AREA COMPUTED BY COORDINATE METHOD.

I, Clyde T. Pearce, PROFESSIONAL LAND SURVEYOR NO. L-2481, certify that this plat is of a survey of an existing parcel or parcels of land and does not create a new street or change an existing street.

Clyde T. Pearce L-2481

" I, CLYDE T. PEARCE, certify that this plat was drawn under my supervision from an actual survey made under my supervision (deed description recorded in Book , page , etc. X other), that the boundaries not surveyed are clearly indicated as drawn from information found in Book , page , that the ratio of precision as calculated is 1:10000, that this plat was prepared in accordance with G.S 47-30 as amended. Witness my original signature, registration number, and seal this 27 day of APRIL , A.D. 1999.

Surveyor
L-2481
Registration Number

Seal or Stamp

PROPERTY SURVEY FOR
ASHLEY TURNER ENTERPRISES

ST. MARY'S TOWNSHIP
WAKE COUNTY
NORTH CAROLINA

PIN 1741.04-73-2924
ZONED: R-30

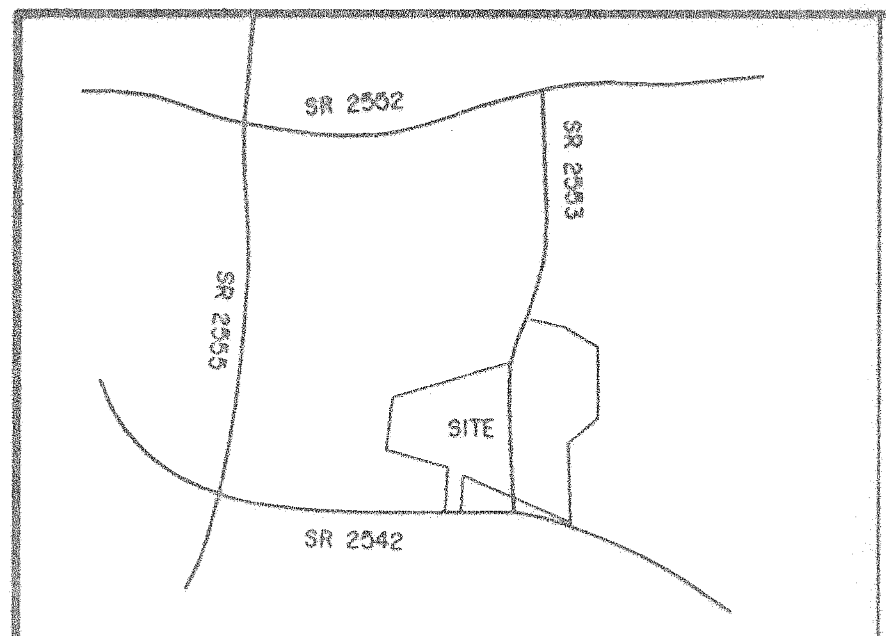
LEGEND
- EXISTING IRON PIPE
- EXISTING CONCRETE MONUMENT
- EXISTING PK NAIL

200 0 200 400 600
GRAPHIC SCALE - FEET

FILE: CTP238 CTP1705
SCALE: 1" = 200'
DATE: 4-27-1999
REVISED: 5-5-1999
FB: 1167

WILLIAMS - PEARCE & ASSOC., P.A. Professional Land Surveyors P.O. Box 892, Zebulon, N.C. Phone (919)269-9605

25-A-70A



VICINITY MAP

" I, CLYDE T. PEARCE, certify that this plat was drawn under my supervision from an actual survey made under my supervision (deed description recorded in Book , page , etc. X other), that the boundaries not surveyed are clearly indicated as drawn from information found in Book , page , that the ratio of precision as calculated is 1:10000, that this plat was prepared in accordance with G.S 47-30 as amended. Witness my original signature, registration number and seal this 23 day of JUNE , A.D. 1995.

Surveyor
L-2481
Registration Number

Seal or Stamp

North Carolina - Franklin County

I, a Notary Public of the County and State aforesaid, certify that Clyde T. Pearce, a Registered Land Surveyor, personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this 23 day of JUNE , 1995

Notary Public

Stamp or Seal

My Commission expires 12-21-97.

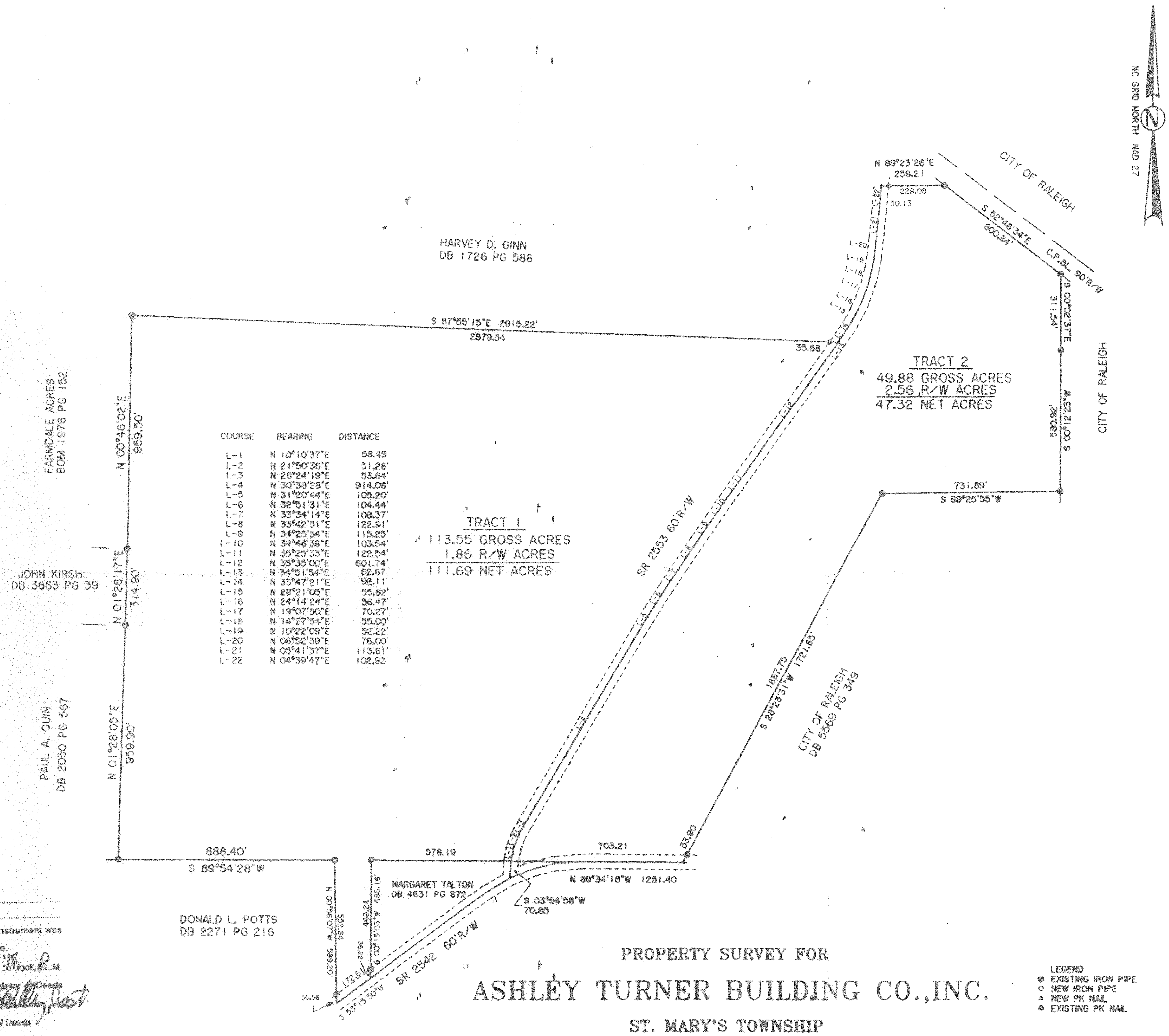
I, CLYDE T. PEARCE, Registered Land Surveyor No. L-2481, certify that this plat is of a survey of an existing parcel or parcels of land.

Clyde T. Pearce L-2481

NOTE: NO NCGS MONUMENT WITHIN 2000'.

NOTE: AREA COMPUTED BY COORDINATE METHOD.

NOTE: THIS MAP IS PREVIOUSLY RECORDED IN BOOK OF MAPS 1995, PAGE 456. THE PURPOSE OF THIS RECORDING IS TO CORRECT THE RIGHT-OF-WAY ACRES ON TRACT 2.



COURSE	BEARING	DISTANCE
L-1	N 10°10'37"E	58.49
L-2	N 21°50'36"E	51.26'
L-3	N 28°24'19"E	53.84'
L-4	N 30°38'28"E	914.06'
L-5	N 31°20'44"E	105.20'
L-6	N 32°51'31"E	104.44'
L-7	N 33°34'14"E	109.37'
L-8	N 33°42'51"E	122.91'
L-9	N 34°25'54"E	115.25'
L-10	N 34°46'39"E	103.54'
L-11	N 35°25'33"E	122.54'
L-12	N 35°35'00"E	601.74'
L-13	N 34°51'54"E	62.67
L-14	N 33°47'21"E	92.11
L-15	N 28°21'05"E	55.62'
L-16	N 24°14'24"E	56.47'
L-17	N 19°07'50"E	70.27'
L-18	N 14°27'54"E	55.00'
L-19	N 10°22'09"E	52.22'
L-20	N 06°52'39"E	76.00'
L-21	N 05°41'37"E	113.61'
L-22	N 04°39'47"E	102.92

NORTH CAROLINA - WAKE COUNTY

The foregoing certificate(s) of Brunette P. Taylor Notary (y) (ies) (are) certified to be correct. This instrument was presented for registration and recorded in this office.

This 23rd day of June 1995 at 1:18 o'clock P.M.

Kenneth C. Wilkins, Register of Deeds

By Charlotte ... Asst.

Deputy Register of Deeds

300 0 300 600 900

GRAPHIC SCALE - FEET

PROPERTY SURVEY FOR

ASHLEY TURNER BUILDING CO.,INC.

ST. MARY'S TOWNSHIP

WAKE COUNTY

NORTH CAROLINA

LEGEND
- EXISTING IRON PIPE
- NEW IRON PIPE
- NEW PK NAIL
- EXISTING PK NAIL

JOB: CTP238
FB: 1067
SCALE: 1"=300'
DATE: 6-23-95

Book 1995 Page 1025

22-B-103a

WILLIAMS - PEARCE & ASSOC., P.A. Registered Land Surveyors P.O. Box 892, Zebulon, N.C. Phone (919)269-9605

APPENDIX 2

Random Waste Screening Forms

1. Waste Inspection Form
2. Refuse/Unidentified Waste Inspection Form
3. USEPA Hazardous Waste Inspection Decision Tree

1. Waste Inspection Form

WASTE INSPECTION FORM

FACILITY: ____________ PERMIT NO. ____________

LOCATION: ____________ DATE: ____________

INSPECTOR: ____________ COMPANY: ____________

Waste Name(s) & Address (es)

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________

Waste Hauler ____________

Address ____________

Driver's Name ____________

Waste Accepted [ ] Rejected [ ] Held [ ]

NOTIFIED: Waste Source [ ] Hauling Management [ ] Site Management [ ]

State [ ] Federal [ ]

Loader Operator: ____________

Personnel Conducting the Inspection: ____________

____

1. Supervisor Conducting the Inspection: ____________

SIGNATURE: ____________

2. Witness: ____________

SIGNATURE: ____________

3. Driver: ____________

SIGNATURE: ____________

4. Other: ____________

Company: ____________ Title: ____________

SIGNATURE: ____________

DATE: ____________ TIME ____________ AM [ ] PM [ ]

ADDITIONAL COMMENTS: on the back

CONTAINER INVENTORY

FACILITY: ____________________ PERMIT NO. ____________________

LOCATION: ____________________ DATE: ____________________

INSPECTOR: ____________________ COMPANY: ____________________

Container:

Drum [ ] Metal [ ] Cardboard [ ] Plastic [ ] Other [ ]

Other: ____

Contents:

1. Full [ ] Partially Full [ ] Empty [ ]
2. Crushed [ ] Punctured [ ]
3. Labeled [ ] Hazardous [ ]

Identified: ____

Additional Information:

Container:

Drum [ ] Metal [ ] Cardboard [ ] Plastic [ ] Other [ ]

Other: ____

Contents:

1. Full [ ] Partially Full [ ] Empty [ ]
2. Crushed [ ] Punctured [ ]
3. Labeled [ ] Hazardous [ ]

Identified: ____

Additional Information:

INSPECTION CHECK LIST:(Check all that apply)

(If "YES" Please explain in the space provided below)

FACILITY: ____________________ PERMIT NO. ____________________

LOCATION: ____________________ DATE: ____________________

INSPECTOR: ____________________ COMPANY: ____________________

	YES	NO
1. Powders/Dusts	___	___
Identified: ______________________________		
Unknown	___	___
2. Unacceptable Saturation	___	___
3. Odor/Fumes	___	___
Strong	___	___
Faint	___	___
Describe: ______________________________		
4. Heat	___	___
Item: ______________________________		
5. Battery	___	___
6. Oil	___	___
7. Biomedical	___	___
8. Radioactivity	___	___
9. Ashes/Residue	___	___
10. Sod/Soil	___	___
11. Asbestos (not properly contained)	___	___
12. PCB	___	___
13. Out of County Waste	___	___

Explanation:

2. Refuse/Unidentified Waste Inspection Form

REFUSE/UNIDENTIFIED WASTE INSPECTION FORM

FACILITY: ____________________ PERMIT NO. ____________________

LOCATION: ____________________ DATE: ____________________

INSPECTOR: ____________________ COMPANY: ____________________

REJECTABLE WASTE DESCRIPTION: ____

____

____

____

WASTE: Rejected [ ] Accepted [ ]

NOTIFIED: [ ] Waste Source [ ] Hauling Management [ ] Federal
[ ] Site Management [ ] State

REFUSED WASTE TRANSPORTED BY:

Hauler Address: ____

____

Destination: ____

____

ACCEPTED WASTE:

Contained area: ____

Secured by: ____

Lab to complete testing: ____

ADDITIONAL COMMENTS: ____

____

____

3. USEPA Hazardous Waste Inspection Decision Tree

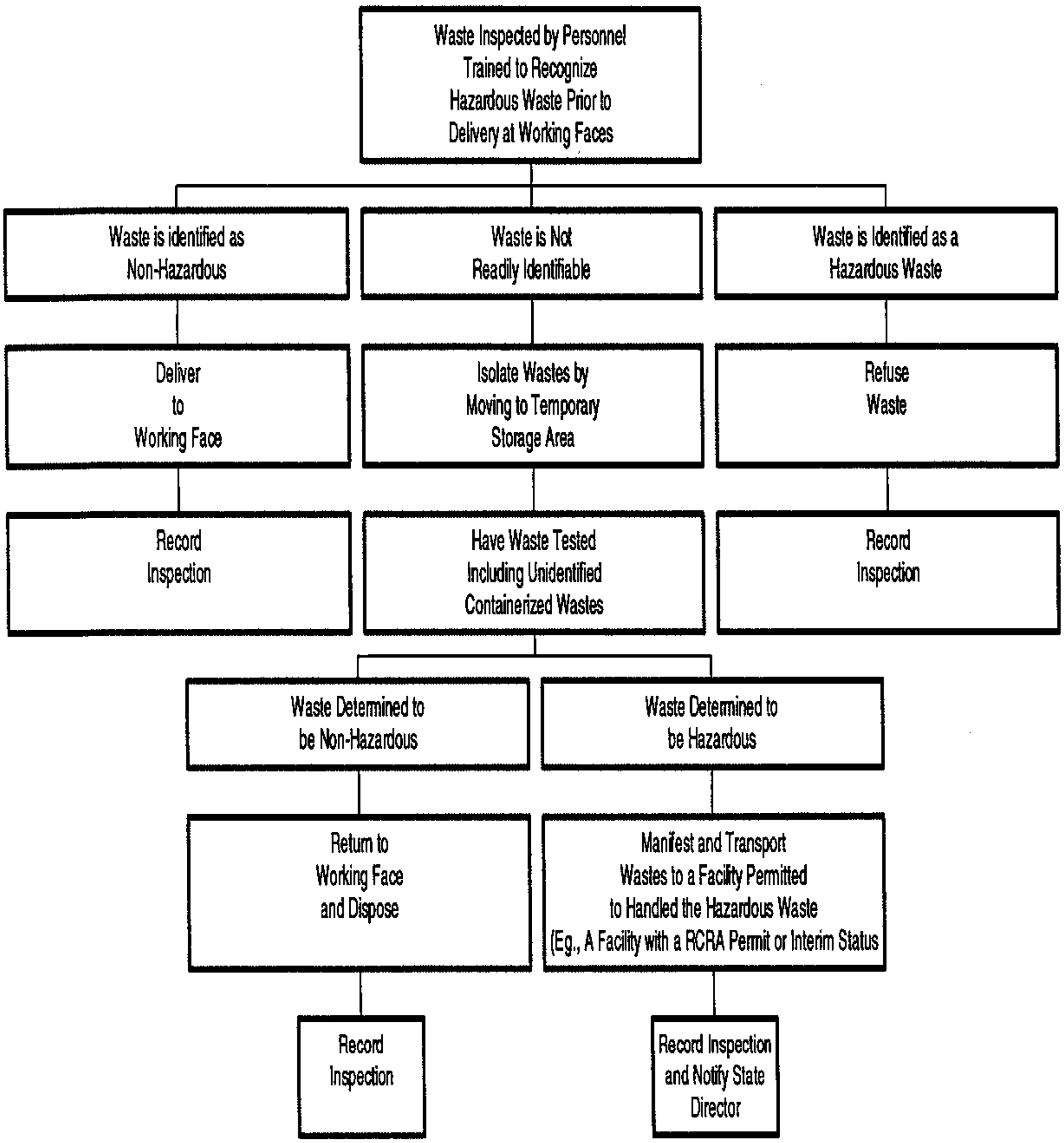


Figure 3-1
Hazardous Waste Inspection Decision Tree
Inspection Prior to Working Face

Source: EPA "Solid Waste Disposal Facility Criteria – Technical Manual". Nov. 1993

APPENDIX 3

Seeding Specifications

SECTION 02936

SEEDING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Preparation of subsoil.

B. Placing topsoil material.

C. Fertilizing.

D. Temporary seeding.

E. Permanent seeding.

F. Mulching.

1.02 RELATED SECTIONS

A. 02200 - Earthwork

1.03 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.04 MAINTENANCE DATA

A. Submit maintenance data for continuing Owner maintenance.

B. Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging will not be acceptable.

C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

D. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

E. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. Topsoil Material: Excavated from site and free of weeds.

2.02 ACCESSORIES

A. Mulching material: Oat or wheat straw, dry, free from weeds and foreign matter detrimental to plant life.

B. Lime: Lime shall comply with applicable North Carolina state laws and shall be delivered in unopened bags or other convenient standard containers, each fully labeled with the manufacturer's guaranteed analysis. Lime shall be ground limestone containing not less than 85 percent total carbonates, and shall be ground to such fineness that 90 percent by weight will pass through a No. 20 mesh sieve and 50 percent by weight will pass through a No. 100 mesh sieve. Apply limestone uniformly into the top 4-6 inches of soil.

C. Fertilizer: Fertilizer shall comply with applicable North Carolina state laws and shall be delivered in unopened bags or other convenient standard container, each fully labeled with the manufacturer's guaranteed analysis. Fertilizer shall contain not less than 10 percent nitrogen, 10 percent available phosphoric acid and 10 percent water soluble potash (N-P-K, 10-10-10). Any fertilizer which becomes caked or otherwise damaged, making it unsuitable for use, will not be acceptable and shall be immediately removed from the job site.

PART 3 EXECUTION

3.01 GENERAL

A. Areas where topsoil material is to be placed and areas to be seeded include all areas disturbed during construction which are not to be paved.

B. Verify that prepared soil base is ready to receive the work of this Section.

3.02 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds, and undesirable plants and their roots. Remove contaminated subsoil.

C. Scarify subsoil to a depth of 3 inches where topsoil material is to be placed. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.03 PLACING TOPSOIL MATERIAL

A. Place topsoil material during dry weather and on dry unfrozen subgrade 2 to 3 weeks prior to sowing seed.

B. Spread topsoil material over area to be seeded. Finished thickness of topsoil material shall be 3 inches minimum after settling and nominal compaction caused by spreading equipment.

C. Grade to eliminate rough, low, or soft areas, and to ensure positive drainage.

D. Rake topsoil material and remove roots, vegetable matter, rocks, clods, and other foreign non-organic material.

3.04 FERTILIZER AND LIME

A. Apply lime and fertilizer according to soil tests, or apply lime at the rate of 90 lbs./1000 sq.ft. and fertilizer at the rate of 20 lbs./1000 sq.ft.

B. Mix thoroughly into upper 4 inches of topsoil.

C. Lightly water to aid the dissipation of fertilizer and lime.

3.05 SEEDBED PREPARATION

A. Chisel compacted areas and spread topsoil 3 inches deep over adverse soil conditions, if available.

B. Rip the entire area to 6 inches depth.

C. Remove all loose rocks, roots and other obstructions leaving surface reasonably smooth and uniform.

D. Apply agricultural lime, fertilizer, and superphosphate uniformly and mix with soil (see below *).

E. Continue tillage until a well-pulverized, firm, reasonably uniform seedbed is prepared 4 to 6 inches deep.

F. Seed on a freshly prepared seedbed and cover seed lightly with seeding equipment or cultipack after seeding.

G. Mulch immediately after seeding and anchor mulch.

H. Inspect all seeded areas and make necessary repairs or reseedings within the planting season, if possible. If stand should be over 60% damaged, reestablish following original lime, fertilizer and seeding rates.

I. Consult EFS Environmental Engineer on maintenance treatment and fertilization after permanent cover is established.

* Apply:	Agricultural Limestone:	2 tons/acre (3 tons/acre in clay soils)
	Fertilizer:	1,000 lbs/acre – 10-10-10
	Superphosphate:	500 lbs/acre – 20% analysis
	Mulch:	2 tons/acre – small grain straw
	Anchor:	Asphalt Emulsion @ 300 gals/acre

3.06 TEMPORARY SEEDING

A. Provide temporary seeding on any cleared, unvegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than one year or when seeding dates will prevent the establishment of vegetative cover if permanent seeding is attempted.

B. Reseed according to optimum season for desired permanent vegetation. Do not allow temporary cover to grow over 12" in height before mowing.

C. To amend soil, follow recommendations of soil tests or apply 2000 lbs/acre ground agricultural limestone and 750 lbs/acre 10-10-10 fertilizer.

D. Mulch with 3-inch straw applied at the rate of 4000 lbs/acre and anchor by tacking with asphalt, netting, or a mulch anchoring tool.

E. Refertilize if growth is not fully adequate.

F. Reseed, refertilize and mulch immediately following erosion or other damage.

G. On channel side slopes above the lining and in channels not requiring temporary linings, apply 4,000 lbs/acre grain straw and anchor straw by stapling netting over the top. Inspect and repair frequently.

3.07 PERMANENT SEEDING

A. Seed in accordance with the following schedule and application rates:

Shoulders, Side Ditches, Slopes (Max 3:1)

Seeding Dates	Seeding Mixture Species	Rate (lbs./acre)
Aug 15 – Nov 1	Tall Fescue	300
Nov 1 – Mar 1	Tall Fescue & Abruzzi Rye	300
Mar 1 – Apr 15	Tall Fescue	300
Apr 15 – Jun 30	Hulled Common Bermudagrass	25
Jul 1 – Aug 15	Tall Fescue **and**	125
	*** Browntop Millet **or**	35
	*** Sorghum-Sudan Hybrids	30

Slopes (3:1 to 2:1)

Seeding Dates	Seeding Mixture Species	Rate (lbs./acre)
Mar 1 – Jun 1	Sericea Lespedeza (scarified)	50
	&	
(Mar 1 – Apr 15)	**Add** Tall Fescue	120
(Mar 1 – Jun 30)	**Or Add** Weeping Love grass	10
(Mar 1 – Jun 30)	**Or Add** Hulled Common Bermudagrass	25
Jun 1 – Sept 1	Tall Fescue **and**	120
	*** Browntop Mullet **or**	35
	*** Sorghum-Sudan Hybrids	30
Sept 1 – Mar 1	Sericea Lespedeza (unhulled – unscarified)	70
(Nov 1 – Mar 1)	**And** Tall Fescue	120
	And Abruzzi Rye	25

Consult EFS (Erosion Flood Stormwater Division) Environmental Engineer for additional information concerning other alternatives for vegetation of denuded areas. The above vegetation rates are those which do well under local conditions; other seeding rate combinations are possible.

Note: *** see section 3.06.B

B. Compact seed areas by means of a roller or other approved equipment immediately after sowing.

C. Mulch with 3 inch straw applied at the rate of 4000 lbs./acre. Anchor straw by tacking with asphalt, netting, or roving, or by crimping with a mulch-anchoring tool.

D. Refertilize in the second year unless growth is fully adequate. Reseed, refertilize, and mulch damaged areas immediately.

END OF SECTION

APPENDIX 4

Erosion and Sediment Control Plan

Prepared for:
Material Recovery, LLC
6512 Litchford Road
Raleigh, North Carolina

EROSION AND SEDIMENT CONTROL PLAN FOR THE

BROWN-FIELD ROAD C&D LANDFILL NORTH AREA

WAKE COUNTY, NORTH CAROLINA

December 2001

Prepared by:

Joyce Engineering, Inc.
2301 West Meadowview Road, Suite 203
Greensboro, North Carolina 27407
(336) 323-0092

TABLE OF CONTENTS

1.0 PROJECT DESCRIPTION 1
2.0 EXISTING SITE CONDITIONS 1
3.0 ADJACENT AREAS 1
4.0 SOIL 1
5.0 CRITICAL EROSION AREAS 2
6.0 EROSION AND SEDIMENT CONTROL MEASURES 2
6.1 Sediment Basin (Reference NCESCPDM 6.61) 2
6.2 Temporary Stormwater Diversion Berms (Reference NCESCPDM 6.20) 2
6.3 Temporary Sediment Traps (Reference NCESCPDM 6.60) 3
6.5 Grass-Lined Channel (Reference NCESCPDM 6.30) 3
7.0 VEGETATIVE STABILIZATION 3
8.0 TEMPORARY STABILIZATION 3
9.0 MAINTENANCE 3
10.0 CONSTRUCTION SEQUENCE 4

SUPPORTING DOCUMENTS

Wake County Soil Erosion and Sedimentation Control Checklist
Request for Plan Approval
Zoning Approval
Local Government Approval
Financial Responsibility/Ownership Form
Erosion Control Specifications
Seeding Specifications

DRAWINGS

Drawing No. 0	Title Sheet
Drawing No. 1	Drawing Index, Notes and Legend
Drawing No. 2	Quarter-Mile Radius Map
Drawing No. 3	North Disposal Area Footprint and Flood Hazard Soil Limits
Drawing No. 4	Phase 1 Erosion and Sediment Control Plan - Overview
Drawing No. 5	Erosion and Sediment Control Features for Phased Waste Progression (Progression Stages 1 and 2)
Drawing No. 6	Erosion and Sediment Control Features for Phased Waste Progression (Progression Stages 3 and 4)
Drawing No. 7	Final Grading Plan (North Disposal Area)
Drawing No. 8	Erosion and Sediment Control Plan Details
Drawing No. 9	Erosion and Sediment Control Plan Details

CALCULATIONS

1.0 PROJECT DESCRIPTION

The subject property is the site of a proposed construction and demolition debris (C&D) landfill. Material Recovery, LLC (MR) owns the property. MR will operate the facility as it is being developed for the disposal of construction and demolition debris.

The property is adjacent to SR2553, known as Brownfield Road, and is located in Wake County, North Carolina. The site is approximately 4 miles northwest of Clayton and 5.5 miles southeast of Raleigh.

Access to the site will be from SR2553 approximately 0.25 miles south of the intersection of Brown-Field Road and Old Battle Bridge Road.

Development of the site will ultimately involve the construction of two disposal areas, the north disposal area, and the south disposal area. Ultimately, the north disposal area will be approximately 48 acres in size; the south disposal area will be approximately 27 acres in size. Permits for the development of each disposal area will be limited to five-year phases in accordance with regulations of the Solid Waste Section, Division Of Waste Management, North Carolina Department of Environment, Health and Natural Resources (NCDEHNR). Each phase will be constructed in stages to minimize excessive expenditures at the start of each phase. Staged development will also help to minimize areas of disturbance that would otherwise go unused by the developer for long periods of time, and which would be subject to erosion during the unused period. The erosion and sediment control plan that is the subject of this application is for Phase 1 of the north disposal area only.

2.0 EXISTING SITE CONDITIONS

The site is characterized by gently sloping hillsides ranging in elevation from 295 to 180 feet above mean sea level (MSL). Its land use in the past has been primarily agricultural. Portions of the property have been logged and cleared, and used as sludge application fields by the City of Raleigh. Two large man-made ponds are present on the property. Buffers will be provided around the ponds to minimize disturbance. Two residential structures used by previous property owners are also present on the site. The north structure and its water supply well will be removed because it lies within the footprint of the proposed landfill. The south structure is proposed to remain intact.

3.0 ADJACENT AREAS

The site is bounded on the east by SR2553, on the north by property owned by the City of Raleigh, on the west by properties owned by Horace Benton Heirs, Polly S. Quinn and MR, and on the south by properties owned by John and Marie Baucom and Margaret Talton. A 200-foot wide buffer will be maintained around the entire property boundary.

4.0 SOIL

Surficial soils on-site are predominantly silty sands and elastic silts. Underlying soils are predominantly silty sands and clayey sands.

5.0 CRITICAL EROSION AREAS

The most critical erosion area will be the surface of the disposal area during landfilling operations. The active face of disposed waste will be covered with compacted soil on a weekly basis. When the waste has reached the height of the perimeter berm, runoff from the covered portions of the landfill will flow to the stormwater conveyance channels adjacent to the access roads. If grass has not yet been established on covered portions of the landfill, then there is a significant potential for the covered areas to be eroded and for sediment to be carried in the runoff. To minimize the potential for erosion, covered areas that are temporarily inactive will be seeded within 30 working days or 120 calendar days after placement of the soil cover, whichever period is shorter. Stormwater channels at the perimeter of the waste disposal area will convey flow to the on-site sediment basin to minimize the potential impact of sediment leaving the disposal area. In addition to providing sediment removal, the basin will reduce the peak rate of discharge to below the pre-developed peak rate of runoff so that excessive velocities in the receiving channel are avoided.

6.0 EROSION AND SEDIMENT CONTROL MEASURES

All vegetative practices and erosion and sediment control features shall be constructed and maintained in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual (NCESCPDM). Design of the features is in accordance with NCESCPDM and the requirements of the NC Department of Environment, Health and Natural Resources, Division of Waste Management. The features are designed to control runoff resulting from the 25-year frequency storm. Supporting design calculations are attached. Plan-view drawings with details are also provided.

6.1 Sediment Basin (Reference NCESCPDM 6.61)

A sediment basin will be constructed at the west end of the proposed north disposal area. The basin is sized to handle runoff from the entire north disposal area when it reaches the maximum proposed footprint size of approximately 48 acres. The disposal area will be developed in phases that are considerably smaller than the size of the ultimate footprint, and the sediment basin will receive runoff from each active phase. At no time during development of the disposal area will the area draining to the basin exceed the area upon which the design of the basin is based (48 acres). Accumulated sediment will be removed from the sediment basin as needed to maintain the design storage capacity. See supporting calculations.

6.2 Temporary Stormwater Diversion Berms (Reference NCESCPDM 6.20)

Inactive portions of the cells that have not received waste will be separated from the active area by the use of temporary diversion berms to segregate uncontaminated and contaminated runoff. As the waste filling progresses, the diversion berms will be relocated to allow for continued filling within the cell. As subsequent cells are opened in the planned sequence, uncontaminated stormwater will be diverted around the active portions of cells for collection and removal.

Temporary stormwater diversion berms will be constructed downgradient of the proposed roadway embankment at the locations shown on the drawings. The diversion berms will direct stormwater runoff from the embankment to a sediment trap during construction of the embankment and roadway. Temporary liners have been specified as needed to protect the berms against erosive velocities. See supporting calculations.

6.3 Temporary Sediment Traps (Reference NCESCPDM 6.60)

Sediment traps will be constructed for at the locations shown on the drawings. The traps provide a minimum of 1800 cubic feet of storage capacity below the outlet crest for each acre of disturbed area draining to the trap. Accumulated sediment will be removed from the sediment traps as needed to maintain the design storage capacity. See supporting calculations.

6.4 Sediment Fence (Reference NCESCPDM 6.62)

Sediment fences will be provided downgradient of the proposed roadway embankment at the locations shown on the drawings. The sediment fences will direct flow to either a sediment deposition area behind the fence or to a sediment trap.

6.5 Grass-Lined Channel (Reference NCESCPDM 6.30)

Grass-lined channels will be constructed at the locations shown on the drawings to direct stormwater runoff to either the proposed sediment basin or to one of the proposed sediment traps. Temporary liners will be provided as needed to protect against erosive velocities in the channels. See supporting calculations.

7.0 VEGETATIVE STABILIZATION

Vegetative cover shall be re-established within 30 working days or 120 calendar days after completion of the activity, whichever period is shorter. Temporary and permanent seeding specifications are attached.

8.0 TEMPORARY STABILIZATION

Disturbed areas will be vegetated in accordance with section 7.0 and the seeding specifications. Temporary control features will remain in place and will be maintained until the upgradient disturbed area has been stabilized with vegetative cover.

9.0 MAINTENANCE

Sediment traps shall be inspected regularly during land disturbing activities and after each significant rainfall. Sediment shall be removed and the trap restored to its original dimensions when sediment has accumulated to one-half the design depth of the trap. Portions of the trap's gravel facing that are contaminated by sediment shall be replaced with fresh gravel during each sediment removal episode.

The sediment basin shall be inspected regularly during land disturbing activities and after each significant rainfall. Sediment shall be removed, and the basin restored to its original dimensions when sediment accumulates to one-half the design depth. The embankment, spillways, and outlet shall be inspected regularly for signs of piping and settlement. Repairs shall be made immediately. The riser and pool area shall be kept free of trash and other debris.

Temporary diversion berms shall be inspected weekly and after each significant rainfall. Accumulated sediment shall be removed immediately from the flow area, and diversion berms repaired promptly. When the upgradient area has been stabilized, remove the diversion berm and the channel so that the grade blends in with the surrounding ground. Stabilize the area of the former berm with vegetation.

Grass-lined channels shall be checked after every rainfall while grass in the channel is being established. After grass is established, the channel shall be checked after each heavy rainfall event, and repairs made immediately. Accumulated sediment shall be removed as necessary to maintain the design capacity of the channel. Grass that is lining the channel shall be kept in a healthy and vigorous condition at all times.

Sediment fences shall be inspected at least once a week and after each rainfall. Repairs shall be made immediately. Sediment deposits shall be removed as needed to provide adequate storage volume for the next rainfall event, and to reduce pressure on the fence. Fencing materials and sediment deposits shall be removed, and the area brought to grade following stabilization of upgradient disturbed areas.

10.0 CONSTRUCTION SEQUENCE

1. Obtain plan approval and other applicable permits.

2. Schedule a pre-construction conference with the Wake County EFS Environmental Engineer.

3. Install gravel construction pad, temporary diversions berms and temporary stormwater conveyance channels, silt fence, sediment traps, sediment basin and other measures as shown on the approved plan. Clear only as necessary to install these devices. Seed temporary diversions, berms and basins immediately after construction.

4. Call the Wake County EFS Environmental Engineer for an onsite inspection to obtain a Certificate of Compliance.

5. Begin clearing and grubbing. Inspect erosion and sediment control features on a regular basis throughout the construction period and immediately following each significant rainfall. Make repairs immediately.

6. Begin construction. Stockpile excess soil.

7. Stabilize the site as areas are brought to finish grade. Use vegetation, ditch linings, etc. as per the Contract Documents. Seed and mulch denuded areas within fifteen (15) days of completion of any phase of construction.

8. When construction is complete and all areas are stabilized completely, call the EFS Environmental Engineer for an inspection.

9. Begin landfilling activities after all required approvals are obtained from the regulatory authorities.

10. Prior to the end of landfilling activities for each stage of development, construct erosion control features that will serve the next stage of construction and landfilling operations. Call the Wake County EFS Environmental Engineer for an onsite inspection to obtain a Certificate of Compliance. Begin construction of the next stage of development. Stockpile excess soil.

11. When construction of each stage is complete and all areas are stabilized completely, call the EFS Environmental Engineer for an inspection. Begin landfilling activities in the newly constructed disposal area after all required approvals are obtained from the regulatory authorities.

12. Following stabilization of upgradient disturbed areas and approval by EFS, remove temporary diversions, silt fence and sediment traps, grade the affected areas to blend with the surrounding terrain. Do not remove the sediment basin or diversions that convey flow to the basin.

13. Seed and stabilize all denuded areas immediately after grading is completed. When vegetation has become established, call for a site inspection by the EFS Environmental Engineer. Obtain a Certificate of Completion.

[END}

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job

Job No. Sheet No. of

Calculated by Date

Checked by Date

Subject Scale

STORMWATER CONVEYANCE CHANNELS

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job Wake County : Brownfield Rd

Job No. ______ Sheet No. ____ of ____

Calculated by RH Date 12-21-01

Checked by ______ Date ______

Subject ______ Scale ______

Temporary Liner Calcs:

SCC 9A

$A = 5.60$ ac

$T_c = 3$ min.

Fig. 8.03(e) ⇒ $i_2(5 \text{ min.}) = 5.75$ in/hr

$C = 0.45$

$$Q_2 = (0.45)(5.75)(5.60)$$

$$Q_2 = 14.5 \text{ cfs}$$

Table 8.05(e) ⇒ straw w/ net ($d = 0.65$) → 'n' = 0.033

Flow Master → depth = 0.79

$$T = 62.4(0.79)(0.0225)$$

$$T = 1.11 < 1.45 \therefore$$ use straw w/ net

SCC 9B

$A = 12.41$ ac

$T_c = 8.5$ min

Fig. 8.03(e) ⇒ $i_2(8.5 \text{ min}) = 4.8$ in/hr

$C = 0.45$

$$Q_2 = (0.45)(4.8)(12.41)$$

$$Q_2 = 26.8 \text{ cfs}$$

Table 8.05(e) ⇒ Straw w/ net (0.5-2') → $n = 0.033$

Flow Master → depth = 1.02'

$$T = 62.4(1.02)(0.0255)$$

$T = 1.62 > 1.45$ No good. Try Synthetic Mat. 'n' = 0.025

$$T = 62.4(0.90)(0.0255)$$

$T = 1.43 < 2.00$ O.K. ∴ use synthetic mat

RJH 12-21-01

SCC ~~8A~~ 9A Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.022500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	14.50	cfs

Results		
Depth	0.79	ft
Flow Area	3.44	ft^2
Wetted Perimeter	6.99	ft
Top Width	6.73	ft
Critical Depth	0.80	ft
Critical Slope	0.020749	ft/ft
Velocity	4.21	ft/s
Velocity Head	0.28	ft
Specific Energy	1.06	ft
Froude Number	1.04	
Flow is supercritical.		

RJH 12-21-01

SCC ~~8B~~ 9B - Bare Condition (Synthetic Mat)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.025500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	26.80	cfs

Results		
Depth	0.90	ft
Flow Area	4.21	ft²
Wetted Perimeter	7.68	ft
Top Width	7.39	ft
Critical Depth	1.09	ft
Critical Slope	0.010968	ft/ft
Velocity	6.36	ft/s
Velocity Head	0.63	ft
Specific Energy	1.53	ft
Froude Number	1.49	
Flow is supercritical.		

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job: Brownfield Rd
Job No.: Sheet No.: of
Calculated by: RJH Date: 12-21-01
Checked by: Date:
Subject: Scale:

Temp. Liner Calcs.

SCC - 9C

A = 18.15 ac
T_c = 13.2 min
Fig. 8.03(e) ⇒ $i_2(13.2) = 3.8$ in/hr
C = 0.45

$Q_2 = 0.45(3.8)(18.15)$
$Q_2 = 31.0$ cfs

Table 8.05(e) ⇒ straw w/ net → n = 0.033

Flow Master → depth = 1.11

$T = 62.4(1.11)(0.024)$
$T = 1.66 > 1.45$ No good ∴ try Synthetic Mat n=0.025

$T = 62.4(0.97)(0.024)$
$T = 1.45 < 2.00$ O.K use **Synthetic Mat**

SCC - 9D

A = 22.84 ac
T_c = 17.2 min
Fig. 8.03(e) ⇒ $i_2(17.2) = 3.2$ in/hr
C = 0.45

$Q_2 = 0.45(3.2)(22.84)$
$Q_2 = 32.9$ cfs

Table 8.05(e) ⇒ straw w/ net → n = 0.033

Flow Master → depth = 1.31

$T = 62.4(1.31)(0.01286) = 1.05 < 1.45$ ∴ use **straw w/ net**

RJH 12-21-01

9C

SCC-~~8C~~ Bare Condition (Synthetic Mat)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.024000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	31.00	cfs

Results		
Depth	0.97	ft
Flow Area	4.80	ft^2
Wetted Perimeter	8.16	ft
Top Width	7.85	ft
Critical Depth	1.17	ft
Critical Slope	0.010758	ft/ft
Velocity	6.46	ft/s
Velocity Head	0.65	ft
Specific Energy	1.62	ft
Froude Number	1.46	
Flow is supercritical.		

9D RJH 12-21-01

SCC ~~8D~~ Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.012860	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	32.90	cfs

Results		
Depth	1.31	ft
Flow Area	7.77	ft²
Wetted Perimeter	10.29	ft
Top Width	9.86	ft
Critical Depth	1.21	ft
Critical Slope	0.018597	ft/ft
Velocity	4.23	ft/s
Velocity Head	0.28	ft
Specific Energy	1.59	ft
Froude Number	0.84	
Flow is subcritical.		

Temp. Liner Calcs.

SCC-10A

A = 3.45 ac
Tc = 3 min
Fig. 8.03(e) ⇒ $i_2(5) = 5.75$ in/hr
C = 0.45

$$Q_2 = (0.45)(5.75)(3.45)$$
$$Q_2 = 8.93 \text{ cfs}$$

Table 8.05(e) → straw w/ net → n = 0.033

Flow Master → depth = 0.61

$$T = 62.4(0.61)(0.024)$$
$$T = 0.91 < 1.45$$ ∴ use <u>straw w/ net</u>

SCC-10B

A = 9.41 ac
Tc = 7.9
Fig. 8.03(e) ⇒ $i_2(7.9) = 4.8$ in/hr
C = 0.45

$$Q_2 = (0.45)(4.8)(9.41)$$
$$Q_2 = 20.3 \text{ cfs}$$

Table 8.05(e) → straw w/ net → n = 0.033

Flow Master → depth = 0.90

$$T = 62.4(0.90)(0.02475)$$
$$T = 1.39 < 1.45$$ O.K. use <u>straw w/ net</u>

10A

RJH 12-21-01

SCC-~~9A~~- Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.024000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	8.93	cfs

Results		
Depth	0.61	ft
Flow Area	2.36	ft²
Wetted Perimeter	5.88	ft
Top Width	5.68	ft
Critical Depth	0.63	ft
Critical Slope	0.022166	ft/ft
Velocity	3.79	ft/s
Velocity Head	0.22	ft
Specific Energy	0.84	ft
Froude Number	1.04	
Flow is supercritical.		

Grass-Lined Channel Design: Determine Q_{25}

SCC-1

Drainage Area = 0.40 x 1.17 ac = 0.47 acre

Find Tc: 1) Overland Flow L = 90' h_t = 12'
Channel Flow L = 140' h_t = 15' > Table 8.03(a) Tc = 1.25 min.

2) Use Table 8.03(e) → i_{25} (5 min duration) = 8.0 inch/hr.

Table 4.1
C = 0.45

3) $Q_{25} = C i_{25} A = 0.45 (8.0)(0.47) = 1.69$ cfs ✓

SCC-2

Drainage Area = 0.60 (1.17 ac) + 0.29 ac = 0.99 acre

Find Tc: 1) Overland Flow L = 65' h_t = 18'
Channel Flow L = 500' h_t = 23' > Table 8.03(a) Tc = 3.5 mins

2) Table 8.03(e) → i_{25} (5 mins duration) = 8.0 in/hr.

3) $Q_{25} = 0.45(8.0)(0.99) = 3.56$ cfs ✓

SCC-3

Drainage Area = 0.10 (1.18 ac) = 0.12 acre

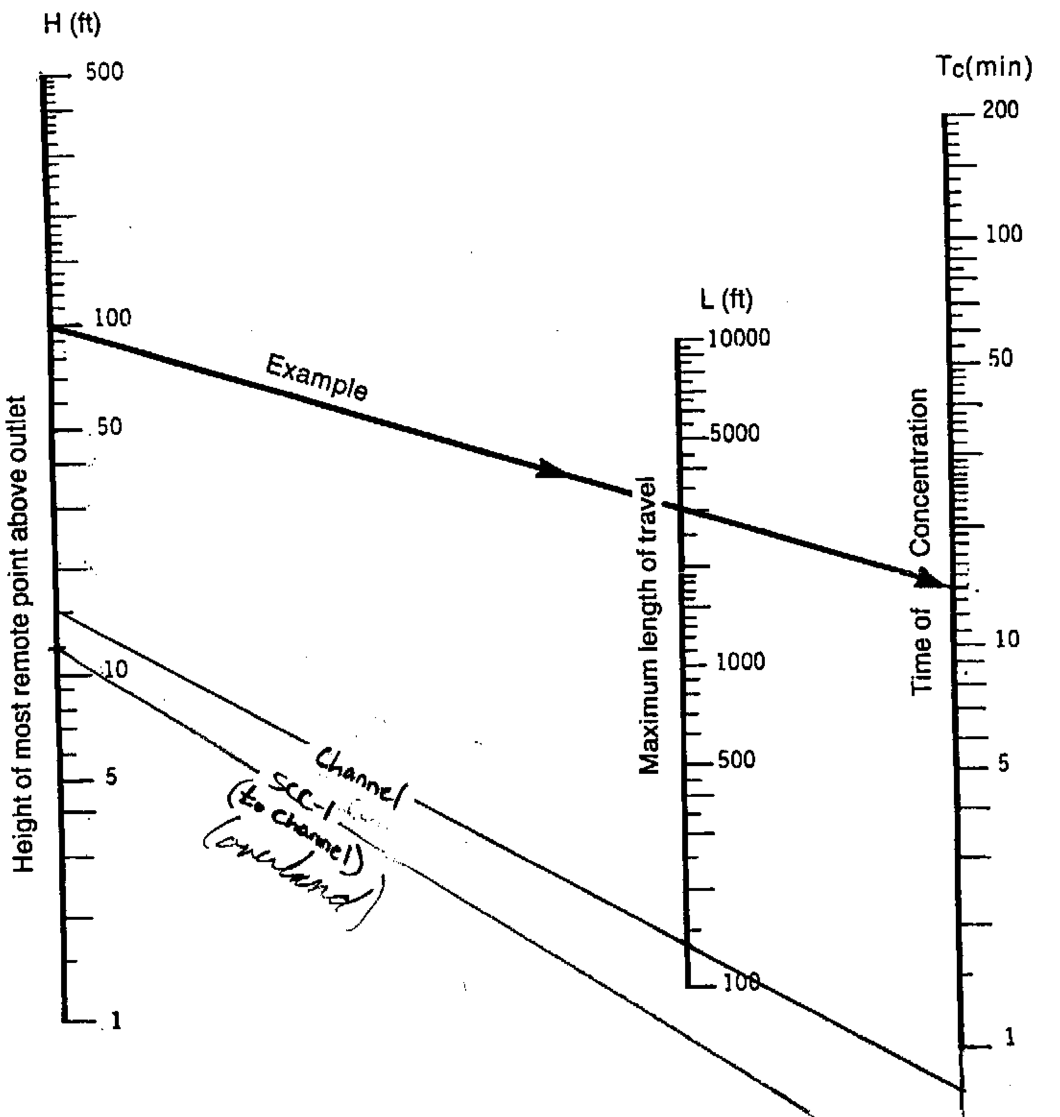
Find Tc: 1) Overland Flow L = 60' h_t = 17'
Channel Flow L = 50' h_t = 6' > Table 8.03(a) Tc < 1 min

2) Table 8.03(e) → i_{25} (5 mins) = 8.0 in/hr.

3) $Q_{25} = 0.45 (8.0)(0.12) = 0.43$ cfs ✓

RJH

SCC-1



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply T_c by 2.

For overland flow, concrete or asphalt surfaces, multiply T_c by 0.4.

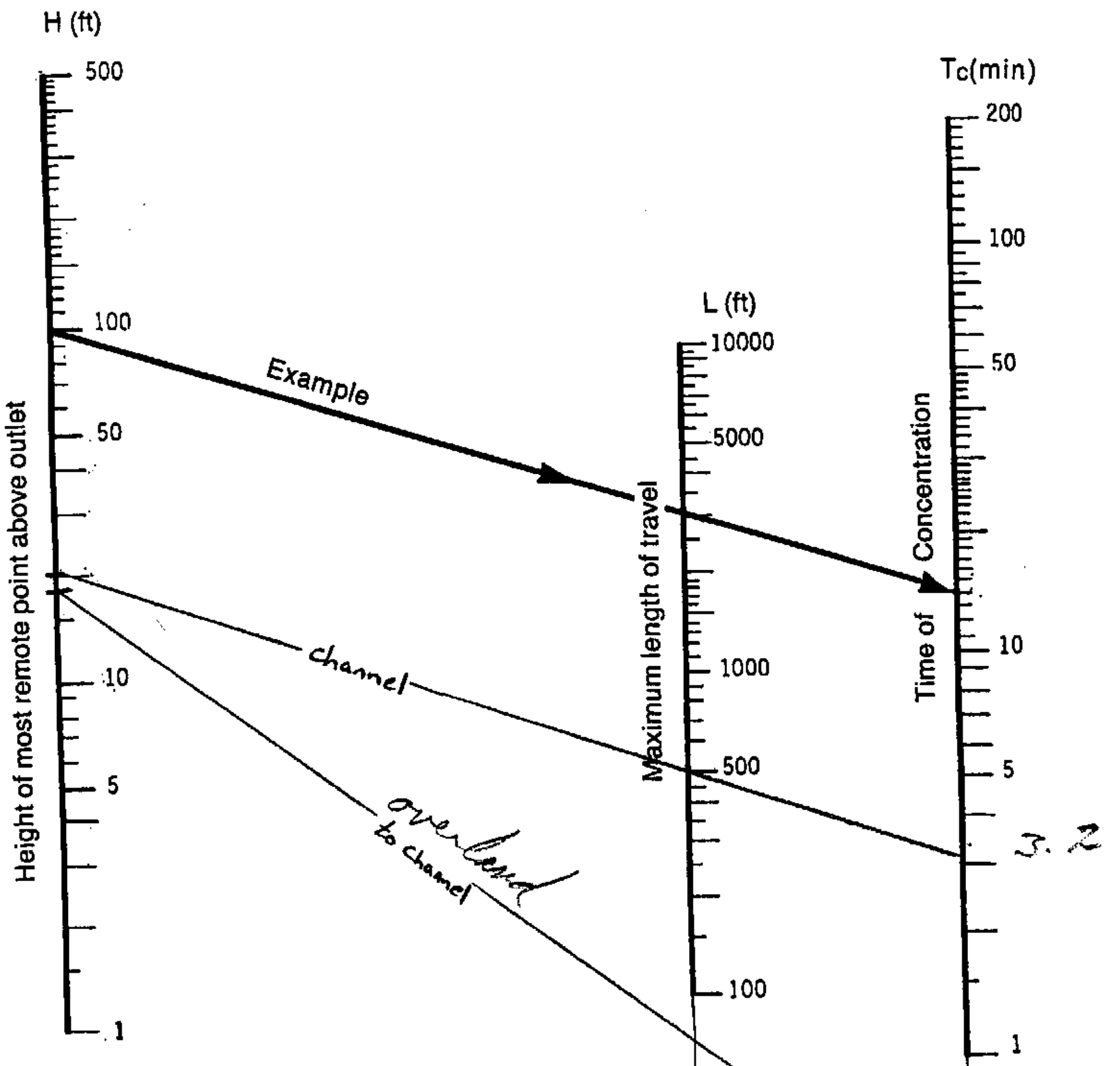
For concrete channels, multiply T_c by 0.2.

$T_c = 1.25$ min.

Figure 8.03a Time of concentration of small drainage basins.

RJH

SCC-2



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

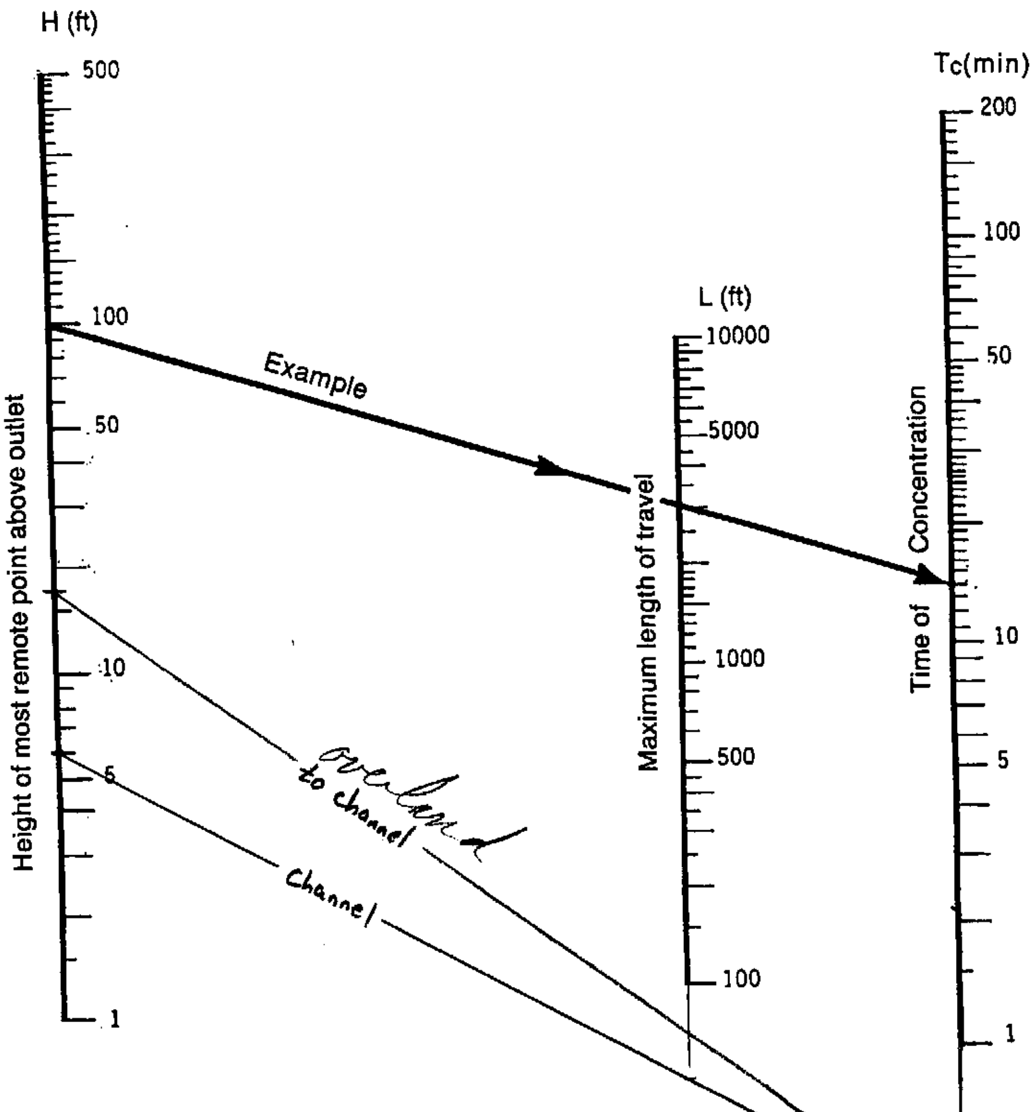
For concrete channels, multiply Tc by 0.2.

Tc = .34 + 3.2
= 3.54

Figure 8.03a Time of concentration of small drainage basins.

RJH

SCC-3



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Tc < 1.0 min

Figure 8.03a Time of concentration of small drainage basins.

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job: Material Recovery - Brownfield Rd

Job No.: Sheet No. 3 of

Calculated by: RJH Date: 12-12-01

Checked by: Date:

Subject: Scale:

SCC-4

Drainage Area = 0.90 (1.18 ac) = 1.06 acre

Find T_c: 1) Overland Flow L = 70' h_t = 16'
Channel Flow L = 490' h_t = 19' > Table 8.03(a) T_c = 3.6 min

2) Table 8.03(e) → i_{25} (5 mins) = 8.0 in/hr

3) Q_{25} = 0.45(8.0)(1.06) = 3.82 cfs ✓

SCC-5

Drainage Area = 0.20 (1.05) = 0.21 acre

Find T_c: 1) Overland Flow L = 70' h_t = 17'
Channel Flow L = 105' h_t = 5' > Table 8.03(a) T_c < 1 min

2) Table 8.03(e) → i_{25} (5 mins) = 8.0 in/hr

3) Q_{25} = 0.45(8.0)(0.21) = 0.76 cfs ✓

SCC-6

Drainage Area = 0.80 (1.05) = 0.84 acre

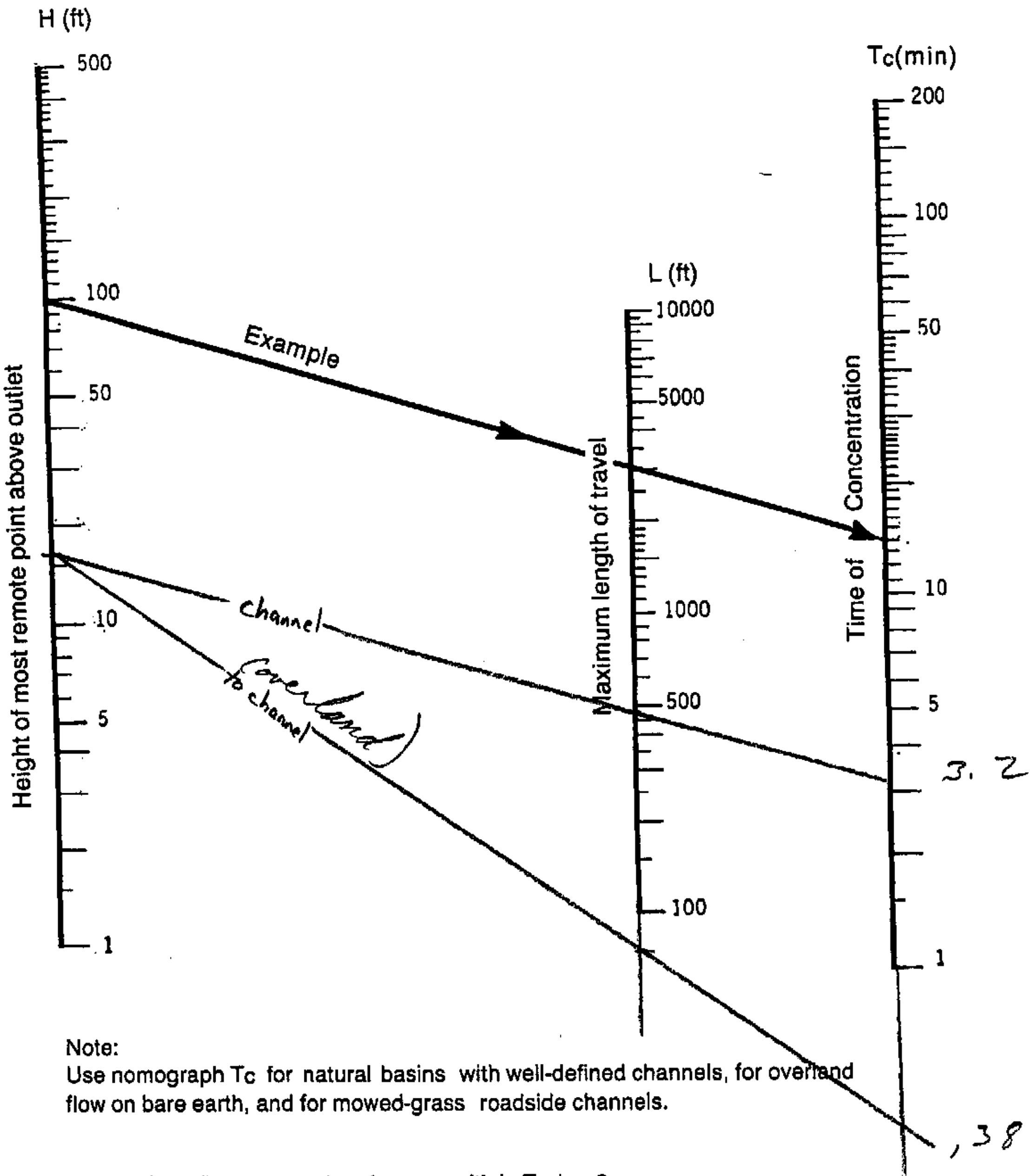
Find T_c: 1) Overland Flow L = 40' h_t = 3'
Channel Flow L = 530' h_t = 36' > Table 8.03(a) T_c = 3.0 min

2) Table 8.03(e) → i_{25} (5 mins) = 8.0 in/hr

3) Q_{25} = 0.45(8.0)(0.84) = 3.02 cfs

RJH

SCC-4



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

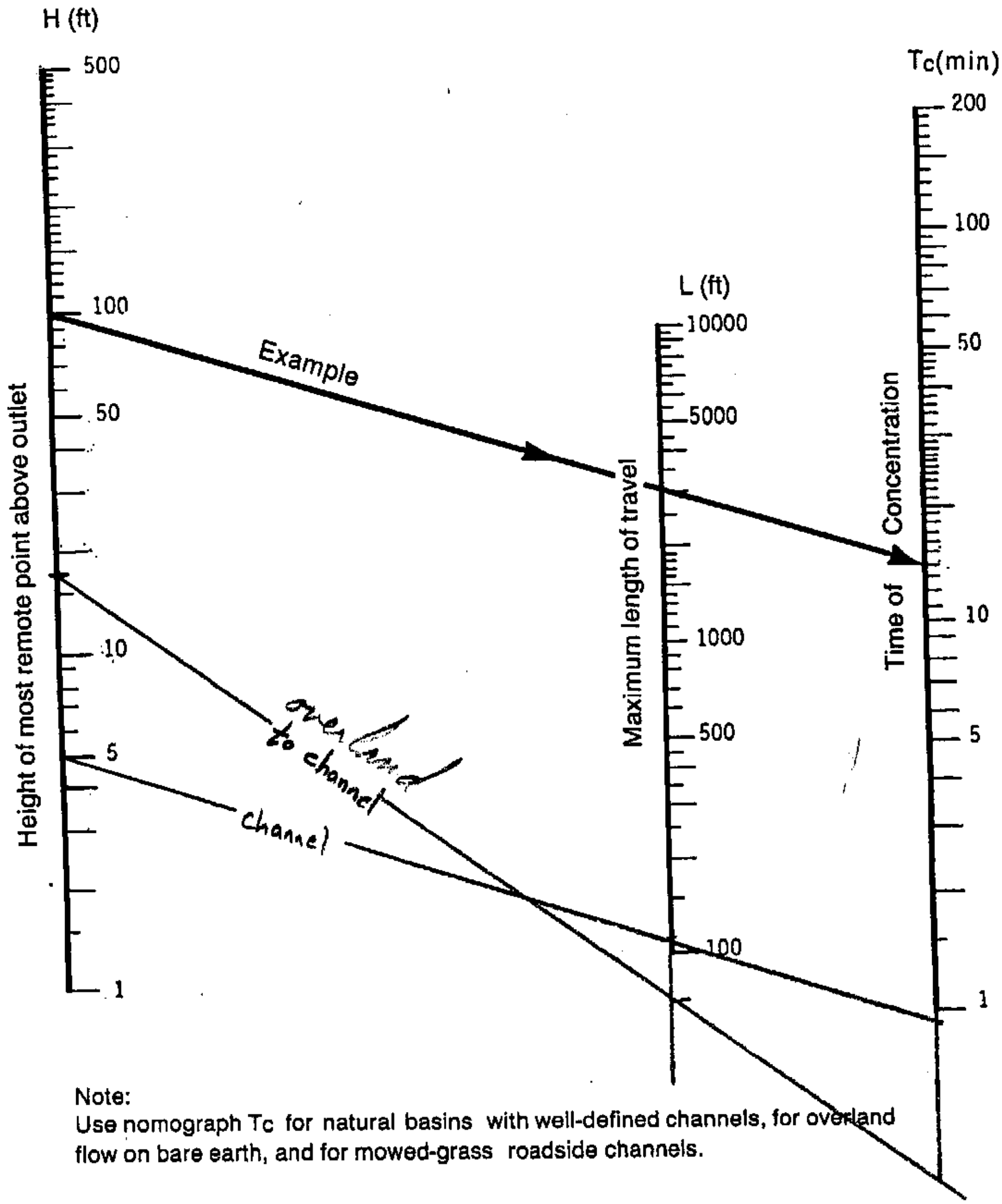
For concrete channels, multiply Tc by 0.2.

Tc ≈ 3.2 min
+.38
3.58

Figure 8.03a Time of concentration of small drainage basins.

RJH

SCC-5



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

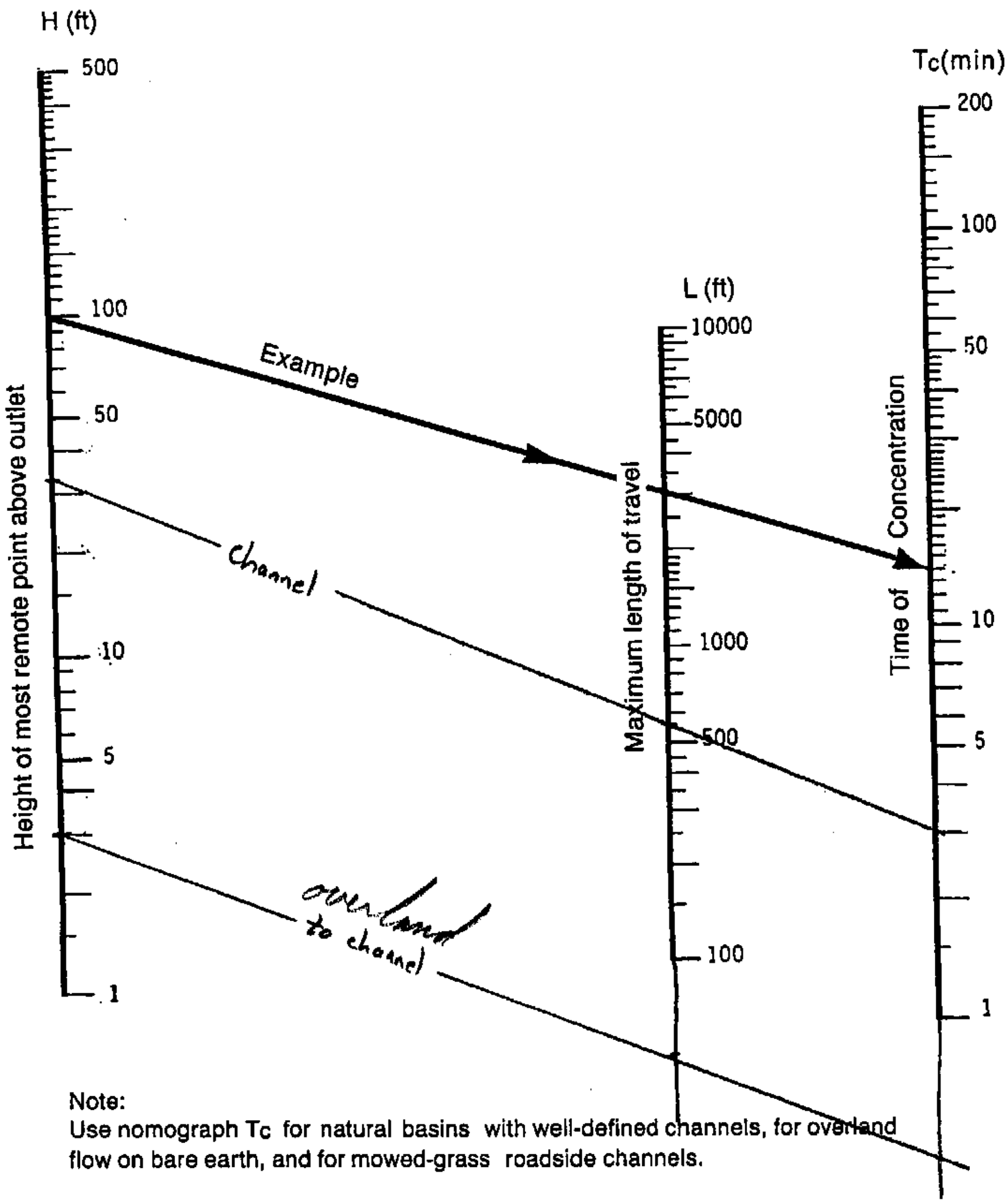
$T_c <$ 1.0 min

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

RJH

SCC-6



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

$T_c \approx 3.0$ min

Figure 8.03a Time of concentration of small drainage basins.

JOYCE ENGINEERING, INC.

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Job Material Recovery - Brownfield Rd

Job No. ______ Sheet No. 4 of ____

Calculated by RJH Date 12-12-01

Checked by ______ Date ______

Subject ______ Scale ______

Shape of Grass-Lined Channels:

SCC-1:

slope = $\frac{15\ Ft}{140\ Ft}$ = 0.11 Ft/Ft

Table 8.05(a): Perm. Velocity = 4.0 Ft/sec

Required Area = $\frac{Q_{25}}{\text{Perm. Vel.}} = \frac{1.69\ cFs}{4.0\ Ft/s}$ = 0.42 sF

*See Attached Flow Master sheet For details.

SCC-2:

slope = $\frac{23'}{500'}$ = 0.05 Table 8.05(a) Vel. = 4.5 $\frac{Ft}{s}$ A = $\frac{3.56}{4.5}$ = 0.79 sF

* See Flow Master sheet.

SCC-3:

slope = $\frac{6'}{50'}$ = 0.12 $\frac{Ft}{Ft}$ Vel. = 4.0 $\frac{Ft}{s}$ A = $\frac{0.43}{4.0}$ = 0.11 s.F.

* see Flow Master sheet.

SCC-4:

slope = $\frac{19'}{490'}$ = 0.039 Vel. = 4.5 $\frac{Ft}{s}$ A = $\frac{3.82}{4.5}$ = 0.85 sF

* see Flow Master Sheet.

SCC-5:

slope = 5/105 = 0.047 Vel. = 4.5 Ft/s A = 0.76/4.5 = 0.17 sF

* see Flow Master sheet.

SCC-6:

slope = 36/530 = 0.06 Vel. = 4.0 Ft/s A = 3.02/4.0 = 0.76 sF

RJH

SCC-1 Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.092	
Channel Slope	0.110000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	1.69	cfs

Results		
Depth	0.38	ft
Flow Area	0.82	ft^2
Wetted Perimeter	3.41	ft
Top Width	3.29	ft
Critical Depth	0.32	ft
Critical Slope	0.215030	ft/ft
Velocity	2.07	ft/s < 4.0 OK
Velocity Head	0.07	ft
Specific Energy	0.45	ft
Froude Number	0.73	
Flow is subcritical.		

RJH

SCC-1 un-Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.320	
Channel Slope	0.110000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	1.69	cfs

Results		
Depth	0.68	ft < 1.0 OK
Flow Area	2.06	ft²
Wetted Perimeter	5.29	ft
Top Width	5.07	ft
Critical Depth	0.32	ft
Critical Slope	2.601757	ft/ft
Velocity	0.82	ft/s
Velocity Head	0.01	ft
Specific Energy	0.69	ft
Froude Number	0.23	
Flow is subcritical.		

RJH

SCC-2 Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.070	
Channel Slope	0.050000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	3.56	cfs

Results		
Depth	0.47	ft
Flow Area	1.60	ft^2
Wetted Perimeter	4.97	ft
Top Width	4.81	ft
Critical Depth	0.38	ft
Critical Slope	0.113576	ft/ft
Velocity	2.23	ft/s < 4.0 OK
Velocity Head	0.08	ft
Specific Energy	0.55	ft
Froude Number	0.68	
Flow is subcritical.		

RJH

SCC-2 un-Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.270	
Channel Slope	0.050000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	3.56	cfs

Results			
Depth	0.91	ft	< 1.0 OK
Flow Area	4.29	ft^2	
Wetted Perimeter	7.74	ft	
Top Width	7.45	ft	
Critical Depth	0.38	ft	
Critical Slope	1.689754	ft/ft	
Velocity	0.83	ft/s	
Velocity Head	0.01	ft	
Specific Energy	0.92	ft	
Froude Number	0.19		
Flow is subcritical.			

RJH

SCC-3 Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.140	
Channel Slope	0.120000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	0.43	cfs

Results			
Depth	0.23	ft	
Flow Area	0.40	ft^2	
Wetted Perimeter	2.48	ft	
Top Width	2.40	ft	
Critical Depth	0.15	ft	
Critical Slope	0.605715	ft/ft	
Velocity	1.08	ft/s	< 4.0 O.K
Velocity Head	0.02	ft	
Specific Energy	0.25	ft	
Froude Number	0.47		
Flow is subcritical.			

RJH

SCC-3 un-Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.320	
Channel Slope	0.120000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	0.43	cfs

Results		
Depth	0.35	ft < 1.0 OK
Flow Area	0.72	ft^2
Wetted Perimeter	3.23	ft
Top Width	3.11	ft
Critical Depth	0.15	ft
Critical Slope	3.164706	ft/ft
Velocity	0.59	ft/s
Velocity Head	0.01	ft
Specific Energy	0.36	ft
Froude Number	0.22	
Flow is subcritical.		

R N 14

SCC-4 Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.070	
Channel Slope	0.039000 ft/ft	
Left Side Slope	3.000000 H : V	
Right Side Slope	3.000000 H : V	
Bottom Width	2.00	ft
Discharge	3.82	cfs

Results		
Depth	0.52	ft
Flow Area	1.84	ft²
Wetted Perimeter	5.27	ft
Top Width	5.11	ft
Critical Depth	0.39	ft
Critical Slope	0.112418 ft/ft	
Velocity	2.08	ft/s < 4.0 OK
Velocity Head	0.07	ft
Specific Energy	0.58	ft
Froude Number	0.61	
Flow is subcritical.		

RJH

SCC-4 un-Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.260	
Channel Slope	0.039000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	3.82	cfs

Results		
Depth	0.98	ft < 1.0 OK
Flow Area	4.82	ft^2
Wetted Perimeter	8.18	ft
Top Width	7.86	ft
Critical Depth	0.39	ft
Critical Slope	1.550915	ft/ft
Velocity	0.79	ft/s
Velocity Head	0.01	ft
Specific Energy	0.99	ft
Froude Number	0.18	
Flow is subcritical.		

RJH

SCC-5 Mowed Condition
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake2
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.120	
Channel Slope	0.045000 ft/ft	
Left Side Slope	3.000000 H : V	
Right Side Slope	3.000000 H : V	
Discharge	0.76	cfs

Results		
Depth	0.50	ft
Flow Area	0.75	ft^2
Wetted Perimeter	3.17	ft
Top Width	3.01	ft
Critical Depth	0.33	ft
Critical Slope	0.409855 ft/ft	
Velocity	1.01	ft/s < 4.0 o.k.
Velocity Head	0.02	ft
Specific Energy	0.52	ft
Froude Number	0.36	
Flow is subcritical.		

RJH

SCC-5 un-Mowed Condition
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake2
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.330	
Channel Slope	0.045000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	0.76	cfs

Results		
Depth	0.73	ft < 1.0 OK
Flow Area	1.61	ft²
Wetted Perimeter	4.63	ft
Top Width	4.40	ft
Critical Depth	0.33	ft
Critical Slope	3.099776	ft/ft
Velocity	0.47	ft/s
Velocity Head	0.35e-2	ft
Specific Energy	0.74	ft
Froude Number	0.14	
Flow is subcritical.		

RJH

SCC-6 Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.075	
Channel Slope	0.060000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	3.02	cfs

Results		
Depth	0.52	ft
Flow Area	1.35	ft^2
Wetted Perimeter	4.32	ft
Top Width	4.15	ft
Critical Depth	0.44	ft
Critical Slope	0.132087	ft/ft
Velocity	2.24	ft/s < 4.0 OK
Velocity Head	0.08	ft
Specific Energy	0.60	ft
Froude Number	0.69	
Flow is subcritical.		

RJH

SCC-6 un-Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.280	
Channel Slope	0.060000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	3.02	cfs

Results		
Depth	0.94	ft < 1.0 OK
Flow Area	3.60	ft²
Wetted Perimeter	6.96	ft
Top Width	6.65	ft
Critical Depth	0.44	ft
Critical Slope	1.840920	ft/ft
Velocity	0.84	ft/s
Velocity Head	0.01	ft
Specific Energy	0.95	ft
Froude Number	0.20	
Flow is subcritical.		

ENGINEERING, INC.

Waste Industry Experts

Job: Wake County: Brownfield Rd

Job No. ______ Sheet No. ____ of ____

Calculated by RH Date ______

Checked by ______ Date ______

Subject ______ Scale ______

Q_{25} Calcs.

SCC-7

Drainage Area = 0.10 ac

T_c = Overland Flow = 60′ h_t = (212 − 210) = 2′
Channel Flow = 100′ h_t = (212 − 195) = 17′
> Table 8.03(a) T_c = < 1.0 min

Table 8.03(e) → i_{25}(5 min) = 8.0 in/hr.

$Q_{25} = 0.45 \times (8.0)(0.10) = 0.36$ cfs

SCC-8

Drainage Area = 0.67 ac

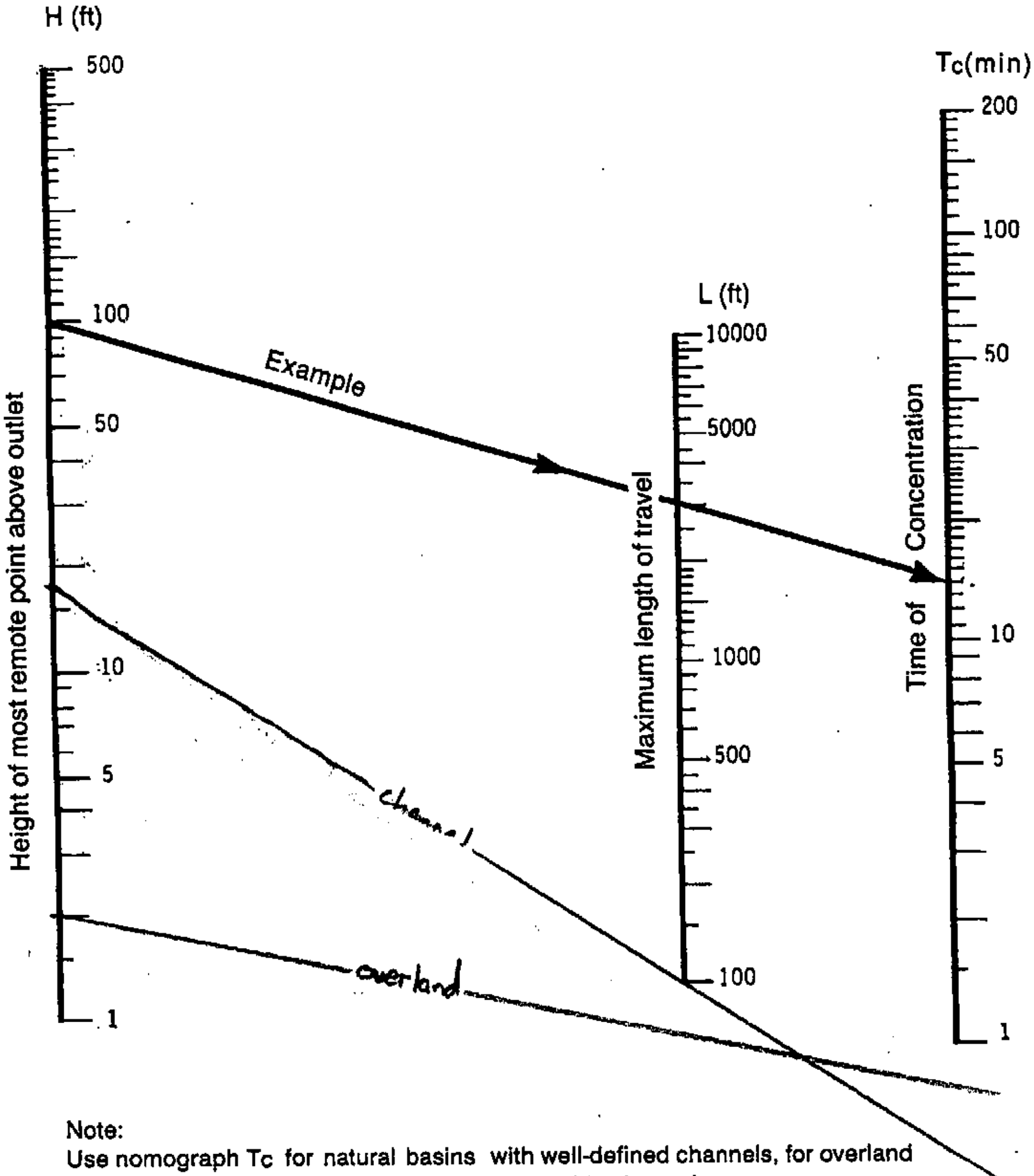
T_c = Overland Flow = 70′ h_t = (222 − 218) = 4′
Channel Flow = 370′ h_t = (218 − 195) = 23′
> Table 8.03(a) T_c = 2.5 min.

Table 8.03(e) → i_{25}(5 min) = 8.0 in/hr

$Q_{25} = 0.45 \times (8.0)(0.67) = 2.41$ cfs

RH

SCC-7



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

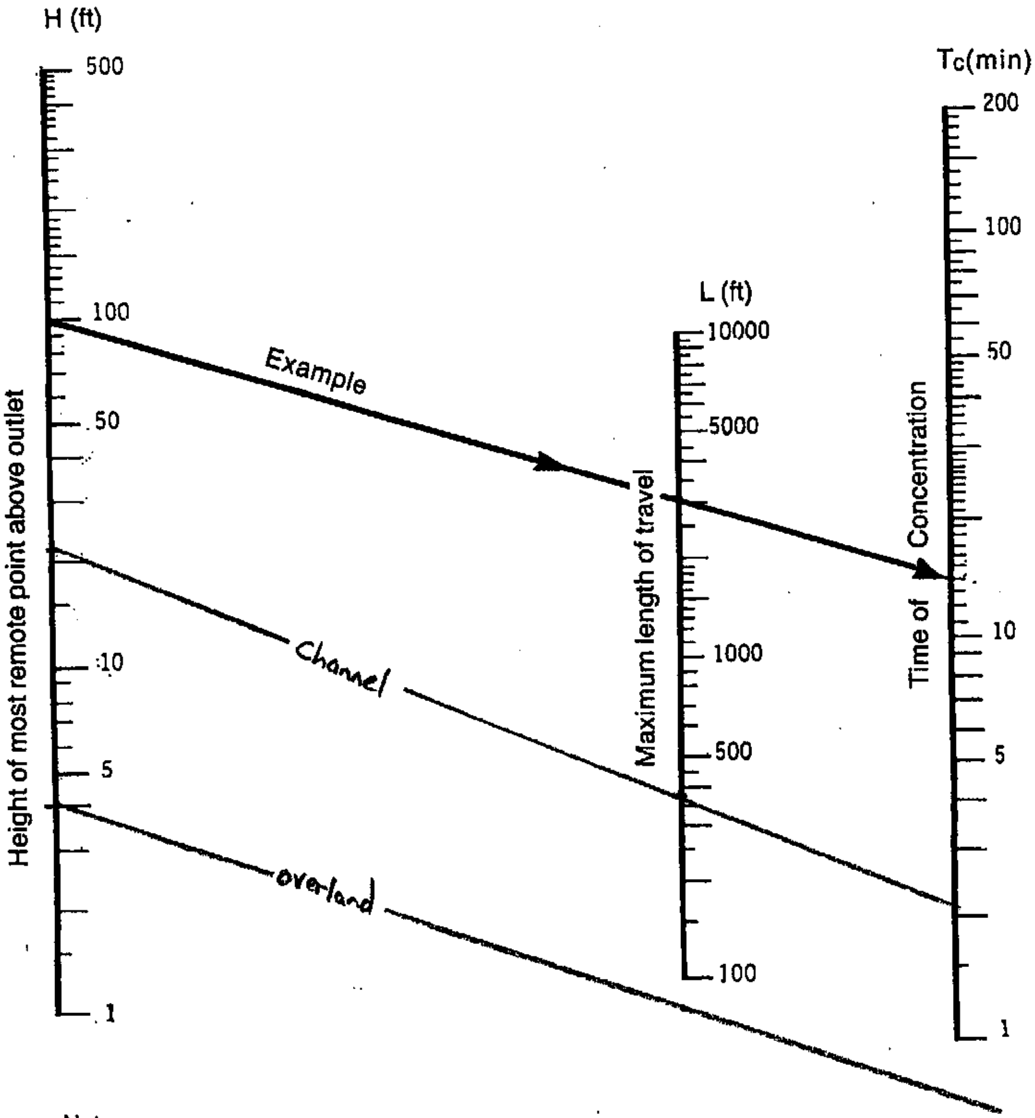
For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

RH

SCC-8



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

Shape of Grass-Lined Channels:

SCC-7

slope = $\frac{17'}{100'}$ = 0.17 ft/ft

Table 8.05(a): Perm. Velocity = 2.5 ft/sec

Req. Area = $\frac{Q_{25}}{\text{Perm. Vel.}}$ = $\frac{0.36}{2.5}$ = 0.14 sF

* see attached Flow Master Sheet for details.

SCC-8

slope = $\frac{23}{370}$ = 0.06

Perm. vel. = 4.0 ft/sec

Req. Area = $\frac{2.41}{4.0}$ = 0.60 sF

* see Attached Flow Master Sheet for details.

Check 'n' values for Mowed and Unmowed Conditions:

SCC-7 : VR = 2.45 × $\left(\frac{0.15}{3.52}\right)$ = 0.10 Fig. 8.05(c) ⇒ Mowed n = 0.20 Unmowed n = 0.32

(change to V-shape) VR = 0.94 × $\left(\frac{0.38}{2.26}\right)$ = 0.16 n = 0.15

VR = 1.16 × $\left(\frac{0.31}{2.03}\right)$ = 0.18 n = 0.14 ✓ o.k.

SCC-8 :

MOWED		UNMOWED	
VR = (3.87)$\left(\frac{0.62}{3.46}\right)$ = 0.69	n = 0.068		n = 0.18
VR = (2.18)$\left(\frac{1.11}{4.28}\right)$ = 0.57	n = 0.072	VR = (1.08)$\left(\frac{2.24}{5.74}\right)$ = 0.42	n = 0.27
VR = (2.09)$\left(\frac{1.15}{4.34}\right)$ = 0.55	n = 0.072	VR = (0.80)$\left(\frac{3.01}{6.57}\right)$ = 0.37	n = 0.28

RH

SCC-7 Mowed Condition
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.140	
Channel Slope	0.170000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	0.36	cfs

Results		
Depth	0.31	ft
Flow Area	0.29	ft^2
Wetted Perimeter	1.98	ft
Top Width	1.88	ft
Critical Depth	0.25	ft
Critical Slope	0.616349	ft/ft
Velocity	1.23	ft/s
Velocity Head	0.02	ft
Specific Energy	0.34	ft
Froude Number	0.55	
Flow is subcritical.		

RH

SCC-7 un-Mowed Condition
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.320	
Channel Slope	0.170000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	0.36	cfs

Results		
Depth	0.43	ft
Flow Area	0.55	ft^2
Wetted Perimeter	2.70	ft
Top Width	2.56	ft
Critical Depth	0.25	ft
Critical Slope	3.220442	ft/ft
Velocity	0.66	ft/s
Velocity Head	0.01	ft
Specific Energy	0.43	ft
Froude Number	0.25	
Flow is subcritical.		

RH

SCC-8 Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.072	
Channel Slope	0.060000 ft/ft	
Left Side Slope	3.000000 H : V	
Right Side Slope	3.000000 H : V	
Bottom Width	2.00	ft
Discharge	2.41	cfs

Results		
Depth	0.37	ft
Flow Area	1.15	ft^2
Wetted Perimeter	4.34	ft
Top Width	4.22	ft
Critical Depth	0.30	ft
Critical Slope	0.127316 ft/ft	
Velocity	2.09	ft/s
Velocity Head	0.07	ft
Specific Energy	0.44	ft
Froude Number	0.70	
Flow is subcritical.		

RH

SCC-8 un-Mowed Condition
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.280	
Channel Slope	0.060000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	2.41	cfs

Results		
Depth	0.73	ft
Flow Area	3.09	ft^2
Wetted Perimeter	6.65	ft
Top Width	6.41	ft
Critical Depth	0.30	ft
Critical Slope	1.925466	ft/ft
Velocity	0.78	ft/s
Velocity Head	0.01	ft
Specific Energy	0.74	ft
Froude Number	0.20	
Flow is subcritical.		

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job Material Recovery - Brownfield Rd

Job No. ______ Sheet No. ____ of ____

Calculated by RJH Date 12-12-01

Checked by ______ Date ______

Subject ______ Scale ______

Calculations to Determine Temporary Liner:

Use Q_2

Table 8.03(e) ⟶ $i = 5.75$ in/hr @ $T_c = 5$ min.

		Table 8.05(e) straw w/net		
SCC-1	$Q_2 = 0.45(5.75)(0.47) = 1.22$ cfs	$n = 0.065$ ✓	* see Flow	Master
SCC-2	$Q_2 = 0.45(5.75)(0.99) = 2.56$ cfs	$n = 0.065$ ✓	"	"
SCC-3	$Q_2 = 0.45(5.75)(0.12) = 0.31$ cfs	$n = 0.065$ ✓	"	"
SCC-4	$Q_2 = 0.45(5.75)(1.06) = 2.74$ cfs	$n = 0.065$	"	"
SCC-5	$Q_2 = 0.45(5.75)(0.21) = 0.54$ cfs	$n = 0.065$ ✓	"	"
SCC-6	$Q_2 = 0.45(5.75)(0.84) = 2.17$ cfs	$n = 0.065$	"	"
SCC-7	$Q_2 = 0.45(5.75)(0.10) = 0.26$ cfs	$n = 0.065$	"	"
SCC-8	$Q_2 = 0.45(5.75)(0.67) = 1.73$ cfs	$n = 0.065$	"	"

RJH 12-19-01

SCC-1 Bare Condition (straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.110000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	1.22	cfs

Results		
Depth	0.27	ft
Flow Area	0.50	ft²
Wetted Perimeter	2.73	ft
Top Width	2.64	ft
Critical Depth	0.27	ft
Critical Slope	0.112281	ft/ft
Velocity	2.44	ft/s
Velocity Head	0.09	ft
Specific Energy	0.37	ft
Froude Number	0.99	
Flow is subcritical.		

Shear Stress (T):

$T = 62.4 \frac{lbs}{Ft^3} (0.27\ Ft)(0.11 \frac{Ft}{Ft})$

$T = 1.85 \frac{lbs}{SF}$

Table 8.05g: straw w/ net $T_d = 1.45$ ∴ 1.85 > 1.45 No good

use synthetic mat $T_d = 2.00$

RJH 12-19-01

SCC-2 Bare Condition (straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.050000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	2.56	cfs

Results		
Depth	0.38	ft
Flow Area	1.20	ft²
Wetted Perimeter	4.41	ft
Top Width	4.28	ft
Critical Depth	0.31	ft
Critical Slope	0.102829	ft/ft
Velocity	2.14	ft/s
Velocity Head	0.07	ft
Specific Energy	0.45	ft
Froude Number	0.71	
Flow is subcritical.		

$T = 62.4(0.38)(0.05)$

$T = 1.18$

$1.18 < 1.45 \therefore$ use straw w/ net

RJH 12-12-01

SCC-3 Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Material Recovery: Brownfield Road (2)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.120000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	0.31	cfs

Results		
Depth	0.13	ft
Flow Area	0.18	ft^2
Wetted Perimeter	1.83	ft
Top Width	1.78	ft
Critical Depth	0.13	ft
Critical Slope	0.137270	ft/ft
Velocity	1.70	ft/s < 2.0 No Liner
Velocity Head	0.05	ft
Specific Energy	0.18	ft
Froude Number	0.94	
Flow is subcritical.		

RJH 12-19-01

SCC-4 Bare Condition (straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.039000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	2.74	cfs

Results		
Depth	0.42	ft
Flow Area	1.37	ft^2
Wetted Perimeter	4.66	ft
Top Width	4.52	ft
Critical Depth	0.33	ft
Critical Slope	0.101791	ft/ft
Velocity	2.00	ft/s
Velocity Head	0.06	ft
Specific Energy	0.48	ft
Froude Number	0.64	
Flow is subcritical.		

$T = 62.4(0.42)(0.039)$

$T = 1.02$

$1.02 < 1.45$ ∴ use <u>straw w/ net</u>

RJH 12-12-01

SCC-5 Bare Condition (straw w/ net)
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Material Recovery: Brownfield Road C&D
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.045000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	0.54	cfs

Results			
Depth	0.35	ft	
Flow Area	0.37	ft²	
Wetted Perimeter	2.22	ft	
Top Width	2.10	ft	
Critical Depth	0.29	ft	
Critical Slope	0.125869	ft/ft	
Velocity	1.47	ft/s	< 2.0 No Liner
Velocity Head	0.03	ft	
Specific Energy	0.38	ft	
Froude Number	0.62		
Flow is subcritical.			

RJH 12-19-01

SCC-6 Bare Condition (jutenet)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.028	
Channel Slope	0.060000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	1.00	ft
Discharge	2.17	cfs

Results		
Depth	0.28	ft
Flow Area	0.51	ft^2
Wetted Perimeter	2.77	ft
Top Width	2.68	ft
Critical Depth	0.37	ft
Critical Slope	0.019252	ft/ft
Velocity	4.23	ft/s
Velocity Head	0.28	ft
Specific Energy	0.56	ft
Froude Number	1.70	
Flow is supercritical.		

$T = 62.4(0.28)(0.06)$

$T = 1.05$

$1.05 < 1.45$ ∴ use Jute net

RJH 12-20-01

SCC-7 Bare Condition (synthetic mat)
Worksheet for Triangular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.036
Channel Slope	0.170000 ft/ft
Left Side Slope	3.000000 H : V
Right Side Slope	3.000000 H : V
Discharge	0.26 cfs

Results		
Depth	0.17	ft
Flow Area	0.08	ft^2
Wetted Perimeter	1.05	ft
Top Width	1.00	ft
Critical Depth	0.22	ft
Critical Slope	0.042567	ft/ft
Velocity	3.13	ft/s
Velocity Head	0.15	ft
Specific Energy	0.32	ft
Froude Number	1.91	
Flow is supercritical.		

$T = 62.4(0.17)(0.17) = 1.80 < 2.00$ ∴ use synthetic mat

RJH 12-20-01

SCC-8 Bare Condition (straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County: Brownfield Road
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.065	
Channel Slope	0.060000 ft/ft	
Left Side Slope	3.000000 H : V	
Right Side Slope	3.000000 H : V	
Bottom Width	2.00	ft
Discharge	1.73	cfs

Results		
Depth	0.29	ft
Flow Area	0.85	ft²
Wetted Perimeter	3.86	ft
Top Width	3.77	ft
Critical Depth	0.25	ft
Critical Slope	0.109185 ft/ft	
Velocity	2.04	ft/s
Velocity Head	0.06	ft
Specific Energy	0.36	ft
Froude Number	0.76	
Flow is subcritical.		

$T = 62.4(0.29)(0.06)$

$T = 1.08 < 1.45$ ∴ use straw w/ net

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job: Material Recovery - Brownfield Rd

Job No. ____ Sheet No. ____ of ____

Calculated by: RJH Date: 12-20-01

Checked by ____ Date ____

Subject ____ Scale ____

Summary

ST-1 : Dimensions (30′ x 30′ x 3′)
ST-2 : Dimensions (30′ x 25′ x 3′)
ST-3 : Dimensions (30′ x 25′ x 3′)
ST4 : (35 x 40 x 3)
ST5 : (40 x 45 x 3)
ST6 : (20 x 25 x 3)

SCC-1 : grass-lined, trapezoidal, 3:1 H:V side slopes, bottom width = 2.0′, slope = 11%
SCC-2 : grass-lined, trapezoidal, 3:1 H:V side slopes, bottom width = 2.0′, slope = 5%
SCC-3 : grass-lined, trapezoidal, 3:1 H:V side slopes, bottom width = 1.0′, slope = 12%
SCC-4 : grass-lined, trapezoidal, 3:1 H:V side slopes, bottom width = 2.0′, slope = 3.9%
SCC-5 : grass-lined, triangular, 3:1 H:V side slopes, slope = 4.5%
SCC-6 : grass-lined, trapezoidal, 3:1 H:V side slopes, bottom width = 3.0′, slope = 6%
SCC-7 : " ", triangular, 3:1 H:V side slopes, slope = 17%
SCC-8 : " ", trapezoidal, 3:1 H:V side slopes, bottom width = 2.0′, slope 6%

Liner Requirements:

SCC-1 : ~~straw w/ net~~ synthetic mat
SCC-2 : ~~synthetic mat or curled wood~~ straw w/ net
SCC-3 : No liner
SCC-4 : straw w/ net
SCC-5 : No liner
SCC-6 : ~~straw w/~~ jute net
SCC-7 : Synthetic Mat
SCC-8 : Straw w/ net

TABLE 7
Summary of Laboratory Soils Test Data
Material Recovery, LLC
Wake County, NC

BORING NUMBER	SAMPLE DEPTH (feet)	SAMPLE TYPE	USCS CLASSIFICATION	USCS SYMBOL	NATURAL MOISTURE CONTENT (%)	UNIT WEIGHT (pcf)		GRADATION RESULTS (% passing)						ATTERBERG LIMITS			POROSITY (percent)	PERMEABILITY (cm/sec)
						WET	DRY	3/8"	#4	#10	#40	#100	#200	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
P-3	5	Bulk	Clayey Sand	SC	19.9	129.1	107.7	100	99	90	58	42	35	35	19	16	33.6	3.81E-07
P-6	9.5-11.5	Split Spoon	Silty Sand	SM	—	—	—	100	100	96	65	44	36	43	37	6	—	—
P-8	0-2	Split Spoon	Elastic Silt	MH	—	—	—	100	100	98	82	64	59	65	34	31	—	—
P-14	17-19	Shelby Tube	Silty Sand	SM	16.1	135.4	116.6	100	100	100	63	32	23	na	na	NP	28.4	2.45E-06
P-15	7-9	Split Spoon	Silty Sand	SM	—	—	—	100	100	99	68	40	30	34	33	1	—	—
P-18	13.5-15.5	Shelby Tube	Silty Sand	SM	19.9	128.6	107.3	100	96	83	42	27	23	39	36	3	35.4	8.80E-06
P-19	0-2	Split Spoon	Silty Sand	SM	—	—	—	100	100	96	69	42	28	21	20	1	—	—

NOTES:

1. na = not applicable
2. NP = non-plastic
3. — = no data available
4. Soils analysis performed by Trigon Engineering Consultants, Inc.

Table 8.01d (continued)

Name	Depth	pH	K	Hydrology Group	Plasticity	Textural Classification[1]		
						USDA	Unified	AASHTO
TUSQUITEE	0-10	4.5-6.0	0.24	B	NP-7	FSL, SL	SM, SM-SC	A-2, A-4
	0-10	4.5-6.0	0.28	B	NP-7	L, SIL	ML, CL-ML, CL, SM	A-4, A-5
	10-48	4.5-6.0	0.20	B	6-15	L, SL, FSL	SM-SC, SM	A-4
	48-60	4.5-6.0	0.20	B	NP-7	GR-SL, GR-FSL	GM, SM-SC, SM, GM-GC	A-4, A-1, A-2
UNISON	0-9	4.5-6.0	0.32	B	2-15	L, SIL, FSL	CL, ML, CL-ML, SM	A-4, A-6
	9-50	4.5-6.0	0.24	B	15-35	CL, C, GR-SIC	CL, CH	A-6, A-7
	50-72	4.5-6.0	0.28	B	5-20	CB-CL, SICL, GRV-L	CL-ML, CL, ML, GM-GC	A-1, A-2, A-6, A-7
VALHALLA	0-21	4.5-6.0	0.15	A	NP	LFS, LS	SM	A-2
	0-21	4.5-6.0	0.15	A	NP	FS, S	SM, SP-SM, SP	A-2, A-3
	21-30	4.5-6.0	0.24	A	NP-10	FSL, SL, SCL	SM, SC, SM-SC	A-2, A-4
	30-99	4.5-6.0	0.15	A	NP	FS, S	SM, SP-SM	A-2, A-3
VANCE	0-5	4.5-6.0	0.24	C	NP-7	FSL, SL, COSL	SM, SM-SC	A-2, A-4
	0-5	4.5-6.0	0.15	C	NP-7	GR-SL, GR-COSL	SM, GM, GM-GC	A-1, A-2, A-4
	0-5	4.5-6.0	0.28	C	8-20	SCL, CL	CL, SC	A-6, A-4
	5-29	4.5-5.5	0.37	C	25-48	CL, SC, C	CH	A-7
	29-72			C		WB		
VARINA	0-14	4.5-6.5	0.15	C	NP-3	LS	SM, SP-SM	A-2
	0-14	4.5-6.5	0.17	C	NP-7	SL	SM, SM-SC	A-2, A-4
	14-38	4.5-5.5	0.28	C	11-25	SC, CL, C	SC, MH, ML, SM	A-6, A-7
	38-80	4.5-5.5	0.28	C	8-26	SC, CL, C	SC, CL, CH	A-4, A-6, A-7
VAUCLUSE	0-15	4.5-6.0	0.15	C	NP	LS, S, LCOS	SM, SP-SM	A-2, A-3
	0-15	4.5-6.0	0.24	C	NP-7	FSL, SL	SM, SM-SC	A-2, A-4
	0-15	4.5-6.0	0.32	C	NP-7	SCL	SM, CL-ML, ML SM-SC	A-4
	15-29	3.6-5.5	0.24	C	5-18	SCL, SL	SC, SM-SC	A-2, A-4, A-6
	29-58	3.6-5.5	0.24	C	NP-20	SCL, SL, SC	SC, SM-SC, SM	A-2, A-4, A-6
	58-72	3.6-5.5	0.17	C	NP-12	SL, SCL, LS	SM, SC, SM-SC	A-2, A-4, A-6
WAGRAM	0-24	4.5-6.0	0.15	A	NP	LS, LFS	SM, SP-SM	A-2, A-3
	0-24	4.5-6.0	0.10	A	NP	FS, S	SP-SM, SM	A-1, A-2, A-3
	24-75	4.5-6.0	0.20	A	8-25	SCL, SL	SC	A-2, A-4, A-6, A-7
WAHEE	0-11	4.5-6.0	0.24	D	NP-7	SL, FSL	SM, SM-SC	A-2, A-4
	0-11	4.5-6.0	0.28	D	2-10	L, SIL, VFSL	ML, CL-ML, CL	A-4
	11-56	3.6-5.5	0.28	D	18-42	C, CL, SIC	CL, CH	A-6, A-7
	56-65	3.6-5.5	0.28	D		Var		
WAKE	0-15	4.5-6.0	0.20	D	NP	GR-LCOS, GR-LS, LS	SP-SM, SM, GM, GP-GM	A-2, A-3, A-1
WAKULLA	0-24	4.5-6.0	0.10	A	NP	LS, LFS	SM, SP-SM	A-2, A-3
	0-24	4.5-6.0	0.10	A	NP	S, FS	SP, SP-SM	A-3
	24-42	4.5-6.0	0.10	A	NP	LS, LFS	SM, SP-SM	A-2
	42-80	4.5-6.0	0.10	A	NP	S, FS	SM, SP-SM	A-2, A-3
WANDO	0-8	5.6-7.3	0.10	A	NP	LFS, FS	SP-SM, SM	A-2, A-3
	8-99	5.6-7.3	0.10	A	NP	S, FS	SP, SP-SM, SM	A-2, A-3
WASDA	0-14	3.6-5.5		B/D	NP	MUCK	PT	
	14-42	4.5-5.5	0.20	B/D	NP-10	CL, SCL, SL	ML, CL, CL-ML	A-4
	42-60	5.6-7.8	0.24	B/D	NP-7	SL, L	ML, SM, CL-ML, SM-SC	A-4
	60-74	5.6-7.8	0.15	B/D		S	SP-SM, SM	A-2, A-3
WEEKSVILLE	0-42	4.5-5.5	0.43	B/D	NP-7	SIL, VFSL, L	CL-ML, ML	A-4
	42-56	4.5-5.5	0.43	B/D	NP-3	FSL, SL	SM	A-2, A-4
	56-72	4.5-5.5	0.32	B/D	NP	S, LS, LFS	SM, SP-SM	A-2

[1]See Tables 8.01b, 8.01c and Figure 8.01d for definition of symbols.

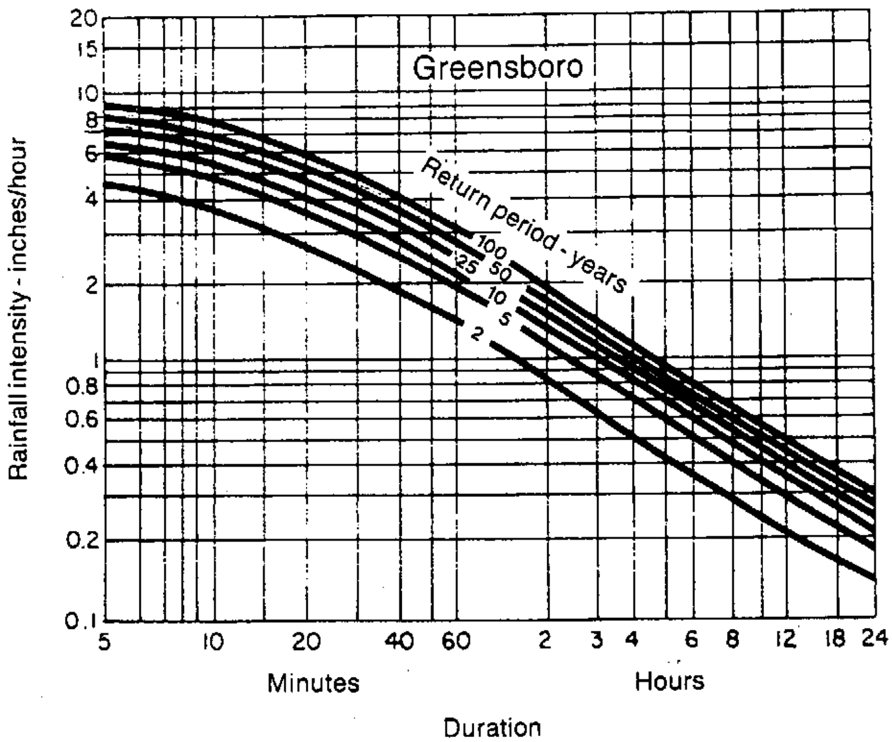


Figure 8.03d Rainfall intensity duration curves—Greensboro.

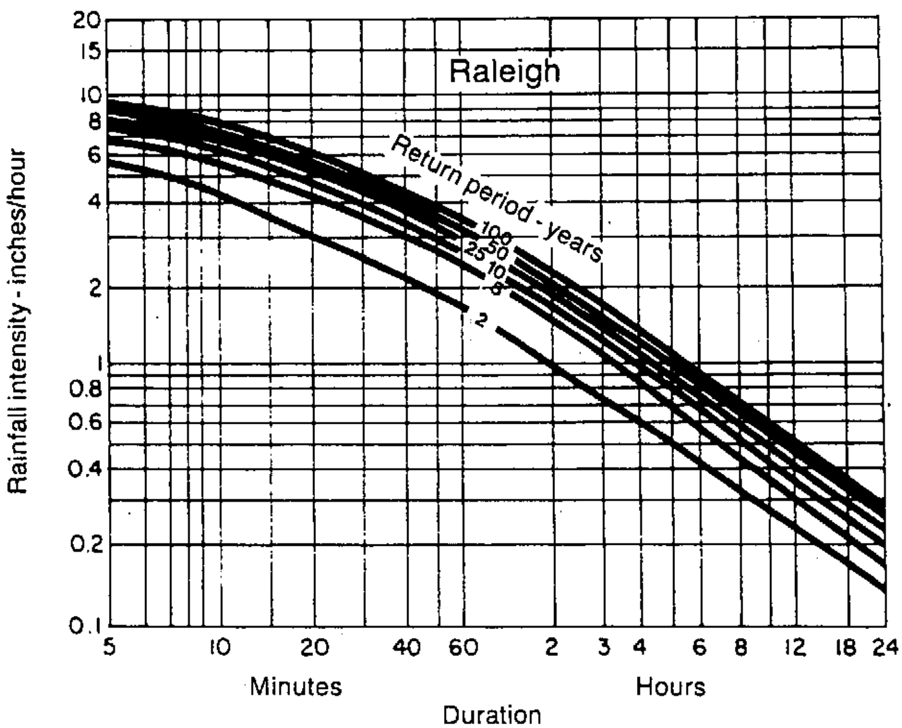


Figure 8.03e Rainfall intensity duration curves—Raleigh.

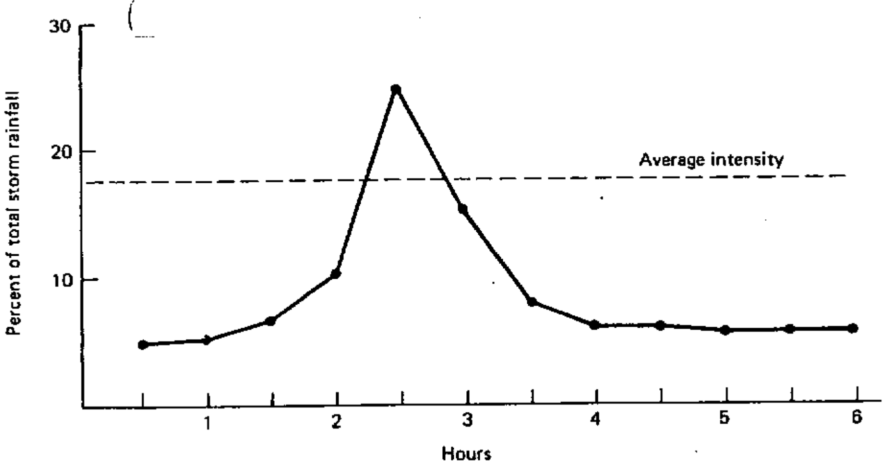


Fig. 4.2 Typical rainfall distribution and storm runoff during a 6-hr storm.

Sediment trapping efficiency is lower during the portion of a storm in which the immediate flow exceeds the average flow. The graph in Fig. 4.2 illustrates a typical rainfall distribution and storm runoff for a 6-hr storm. Peak intensity occurs at the top of the distribution curve; average intensity is indicated by a dashed line. Only during a small portion of the storm will the flow exceed average design flow. The graph was generated by placing the ½-hr incremental rainfall for a 6-hr storm in the sequence suggested by the U.S. Soil Conservation Service (SCS), 6-hr design storm distribution. (11, 12)

Use of average flow is a cost-saving measure. For the same design storm return interval, peak flow, which is based on a short time of concentration, is much larger than average flow of longer duration. A basin sized by using peak flow will thus be much larger than one sized by using the average flow. The sizing procedure is described in Chap. 8.

4.1e Runoff Coefficient *C*

The runoff coefficient *C* determines the portion of rainfall that will run off the watershed. It is based on the permeability and water-holding capacity of the various surfaces in the watershed. The *C* value can vary from close to zero to up to 1.0. A low *C* value indicates that most of the water is retained for a time on the site, as by soaking into the ground or forming puddles, whereas a high *C* value means that most of the rain runs off rapidly. Well-vegetated areas have low *C* values. Developed land, with its pavement, rooftops, and other impermeable surfaces, has a high *C* value. A high runoff coefficient produces higher runoff than does a low *C* value, and *Q* is directly proportional to *C*.

Table 4.1 lists *C* values for use in the rational formula. Select a *C* value within the range for land use. The designer must exercise judgment in selecting *C* from

TABLE 4.1 Rational Method *C* Values (13)

Land use	*C*	Land use	*C*
Business		Lawns	
Downtown areas	0.70–0.95	Sandy soil, flat, 2%	0.05–0.10
Neighborhood areas	0.50–0.70	Sandy soil, average, 2–7%	0.10–0.15
Residential		Sandy soil, steep, 7%	0.15–0.20
Single-family areas	0.30–0.50	Heavy soil, flat, 2%	0.13–0.17
Multi units, detached	0.40–0.60	Heavy soil, average, 2–7%	0.18–0.22
Multi units, attached	0.60–0.75	Heavy soil, steep, 7%	0.25–0.35
Suburban	0.25–0.40	Agricultural land, 0–30%	
Industrial		Bare packed soil	
Light areas	0.50–0.80	Smooth	0.30–0.60
Heavy areas	0.60–0.90	Rough	0.20–0.50
Parks, cemeteries	0.10–0.25	Cultivated rows	
Playgrounds	0.20–0.35	Heavy, soil, no crop	0.30–0.60
Railroad yard areas	0.20–0.40	Heavy soil with crop	0.20–0.50
Unimproved areas	0.10–0.30	Sandy soil, no crop	0.20–0.40
Streets		Sandy soil with crop	0.10–0.25
Asphaltic	0.70–0.95	Pasture	
Concrete	0.80–0.95	Heavy soil	0.15–0.45
Brick	0.70–0.85	Sandy soil	0.05–0.25
Drives and walks	0.75–0.85	Woodlands	0.05–0.25
Roofs	0.75–0.95	Barren slopes, >30%*	
		Smooth, impervious	0.70–0.90
		Rough	0.50–0.70

Note: The designer must use judgment to select the appropriate *C* value within the range. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest *C* values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should be assigned highest *C* values.

*From Portland Cement Association, *Handbook of Concrete Culvert Pipe Hydraulics*, 1964, p. 45.

the range given by considering factors such as permeability, soil type, steepness, and vegetation.

For construction sites, when the soil is bare and the slope is less than 30 percent, use the agricultural values in the table and consider soil conditions and density of vegetation. For areas with temporary vegetative cover, select a value from the ranges for "cultivated rows"; for undisturbed areas under natural grass and shrub cover assign an appropriate "unimproved areas" *C* value between 0.10 and 0.30. If the slope gradient is greater than 30 percent, for example, 3:1 or 2:1, choose a value in the range 0.50–0.90 under "barren slopes." Soil depth or depth to impermeable rock influences the choice within the ranges given; the *C* value is higher for shallower soils. For sites with mixed land uses, compute a weighted average of the individual *C* values, as follows:

If area $A = x + y$, then

$$C\ (\text{weighted}) = \frac{(x \times C_x) + (y \times C_y)}{A}$$

Table 8.05a
Maximum Allowable Design Velocities[1]
for Vegetated Channels

Typical Channel Slope Application	Soil Characteristics[2]	Grass Lining	Permissible Velocity[3] for Established Grass Lining (ft/sec)
0-5%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	5.0
		Tall fescue	4.5
		Bahiagrass	4.5
		Kentucky bluegrass	4.5
		Grass-legume mixture	3.5
	Erosion Resistant Plastic (Clay mixes)	Bermudagrass	6.0
		Tall fescue	5.5
		Bahiagrass	5.5
		Kentucky bluegrass	5.5
		Grass-legume mixture	4.5
5-10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	4.5
		Tall fescue	4.0
		Bahiagrass	4.0
		Kentucky bluegrass	4.0
		Grass-legume mixture	3.0
	Erosion Resistant Plastic (Clay Mixes)	Bermudagrass	5.5
		Tall fescue	5.0
		Bahiagrass	5.0
		Kentucky bluegrass	5.0
		Grass-legume mixture	3.5
>10%	Easily Erodible Non-plastic (Sands & Silts)	Bermudagrass	3.5
		Tall fescue	2.5
		Bahiagrass	2.5
		Kentucky bluegrass	2.5
	Erosion Resistant Plastic (Clay Mixes)	Bermudagrass	4.5
		Tall fescue	3.5
		Bahiagrass	3.5
		Kentucky bluegrass	3.5

Source: USDA-SCS Modified

NOTE: [1]Permissible Velocity based on 10-yr storm peak runoff
[2]Soil erodibility based on resistance to soil movement from concentrated flowing water.
[3]Before grass is established, permissible velocity is determined by the type of temporary liner used.

Selecting Channel Cross-Section Geometry

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change throughout the length of a channel, subdivide the channel into design reaches, and design each reach to carry the appropriate capacity.

The three most commonly used channel cross-sections are "V"-shaped, parabolic, and trapezoidal. Figure 8.05b gives mathematical formulas for the area, hydraulic radius and top width of each of these shapes.

Table 8.05d Maximum Permissible Velocities for Unprotected Soils in Existing Channels.

Materials	Maximum Permissible Velocities (fps)
Fine Sand (noncolloidal)	2.5
Sand Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5

Sample Problem 8.05a Design of a grass-lined channel.

Given:

Design Q_{10} = 16.6 cfs

Proposed channel grade = 2%
Proposed vegetation: Tall fescue
Soil: Creedmoor (easily erodible)
Permissible velocity, V_p = 4.5 ft/s (Table 8.05a)
Retardance class: "B" uncut, "D" cut (Table 8.05c).
Trapezoidal channel dimensions:
designing for low retardance condition (retardance class D)
design to meet V_p.

Find:

Channel dimensions

Solution:

Make an initial estimate of channel size
A = Q/V; 16.6 cfs/4.5 ft/sec = 3.69 ft^2

Try bottom width = 3.0 ft w/side slopes of 3:1

$Z = 3$
$A = bd + Zd^2$
$P = b + 2d\sqrt{Z^2 + 1}$
$R = A/P$

An iterative solution using Figure 8.05a to relate flow depth to Manning's *n* proceeds as follows: Manning's equation is used to check velocities

*From Fig. 8.05c, pg. 8.05.7, Retardance Class d (VR=4.5x0.54=2.43)

d (ft)	A (ft^2)	R (ft)	* n	V (fps)	Q (cfs)	Comments
0.8	4.32	0.54	0.043	3.25	14.0	$V<V_p$ OK, $Q<Q_{10}$, (too small, try deeper channel)
0.9	5.13	0.59	0.042	3.53	18.10	$V<V_p$, OK, $Q>Q_{10}$, OK

Now design for high retardance (class B):

For the ease of construction and maintenance Assume and Try d = 1.5 ft and trial velocity, V_t = 3.0 ft/sec

d (ft)	A (ft^2)	R (ft)	V_t (fps)	n	V (fps)	Q (cfs)	Comments
1.5	11.25	0.90	3.0	0.08	2.5	28	reduce Vt
			2.0	0.11	1.8	20	reduce V_t
			1.6	0.12	1.6	18	
			**1.5	0.13	1.5	17	$Q>Q_{10}$ OK

**These assumptions = actual V (fps.) (chart continued on next page)

Table 8.05g
Permissible Shear Stresses for Riprap and Temporary Liners

Lining Category	Lining Type	Permissible Unit Shear Stress, T_d (lb/ft^2)
Temporary	Woven Paper Net	0.15
	Jute Net	0.45
	Fiberglass Roving:	
	Single	0.60
	Double	0.85
	Straw with Net	1.45
	Curled Wood mat	1.55
	Synthetic Mat	2.00
	d_{50} Stone Size (inches)	
Gravel Riprap	1	0.33
	2	0.67
Rock Riprap	6	2.00
	9	3.00
	12	4.00
	15	5.00
	18	6.00
	21	7.80
	24	8.00

Adapted From: FHWA, HEC-15, April 1983, pgs. 17 & 37.

Design Procedure-Temporary Liners

The following is a step-by-step procedure for designing a temporary liner for a channel. Because temporary liners have a short period of service, the design Q may be reduced. For liners that are needed for six months or less, the 2-yr frequency storm is recommended.

Step 1. Select a liner material suitable for site conditions and application. Determine roughness coefficient from manufacturer's specifications or Table 8.05e, pg. 8.05.10.

Step 2. Calculate the normal flow depth using Manning's equation (Figure 8.05d). Check to see that depth is consistent with that assumed for selection of Manning's *n* in Figure 8.05d, pg. 8.05.11. For smaller runoffs Figure 8.05d is not as clearly defined. Recommended solutions can be determined by using the Manning equation.

Step 3. Calculate shear stress at normal depth.

Step 4. Compare computed shear stress with the permissible shear stress for the liner.

Step 5. If computed shear is greater than permissible shear, adjust channel dimensions to reduce shear or select a more resistant lining and repeat steps 1 through 4.

Design of a channel with temporary lining is illustrated in Sample Problem 8.05b, pg. 8.05.14.

(continued)
Sample Problem 8.05a
Design of a grass-lined channel.

Channel summary:
Trapezoidal shape, Z=3, b=3 ft, d=1.5 ft, grade = 2%

Note: In Sample Problem 8.05a the "n-value" is first choosen based on a permissible velocity and not a design velocity criteria. Therefore the use of table 8.05c may not be as accurate as individual retardance class charts when a design velocity is the determining factor.

Tractive Force Procedure

The design of riprap-lined channels and temporary channel linings is based on analysis of tractive force.

NOTE: This procedure is for uniform flow in channels and is *not* to be used for design of deenergizing devices and may not be valid for larger channels

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change through the length of a channel, subdivide the channel into design reaches as appropriate.

PERMISSIBLE SHEAR STRESS
The permissible shear stress, T_d, is the force required to initiate movement of the lining material. Permissible shear stress for the liner is not related to the erodibility of the underlying soil. However, if the lining is eroded or broken, the bed material will be exposed to the erosive force of the flow.

COMPUTING NORMAL DEPTH
The first step in selecting an appropriate lining is to compute the design flow depth (the normal depth) and determine the shear stress.

Normal depths can be calculated by Manning's equation as shown for trapezoidal channels in Figure 8.05d. Values of the Manning's roughness coefficient for different ranges of depth are provided in Table 8.05e for temporary linings and Table 8.05f for riprap. The coefficient of roughness generally decreases with increasing flow depth.

Table 8.05e
Manning's Roughness Coefficients for Temporary Lining Materials

	n value for Depth Ranges*		
	0-0.5 ft	0.5-2.0 ft	>2.0 ft
Lining Type			
Woven Paper Net	0.016	0.015	0.015
Jute Net	0.028	0.022	0.019
Fiberglass Roving	0.028	0.021	0.019
Straw with Net	0.065	0.033	0.025
Curled Wood Mat	0.066	0.035	0.028
Synthetic Mat	0.036	0.025	0.021

* Adapted from: FHWA-HEC 15, Pg. 37 - April 1988

Step 10. For grass-lined channels once the appropriate channel dimensions have been selected for low retardance conditions, repeat steps 6 through 8 using a higher retardance class, corresponding to tall grass. Adjust capacity of the channel by varying depth where site conditions permit.

NOTE 1: If design velocity is greater than 2.0 ft/sec., a temporary lining may be required to stabilize the channel until vegetation is established. The temporary liner may be designed for peak flow from the 2-yr storm. If a channel requires temporary lining, the designer should analyze shear stresses in the channel to select the liner that provides protection and promotes establishment of vegetation. For the design of temporary liners, use tractive force procedure.

NOTE 2: Design Tables—Vegetated Channels and Diversions at the end of this section may be used to design grass-lined channels with parabolic cross-sections.

Step 11. Check outlet for carrying capacity and stability. If discharge velocities exceed allowable velocities for the receiving stream, an outlet protection structure will be required (Table 8.05d, pg. 8.05.9).

Sample Problem 8.05a illustrates the design of a grass-lined channel.

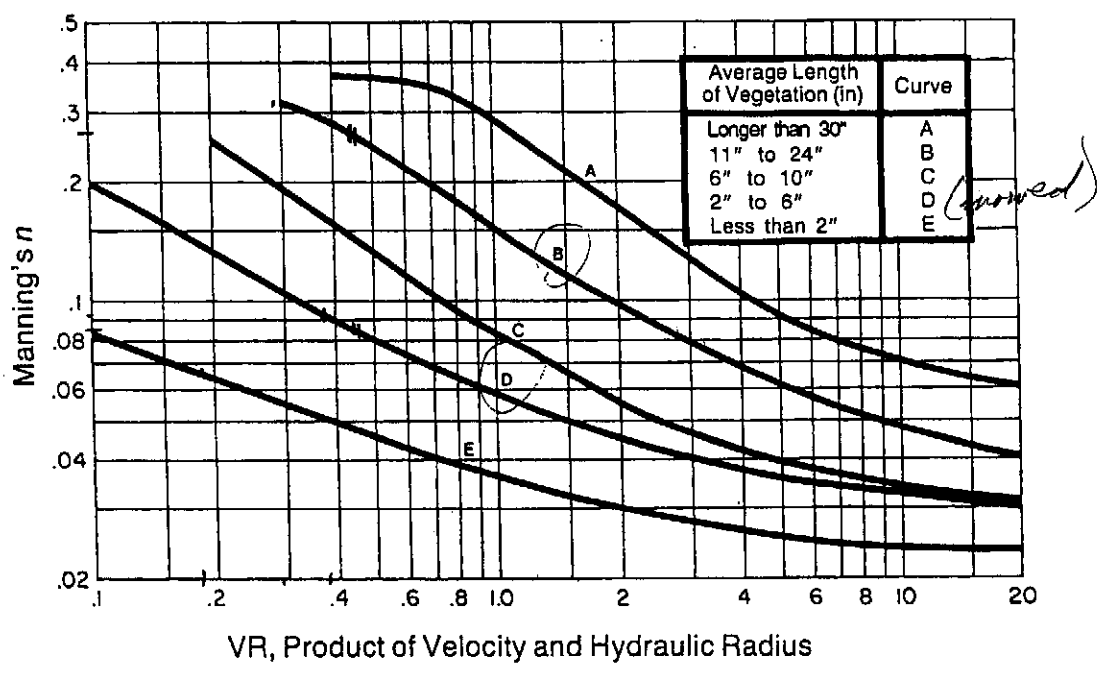


Figure 8.05c Manning's *n* related to velocity, hydraulic radius, and vegetal retardance.
Note: From Sample Problem 8.05a multiply Vp x Hydralulic Radius (4.5x0.54=2.43), then enter the product of VR and extend a straight line up to Retardance class "D", next project a straight line to the left to determine a trial manning's *n*.

Weir length and depth—Keep the spillway weir at least 4 ft long and sized to pass the peak discharge of the 10-yr storm (Figure 6.60a). A maximum flow depth of 1 ft, a minimum freeboard of 0.5 ft, and maximum side slopes of 2:1 are recommended. Weir length may be selected from Table 6.60a shown for most site locations in North Carolina.

Table 6.60a
Design of Spillways

Drainage Area (acres)	Weir Length[1] (ft)
1	4.0
2	6.0
3	8.0
4	10.0
5	12.0

[1]Dimensions shown are minimum

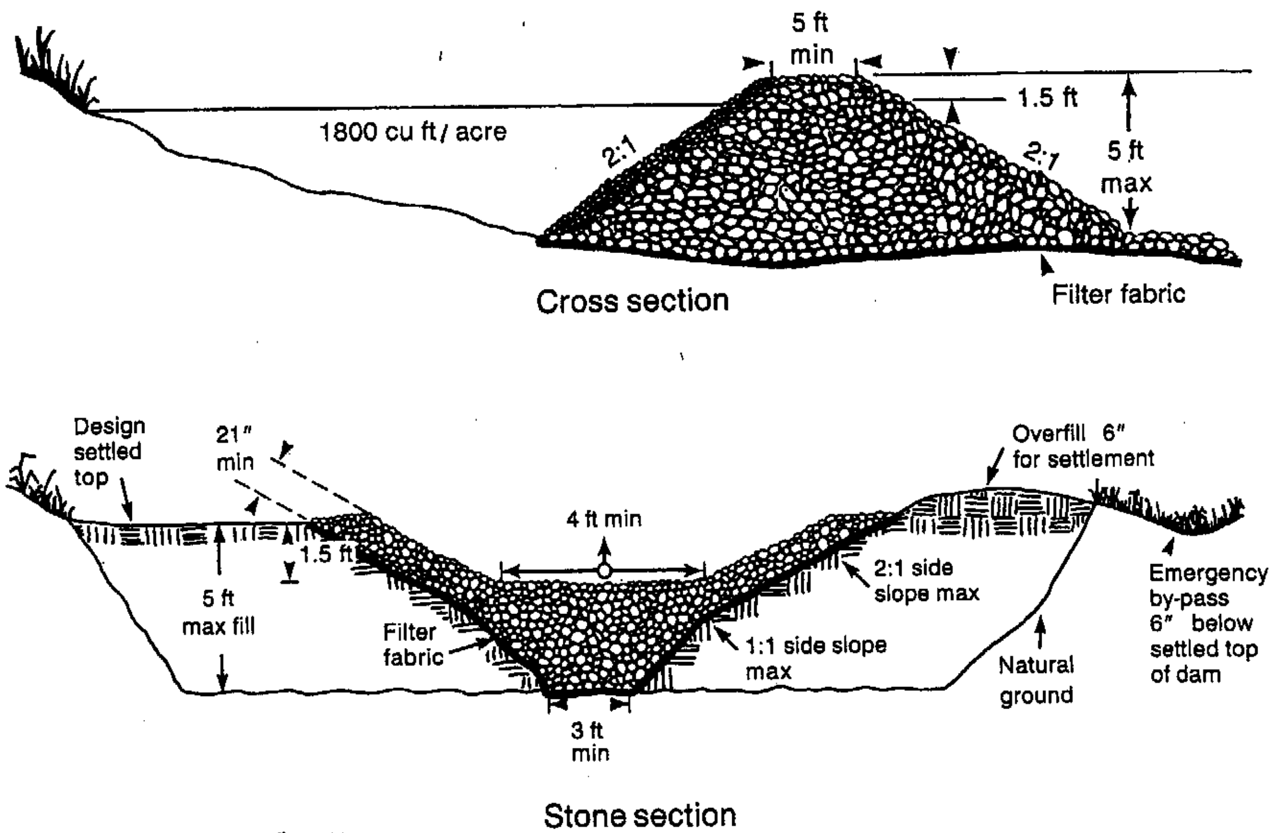
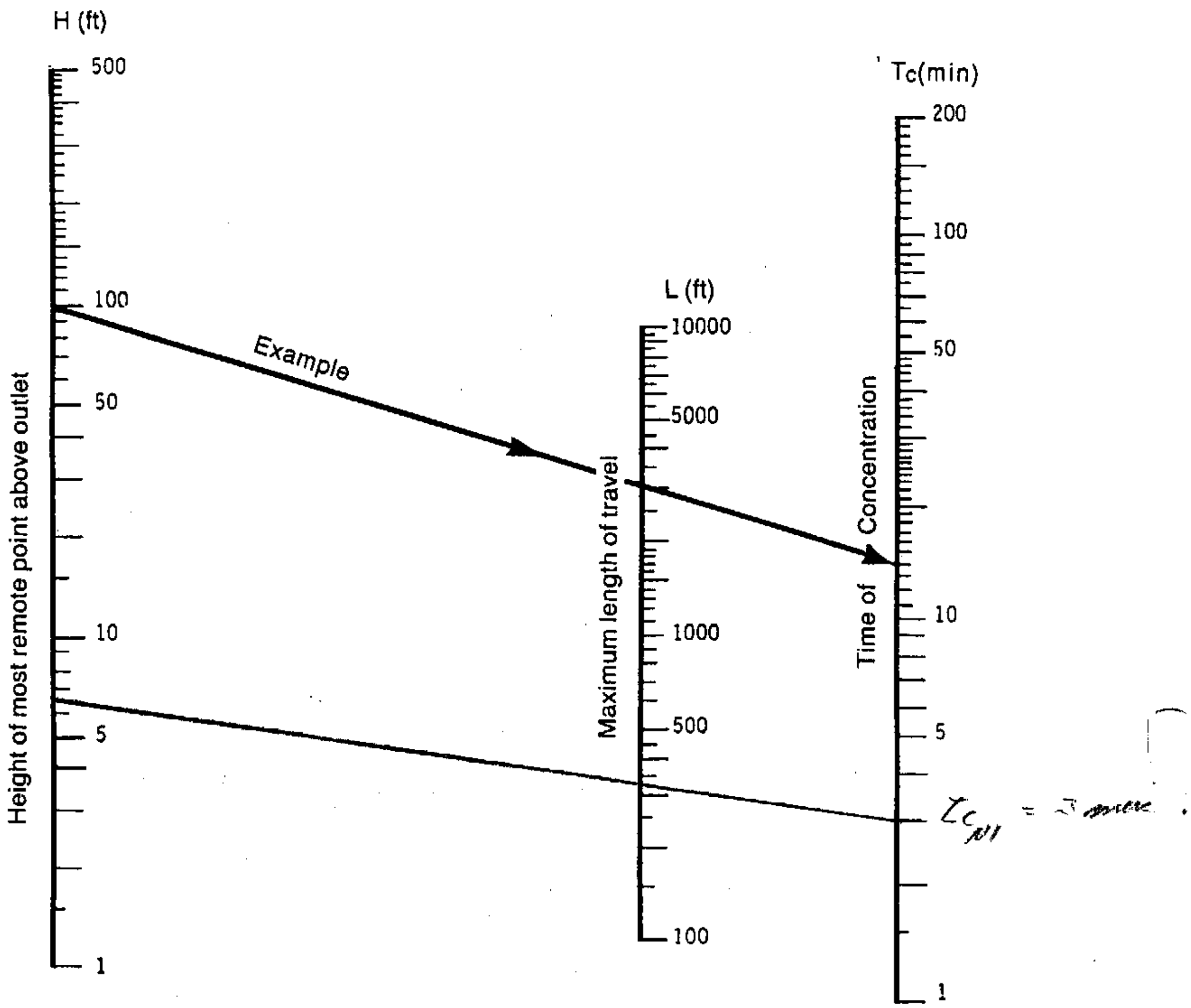


Figure 6.60a Temporary sediment trap.

Construction Specifications

1. Clear, grub, and strip the area under the embankment of all vegetation and root mat. Remove all surface soil containing high amounts of organic matter and stockpile or dispose of it properly. Haul all objectionable material to the designated disposal area.

Estimate Peak Flow to SCC-9A



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

Diversion Berm

$l_1 = 330$

$s = 2\%$

$H = .02 \times 330 = 6.6$

$i_{25} = 8$ in/hr.

(Ignore travel time to next slope drain because the additional contribution area flowing directly to the conveyance channel is insignificant. Qp will be conservative (high).)

$Q_p = c\,i\,A$

$= (0.45)(8)(5.60)$

$= 20.2$ cfs.

SCC-19A
Worksheet for Trapezoidal Channel

JPB

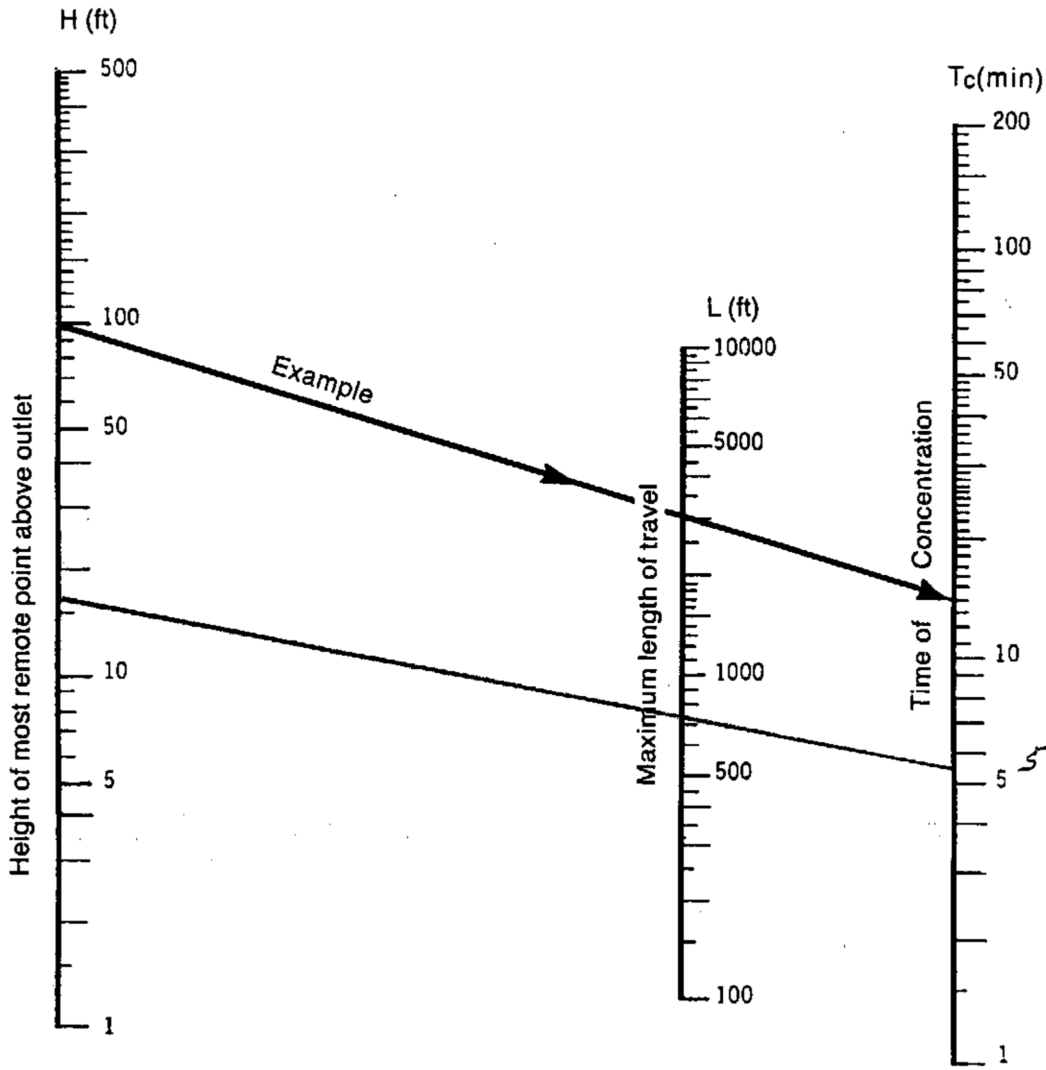
Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.022500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	20.20	cfs

Results		
Depth	1.06	ft
Flow Area	5.53	ft^2
Wetted Perimeter	8.73	ft
Top Width	8.39	ft
Critical Depth	0.95	ft
Critical Slope	0.036903	ft/ft
Velocity	3.65	ft/s
Velocity Head	0.21	ft
Specific Energy	1.27	ft
Froude Number	0.79	
Flow is subcritical.		

Peak Flow to SCC-9B

JPB



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l_2 = 720$

$H_2 = .0225 \times 720 = 16.2$ ft.

T_c = 3 min for W1 + 5.5 min in channel = 8.5 min.

i_{25} = 7 in/hr.

$A = 5.60 + 6.81 = 12.41$.

$Q_{P25} = (0.45)(7)(12.41) = 39.1$ cfs.

SCC 9B

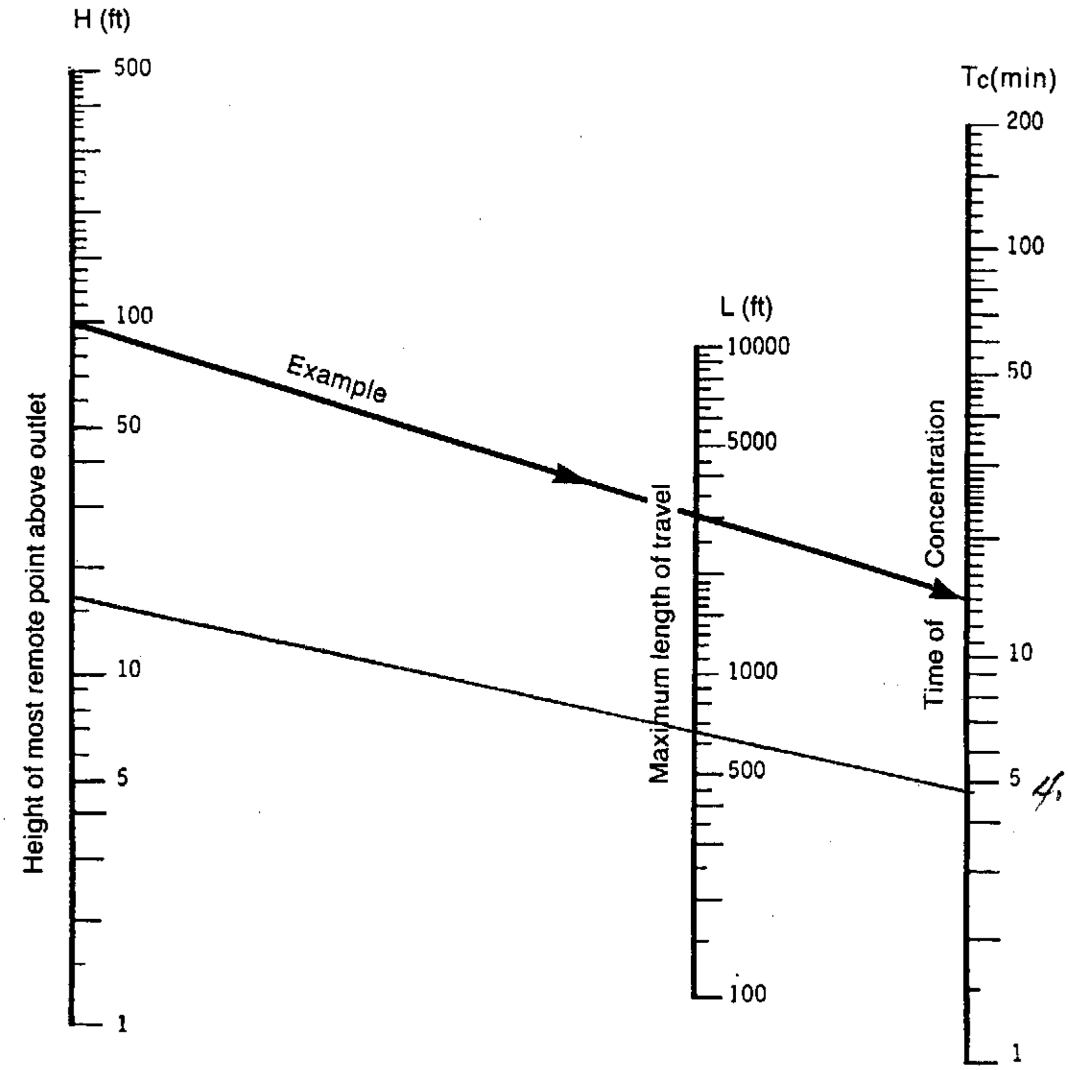
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.025500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	39.10	cfs

Results		
Depth	1.39	ft
Flow Area	8.63	ft^2
Wetted Perimeter	10.82	ft
Top Width	10.37	ft
Critical Depth	1.31	ft
Critical Slope	0.033800	ft/ft
Velocity	4.53	ft/s
Velocity Head	0.32	ft
Specific Energy	1.71	ft
Froude Number	0.88	
Flow is subcritical.		

Peak Flow to SCC-9C



4.7 min

Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

l_3 = 650 ft.
H_3 = .0255 X 650
= 16.6 ft.
T_c = 8.5 + 4.7 = 13.2 min
i_{25} = 6.3 in/hr.
A = 12.41 + 5.74 = 18.15 ac.
Q_{P25} = (0.45)(6.3)(18.1
= 51.5 cfs.

J PD

SCC 9C

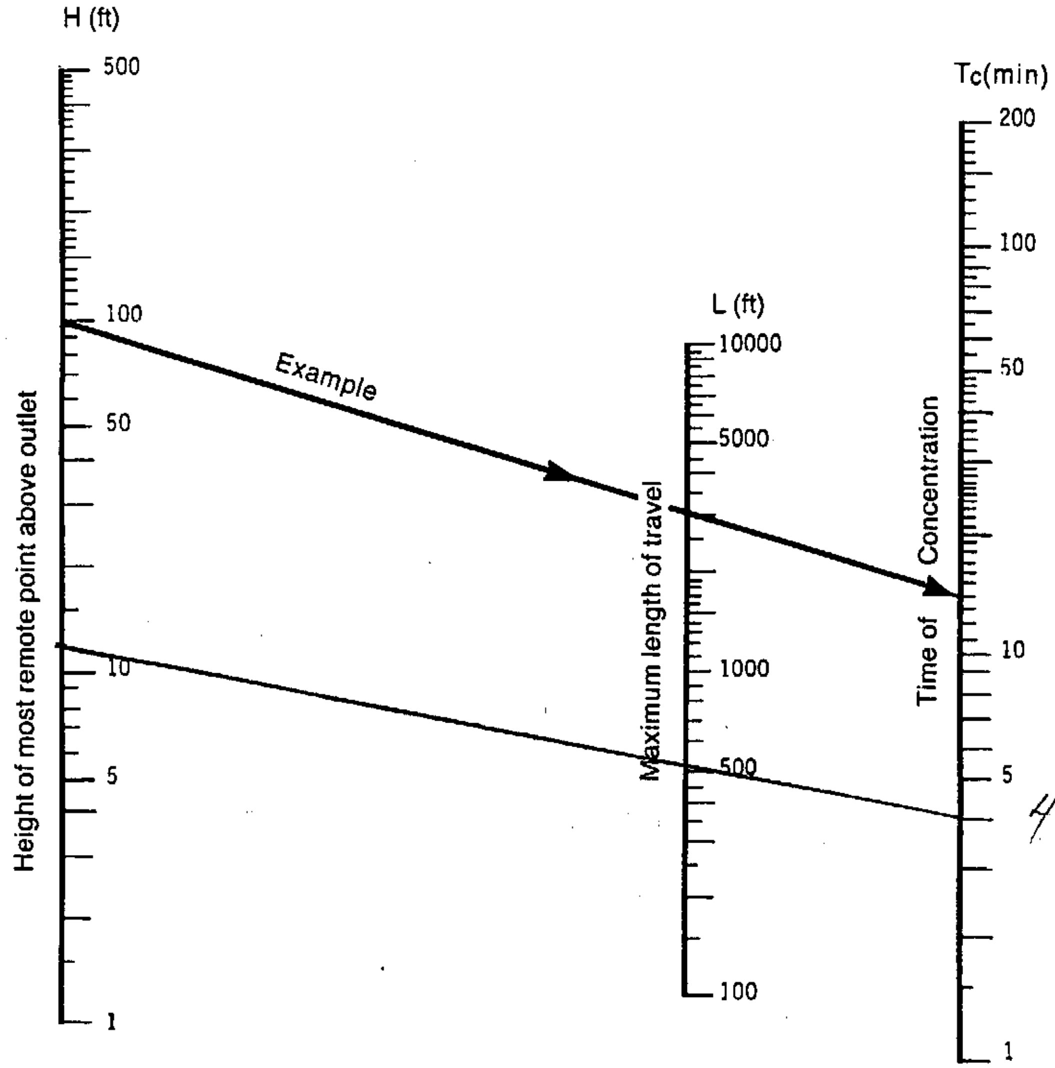
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.024000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	51.50	cfs

Results		
Depth	1.60	ft
Flow Area	10.83	ft^2
Wetted Perimeter	12.09	ft
Top Width	11.58	ft
Critical Depth	1.49	ft
Critical Slope	0.032592	ft/ft
Velocity	4.75	ft/s
Velocity Head	0.35	ft
Specific Energy	1.95	ft
Froude Number	0.87	
Flow is subcritical.		

Peak Flow to SCC-9D



4 min.

Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

l_H = 500'
H_H = .024 X 500 = 12'
T_c = 13.2 × 4 = 17.2 min
i_{25} = 5.7 in/hr.
A = 18.15 + 4.69
= 22.84 ac.
Q_{P25} = (0.45)(5.7)(22.8)
= 58.6 cfs.

Figure 8.03a Time of concentration of small drainage basins.

SCC-9D

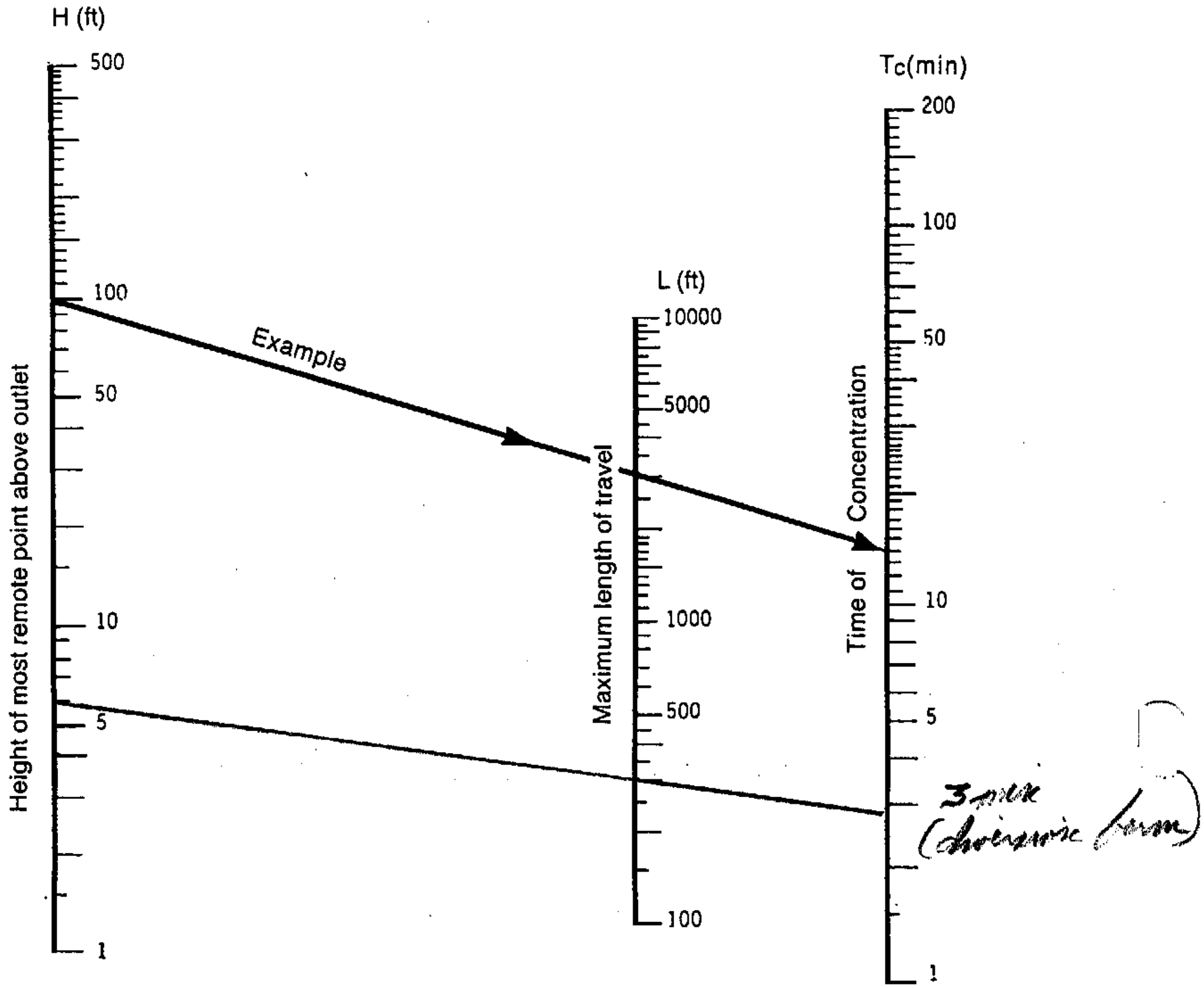
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.012860	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	58.60	cfs

Results		
Depth	1.93	ft
Flow Area	15.06	ft²
Wetted Perimeter	14.22	ft
Top Width	13.59	ft
Critical Depth	1.59	ft
Critical Slope	0.032040	ft/ft
Velocity	3.89	ft/s
Velocity Head	0.24	ft
Specific Energy	2.17	ft
Froude Number	0.65	
Flow is subcritical.		

Peak Flow to SCC-10A



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

l = 300'
H = .02 X 300 = 6'
i_{25} = 8 in/hr.
A = 3.45 ac.
Q_{p25} = C i A
= (0.45)(8)(3.45)
= 12.4 cfs

Figure 8.03a Time of concentration of small drainage basins.

SCC-# /10A

JPD

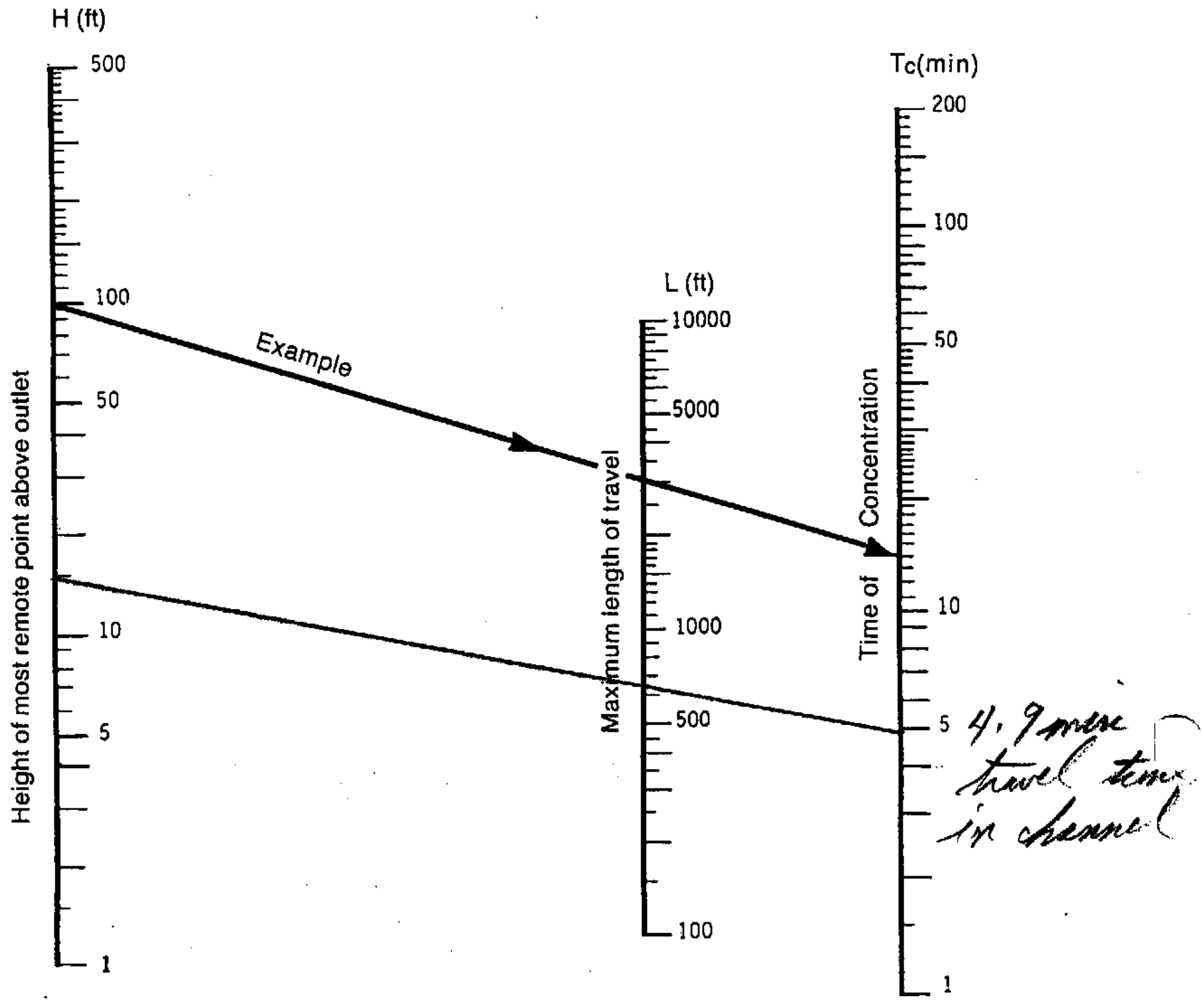
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.024000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	12.40	cfs

Results		
Depth	0.84	ft
Flow Area	3.76	ft²
Wetted Perimeter	7.28	ft
Top Width	7.01	ft
Critical Depth	0.74	ft
Critical Slope	0.039410	ft/ft
Velocity	3.29	ft/s
Velocity Head	0.17	ft
Specific Energy	1.00	ft
Froude Number	0.79	
Flow is subcritical.		

Peak Flow to SCC-10B



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$L_4 = 620'$
$H_4 = (0.024)(620) = 14.9'$

$T_c = 3 + 4.9 = 7.9$ min.
$i_{25} = 6.9$ in/hr.
$A = 3.45 + 5.96 = 9.41$ ac
$Q_{P25} = (0.45)(6.9)(9.41) = 29.2$ cfs.

SCC~~39~~/10B

Worksheet for Trapezoidal Channel

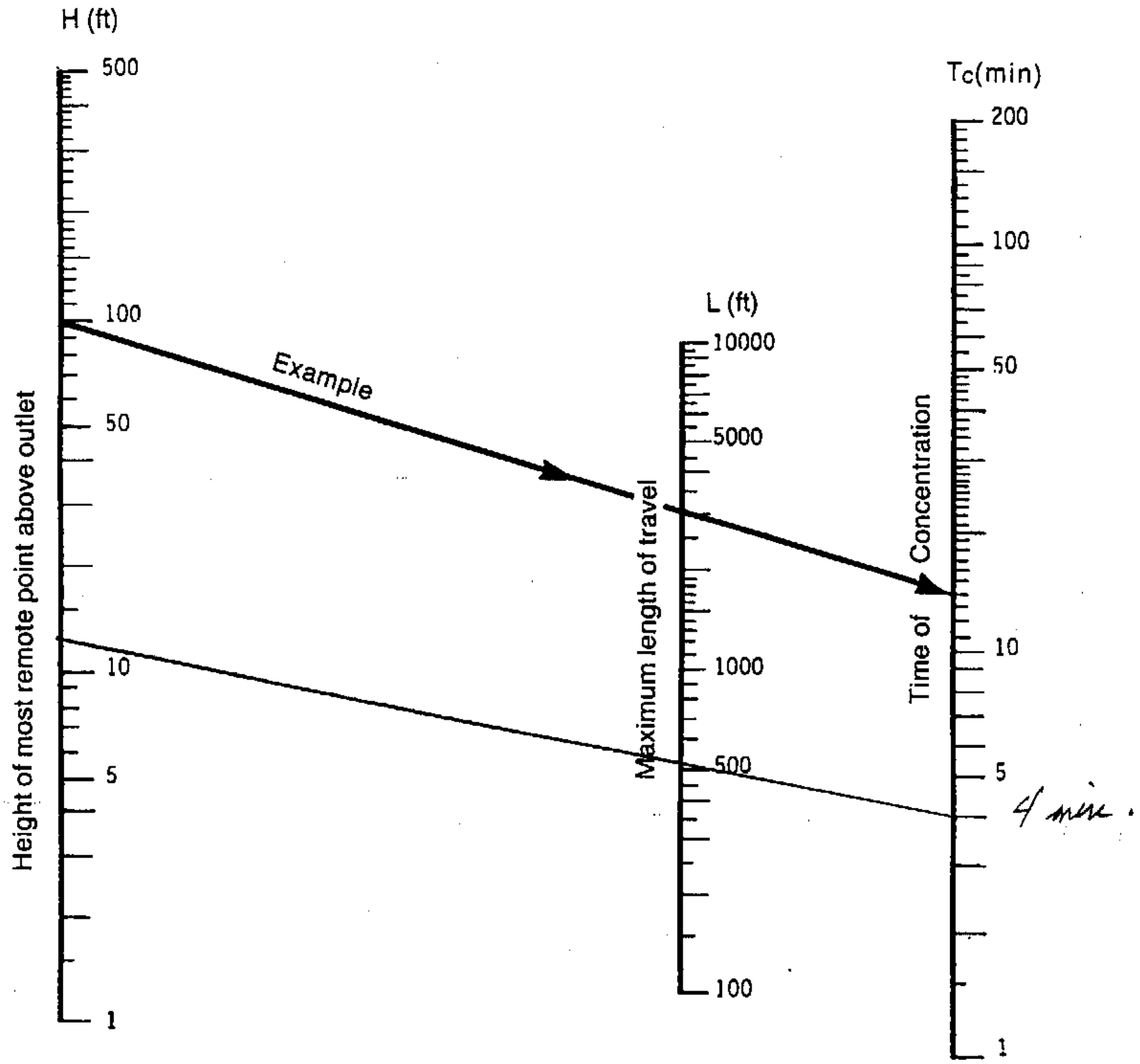
Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.024750	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	29.20	cfs

Results		
Depth	1.23	ft
Flow Area	7.02	ft²
Wetted Perimeter	9.79	ft
Top Width	9.39	ft
Critical Depth	1.14	ft
Critical Slope	0.035135	ft/ft
Velocity	4.16	ft/s
Velocity Head	0.27	ft
Specific Energy	1.50	ft
Froude Number	0.85	
Flow is subcritical.		

JMD

Peak Flow to SCC-10C



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l = 505'$

$H = (.02475)(505) = 12.5'$

$T_c = 7.9 + 4 = 11.9$ min.

$i_{25} = 6.8$ in/hr.

$A = 9.41 + 6.56 = 15.97$ ac

$Q_{p_{25}} = (.45)(6.8)(15.97) = 48.9$ cfs.

JPW

SCC-#/NC

Worksheet for Trapezoidal Channel

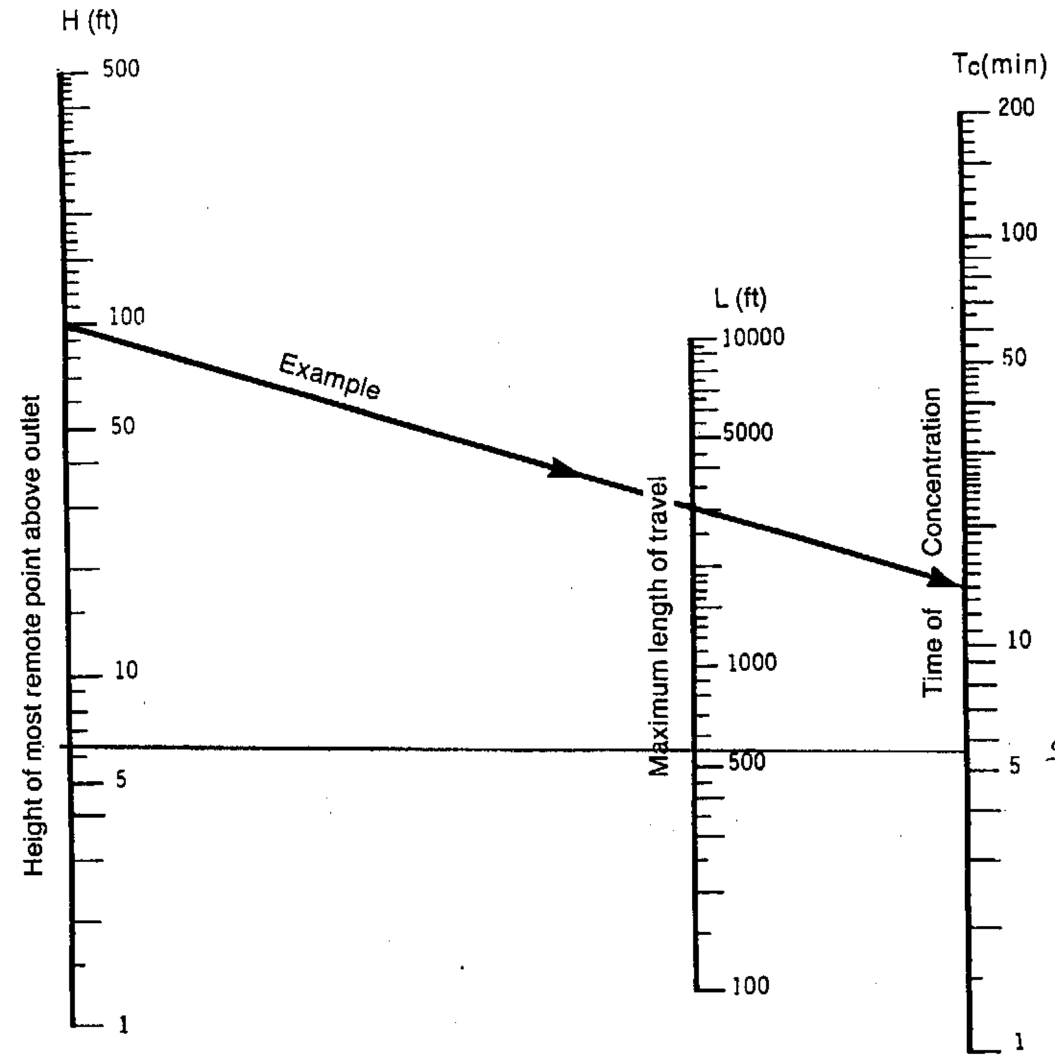
Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.011560	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	48.90	cfs

Results		
Depth	1.83	ft
Flow Area	13.69	ft²
Wetted Perimeter	13.57	ft
Top Width	12.97	ft
Critical Depth	1.46	ft
Critical Slope	0.032815	ft/ft
Velocity	3.57	ft/s
Velocity Head	0.20	ft
Specific Energy	2.03	ft
Froude Number	0.61	
Flow is subcritical.		

Peak Flow to SCC-10D

JPD



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

l = 545'
H = (.01156)(545)
= 6.3'

Tc = 11.9 + 5.6 = 17.5 min
i25 = 5.5 in/hr.
A = 15.97 + 4.87
= 20.84 ac.
Qp25 = (.45)(5.5)(20.8)
= 51.6 cfs.

J P R

SCC-8 10D

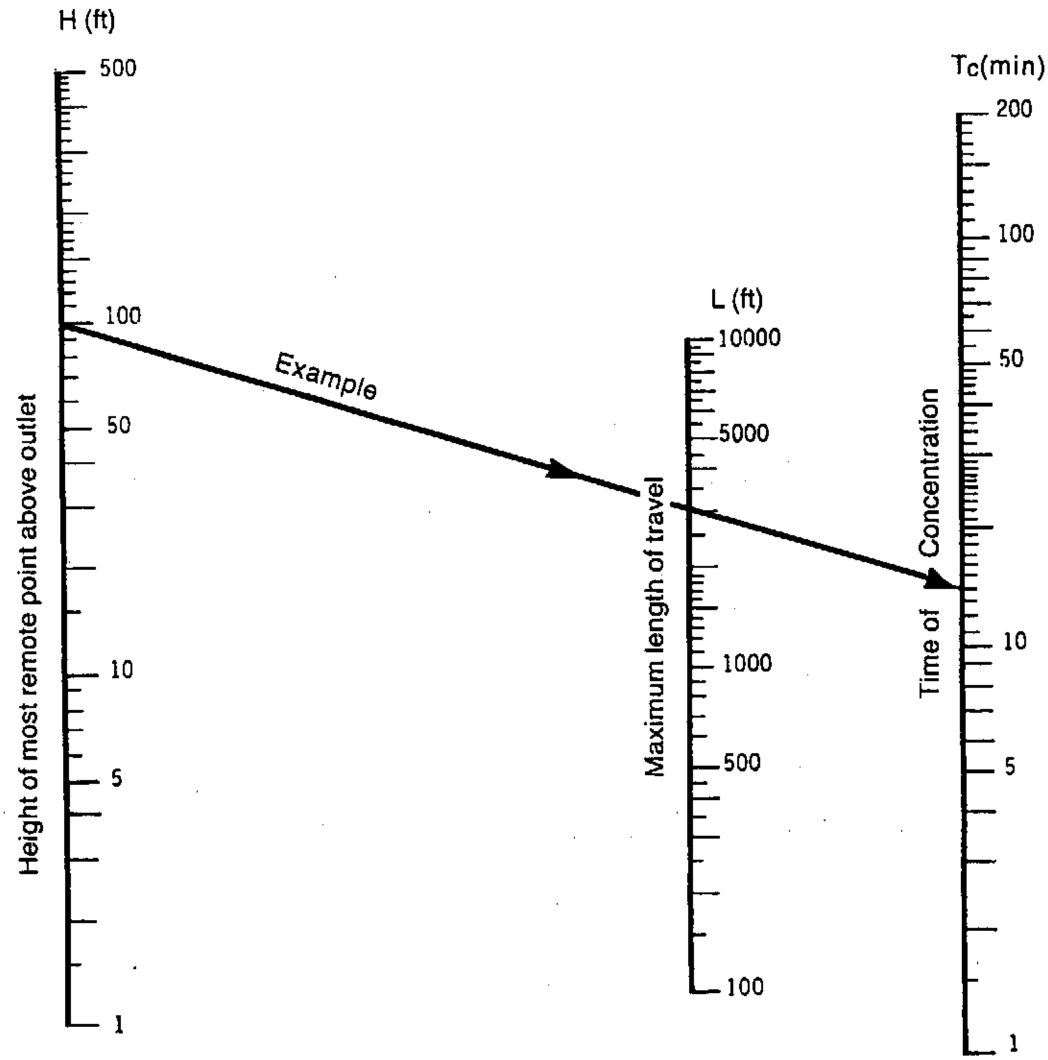
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.010000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	51.60	cfs

Results		
Depth	1.93	ft
Flow Area	15.04	ft^2
Wetted Perimeter	14.21	ft
Top Width	13.58	ft
Critical Depth	1.49	ft
Critical Slope	0.032584	ft/ft
Velocity	3.43	ft/s
Velocity Head	0.18	ft
Specific Energy	2.11	ft
Froude Number	0.57	
Flow is subcritical.		

Peak Flow to SCC-10E



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l = 620'$
$H = .01 \times 620 = 6.2'$
$T_c = 17.5 + 6.7 = 24.2$ min
$i_{25} = 4.8$ in/hr.
$A = 20.84 + 4.4 = 25.24$ ac.
$Q_{p25} = (.45)(4.8)(25.24) = 54.5$ cfs.

SCC-#/10E

8/10

Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.015500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	54.50	cfs

Results		
Depth	1.80	ft
Flow Area	13.30	ft^2
Wetted Perimeter	13.38	ft
Top Width	12.79	ft
Critical Depth	1.53	ft
Critical Slope	0.032349	ft/ft
Velocity	4.10	ft/s
Velocity Head	0.26	ft
Specific Energy	2.06	ft
Froude Number	0.71	
Flow is subcritical.		

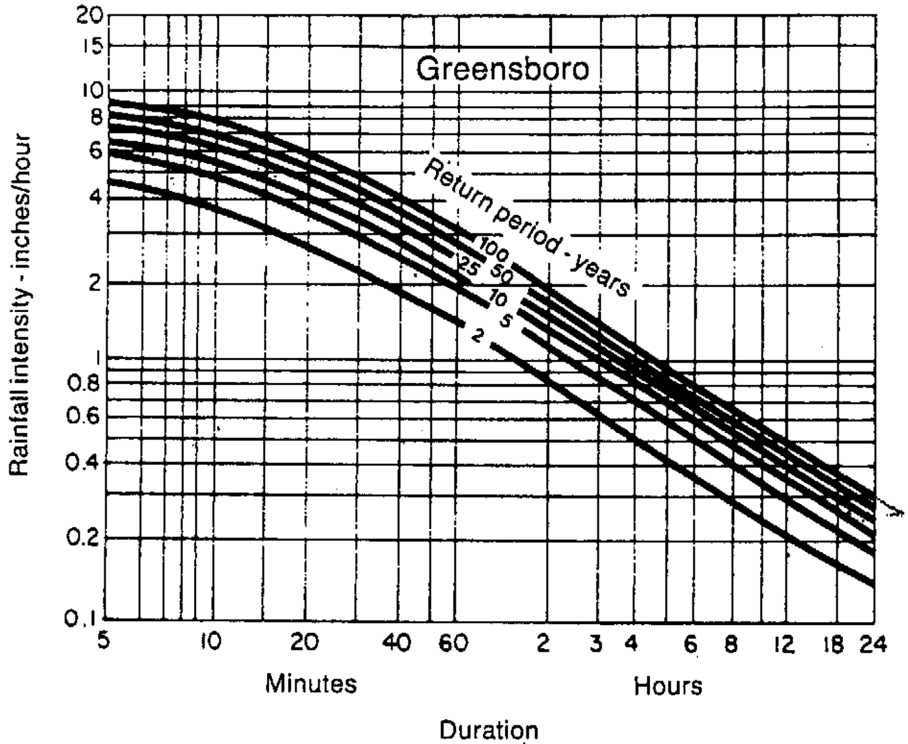


Figure 8.03d Rainfall intensity duration curves—Greensboro.

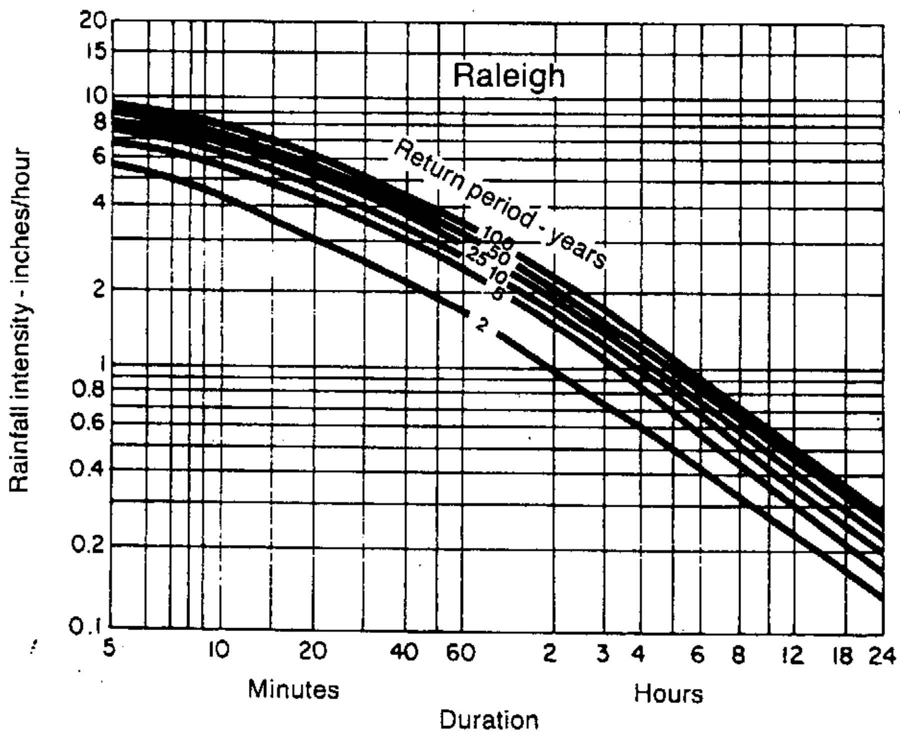


Figure 8.03e Rainfall intensity duration curves—Raleigh.

/10B

SCC ~~9B~~ Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

RJH 12-21-01

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.024750	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	20.30	cfs

Results		
Depth	0.90	ft
Flow Area	4.26	ft²
Wetted Perimeter	7.72	ft
Top Width	7.42	ft
Critical Depth	0.95	ft
Critical Slope	0.019833	ft/ft
Velocity	4.77	ft/s
Velocity Head	0.35	ft
Specific Energy	1.26	ft
Froude Number	1.11	
Flow is supercritical.		

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Waste Industry Experts

Job: Brownfield Rd
Job No. ______ Sheet No. ______ of ______
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Subject ______ Scale ______

Calcs. for Temp. Liner:

SCC-10C

A = 15.97 ac
Tc = 11.9
Fig. 8.03(e) → $i_2(11.9) = 4.0$ in/hr
C = 0.45

$Q_2 = 0.45(4.0)(15.97)$
$Q_2 = 28.75$ cfs

Table 8.05(e) → straw w/ net → n = 0.033

Flow Master → depth = 1.26

$T = 62.4(1.26)(0.01156)$
$T = 0.91 < 1.45$ use **straw w/ net**

SCC-10D

A = 20.84 ac
Tc = 17.5
Fig 8.03(e) → $i_2(17.5) = 3.2$ in/hr
C = 0.45

$Q_2 = 0.45(3.2)(20.84)$
$Q_2 = 30.0$ cfs

Table 8.05(e) → straw w/ net → n = 0.033

Flow Master → depth = 1.33

$T = 62.4(1.33)(0.01)$
$T = 0.83 < 1.45$ use **straw w/ net**

RJH 12-21-01

/DC

SCC-~~8C~~ Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.011560	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	28.75	cfs

Results		
Depth	1.26	ft
Flow Area	7.31	ft^2
Wetted Perimeter	9.99	ft
Top Width	9.58	ft
Critical Depth	1.13	ft
Critical Slope	0.018933	ft/ft
Velocity	3.93	ft/s
Velocity Head	0.24	ft
Specific Energy	1.50	ft
Froude Number	0.79	
Flow is subcritical.		

10D

RJH 12-21-01

SCC ~~9D~~- Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.010000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	30.00	cfs

Results		
Depth	1.33	ft
Flow Area	7.96	ft^2
Wetted Perimeter	10.41	ft
Top Width	9.98	ft
Critical Depth	1.15	ft
Critical Slope	0.018826	ft/ft
Velocity	3.77	ft/s
Velocity Head	0.22	ft
Specific Energy	1.55	ft
Froude Number	0.74	
Flow is subcritical.		

JOYCE ENGINEERING, INC.

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Job: Brownfield Rd
Job No.: Sheet No.: of
Calculated by: RJH Date: 12-21-01
Checked by: Date:
Subject: Scale:

Temp. Liner Calcs:

<u>SCC-10E</u>

$A = 25.24$ ac
$T_c = 24.2$ min.
Fig. 8.03(e) → $i_2(24.2) = 2.8$ in/hr
$C = 0.45$

$$Q_2 = 0.45(2.8)(25.24)$$
$$Q_2 = 31.8 \text{ cfs}$$

Table 8.05(e) → straw w/ net → $n = 0.033$

Flow Master → depth = 1.24

$$T = 62.4(1.24)(0.0155)$$
$$T = 1.20 < 1.45$$ ∴ use <u>straw w/ net</u>

RJH 12-21-01

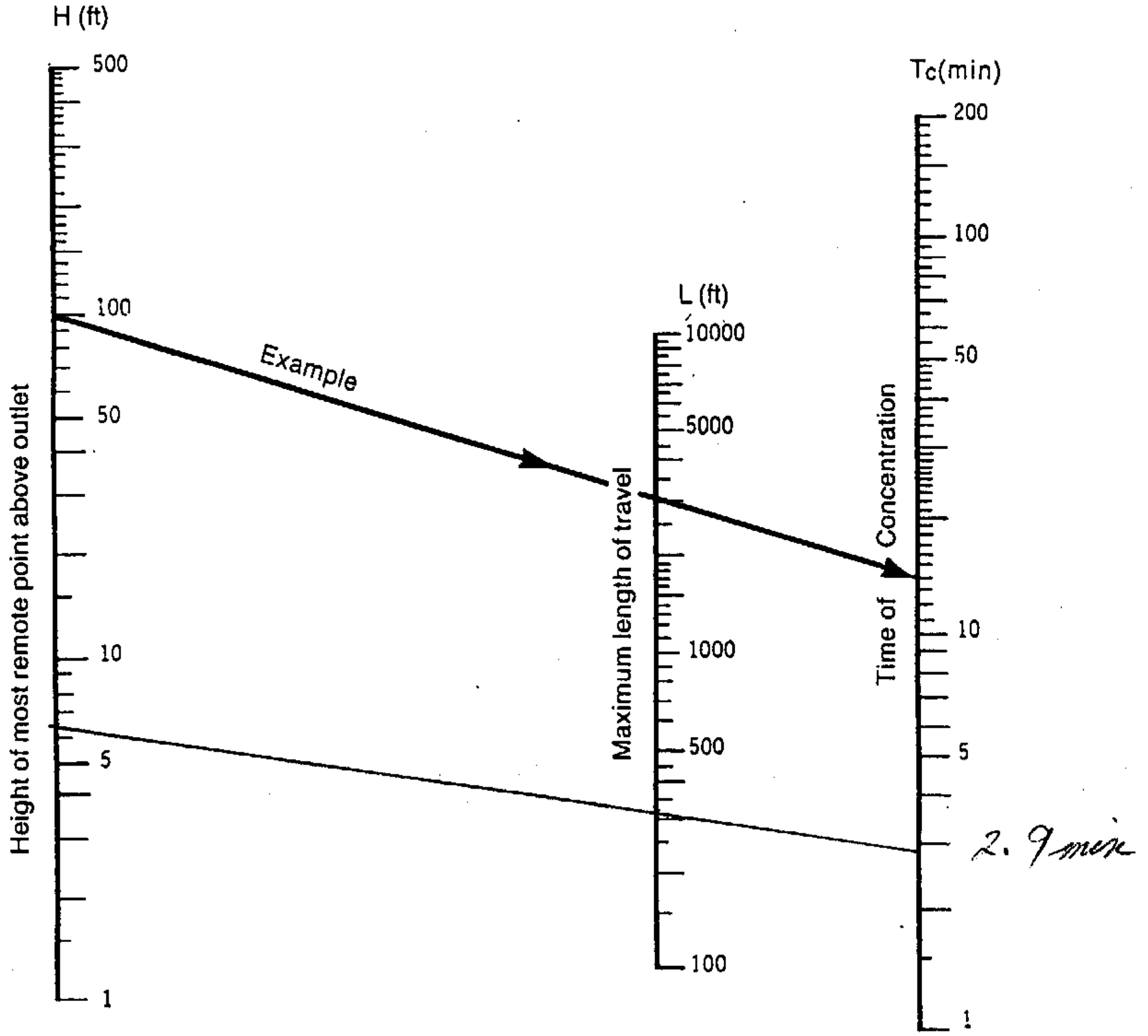
SCC ~~9E~~ 10E Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.015500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	31.80	cfs

Results		
Depth	1.24	ft
Flow Area	7.07	ft^2
Wetted Perimeter	9.82	ft
Top Width	9.42	ft
Critical Depth	1.19	ft
Critical Slope	0.018681	ft/ft
Velocity	4.50	ft/s
Velocity Head	0.31	ft
Specific Energy	1.55	ft
Froude Number	0.92	
Flow is subcritical.		

Peak Flow to SCC-11A



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

$l = 315'$
$H = .02 \times 315 = 6.3'$
$T_c = 2.9$ min.
$i_{25} = 8.5$ in/hr.
$Q = CiA$
$= (.45)\,8.5\,(3.65)$
$= 14.0$ cfs.

Figure 8.03a Time of concentration of small drainage basins.

SCC-11A

Worksheet for Trapezoidal Channel

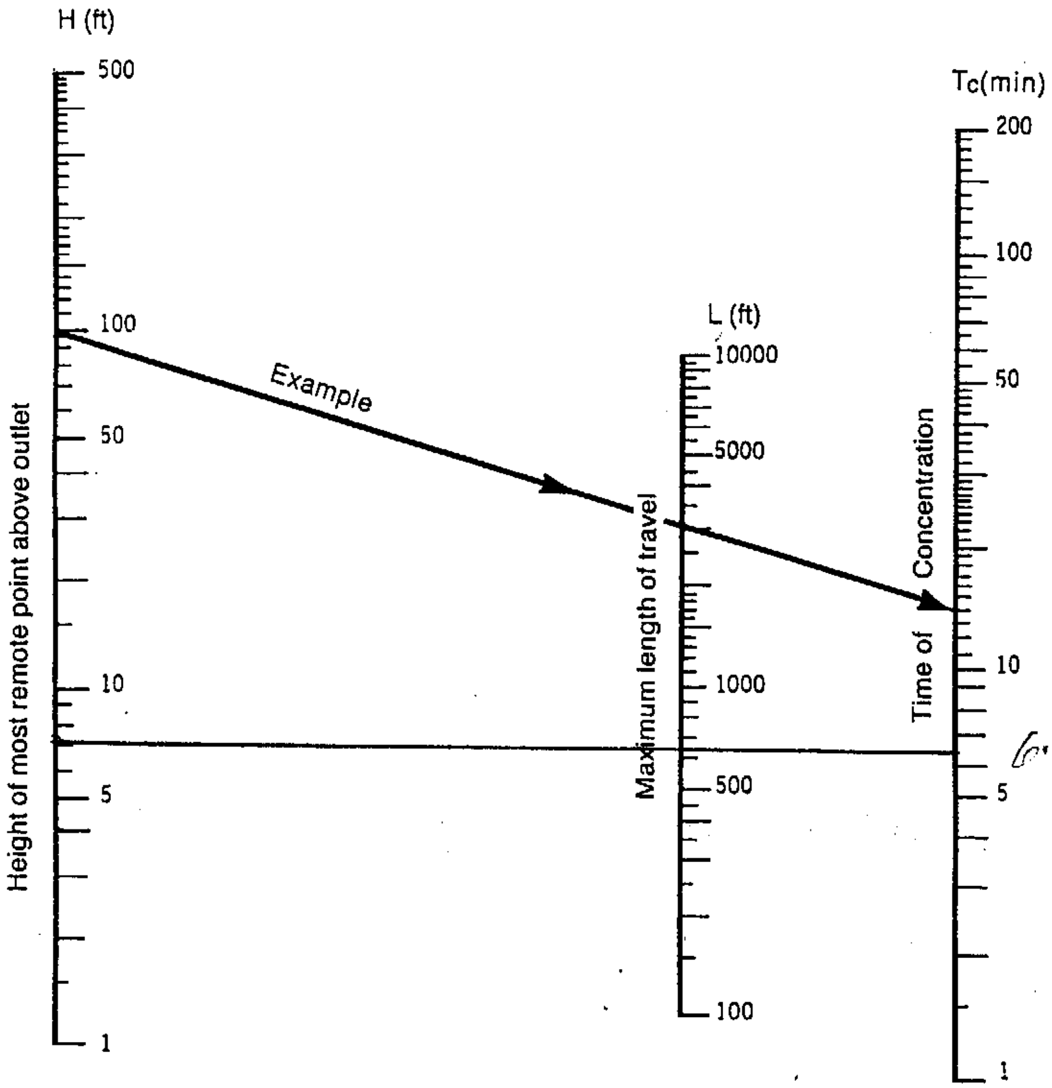
Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: South CEll
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.011590	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	14.00	cfs

Results		
Depth	1.05	ft
Flow Area	5.39	ft^2
Wetted Perimeter	8.63	ft
Top Width	8.29	ft
Critical Depth	0.79	ft
Critical Slope	0.038768	ft/ft
Velocity	2.60	ft/s
Velocity Head	0.10	ft
Specific Energy	1.15	ft
Froude Number	0.57	
Flow is subcritical.		

8

Peak Flow to SCC-11B



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

$l = 630'$,
$H = 7.3'$
$T_c = 2.9 + 6.4$
$= 9.3$ min.
$i_{25} = 7.0$ in/hr.
$Q = (.45)(7.0)(3.65 + 5.07)$
$= (3.15)(8.72)$
$= 27.5$ cfs.

Figure 8.03a Time of concentration of small drainage basins.

SCC-~~2~~ 11B

Worksheet for Trapezoidal Channel

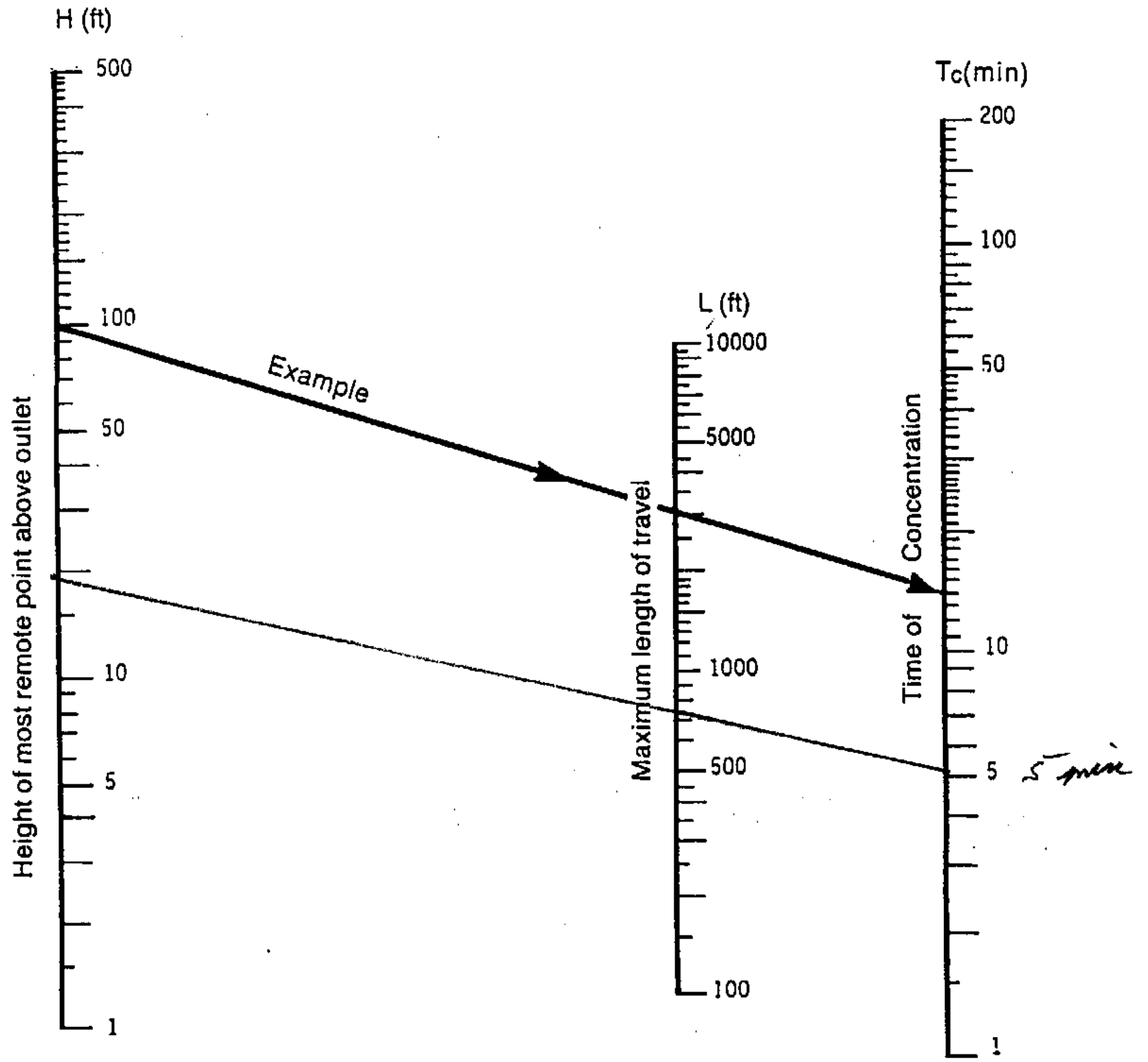
Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D; South Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.026390	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	27.50	cfs

Results		
Depth	1.18	ft
Flow Area	6.55	ft²
Wetted Perimeter	9.47	ft
Top Width	9.09	ft
Critical Depth	1.11	ft
Critical Slope	0.035416	ft/ft
Velocity	4.20	ft/s
Velocity Head	0.27	ft
Specific Energy	1.46	ft
Froude Number	0.87	
Flow is subcritical.		

Peak Flow to SCC-11C

JPR



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

l = 720'
H = 19.0'
T_c = 9.3 + 5
= 14.3 min.
i_{25} = 6.0 in/hr.
A = 8.72 + 3.76 = 12.48
Q_{25} = (.45)(6.0)(12.48)
= 33.7 cfs.

Figure 8.03a Time of concentration of small drainage basins.

J R R

SCC-# 11C

Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: South CEll
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.017190	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	33.70	cfs

Results		
Depth	1.43	ft
Flow Area	8.94	ft^2
Wetted Perimeter	11.01	ft
Top Width	10.55	ft
Critical Depth	1.22	ft
Critical Slope	0.034471	ft/ft
Velocity	3.77	ft/s
Velocity Head	0.22	ft
Specific Energy	1.65	ft
Froude Number	0.72	
Flow is subcritical.		

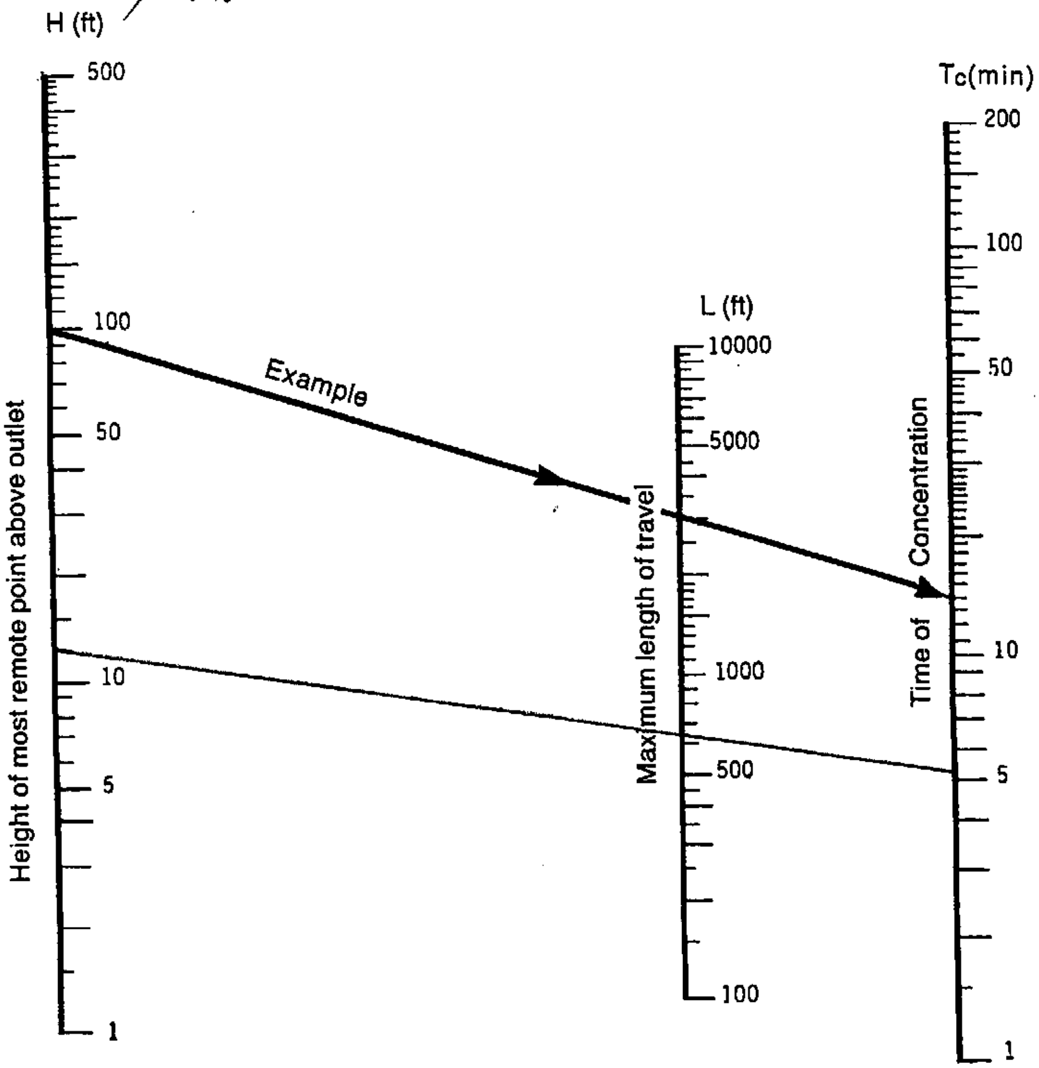
$$S = \frac{254.5 - 2.5' \text{ deep} - 241}{640'}$$

$$= 11/640$$

$$= .01719$$

JPD

Travel time in SCC-11C



5 min

Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

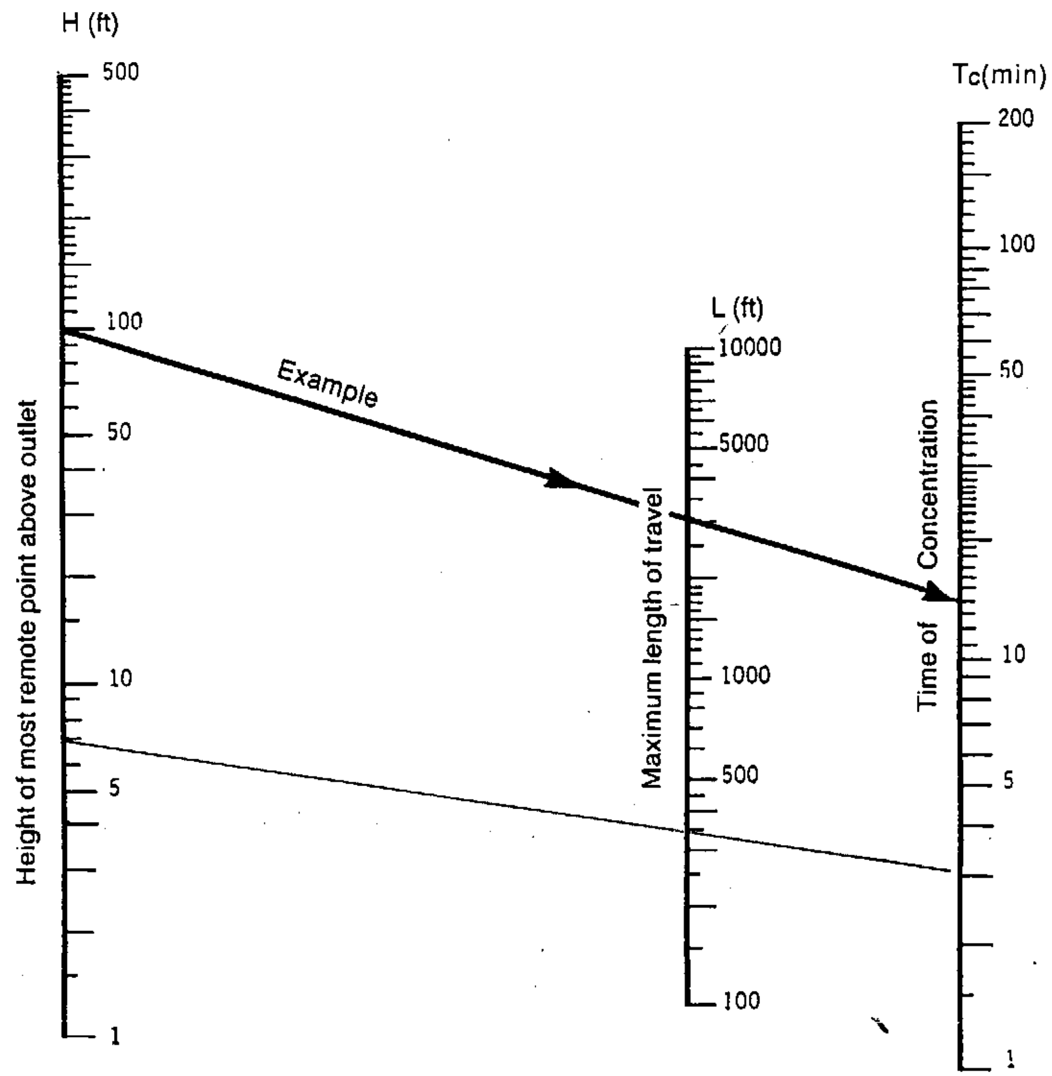
For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

l = 650'
H = 12'
∴ Total Tc for SB-2 = 14.3 + 5 = 19.3 min

Peak Flow at SCL-12A



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l = 350'$
$H = .02 \times 350 = 7.0'$
$T_c = 3$ min
$i_{25} = 8.5$
$Q = (.45)(8.5)(3.22)$
$= 12.3$ cfs.

J P [illegible]

SCC-#/2A

Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: South CEll
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

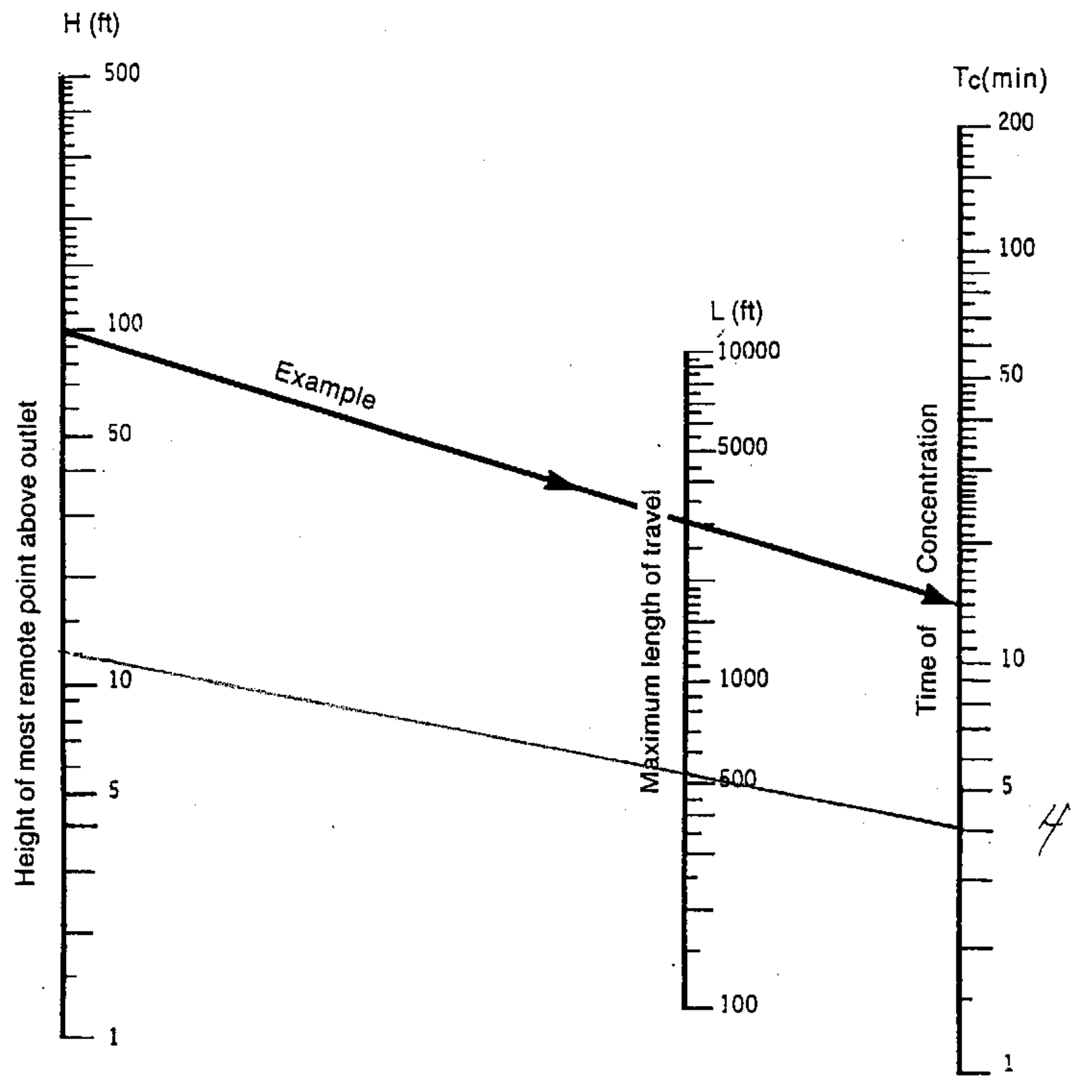
Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.023580	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	12.30	cfs

Results		
Depth	0.84	ft
Flow Area	3.77	ft²
Wetted Perimeter	7.28	ft
Top Width	7.01	ft
Critical Depth	0.74	ft
Critical Slope	0.039454	ft/ft
Velocity	3.27	ft/s
Velocity Head	0.17	ft
Specific Energy	1.00	ft
Froude Number	0.79	
Flow is subcritical.		

3rd

8

Peak Flow to SCC-12B



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l = 530'$

$H = (.02358)(530) = 12.5'$

$T_c = 4 + 3 = 7$ min

$i_{25} = 8$ in/hr

$Q = (.45)(8)(3.22 + 4.0) = 26.3$ cfs.

SCC # 17B

Worksheet for Trapezoidal Channel

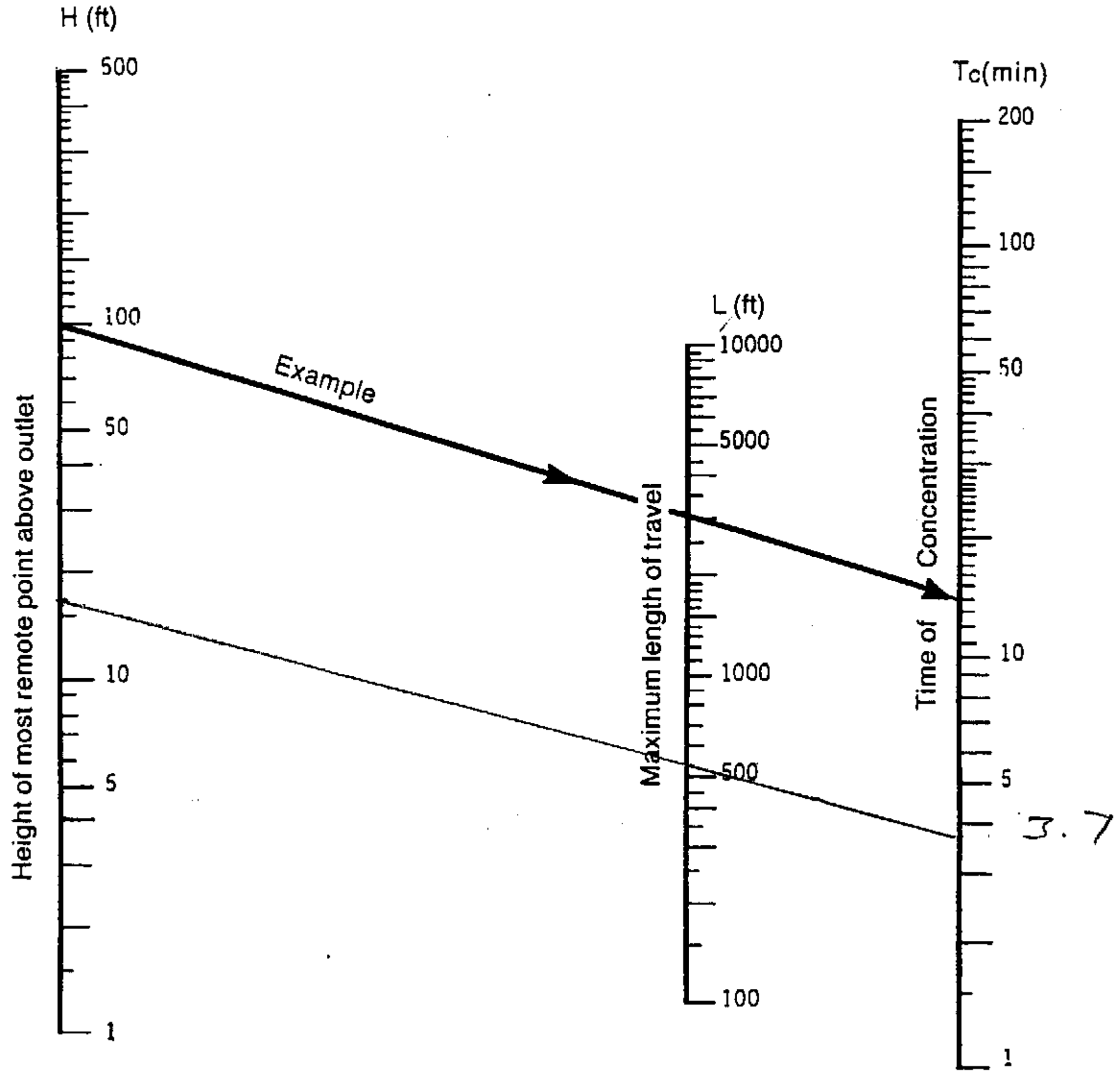
Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: South CEll
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.030470	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	26.30	cfs

Results		
Depth	1.12	ft
Flow Area	6.01	ft²
Wetted Perimeter	9.09	ft
Top Width	8.73	ft
Critical Depth	1.08	ft
Critical Slope	0.035626	ft/ft
Velocity	4.38	ft/s
Velocity Head	0.30	ft
Specific Energy	1.42	ft
Froude Number	0.93	
Flow is subcritical.		

Peak Flow at SCC-12C

8 PR



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l = 535'$
$H = (.03047)(535)$
$= 16.3'$
$T_c = 3.7 + 7 = 10.7$
$i_{25} = 6.8$ in/hr.
$Q = (.45)(6.8)(4.52 + 7.3)$
$= 36.2$ cfs.

SCC-# 12C

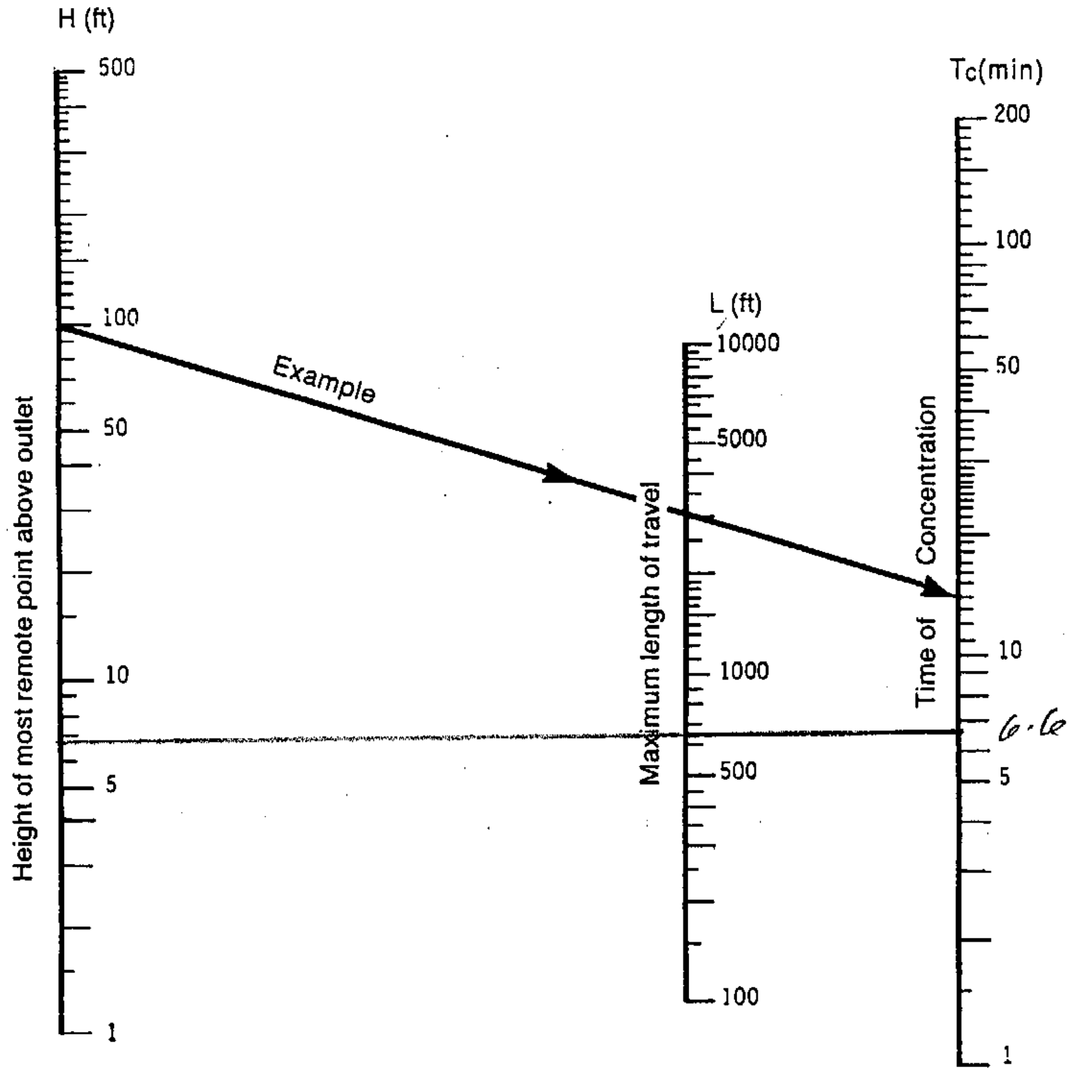
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: South CEll
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.045	
Channel Slope	0.010806	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	36.20	cfs

Results		
Depth	1.63	ft
Flow Area	11.22	ft^2
Wetted Perimeter	12.30	ft
Top Width	11.77	ft
Critical Depth	1.26	ft
Critical Slope	0.034147	ft/ft
Velocity	3.23	ft/s
Velocity Head	0.16	ft
Specific Energy	1.79	ft
Froude Number	0.58	
Flow is subcritical.		

Travel Time in SCC-12C



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

l = 620'
H = 250.2 - 2.5 - 241.0
= 6.7'
Tc = 6.6 + 10.7
= 17.3 min.
i25 = 5.5 in/hr
Q = (.45)(5.5)(2.95 + 11.2)
= 36.6 cfs

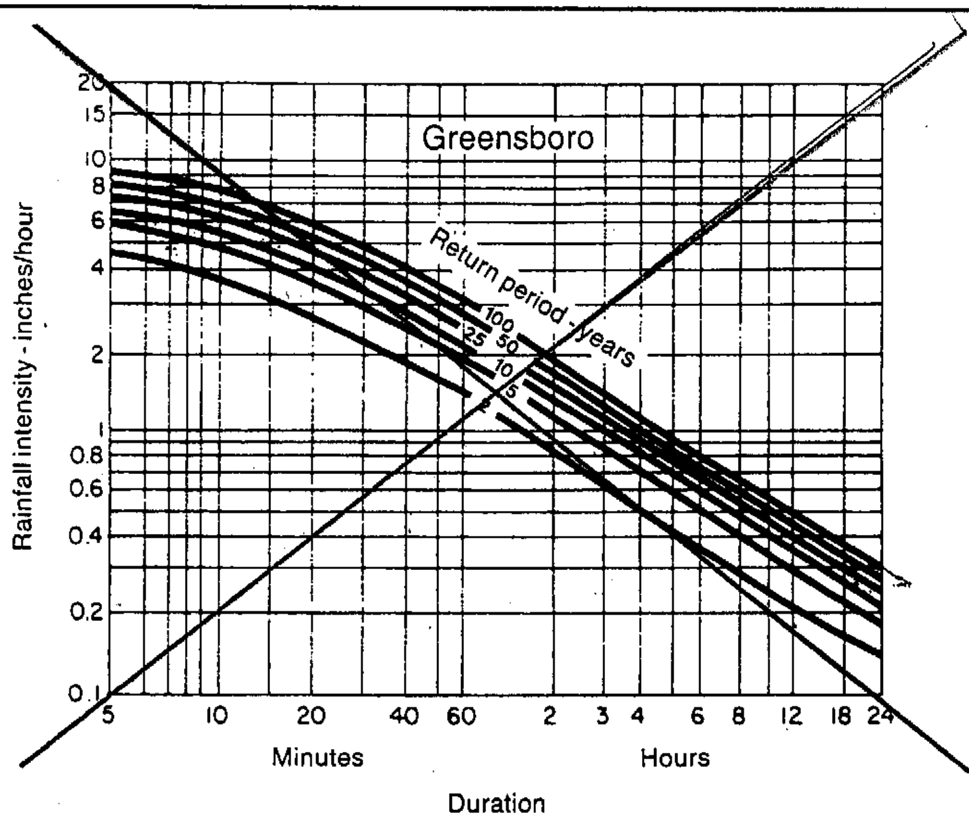


Figure 8.03d Rainfall intensity duration curves—Greensboro.

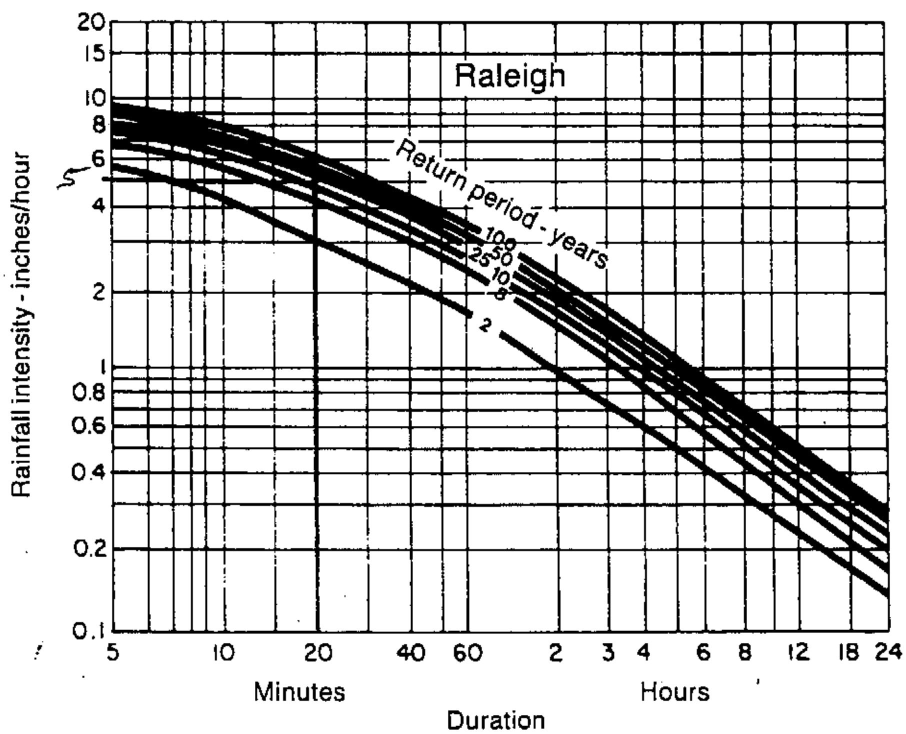


Figure 8.03e Rainfall intensity duration curves—Raleigh.

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job: Brownfield Rd
Job No.: Sheet No. of
Calculated by: RJH Date: 12-21-01
Checked by: Date:
Subject: Scale:

Temp. Liner Calcs:

SCC-11A

$A = 3.65$ ac
$T_c = 2.9$ min
Fig. 8.03(e) → $i_2(5) = 5.75$ in/hr
$C = 0.45$

$Q_2 = 0.45(5.75)(3.65)$
$Q_2 = 9.4$ cfs

Table 8.05(e) → straw w/ net → $n = 0.033$

Flow Master → depth = 0.75

$T = 62.4(0.75)(0.01159)$
$T = 0.54 < 1.45$ use straw w/ net

SCC-11B

$A = 8.72$ ac
$T_c = 9.3$ min.
Fig. 8.03(e) → $i_2(9.3) = 4.3$ in/hr
$C = 0.45$

$Q_2 = 0.45(4.3)(8.72)$
$Q_2 = 16.9$ cfs

Table 8.05(e) → straw w/ net → $n = 0.033$

Flow Master → depth = 0.82

$T = 62.4(0.82)(0.02639)$
$T = 1.35 < 1.45$ use straw w/ net

RJH 12-21-01

11A

SCC ~~10A~~ Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.011590	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	9.40	cfs

Results		
Depth	0.75	ft
Flow Area	3.19	ft²
Wetted Perimeter	6.75	ft
Top Width	6.51	ft
Critical Depth	0.64	ft
Critical Slope	0.022011	ft/ft
Velocity	2.94	ft/s
Velocity Head	0.13	ft
Specific Energy	0.89	ft
Froude Number	0.74	
Flow is subcritical.		

RJH 12-21-01

11B

SCC ~~10B~~- Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.026390	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	16.90	cfs

Results		
Depth	0.82	ft
Flow Area	3.63	ft^2
Wetted Perimeter	7.16	ft
Top Width	6.90	ft
Critical Depth	0.87	ft
Critical Slope	0.020327	ft/ft
Velocity	4.65	ft/s
Velocity Head	0.34	ft
Specific Energy	1.15	ft
Froude Number	1.13	
Flow is supercritical.		

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job: Brownfield Rd

Job No. ______ Sheet No. ______ of ______

Calculated by: RJH Date: 12-21-01

Checked by: ______ Date: ______

Subject: ______ Scale: ______

Temp. Liner Calcs.

<u>SCC-11 C</u>

$A = 12.48$

$T_c = 19.3$

Fig. 8.03 (e) → $i_2(19.3) = 3.0$ in/hr

$C = 0.45$

$$Q_2 = 0.45(3.0)(12.48)$$

$$Q_2 = 16.8 \text{ cfs}$$

Table 8.05(e) → straw w/ net → $n = 0.033$

Flow Master → depth = 0.90

$$T = 62.4(0.90)(0.01719)$$

$$T = 0.97 < 1.45$$ use <u>straw w/ net</u>

RJH 12-21-01

SCC ~~10C~~ 11C Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.017190	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	16.80	cfs

Results		
Depth	0.90	ft
Flow Area	4.24	ft^2
Wetted Perimeter	7.70	ft
Top Width	7.41	ft
Critical Depth	0.87	ft
Critical Slope	0.020342	ft/ft
Velocity	3.96	ft/s
Velocity Head	0.24	ft
Specific Energy	1.15	ft
Froude Number	0.92	
Flow is subcritical.		

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Job Brownfield Rd

Job No. ______ Sheet No. ____ of ____

Calculated by RJH Date 12-21-01

Checked by ______ Date ______

Subject ______ Scale ______

Temp. Liner Calcs.

SCC-12A

A = 3.22 ac

Tc = 3 min

Fig. 8.03(e) → $i_2(5) = 5.75$ in/hr

C = 0.45

$Q_2 = 0.45(5.75)(3.22)$

$Q_2 = 8.33$ cfs

Table 8.05(e) → straw w/ net → n = 0.033

Flow Master → depth = 0.60

T = 62.4(0.60)(0.02358)

T = 0.88 < 1.45 use straw w/ net

SCC-12B

A = 7.30 ac

Tc = 7 min

Fig. 8.03(e) → $i_2(7) = 5.0$ in/hr

C = 0.45

$Q_2 = 0.45(5.0)(7.30)$

$Q_2 = 16.4$ cfs

Table 8.05(e) → straw w/ net → n = 0.033

Flow Master → depth = 0.78

T = 62.4(0.78)(0.03047)

T = 1.48 > 1.45 No Good - Try Synthetic Mat → n=0.0

T = 62.4(0.68)(0.03047)

T = 1.29 < 2.0 O.K. use Synthetic Mat

12A RJH 12-21-01

SCC ~~11A~~ Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.023580	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	8.33	cfs

Results		
Depth	0.60	ft
Flow Area	2.25	ft^2
Wetted Perimeter	5.76	ft
Top Width	5.57	ft
Critical Depth	0.60	ft
Critical Slope	0.022379	ft/ft
Velocity	3.70	ft/s
Velocity Head	0.21	ft
Specific Energy	0.81	ft
Froude Number	1.02	
Flow is supercritical.		

RJH 12-21-01

SCC ~~11B~~ 12B Bare Condition (Synthetic Mat)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.025	
Channel Slope	0.030470	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	16.40	cfs

Results		
Depth	0.68	ft
Flow Area	2.75	ft²
Wetted Perimeter	6.30	ft
Top Width	6.08	ft
Critical Depth	0.86	ft
Critical Slope	0.011713	ft/ft
Velocity	5.97	ft/s
Velocity Head	0.55	ft
Specific Energy	1.23	ft
Froude Number	1.56	
Flow is supercritical.		

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Job Brownfield Road

Job No. ______ Sheet No. ______ of ______

Calculated by RJH Date 12-21-01

Checked by ______ Date ______

Subject ______ Scale ______

Temp. Liner Calcs.

SCC-12C

$A = 11.82 ac$

$T_c = 10.7 \, min$

Fig. 8.03(e) → $i_2(10.7) = 4.0 \, in/hr$

$C = 0.45$

$$Q_2 = 0.45(4.0)(11.82)$$

$$Q_2 = 21.3 \, cfs$$

Table 8.05(e) → straw w/ net → $n = 0.033$

Flow Master → depth = 1.12

$$T = 62.4(1.12)(0.010806)$$

$$T = 0.76 < 1.45$$ use straw w/net

RJH 12-21-01

12 C

SCC ~~11C-~~ Bare Condition (Straw w/ net)
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Wake County C&D: North Cell
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.033	
Channel Slope	0.010806	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	21.30	cfs

Results		
Depth	1.12	ft
Flow Area	6.00	ft^2
Wetted Perimeter	9.08	ft
Top Width	8.72	ft
Critical Depth	0.97	ft
Critical Slope	0.019705	ft/ft
Velocity	3.55	ft/s
Velocity Head	0.20	ft
Specific Energy	1.32	ft
Froude Number	0.75	
Flow is subcritical.		

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Job
Job No. Sheet No. of
Calculated by Date
Checked by Date
Subject Scale

SEDIMENT TRAPS

From AutoCADD:
(Drwg. No. 4)

Area 1 : 1.17 ac
2 : 0.29 ac
3 : 1.18 ac
4 : 1.05 ac

Sediment Trap Storage Volumes:

$V_{min} = 1800\ ft^3/ac$

$V_{ST1} = 1800 \frac{ft^3}{ac} \times (1.17 + 0.29)\ ac = 2,628\ ft^3$ ✓

$V_{ST2} = 1800 \frac{ft^3}{ac} \times (1.18\ ac) = 2,124\ ft^3$ ✓

$V_{ST3} = 1800 \frac{ft^3}{ac} \times (1.05\ ac) = 1,890\ ft^3$ ✓

Shape of Sed. Traps:

L x W x D

$ST_1 = 30' \times 30' \times 3' = 2,700\ ft^3 > 2,628\ ft^3 \therefore$ o.k.

$ST_2 = 30' \times 25' \times 3' = 2,250\ ft^3 > 2,124\ ft^3 \therefore$ o.k.

$ST_3 = 30' \times 25' \times 3' = 2,250\ ft^3 > 1,890\ ft^3 \therefore$ o.k.

Table 6.60 (a) ⇒ Weir Lengths

$ST_1 = 6.0'$
$ST_2 = 4.0'$
$ST_3 = 4.0'$

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Job: Wake County: Brownfield Rd
Job No. ______ Sheet No. ____ of ____
Calculated by: RH Date ______
Checked by ______ Date ______
Subject ______ Scale ______

From AutoCAD:

Area ST_4 = 2.2 ac
Area ST_5 = 2.9 ac
Area ST_6 = 0.77 ac

Min. ST_{Vol} = 1800 ft^3/acre

$\therefore ST_{VOL,4} = 1800 \frac{ft^3}{ac} \times 2.2\,ac = 3960\ ft^3$

$\therefore ST_{VOL,5} = 1800 \times 2.9\,ac = 5220\ ft^3$

$\therefore ST_{VOL,6} = 1800 \times 0.77\,ac = 1386\ ft^3$

	L	x	W	x	d					
ST_4	35'	x	40'	x	3'	=	4200 ft^3	>	3960 ft^3	o.k.
ST_5	40'	x	45'	x	3'	=	5400 ft^3	>	5220 ft^3	o.k.
ST_6	20'	x	25'	x	3'	=	1500 ft^3	>	1386 ft^3	o.k.

Table 6.60(a) ⇒ Weir Lengths

ST_4 = 6.0'
ST_5 = 8.0'
ST_6 = 4.0'

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Job

Job No. Sheet No. of

Calculated by Date

Checked by Date

Subject Scale

SB-1

JOYCE ENGINEERING, INC.

JOB Wake Co - Brownfield Rd

JOB NO. ______ SHEET NO. ______ OF ______

CALCULATED BY JPR DATE ______

CHECKED BY ______ DATE ______

SUBJECT ______ SCALE ______

N. Cell

Estimate peak flow into sediment basin.

Check flow for 25-yr and 100-yr. events.

T_c = 20 min (see attached calcs.); A = 47.8 ac.

Estimate composite 'C' value. Worst case will be for approximately 15 acres disturbed, 32.8 acres grassed. Use C ≈ 0.70 for barren slopes. (Ref. Erosion & Sediment Control Handbook, McGraw Hill, 1986, p. 4.7) For grassed areas, use C ≈ 0.30.

Composite $C \approx \frac{(15)(0.70)+(32.8)(0.30)}{47.8} = 0.43$.

i_{25} = 5 in/hr. i_{100} = 6.2 in/hr.

Q_{p25} = ciA Q_{p100} = ciA

= (0.43)(5)(47.8) = (0.43)(6.2)(47.8)

= 103 cfs. = 127 cfs.

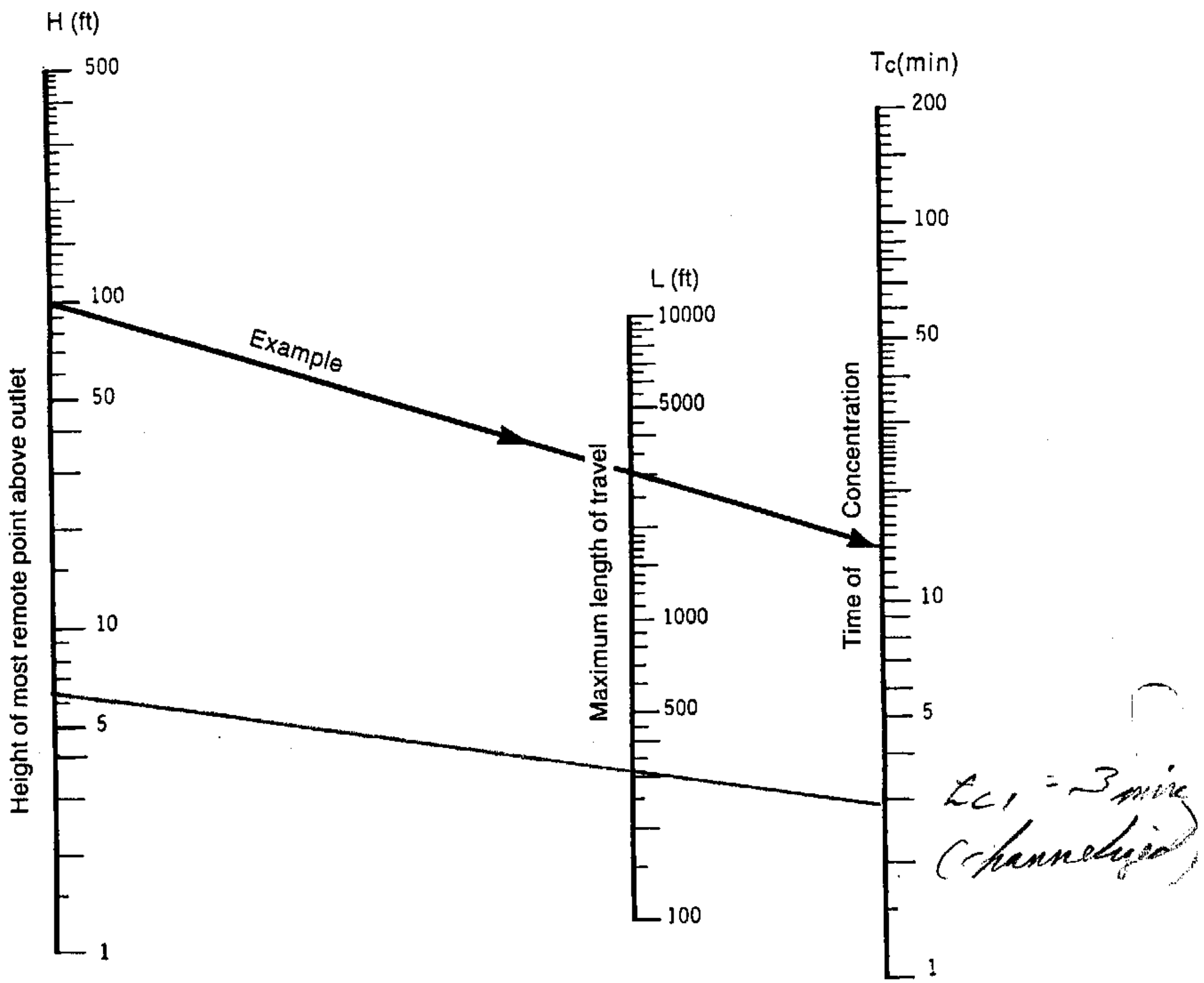
Min. volume required 1800 ft.³/acre

$1800 \frac{ft^3}{ac.} \times 47.8\ ac. = 86,040\ ft.^3$

Sediment cleanout level: provide $\frac{86,040}{2}$ = 43,020 ft.³ storage before cleanout is required.

Surface area required: (0.01)(103) = 1.0 ac.

Estimate Tc, JPD



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

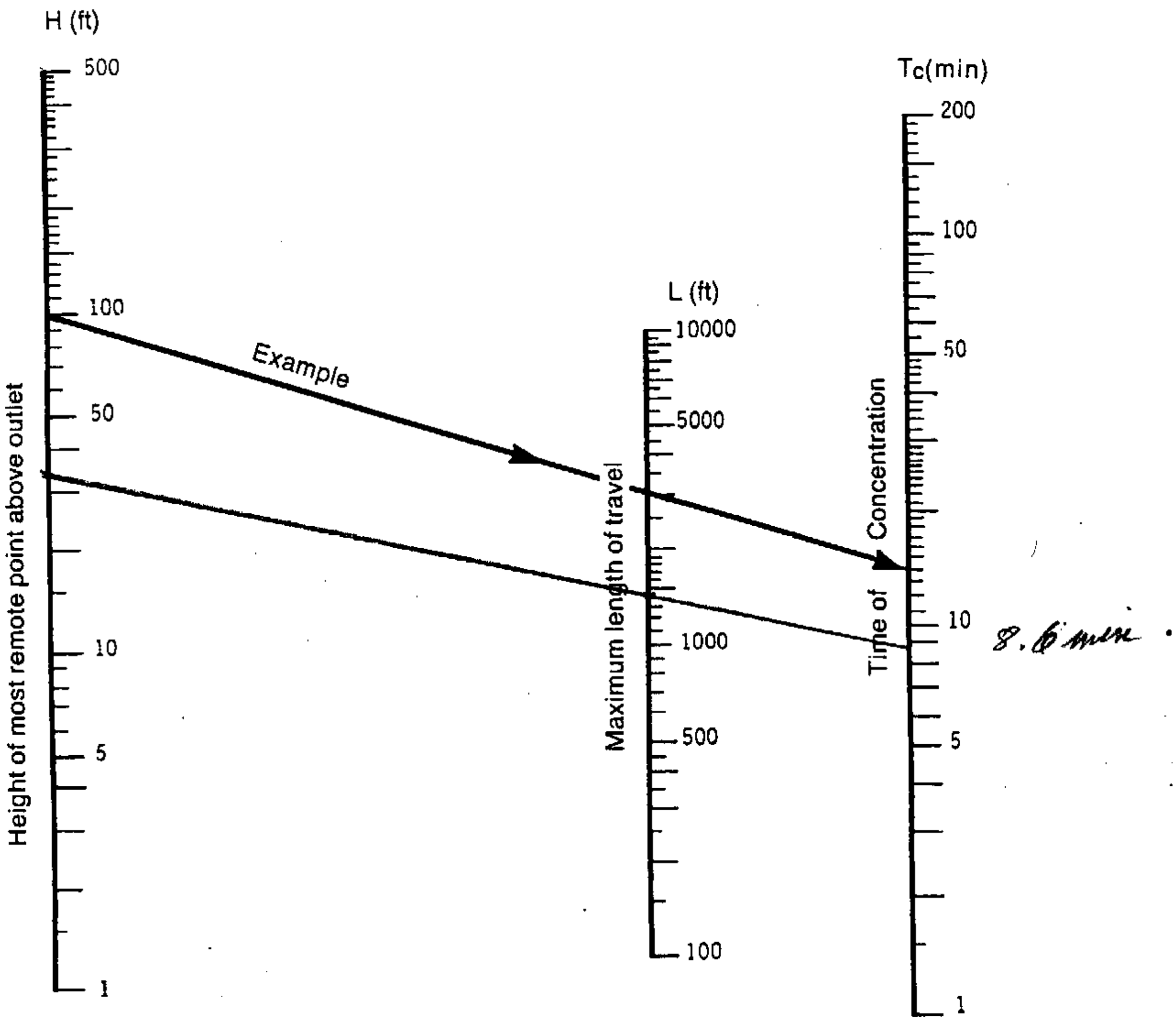
For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l_1 = 320'$
$H_1 = .02 \times 320 = 6.4'$

8.8



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

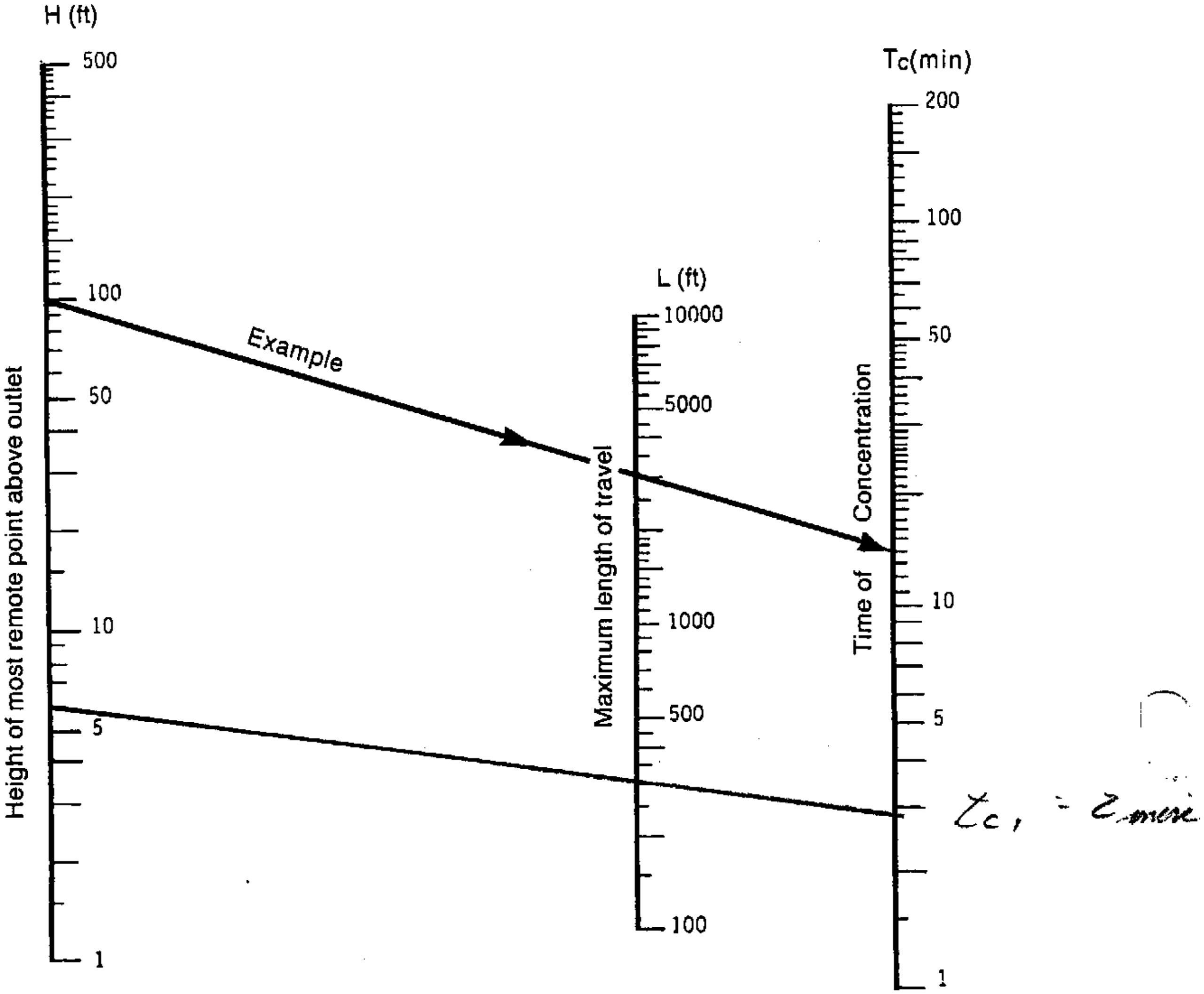
For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l_2 = 1850'$
$H_2 \approx 268 - 224 = 44'$
$T_{c_1} = t_{c_1} + t_{c_2} = 3 + 8.6 = 11.6$ min.

Estimate Tc2



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

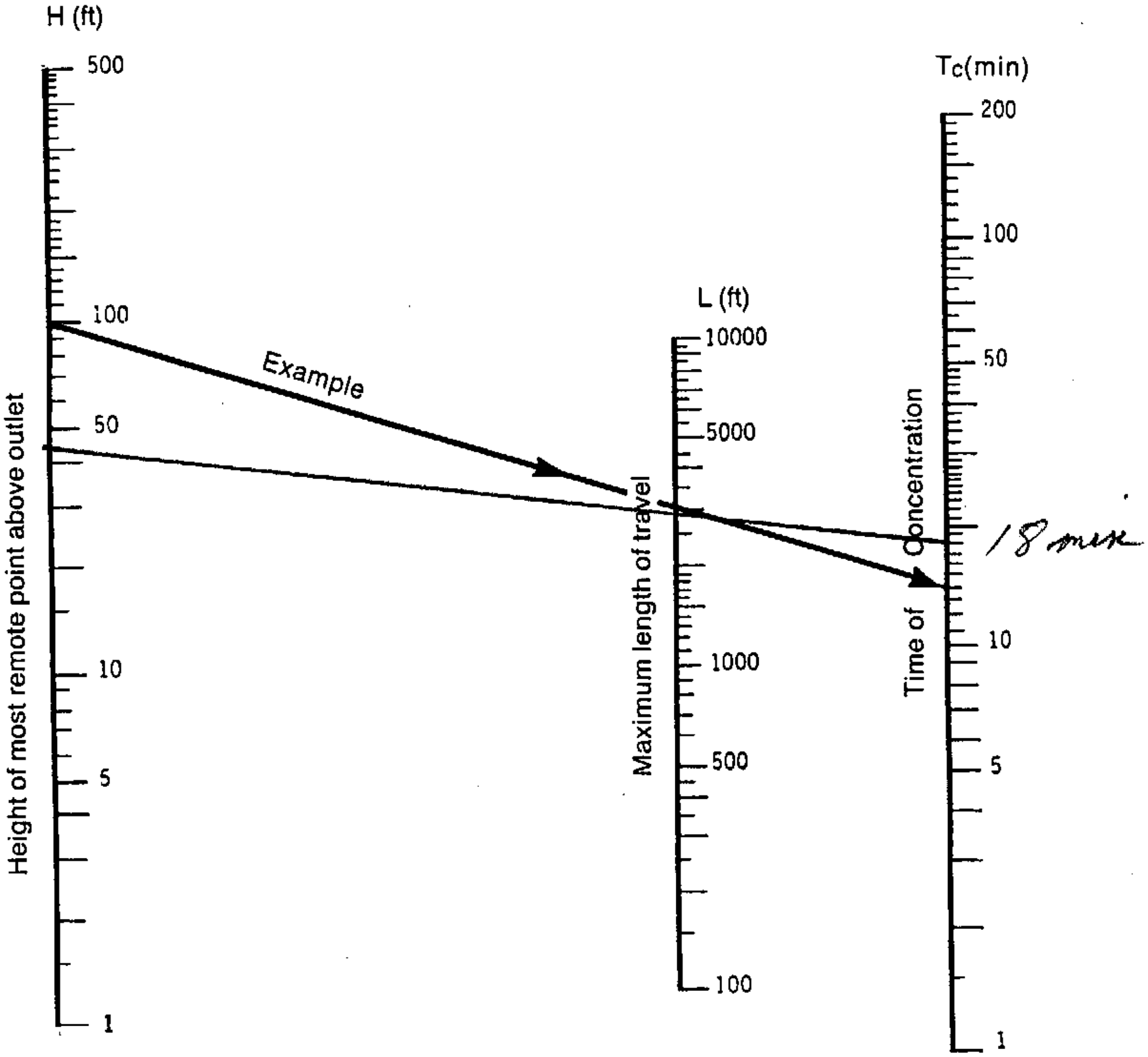
For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

L_1 = 300'
H_1 = .02 x 300 = 6'



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

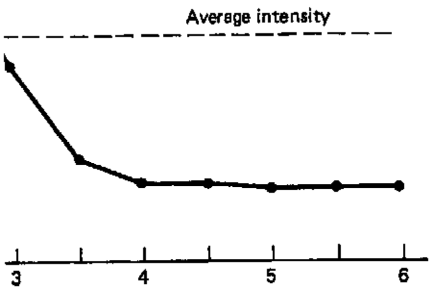
For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

$l_2 = 2900'$
$H_2 \simeq 268 - 224 = 44'$
$T_{c_2} = T_{c_1} + T_{c_2} = 2 + 18 = 20$ min.



.orm runoff during a 6-hr storm.

during the portion of a storm in which flow. The graph in Fig. 4.2 illustrates a unoff for a 6-hr storm. Peak intensity ·ve; average intensity is indicated by a of the storm will the flow exceed average y placing the ½-hr incremental rainfall d by the U.S. Soil Conservation Service 1, 12) asure. For the same design storm return ı short time of concentration, is much on. A basin sized by using peak flow will sing the average flow. The sizing proce-

portion of rainfall that will run off the y and water-holding capacity of the var- lue can vary from close to zero to up to the water is retained for a time on the rming puddles, whereas a high C value pidly. Well-vegetated areas have low C it, rooftops, and other impermeable sur- coefficient produces higher runoff than portional to C. ·ational formula. Select a C value within .t exercise judgment in selecting C from

TABLE 4.1 Rational Method C Values (13)

Land use	C
Business	
Downtown areas	0.70–0.95
Neighborhood areas	0.50–0.70
Residential	
Single-family areas	0.30–0.50
Multi units, detached	0.40–0.60
Multi units, attached	0.60–0.75
Suburban	0.25–0.40
Industrial	
Light areas	0.50–0.80
Heavy areas	0.60–0.90
Parks, cemeteries	0.10–0.25
Playgrounds	0.20–0.35
Railroad yard areas	0.20–0.40
Unimproved areas	0.10–0.30
Streets	
Asphaltic	0.70–0.95
Concrete	0.80–0.95
Brick	0.70–0.85
Drives and walks	0.75–0.85
Roofs	0.75–0.95

Land use	C
Lawns	
Sandy soil, flat, 2%	0.05–0.10
Sandy soil, average, 2–7%	0.10–0.15
Sandy soil, steep, 7%	0.15–0.20
Heavy soil, flat, 2%	0.13–0.17
Heavy soil, average, 2–7%	0.18–0.22
Heavy soil, steep, 7%	0.25–0.35
Agricultural land, 0–30%	
Bare packed soil	
Smooth	0.30–0.60
Rough	0.20–0.50
Cultivated rows	
Heavy, soil, no crop	0.30–0.60
Heavy soil with crop	0.20–0.50
Sandy soil, no crop	0.20–0.40
Sandy soil with crop	0.10–0.25
Pasture	
Heavy soil	0.15–0.45
Sandy soil	0.05–0.25
Woodlands	0.05–0.25
Barren slopes, >30%*	
Smooth, impervious	0.70–0.90
Rough	0.50–0.70

Note: The designer must use judgment to select the appropriate C value within the range. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should be assigned highest C values.

*From Portland Cement Association, *Handbook of Concrete Culvert Pipe Hydraulics*, 1964, p. 45.

the range given by considering factors such as permeability, soil type, steepness, and vegetation.

For construction sites, when the soil is bare and the slope is less than 30 percent, use the agricultural values in the table and consider soil conditions and density of vegetation. For areas with temporary vegetative cover, select a value from the ranges for "cultivated rows"; for undisturbed areas under natural grass and shrub cover assign an appropriate "unimproved areas" C value between 0.10 and 0.30. If the slope gradient is greater than 30 percent, for example, 3:1 or 2:1, choose a value in the range 0.50–0.90 under "barren slopes." Soil depth or depth to impermeable rock influences the choice within the ranges given; the C value is higher for shallower soils. For sites with mixed land uses, compute a weighted average of the individual C values, as follows:

If area $A = x + y$, then

$$C\ (\text{weighted}) = \frac{(x \times C_x) + (y \times C_y)}{A}$$

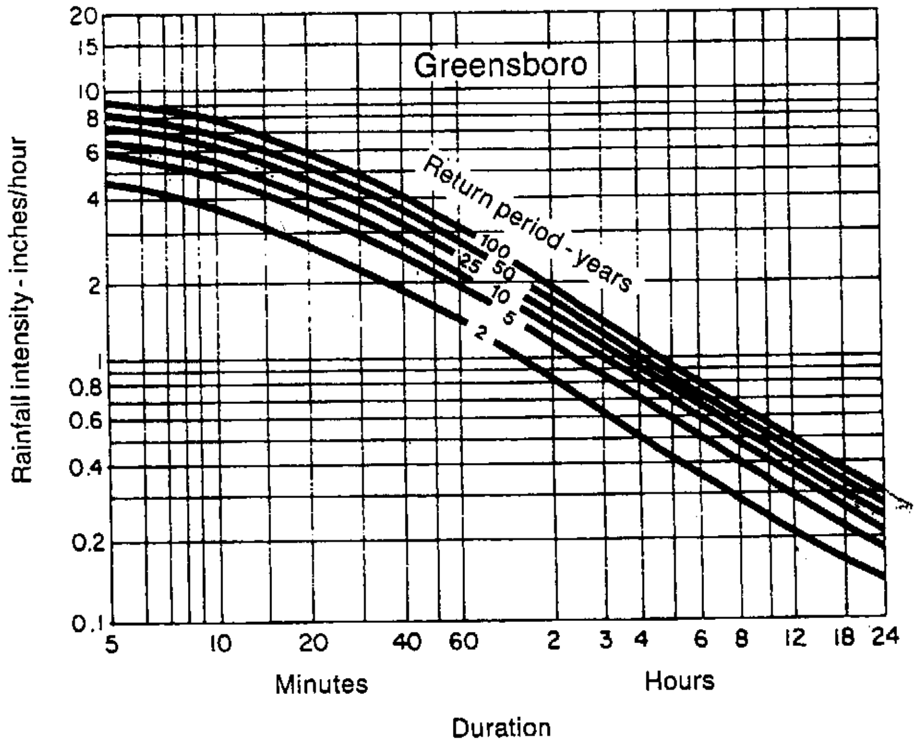


Figure 8.03d Rainfall intensity duration curves—Greensboro.

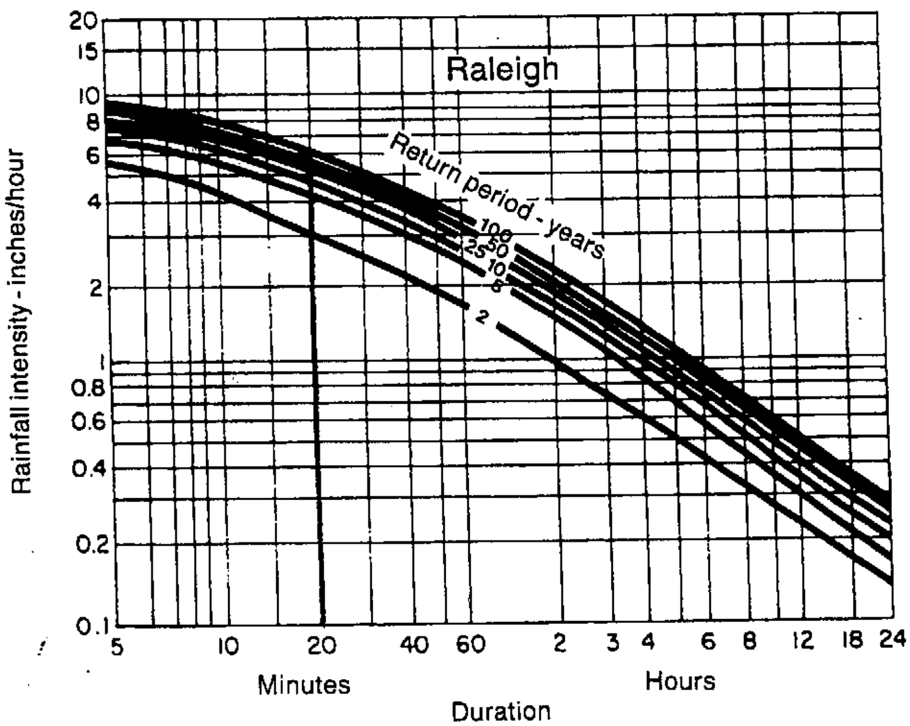


Figure 8.03e Rainfall intensity duration curves—Raleigh.

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Job ____

Job No. ____ Sheet No. ____ of ____

Calculated by JPD Date ____

Checked by ____ Date ____

Subject ____ Scale ____

Stage / Storage Relationship (SB-1)

Elevation	Area (ft.²)	Avg. Area (ft.²)	Approx. Incremental Volume (ft.³)	Cumulative Volume (ft.³)
200	37,200			0
		39,292	78,584	
202	41,385			78,584
		43,400	86,800	
204	45,415			165,384
		47,818	95,636	
206	50,220			261,020
		52,700	105,400	
208	55,180			366,420
		57,272	114,544	
210	59,365			480,964

JPD

NORMAL FLOW DEPTH (100-YR PEAK DISCHARGE

Worksheet for Circular Channel

Check normal flow depth in SB-1 Discharge Barrel

Project Description	
Project File	untitled.fm2
Worksheet	Normal Flow Depth in SB-1 Disch Barrel
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.040000	ft/ft
Diameter	48.00	in
Discharge	127.00	cfs

$\left(\frac{200-194}{150}\right)$

Results		
Depth	2.75	ft
Flow Area	9.20	ft²
Wetted Perimeter	7.81	ft
Top Width	3.71	ft
Critical Depth	3.38	ft
Percent Full	68.67	
Critical Slope	0.025330	ft/ft
Velocity	13.81	ft/s
Velocity Head	2.96	ft
Specific Energy	5.71	ft
Froude Number	1.55	
Maximum Discharge	167.39	cfs
Full Flow Capacity	155.61	cfs
Full Flow Slope	0.026645	ft/ft
Flow is supercritical.		

⇒ Barrel is not full.

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JOB ______ JOB NO. ______ SHEET NO. ___ OF ___
CALCULATED BY JPW DATE ______
CHECKED BY ______ DATE ______
SUBJECT ______ SCALE ______

Barrel flows partially full (see printout)

H W = 6.4' under inlet control (see attached nomograph).

∴ Set principal spillway crest at 200 + 6.5' = 206.5'

Select riser size.

Cross sectional area of riser should be at least 1.5 times the cross-sectional area of the barrel.

Cross-sectional area of barrel = $\pi(2)^2$
$= 12.57\ ft^2$

Try 60" diameter riser

$A = \pi(2.5)^2 = 19.63$

$\frac{19.63}{12.57} = 1.56 > 1.5$ ∴ OK

Head at crest = 1.53' for 25-yr. peak (Fig. 8.07-b)

∴ High water elevation is at

$206.5 + 1.53 = 208.0'$

Top of embankment to 1' above high water.

With top of embankment at 210.0, 2' of freeboard is provided ∴ OK.

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Job ____________________

Job No. ____________________ Sheet No. ______ of ______

Calculated by JPR Date ______

Checked by ______ Date ______

Subject ______ Scale ______

Check ability of riser to pass 100-yr. peak

@ Q_{100} = 127 cfs.

From fig. 8.07b, H = 1.575'

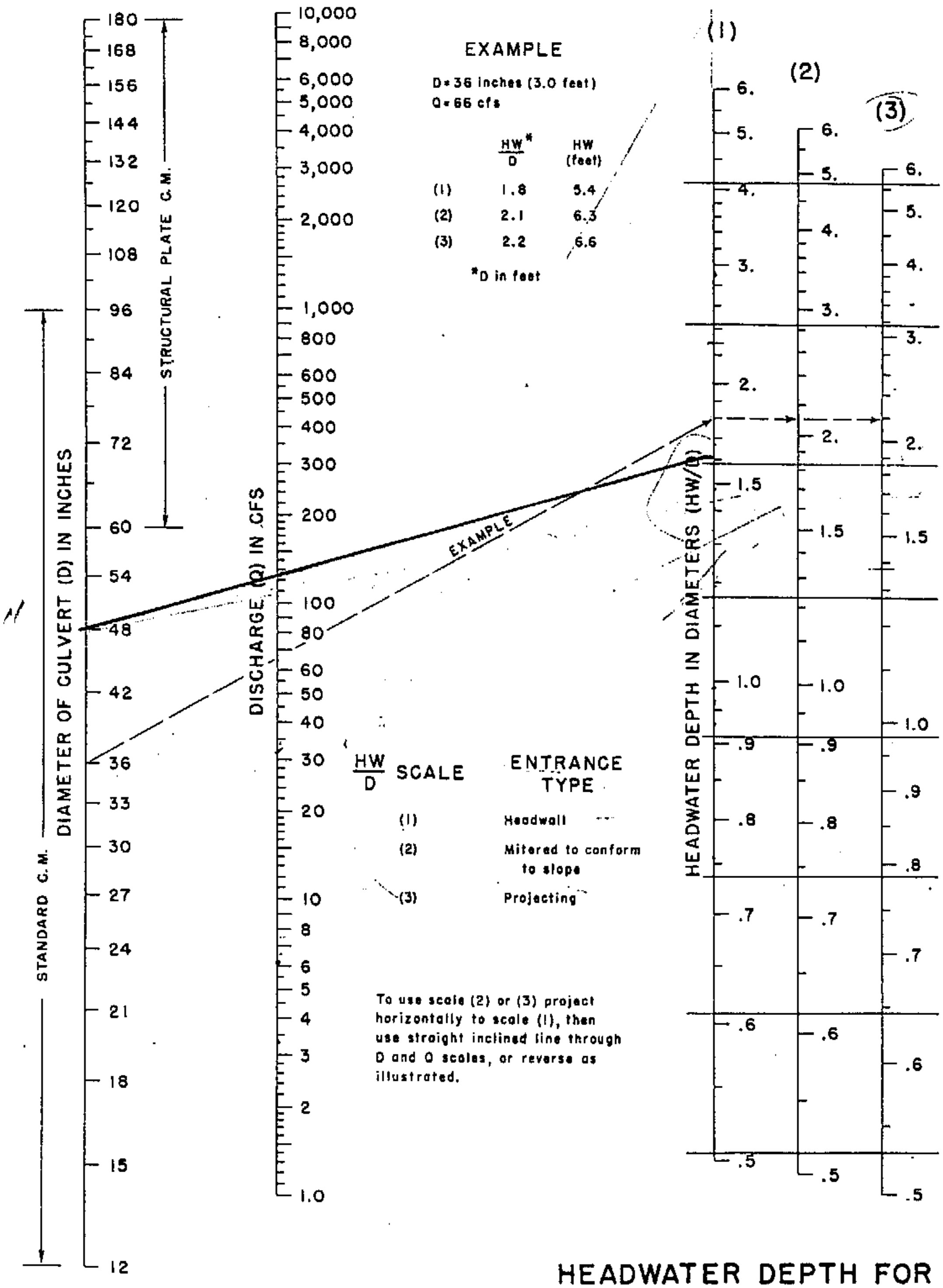
High water elev. during 100 yr. event is

206.5 + 1.58 = 208.08

freeboard = 210.0 - 208.08 = 1.92' O.K.

JPO

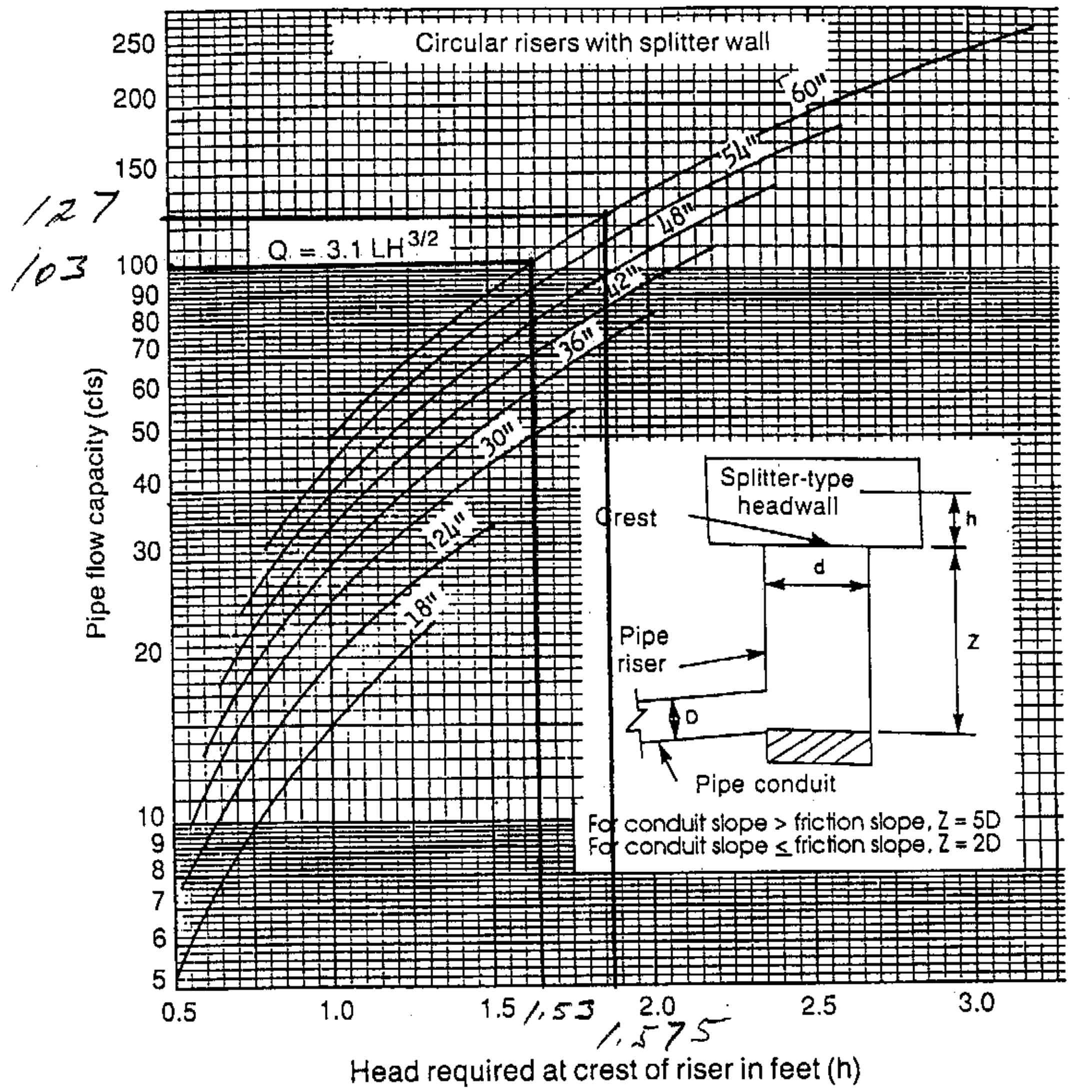
CHART 5



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

HW/D ≈ 1.6
HW = 1.6x4 = 6.4'



Inlet Proportions	
Pipe Conduit (D) - in	Pipe Riser (d) - in
8-12	18
15	21
18	24
21	30
24	30
30	36
36	48
42	54
48	60

Pipe drop inlet spillway design:

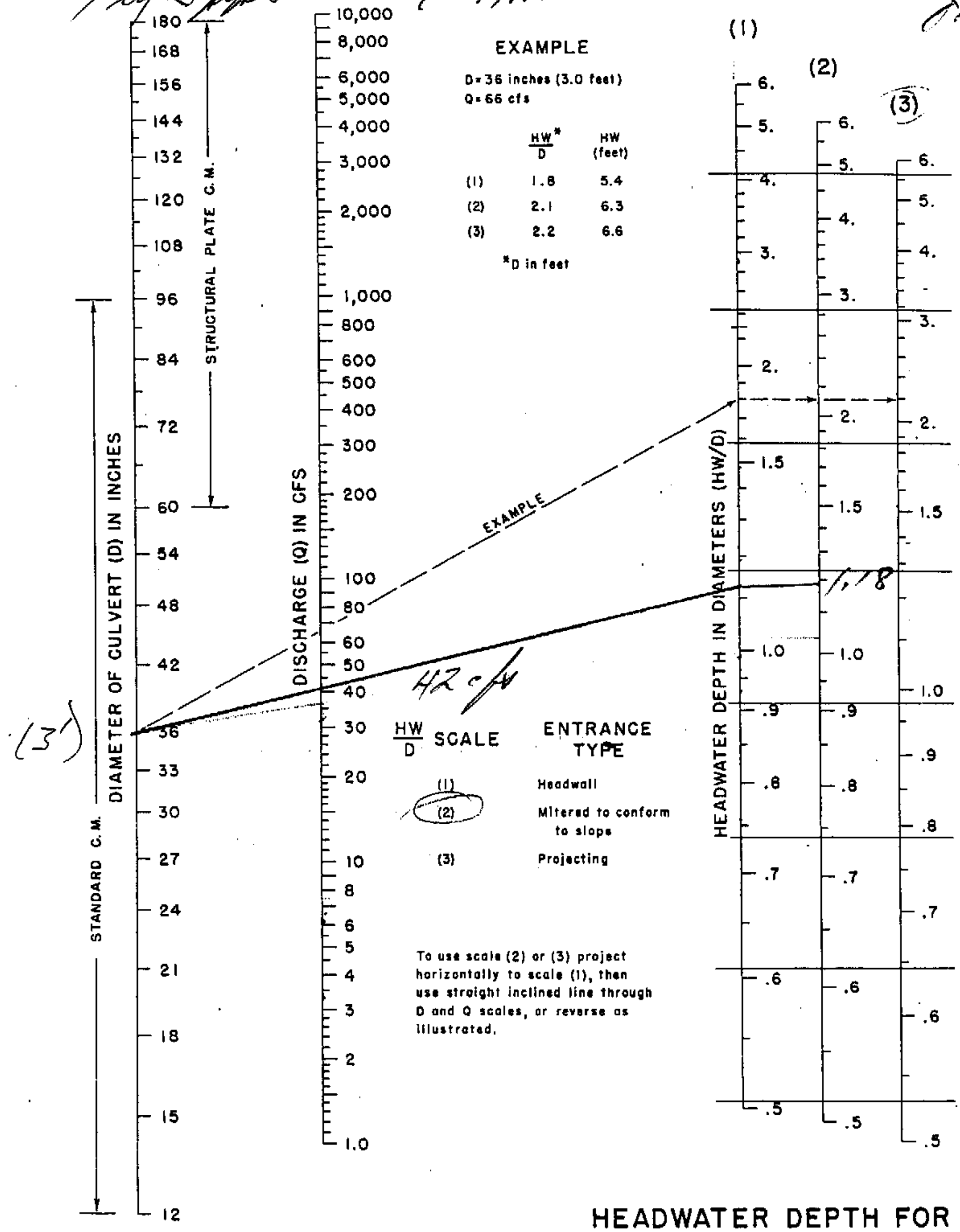
For a given Q and H, refer to Table 8.07a or 8.07b for conduit size. Then determine the riser diameter (d) from the Inlet Proportions Table on this figure. Next, refer to the above curves, using the conduit capacity and riser diameter, and find the head (h) required above the crest of the riser. The height of the riser should not be less than 5D - h, except as noted in the above sketch.

Example - Given: CMP; Q = 20 cfs; H = 14 ft, h max. 1.0 ft; L = 70 ft. From Table 8.07a find conduit size (D) = 18 inches. From Inlet Proportions Table, riser size = 24 inches. Head (h) required for Q = 20 and d = 24 is 1.0 ft.

Figure 8.07b Design chart for riser outlet.

Select culvert size for pipes discharging into SD-1.
Try 3 pipes to carry Q_{prop}; $\frac{127}{3}$ = 42 cfs.

CHART 5



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

HW ≈ 1.18 × 3' = 3.54'
use three (3) 36-in CMP to pass 127 cfs (Q_{prop})
Inv. elev. at entrance = 220-1'-3.5' = 215.5.
(1' of cover provided over pipe.)

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Job ____

Job No. ____ Sheet No. ____ of ____

Calculated by JRB Date ____

Checked by ____ Date ____

Subject ____ Scale ____

Barrel Dewatering

As per the recommendations in the N.C. Erosion and Sediment Control Planning and Design Manual, perforate the lower half of the riser with 1/2-inch diameter holes spaced three inches apart in each outside pipe valley (Ref: NCESCPDM pg. 6.61.4). Cover the perforated section with two feet of NCDOT # 57 stone.

Anti-seep collar

Anti-seep collars must project at least 1.5 ft. from the pipe, and be no closer than 2 ft to a pipe joint. Connections shall be watertight.

Outside diameter of 48-inch helical CMP = 50"

∴ anti seep collar should be at least 50" + 18" + 18" = 86" in diameter (7'-2").

From figs 1-26 & 1-27, # of collars required = 2

Size of collars: 6.6' < 7'-2" ∴ use 7'-2" x 7'-2" collars

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Job ______
Job No. ______ Sheet No. ____ of ____
Calculated by JPB Date ______
Checked by ______ Date ______
Subject ______ Scale ______

Maximum spacing of collars should be 14 times the projection of the collar measured perpendicular to the pipe.

$\therefore$ max spacing $= (14)\left(\frac{86-50}{2}\right) = 252''$

$= 21'-0''$

Size anti-flotation block

wt of water displaced $= \frac{62.4\#}{ft^3}(6.5')(\pi \times 2.5'^2)$

$= 7964\#$

Size block to provide 1.1 times wt of water displaced: $1.1 \times 7964 = 8760\#$

Use block 12" thick; wt of concrete $= 150\#/ft^3$.

$8760/150 = 58.4\ ft^3$ concrete

$\sqrt{58.4} = 7.64' \Rightarrow$ use block $7'\text{-}8'' \times 7'\text{-}8'' \times 12''$

Check: $7.67 \times 7.67 \times 1.0 \times 150 = 8824\# > 8760\#$ O.K.

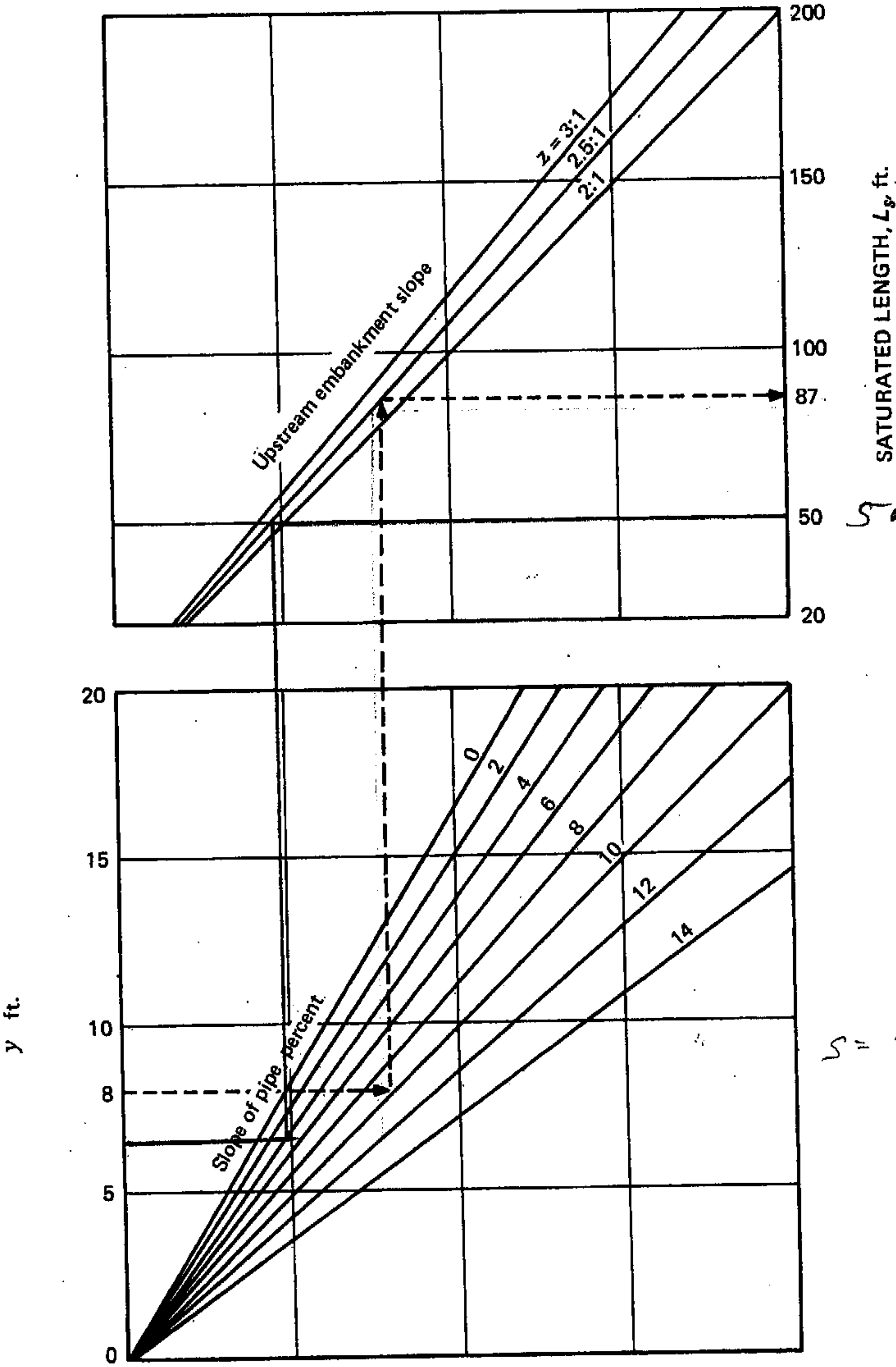


Figure I-26. Pipe length in saturated zone.[1]

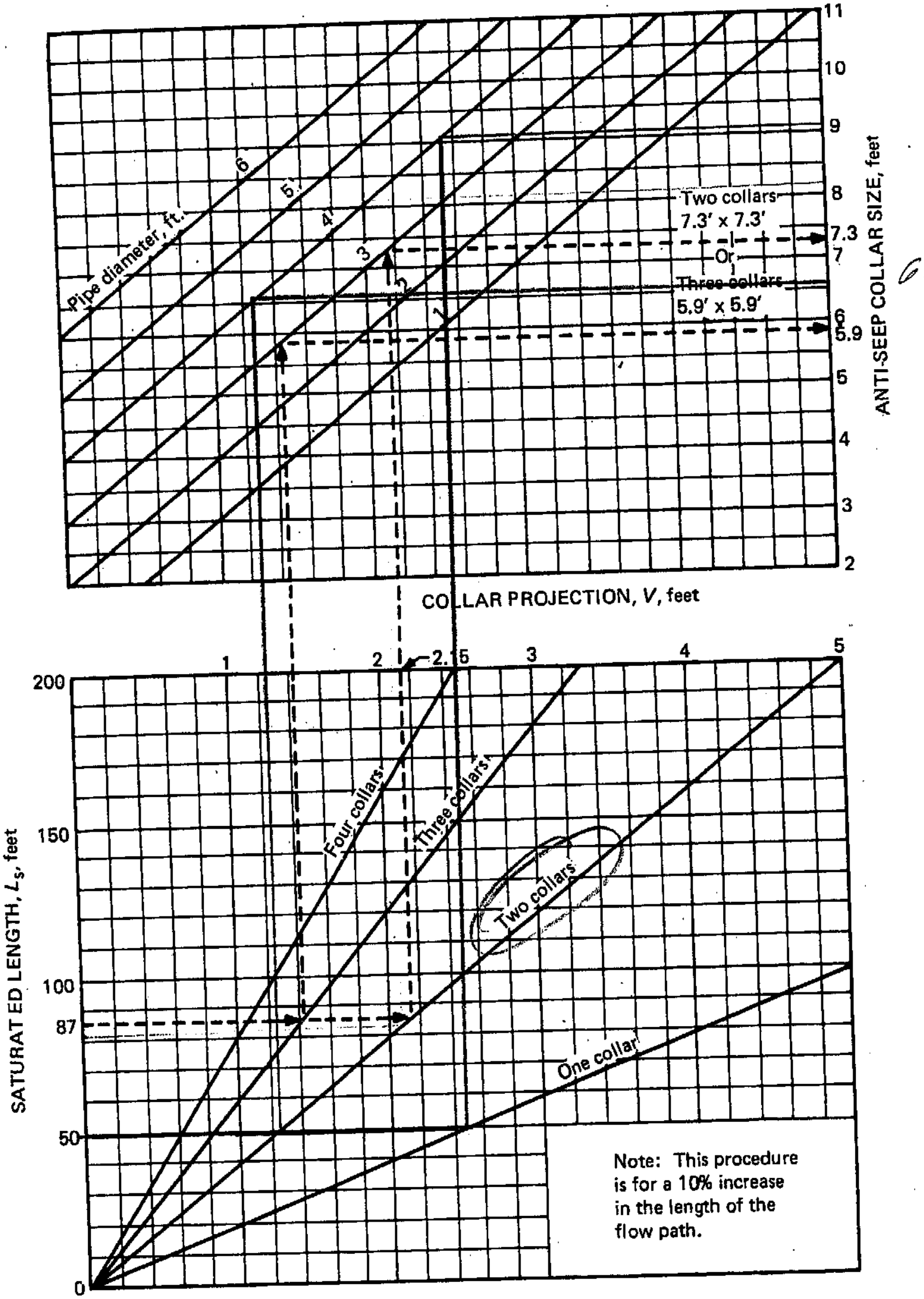
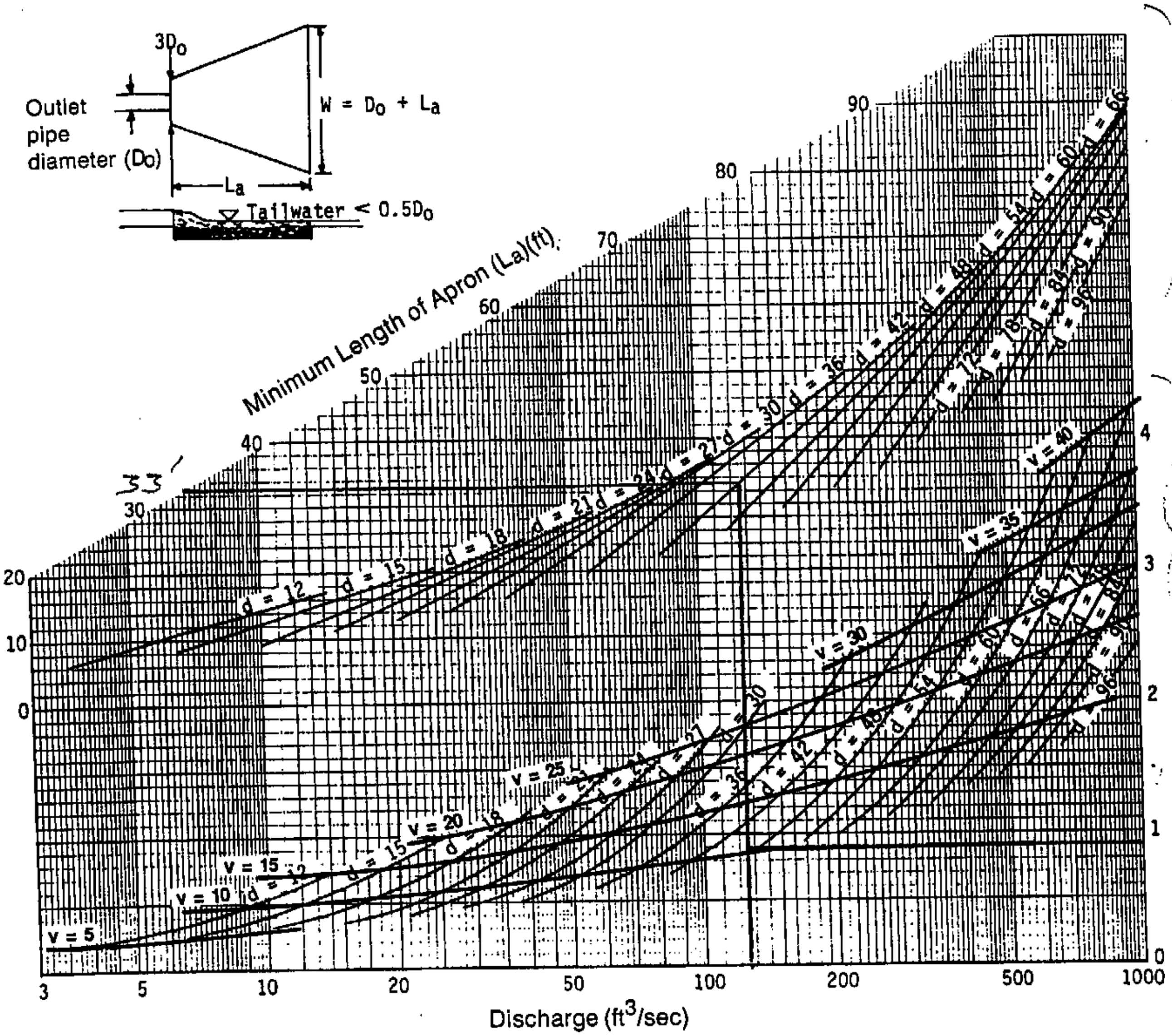


Figure I-27. Anti-seep collars — number and size.[1]



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).

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Job

Job No. Sheet No. of

Calculated by Date

Checked by Date

Subject Scale

SB - 2

JOYCE ENGINEERING, INC.

JOB: Wake Co - Rosenfield Rd
JOB NO. ____ SHEET NO. ____ OF ____
CALCULATED BY: JPR DATE: 11/20/01
CHECKED BY: ____ DATE: ____
SUBJECT: ____ SCALE: ____

South Cell

Estimate peak flow rate sediment basin.

A = 27.4 ac.

T_c = 19.3 min. (See channel calculations)

i_{25} = 5.2 in/hr.

i_{100} = 6.3 in/hr.

$Q_{p_{25}}$ = C i A = (0.45)(5.2)(27.4) = 64.1 cfs.

$Q_{p_{100}}$ = C i A = (.45)(6.3)(27.4) = 78 cfs.

Estimate composite 'C' value. Worst case will be for approximately 3/8 of the disposal area disturbed and 5/8 grassed. Use C = 0.70 for barren slopes. For grassed areas, use C ≈ 0.30

Composite C = [(10.3)(.7) + (17.1)(.3)] / 27.4 = 0.45

Min. volume required: 1800 ft³/acre

1800 ft³/ac. × 27.4 ac. = 49,320 ft³

Sediment cleanout level: provide 49,320/2 = 24,660 ft³ storage.

Surface area required: (0.01)(64 cfs.) = 0.64 ac.

Set bottom of sediment basin at elevation 214.0

Set riser crest at 218.2 (see calcs)

Head on crest: 1.35' ⇒ high water at 218.2 + 1.35 = 219.55

Set top of bank at 221.0 ⇒ freeboard provided = 221.0 - 219.55 = 1.45' > 1.0' ∴ O.K.

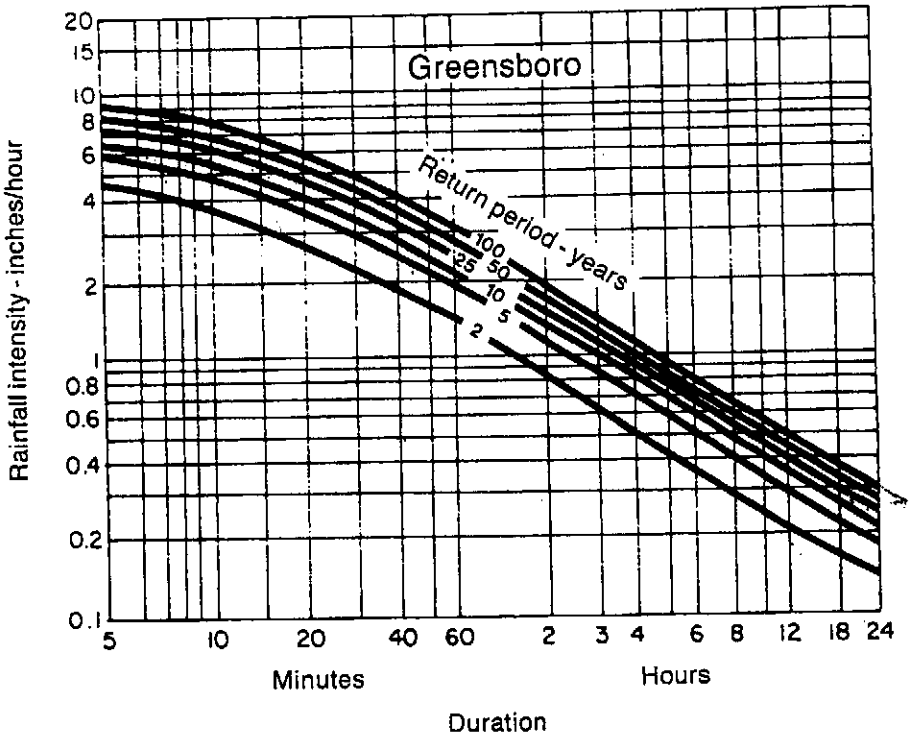

Figure 8.03d Rainfall intensity duration curves—Greensboro.

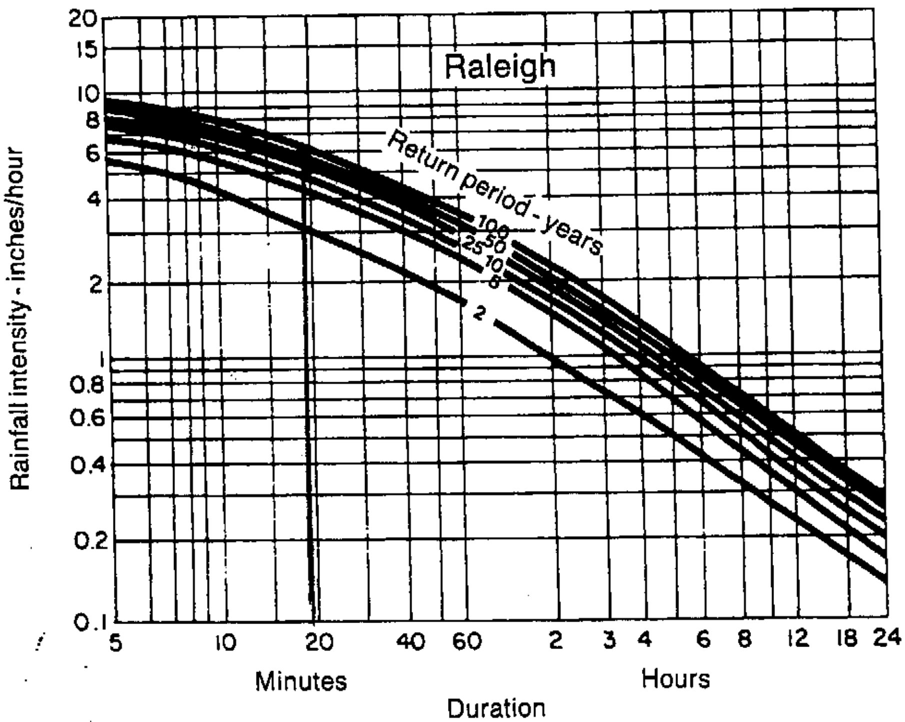

Figure 8.03e Rainfall intensity duration curves—Raleigh.

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Job ______ Job No. ______ Sheet No. ____ of ____

Calculated by [signature] Date ______

Checked by ______ Date ______

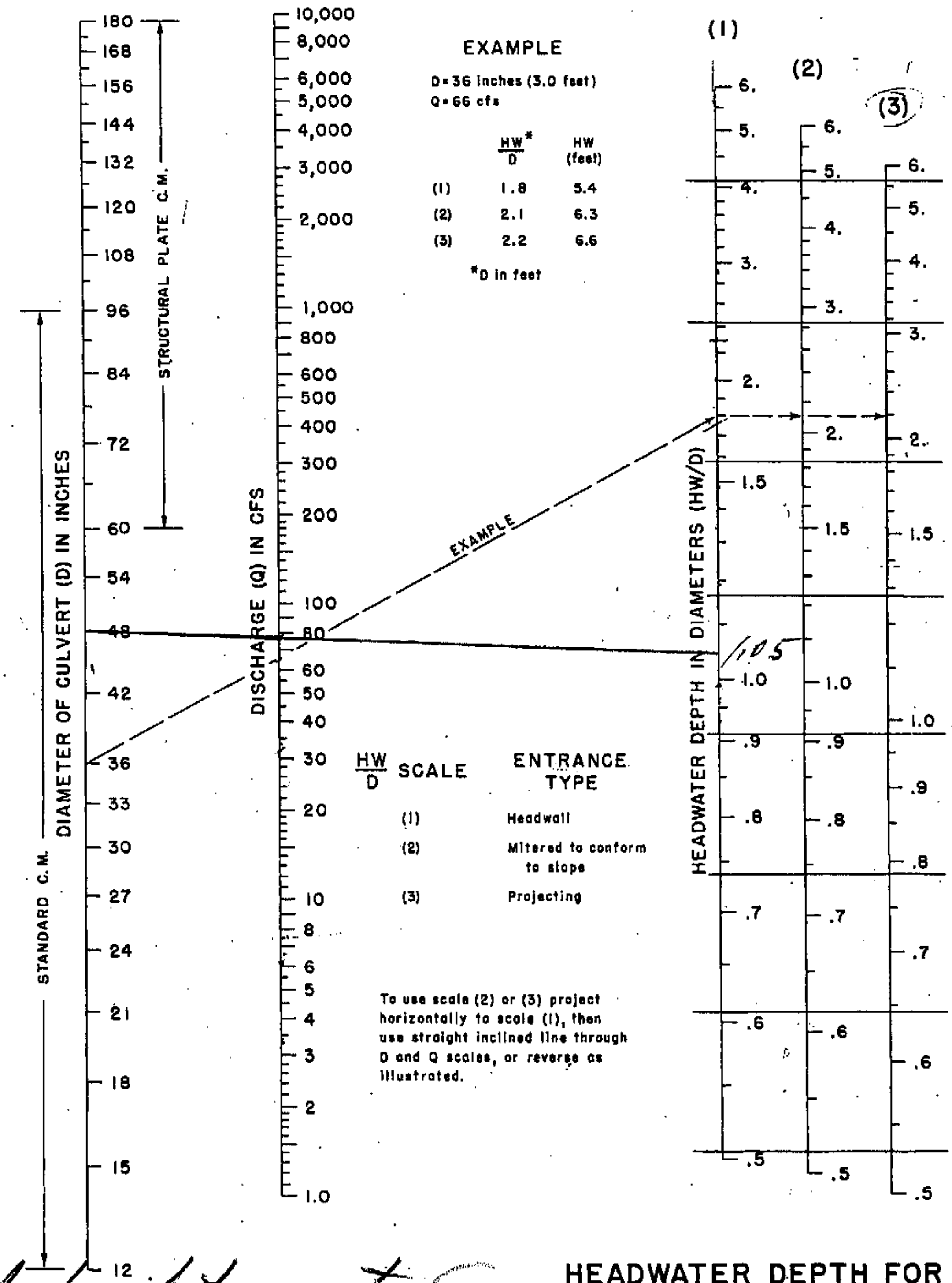
Subject ______ Scale ______

Stage / Storage Relationship (SB-2)

Elevation	Area (ft.^{2})	Avg. Area (ft.^{2})	Approx. Incremental Volume (ft.^{3})	Cumulative Volume (ft.^{3})
214	38130			0
		40145	80,290	
216	42160			80,290
		45105	90210	
218	48050			170,500
		50298	100596	
220	52545			271,096
221				

S. cell (sediment basin (SB-2)) SPD
discharge panel.

CHART 5



Check inlet control

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HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

HW/D = 1.05

HW = 1.05 × 4' = 4.2'

HW elev = 214 + 4.2 = 218.2

⇒ Set riser crest at 218.2.

Check outlet control in SB-2 Barrel

JPd

Normal Depth in SB-2 Barrel (100-yr q)
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	SB-2 Discharge Barrel (Normal Depth)
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.054000 ft/ft	
Diameter	48.00	in
Discharge	78.00	cfs

Results		
Depth	1.84	ft
Flow Area	5.63	ft²
Wetted Perimeter	5.96	ft
Top Width	3.99	ft
Critical Depth	2.67	ft
Percent Full	45.91	
Critical Slope	0.016222 ft/ft	
Velocity	13.86	ft/s
Velocity Head	2.98	ft
Specific Energy	4.82	ft
Froude Number	2.06	
Maximum Discharge	194.48	cfs
Full Flow Capacity	180.80	cfs
Full Flow Slope	0.010051 ft/ft	
Flow is supercritical.		

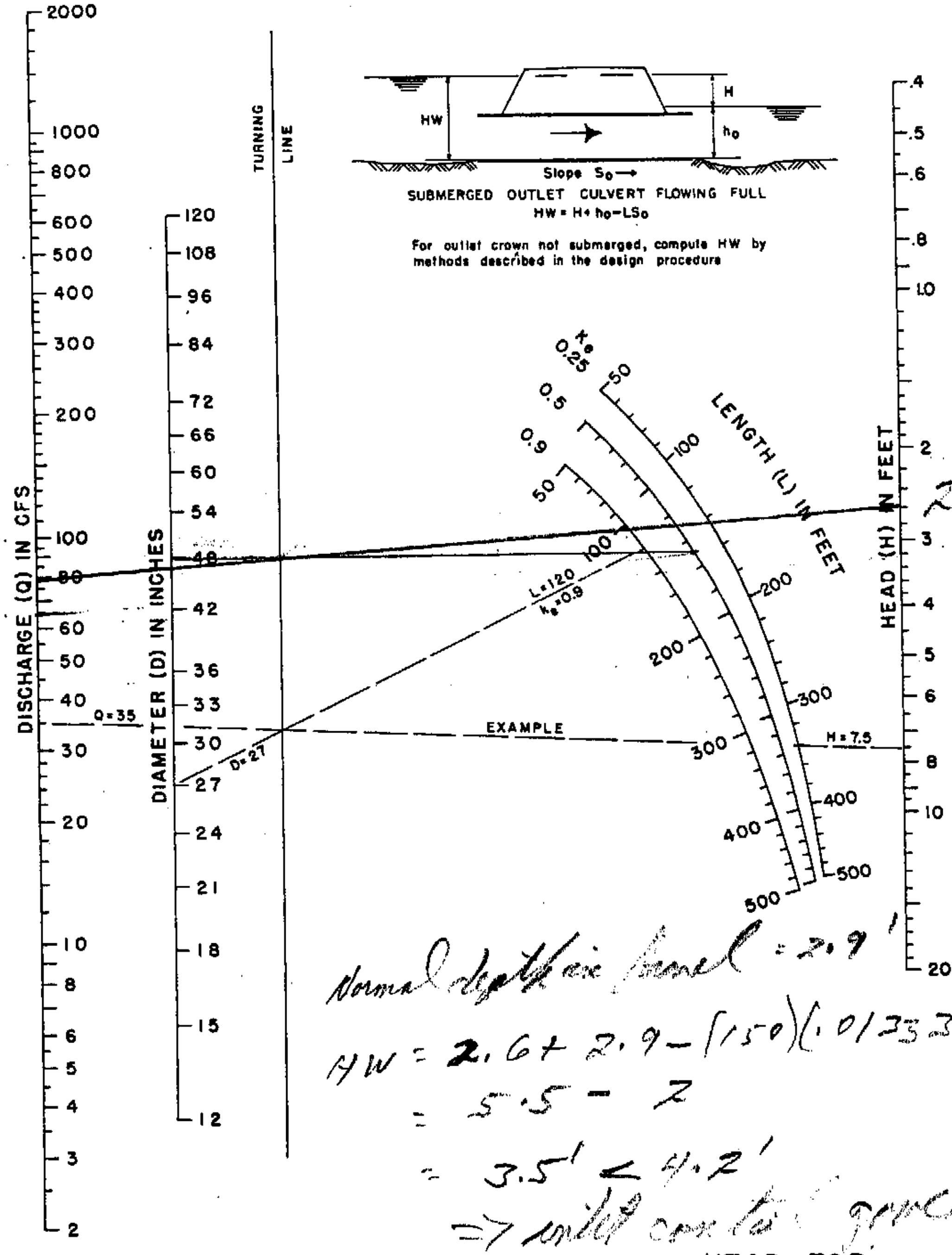
(pipe is part full)

$$S = \frac{214 - 204}{185} = .054$$

S. ed... sediment ... drainage ...

J.P.L. 11/20/01

CHART 11



Normal depth in channel = 2.9'

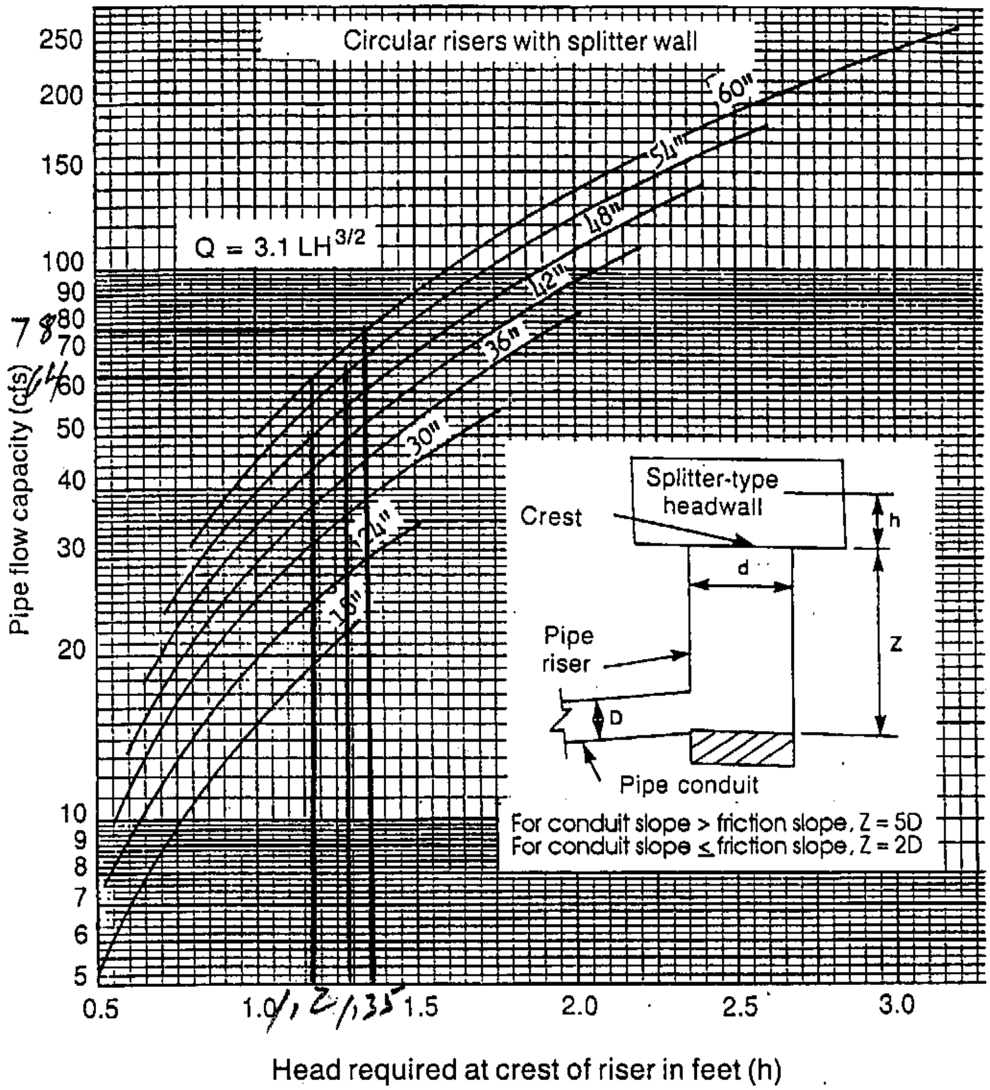
HW = 2.6 + 2.9 − (150)(.01333)
= 5.5 − 2
= 3.5' < 4.2'
⇒ inlet control governs.

HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

JPR 11/20/01

S. Cell Sediment Basin Spillway (60" Riser)



Inlet Proportions	
Pipe Conduit (D) - in	Pipe Riser (d) - in
8-12	18
15	21
18	24
21	30
24	30
30	36
36	48
42	54
48	60

Pipe drop inlet spillway design:

For a given Q and H, refer to Table 8.07a or 8.07b for conduit size. Then determine the riser diameter (d) from the Inlet Proportions Table on this figure. Next, refer to the above curves, using the conduit capacity and riser diameter, and find the head (h) required above the crest of the riser. The height of the riser should not be less than 5D - h, except as noted in the above sketch.

Example - Given: CMP; Q = 20 cfs; H = 14 ft, h max. 1.0 ft; L = 70 ft. From Table 8.07a find conduit size (D) = 18 inches. From Inlet Proportions Table, riser size = 24 inches. Head (h) required for Q = 20 and d = 24 is 1.0 ft.

Figure 8.07b Design chart for riser outlet.

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JOB

JOB NO. SHEET NO. OF

CALCULATED BY J.K. DATE 11/29/01

CHECKED BY DATE

SUBJECT SCALE

S. Cell

Select culvert size for pipe discharging into sediment basin.

Q_{p100} = 78 cfs. 78/3 = 26 cfs.

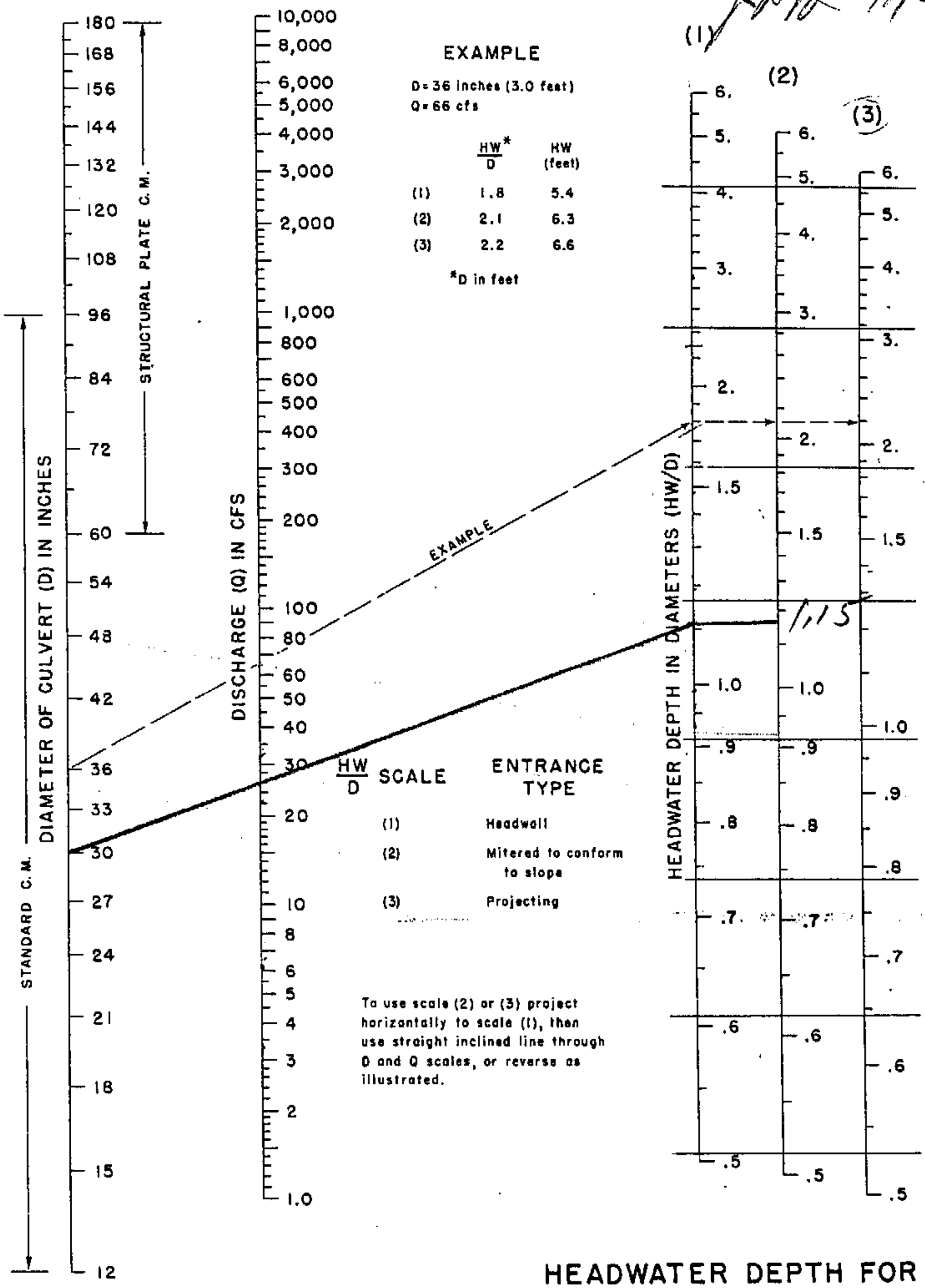
From nomograph, select (3) 30" CMPs

HW = 2.9'

Set entrance invert at 244-1-2.9 = 240.1

S. cell ; pipe discharging into sediment basin.
Check inlet control.

CHART 5 *[illegible] 11/20/01*



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

HW/D = 1.15
HW = 1.15 X 2.5 = 2.9'
Set entrance invert at [illegible] - 2.9 = 240.1
use three (3) 30" CMPs.

JOYCE ENGINEERING, INC.

JOB ______
JOB NO. ______ SHEET NO. ____ OF ____
CALCULATED BY [signature] DATE ______
CHECKED BY ______ DATE ______
SUBJECT ______ SCALE ______

Basin Dewatering

As per the recommendations in the N.C. Erosion and Sediment Control Planning and Design Manual, perforate the lower half of the riser with 1/2-inch diameter holes spaced three inches apart in each outside pipe valley (Ref. NCESCPDM pg. 6.61.4). Cover the perforated section with two feet of NCDOT #57 stone.

Anti-seep collar.

Anti-seep collar must project at least 1.5 ft. from the pipe, and be no closer than 2 ft to a pipe joint. Connection shall be watertight.

Outside diameter of 48-inch helical CMP = 50"

∴ anti-seep collar should be at least

50" + 18" + 18" = 86" in diameter (7'-2").

From Figs 1-26 & 1-27, # of collars required = 1.

Size of collars: 7'-8" > 7'-2" ∴ use 7'-8" × 7'-8" collars

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JOB
JOB NO. SHEET NO. OF
CALCULATED BY JRB DATE
CHECKED BY DATE
SUBJECT SCALE

Size anti-flotation block

Wt. of water displaced = (62.4)(4.2)(π X 2.5^2)

= 5145 #

Size block to provide 1.1 times wt of water displaced : 1.1 X 5145 # = 5660 #

Use block 12" thick, wt. of concrete = 150 #/ft.^{3}

$\frac{5660}{150}$ = 37.7 ft.^{3} concrete

$\sqrt{37.7}$ = 6.14' ⇒ 7' use block 7' X 7' X 12"

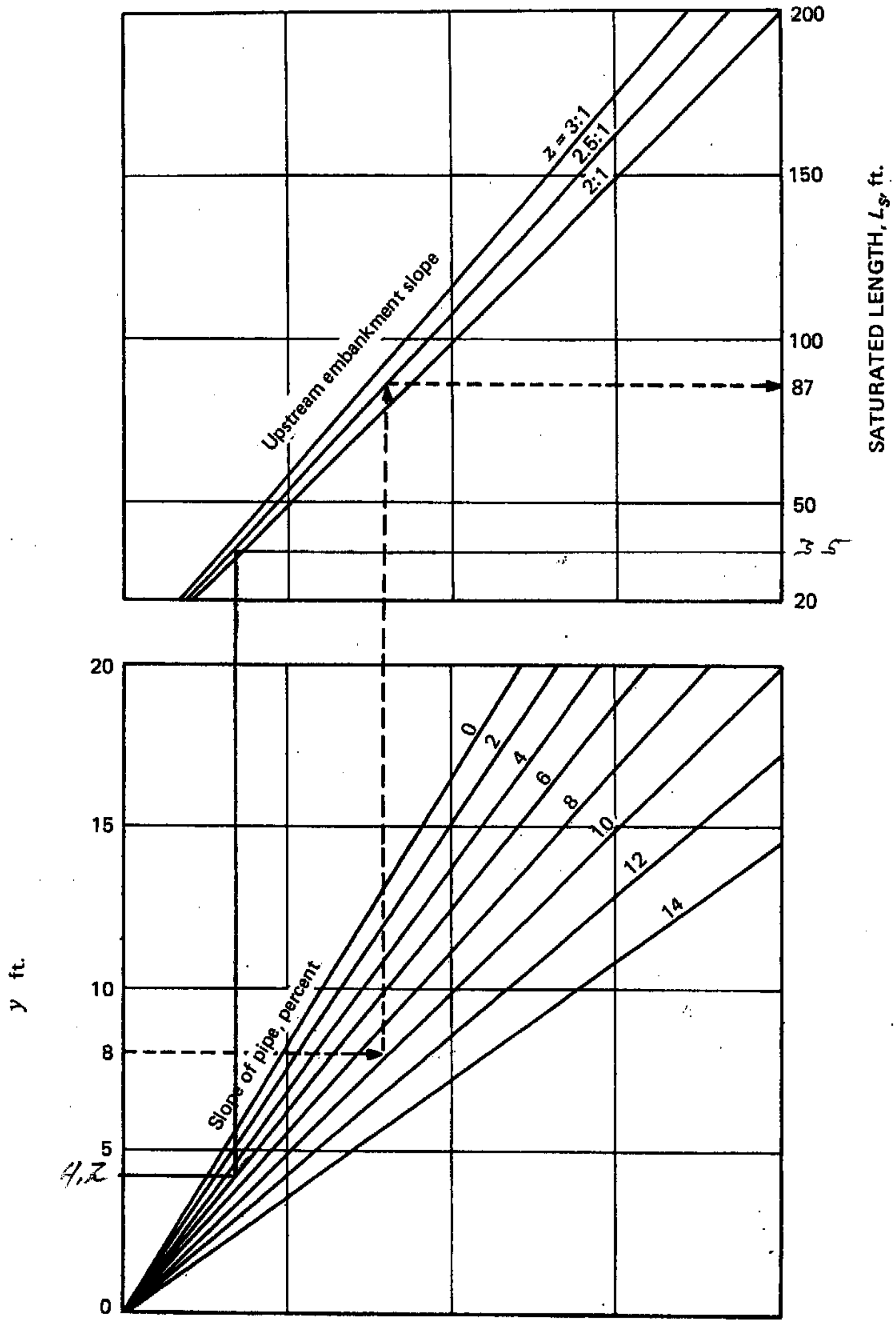


Figure I-26. Pipe length in saturated zone.[1]

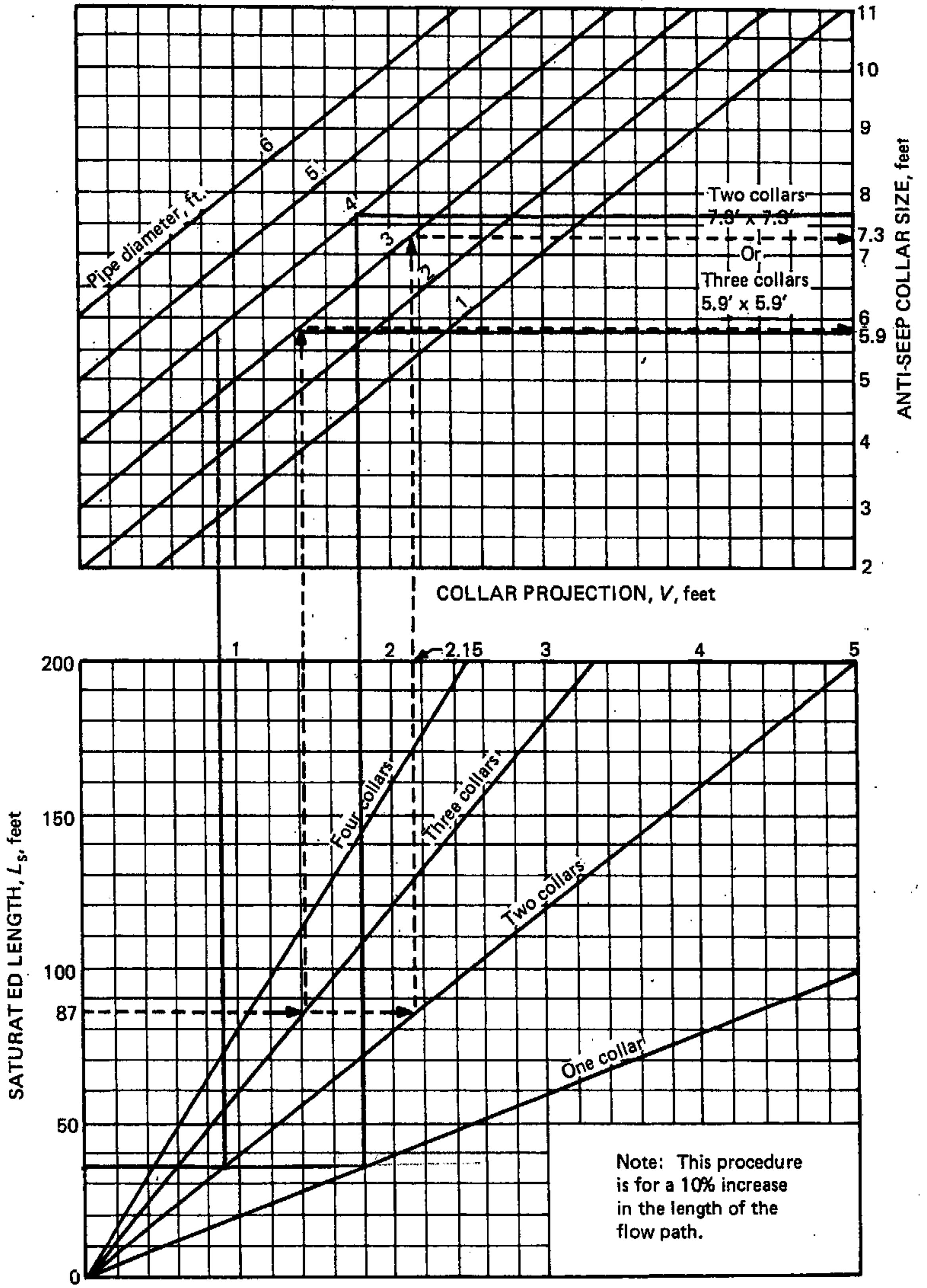
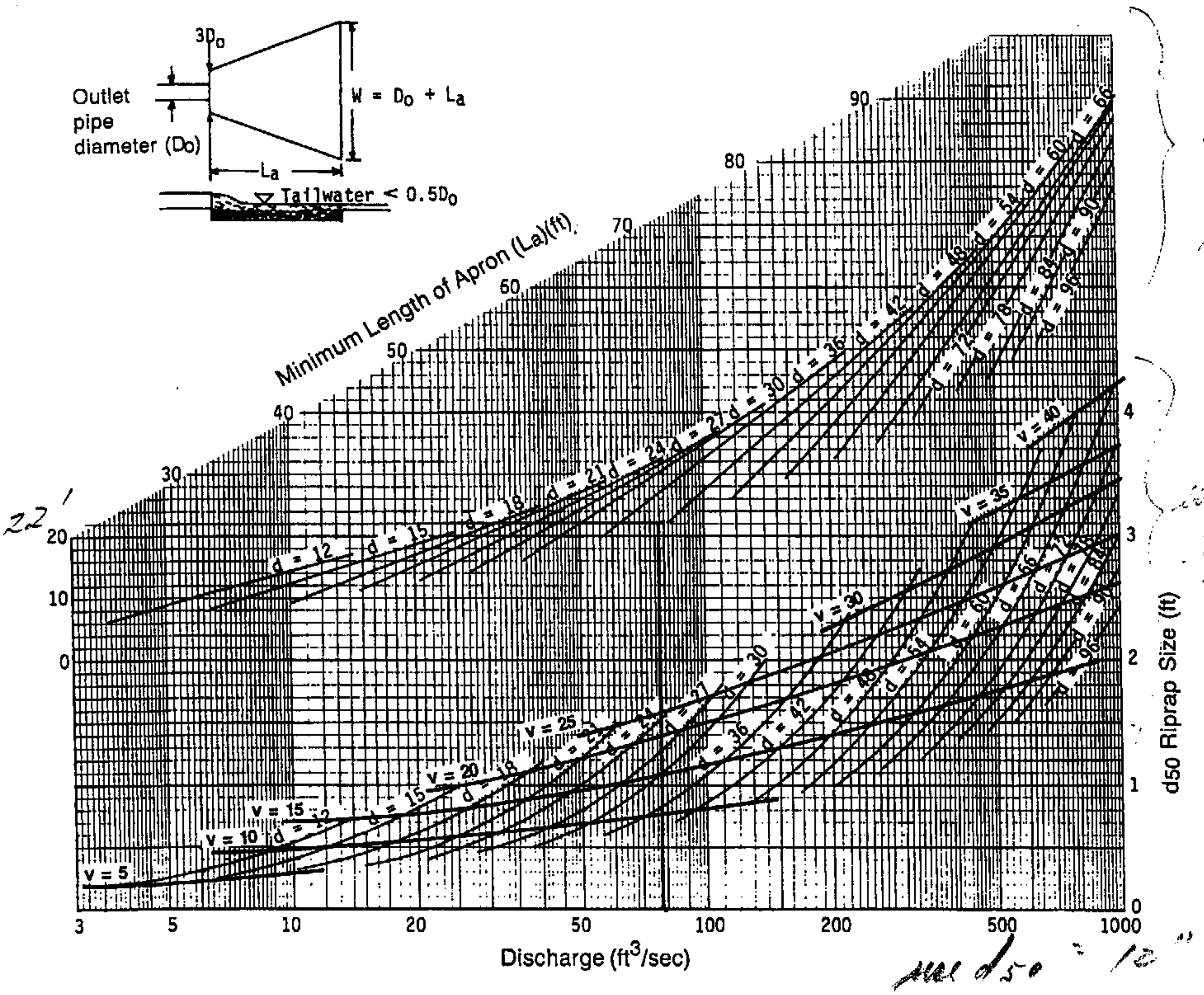


Figure I-27. Anti-seep collars — number and size.[1]



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).

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Job: Brown-Field Rd C+D Site
Job No.
Sheet No. ___ of ___
Calculated by: [illegible]
Date: 12/22/01
Checked by
Date
Subject
Scale

Compare Pre-developed 10-yr. peak flow vs. Post-Developed peak flow from contributing drainage areas at the proposed discharge location:

Pre-Developed

Estimate T_c

T_{t_1} (sheet flow)

use $t_t = \frac{0.007 (nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$ hr. Ref: TR-55 eq. 3-3

$L = 300'$; $n = 0.80$ for dense underbrush

P_2 = 2yr, 24hr. rainfall = 3.75"

$s = (295.7 - 270)/300 = .08567$

$\therefore t_t = \frac{(0.007)(0.8 \times 300)^{0.8}}{(3.75)^{0.5} (.08567)^{0.4}} = 0.77$ hr.

Concentrated flow

avg. V = 5.2 ft/s from Fig. 3.1, TR-55

t_{t_2} = 270'/5.2 ft/sec. = 0.9 min = .01 hr.

t_{t_3} = 13.8 min = 0.23 hr. from Fig. 8.03a

$T_c = t_{t_1} + t_{t_2} + t_{t_3}$ = 0.77 + .01 + 0.23 = 1.01 hr.
= [illegible] min.

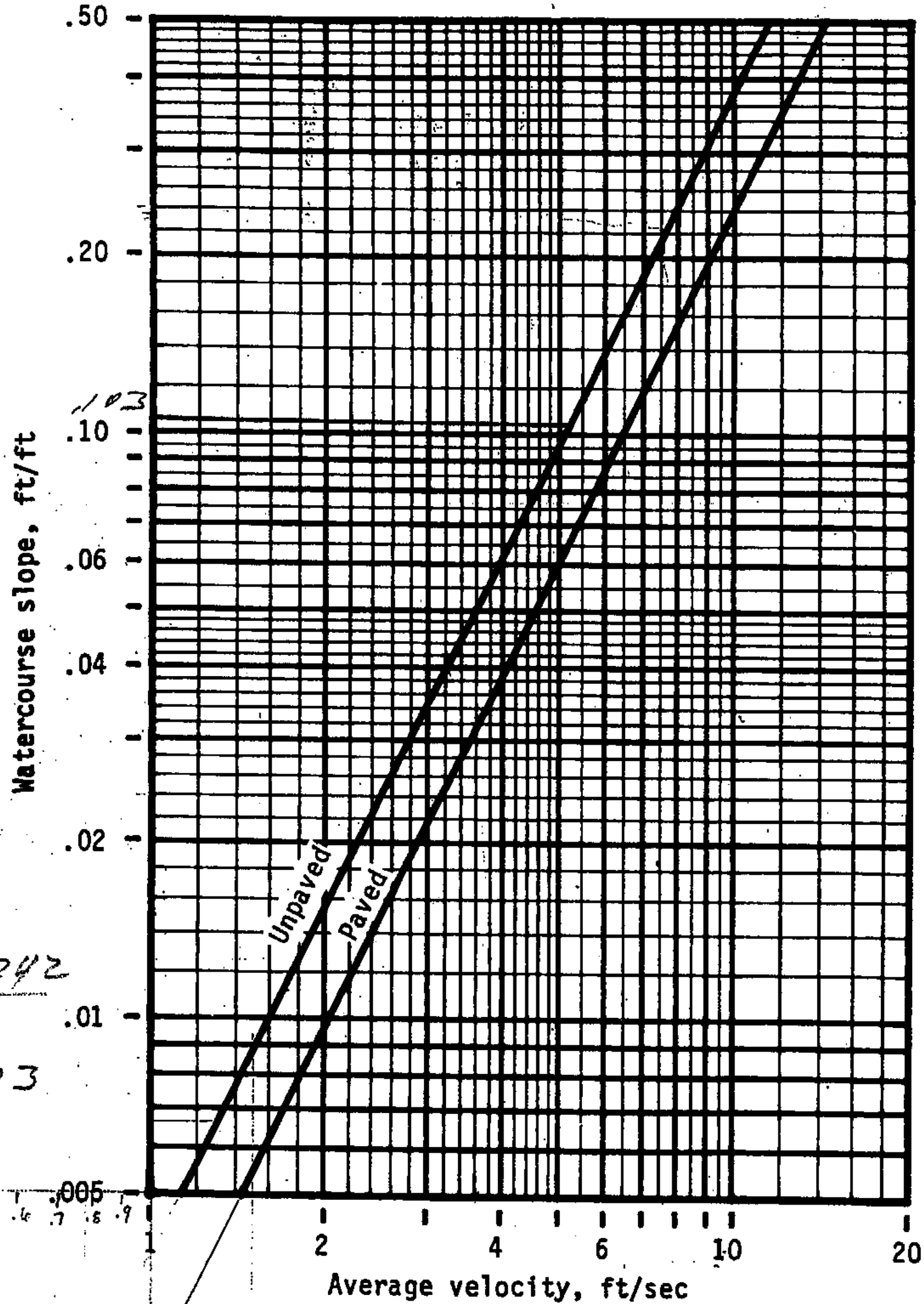
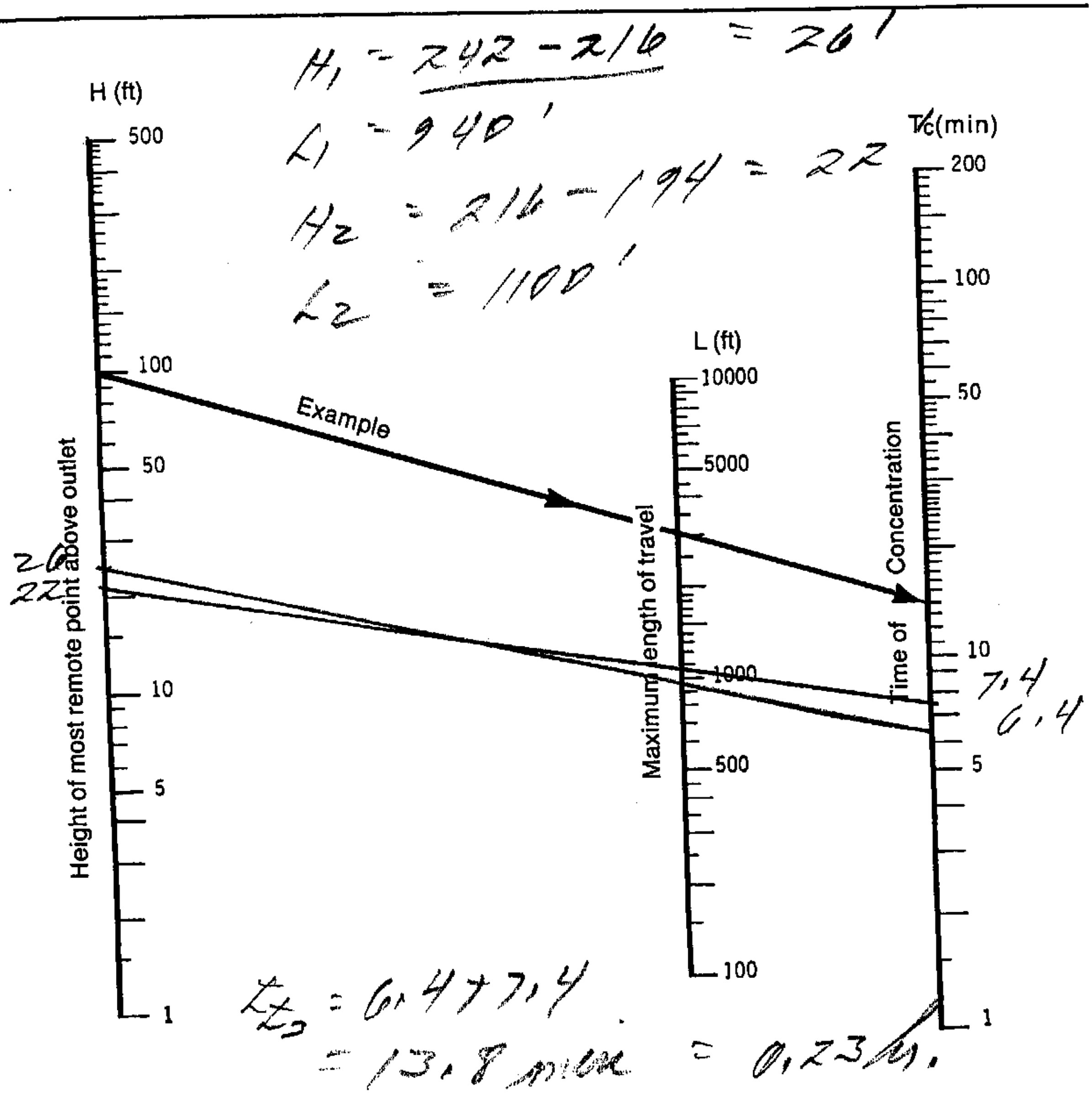


Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

HYDROLOGIC ROUTING
NORTH DISPOSAL AREA
10-YR 24-HR STORM

1) PRE-DEVELOPED CONDITIONS
2) CONSTRUCTION CONDITIONS
3) POST-DEVELOPED CONDITIONS

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job ______
Job No. ______ Sheet No. ____ of ____
Calculated by JPB Date ______
Checked by ______ Date ______
Subject ______ Scale ______

Select CN value

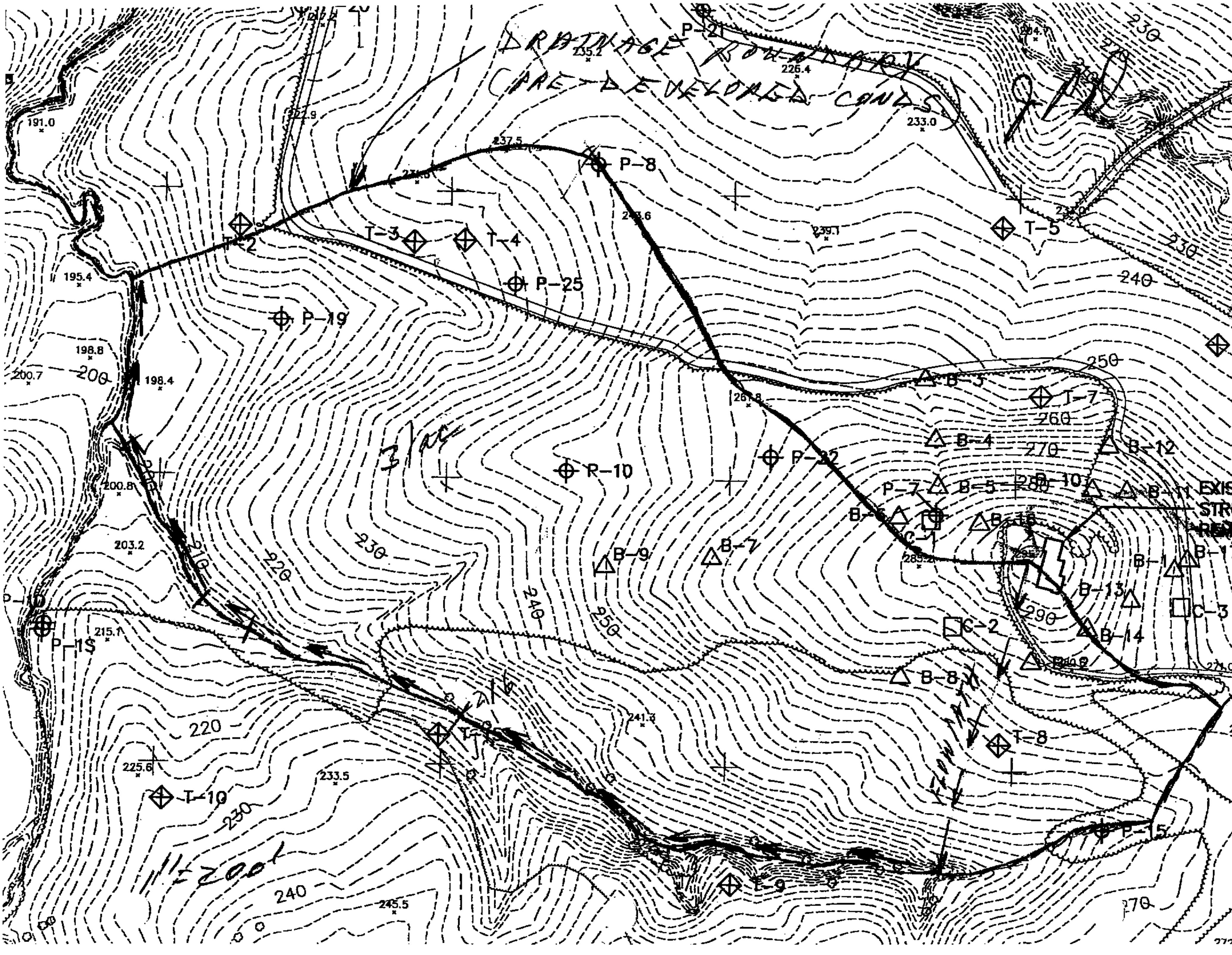
On-site soils are primarily silty sands.

=> Use hydrologic soil group A.

Site is approximately ½ wooded, ½ dense brush. => use CN = 47

Post-Developed Conditions

Use CN = 49 (Open space or pasture, fair cond. for finished landfill w/ cover)



DRAINAGE BOUNDARY
(PRE-DEVELOPED CONDS)
P-21
P-8
T-2
T-3
T-4
T-5
P-25
P-19
B-3
T-7
B-4
B-12
P-10
P-22
P-7
B-5
B-10
B-11
B-6
C-1
B-16
B-9
B-7
B-13
P-15
C-2
C-3
B-14
B-8
T-8
T-10
T-9
P-15
191.0
195.4
198.8
200.7
198.4
200.8
203.2
215.1
225.6
233.5
245.5
241.3
237.5
222.9
225.4
233.0
239.1
261.8
285.2
200
210
220
230
240
250
260
270
280
290
1"=200'

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:25:06
Watershed file: --> MRC-DPRE.WSD
Hydrograph file: --> MRCDPRE .HYD

MR, LLC C&D; North Disposal Area
Pre-Developed Conds For Existing Site Area to Point of Discharge
10-YR 24_HR Storm

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
1	31.00	47.0	1.00	0.00	5.80	0.85	.39 .30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 31.00 acres or 0.04844 sq.mi
Peak discharge = 12 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
1	1.01	0.00	1.00	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 2

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:25:06
Watershed file: --> MRC-DPRE.WSD
Hydrograph file: --> MRCDPRE .HYD

MR, LLC C&D; North Disposal Area
Pre-Developed Conds For Existing Site Area to Point of Discharge
10-YR 24_HR Storm

>>>> Summary of Subarea Times to Peak <<<<

JPB

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
1	12	13.0
Composite Watershed	12	13.0

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 3

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:25:06
Watershed file: --> MRC-DPRE.WSD
Hydrograph file: --> MRCDPRE .HYD

MR, LLC C&D; North Disposal Area
Pre-Developed Conds For Existing Site Area to Point of Discharge
10-YR 24_HR Storm

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
1	0	0	0	0	0	0	1	2	3
Total (cfs)	0	0	0	0	0	0	1	2	3

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
1	6	8	10	11	12	9	7	6	5
Total (cfs)	6	8	10	11	12	9	7	6	5

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
1	4	3	3	2	2	2	2	1	1
Total (cfs)	4	3	3	2	2	2	2	1	1

Subarea	18.0	19.0	20.0	22.0	26.0

Description	hr	hr	hr	hr	hr
1	1	1	1	1	0
Total (cfs)	1	1	1	1	0

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 4

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:25:06
Watershed file: --> MRC-DPRE.WSD
Hydrograph file: --> MRCDPRE .HYD

MR, LLC C&D; North Disposal Area
Pre-Developed Conds For Existing Site Area to Point of Discharge
10-YR 24_HR Storm

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	2
11.1	0	14.9	2
11.2	0	15.0	2
11.3	0	15.1	2
11.4	0	15.2	2
11.5	0	15.3	2
11.6	0	15.4	2
11.7	0	15.5	2
11.8	0	15.6	2
11.9	0	15.7	2
12.0	0	15.8	2
12.1	0	15.9	2
12.2	1	16.0	2
12.3	2	16.1	2
12.4	3	16.2	2
12.5	6	16.3	2
12.6	8	16.4	2
12.7	10	16.5	2
12.8	11	16.6	2
12.9	12	16.7	2
13.0	12	16.8	1
13.1	10	16.9	1
13.2	9	17.0	1
13.3	8	17.1	1
13.4	7	17.2	1
13.5	7	17.3	1
13.6	6	17.4	1
13.7	6	17.5	1
13.8	5	17.6	1
13.9	4	17.7	1
14.0	4	17.8	1

14.1	4	17.9	1
14.2	3	18.0	1
14.3	3	18.1	1
14.4	3	18.2	1
14.5	3	18.3	1
14.6	3	18.4	1
14.7	3	18.5	1

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 5

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:25:06
Watershed file: --> MRC-DPRE.WSD
Hydrograph file: --> MRCDPRE .HYD

MR, LLC C&D; North Disposal Area
Pre-Developed Conds For Existing Site Area to Point of Discharge
10-YR 24_HR Storm

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	1	22.4	1
18.7	1	22.5	1
18.8	1	22.6	1
18.9	1	22.7	1
19.0	1	22.8	1
19.1	1	22.9	1
19.2	1	23.0	1
19.3	1	23.1	1
19.4	1	23.2	1
19.5	1	23.3	1
19.6	1	23.4	1
19.7	1	23.5	1
19.8	1	23.6	1
19.9	1	23.7	1
20.0	1	23.8	1
20.1	1	23.9	1
20.2	1	24.0	0
20.3	1	24.1	0
20.4	1	24.2	0
20.5	1	24.3	0
20.6	1	24.4	0
20.7	1	24.5	0
20.8	1	24.6	0
20.9	1	24.7	0
21.0	1	24.8	0
21.1	1	24.9	0
21.2	1	25.0	0
21.3	1	25.1	0
21.4	1	25.2	0
21.5	1	25.3	0
21.6	1	25.4	0

21.7	1	25.5	0
21.8	1	25.6	0
21.9	1	25.7	0
22.0	1	25.8	0
22.1	1	25.9	0
22.2	1		
22.3	1		

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Job
Job No. Sheet No. of
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Checked by Date
Subject Scale

Select CN for construction conditions.

Assume 2/3 of landfill is capped + grassed; 1/3 is bare. (Worst Case)

$CN_{grassed} = 49$

$CN_{bare} = 77$

Composite $CN = 2/3(49) + 1/3(77)$

$= 58$

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-27-2001 09:47:21
Watershed file: --> MRCDCONS.WSD
Hydrograph file: --> MRCDCONS.HYD

MR, LLC C&D; NORTH DISPOSAL AREA
CONSTRUCTION CONDITIONS
10-YR 24-HR STORM

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
1	47.80	58.0	0.30	0.00	5.80	1.63	.25 .30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 47.80 acres or 0.07469 sq.mi
Peak discharge = 70 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
1	0.30	0.00	**	**	No	--

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 2

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-27-2001 09:47:21
Watershed file: --> MRCDCONS.WSD
Hydrograph file: --> MRCDCONS.HYD

MR, LLC C&D; NORTH DISPOSAL AREA
CONSTRUCTION CONDITIONS
10-YR 24-HR STORM

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
1	70	12.3
Composite Watershed	70	12.3

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 3

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-27-2001 09:47:21
Watershed file: --> MRCDCONS.WSD
Hydrograph file: --> MRCDCONS.HYD

MR, LLC C&D; NORTH DISPOSAL AREA
CONSTRUCTION CONDITIONS
10-YR 24-HR STORM

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
1	0	0	0	1	8	31	64	70	55
Total (cfs)	0	0	0	1	8	31	64	70	55

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
1	37	27	21	17	13	11	9	9	8
Total (cfs)	37	27	21	17	13	11	9	9	8

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
1	7	6	6	5	5	4	4	4	4
Total (cfs)	7	6	6	5	5	4	4	4	4

8 PD

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
1	3	3	3	2	0
Total (cfs)	3	3	3	2	0

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 4

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-27-2001 09:47:21
Watershed file: --> MRCDCONS.WSD
Hydrograph file: --> MRCDCONS.HYD

MR, LLC C&D; NORTH DISPOSAL AREA
CONSTRUCTION CONDITIONS
10-YR 24-HR STORM

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	6
11.1	0	14.9	5
11.2	0	15.0	5
11.3	0	15.1	5
11.4	0	15.2	5
11.5	0	15.3	5
11.6	0	15.4	5
11.7	0	15.5	5
11.8	1	15.6	5
11.9	1	15.7	5
12.0	8	15.8	4
12.1	31	15.9	4
12.2	64	16.0	4
12.3	70	16.1	4
12.4	55	16.2	4
12.5	37	16.3	4
12.6	27	16.4	4
12.7	21	16.5	4
12.8	17	16.6	4
12.9	15	16.7	4
13.0	13	16.8	4
13.1	12	16.9	4
13.2	11	17.0	4
13.3	10	17.1	4
13.4	9	17.2	4
13.5	9	17.3	4
13.6	9	17.4	4
13.7	8	17.5	4
13.8	8	17.6	4
13.9	8	17.7	4

8 pk

14.0	7	17.8	3
14.1	7	17.9	3
14.2	6	18.0	3
14.3	6	18.1	3
14.4	6	18.2	3
14.5	6	18.3	3
14.6	6	18.4	3
14.7	6	18.5	3

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-27-2001 09:47:21
Watershed file: --> MRCDCONS.WSD
Hydrograph file: --> MRCDCONS.HYD

MR, LLC C&D; NORTH DISPOSAL AREA
CONSTRUCTION CONDITIONS
10-YR 24-HR STORM

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	3	22.4	2
18.7	3	22.5	2
18.8	3	22.6	2
18.9	3	22.7	2
19.0	3	22.8	2
19.1	3	22.9	2
19.2	3	23.0	2
19.3	3	23.1	1
19.4	3	23.2	1
19.5	3	23.3	1
19.6	3	23.4	1
19.7	3	23.5	1
19.8	3	23.6	1
19.9	3	23.7	1
20.0	3	23.8	1
20.1	3	23.9	1
20.2	3	24.0	1
20.3	3	24.1	1
20.4	3	24.2	1
20.5	3	24.3	1
20.6	3	24.4	1
20.7	3	24.5	1
20.8	3	24.6	1
20.9	3	24.7	1
21.0	2	24.8	1
21.1	2	24.9	1
21.2	2	25.0	0
21.3	2	25.1	0
21.4	2	25.2	0
21.5	2	25.3	0

21.6	2	25.4	0
21.7	2	25.5	0
21.8	2	25.6	0
21.9	2	25.7	0
22.0	2	25.8	0
22.1	2	25.9	0
22.2	2		
22.3	2		

JRB

EXECUTED: 12-27-2001 09:19:03

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*************************************************
*                                               *
*             MR, LLC C&D LANDFILL              *
*             BROWNFIELD ROAD SITE              *
* ROUTE 10-YR 24-HR STORM RUNOFF THROUGH SB-1   *
* Construction Conditions                       *
*                                               *
*************************************************
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Inflow Hydrograph: MRCDCONS.HYD
Rating Table file: WAKESB-1.PND

----INITIAL CONDITIONS----
Elevation = 200.00 ft ⇒ No sediment accumulation at start of event.
Outflow = 0.00 cfs
Storage = 0 cu-ft

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)	2S/t (cfs)	2S/t + 0 (cfs)
200.00	0.0	0	0.0	0.0
200.50	0.0	18,856	104.8	104.8
201.00	0.0	38,228	212.4	212.4
201.50	0.0	58,123	322.9	322.9
202.00	0.0	78,548	436.4	436.4
202.50	0.0	99,488	552.7	552.7
203.00	0.0	120,925	671.8	671.8
203.50	0.0	142,866	793.7	793.7
204.00	0.0	165,317	918.4	918.4
204.50	0.0	188,318	1046.2	1046.2
205.00	0.0	211,913	1177.3	1177.3
205.50	0.0	236,108	1311.7	1311.7
206.00	0.0	260,911	1449.5	1449.5
206.50	0.0	286,331	1590.7	1590.7
207.00	18.3	312,367	1735.4	1753.7
207.50	51.8	339,019	1883.4	1935.2
208.00	95.2	366,295	2035.0	2130.2
208.50	133.7	394,142	2189.7	2323.4
209.00	149.5	422,508	2347.3	2496.8
209.50	163.8	451,397	2507.8	2671.6

Time increment (t) = 0.100 hrs.

EXECUTED: 12-27-2001 09:19:03

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	0.00	-----	0.0	0.0	0.00	200.00
11.100	0.00	0.0	0.0	0.0	0.00	200.00
11.200	0.00	0.0	0.0	0.0	0.00	200.00
11.300	0.00	0.0	0.0	0.0	0.00	200.00
11.400	0.00	0.0	0.0	0.0	0.00	200.00
11.500	0.00	0.0	0.0	0.0	0.00	200.00
11.600	0.00	0.0	0.0	0.0	0.00	200.00
11.700	0.00	0.0	0.0	0.0	0.00	200.00
11.800	1.00	1.0	1.0	1.0	0.00	200.00
11.900	1.00	2.0	3.0	3.0	0.00	200.01
12.000	8.00	9.0	12.0	12.0	0.00	200.06
12.100	31.00	39.0	51.0	51.0	0.00	200.24
12.200	64.00	95.0	146.0	146.0	0.00	200.69
12.300	70.00	134.0	280.0	280.0	0.00	201.31
12.400	55.00	125.0	405.0	405.0	0.00	201.86
12.500	37.00	92.0	497.0	497.0	0.00	202.26
12.600	27.00	64.0	561.0	561.0	0.00	202.53
12.700	21.00	48.0	609.0	609.0	0.00	202.74
12.800	17.00	38.0	647.0	647.0	0.00	202.90
12.900	15.00	32.0	679.0	679.0	0.00	203.03
13.000	13.00	28.0	707.0	707.0	0.00	203.14
13.100	12.00	25.0	732.0	732.0	0.00	203.25
13.200	11.00	23.0	755.0	755.0	0.00	203.34
13.300	10.00	21.0	776.0	776.0	0.00	203.43
13.400	9.00	19.0	795.0	795.0	0.00	203.51
13.500	9.00	18.0	813.0	813.0	0.00	203.58
13.600	9.00	18.0	831.0	831.0	0.00	203.65
13.700	8.00	17.0	848.0	848.0	0.00	203.72
13.800	8.00	16.0	864.0	864.0	0.00	203.78
13.900	8.00	16.0	880.0	880.0	0.00	203.85
14.000	7.00	15.0	895.0	895.0	0.00	203.91
14.100	7.00	14.0	909.0	909.0	0.00	203.96
14.200	6.00	13.0	922.0	922.0	0.00	204.01
14.300	6.00	12.0	934.0	934.0	0.00	204.06
14.400	6.00	12.0	946.0	946.0	0.00	204.11
14.500	6.00	12.0	958.0	958.0	0.00	204.15
14.600	6.00	12.0	970.0	970.0	0.00	204.20
14.700	6.00	12.0	982.0	982.0	0.00	204.25
14.800	6.00	12.0	994.0	994.0	0.00	204.30
14.900	5.00	11.0	1005.0	1005.0	0.00	204.34
15.000	5.00	10.0	1015.0	1015.0	0.00	204.38
15.100	5.00	10.0	1025.0	1025.0	0.00	204.42
15.200	5.00	10.0	1035.0	1035.0	0.00	204.46
15.300	5.00	10.0	1045.0	1045.0	0.00	204.50
15.400	5.00	10.0	1055.0	1055.0	0.00	204.53

POND-2 Version: 5.20 S/N: 1903052001
EXECUTED: 12-27-2001 09:19:03

Page 3

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	5.00	10.0	1065.0	1065.0	0.00	204.57
15.600	5.00	10.0	1075.0	1075.0	0.00	204.61
15.700	5.00	10.0	1085.0	1085.0	0.00	204.65
15.800	4.00	9.0	1094.0	1094.0	0.00	204.68
15.900	4.00	8.0	1102.0	1102.0	0.00	204.71
16.000	4.00	8.0	1110.0	1110.0	0.00	204.74
16.100	4.00	8.0	1118.0	1118.0	0.00	204.77
16.200	4.00	8.0	1126.0	1126.0	0.00	204.80
16.300	4.00	8.0	1134.0	1134.0	0.00	204.83
16.400	4.00	8.0	1142.0	1142.0	0.00	204.87
16.500	4.00	8.0	1150.0	1150.0	0.00	204.90
16.600	4.00	8.0	1158.0	1158.0	0.00	204.93
16.700	4.00	8.0	1166.0	1166.0	0.00	204.96
16.800	4.00	8.0	1174.0	1174.0	0.00	204.99
16.900	4.00	8.0	1182.0	1182.0	0.00	205.02
17.000	4.00	8.0	1190.0	1190.0	0.00	205.05
17.100	4.00	8.0	1198.0	1198.0	0.00	205.08
17.200	4.00	8.0	1206.0	1206.0	0.00	205.11
17.300	4.00	8.0	1214.0	1214.0	0.00	205.14
17.400	4.00	8.0	1222.0	1222.0	0.00	205.17
17.500	4.00	8.0	1230.0	1230.0	0.00	205.20
17.600	4.00	8.0	1238.0	1238.0	0.00	205.23
17.700	4.00	8.0	1246.0	1246.0	0.00	205.26
17.800	3.00	7.0	1253.0	1253.0	0.00	205.28
17.900	3.00	6.0	1259.0	1259.0	0.00	205.30
18.000	3.00	6.0	1265.0	1265.0	0.00	205.33
18.100	3.00	6.0	1271.0	1271.0	0.00	205.35
18.200	3.00	6.0	1277.0	1277.0	0.00	205.37
18.300	3.00	6.0	1283.0	1283.0	0.00	205.39
18.400	3.00	6.0	1289.0	1289.0	0.00	205.42
18.500	3.00	6.0	1295.0	1295.0	0.00	205.44
18.600	3.00	6.0	1301.0	1301.0	0.00	205.46
18.700	3.00	6.0	1307.0	1307.0	0.00	205.48
18.800	3.00	6.0	1313.0	1313.0	0.00	205.50
18.900	3.00	6.0	1319.0	1319.0	0.00	205.53
19.000	3.00	6.0	1325.0	1325.0	0.00	205.55
19.100	3.00	6.0	1331.0	1331.0	0.00	205.57
19.200	3.00	6.0	1337.0	1337.0	0.00	205.59
19.300	3.00	6.0	1343.0	1343.0	0.00	205.61
19.400	3.00	6.0	1349.0	1349.0	0.00	205.64
19.500	3.00	6.0	1355.0	1355.0	0.00	205.66
19.600	3.00	6.0	1361.0	1361.0	0.00	205.68
19.700	3.00	6.0	1367.0	1367.0	0.00	205.70
19.800	3.00	6.0	1373.0	1373.0	0.00	205.72
19.900	3.00	6.0	1379.0	1379.0	0.00	205.74
20.000	3.00	6.0	1385.0	1385.0	0.00	205.77

POND-2 Version: 5.20 S/N: 1903052001
EXECUTED: 12-27-2001 09:19:03

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD

Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	3.00	6.0	1391.0	1391.0	0.00	205.79
20.200	3.00	6.0	1397.0	1397.0	0.00	205.81
20.300	3.00	6.0	1403.0	1403.0	0.00	205.83
20.400	3.00	6.0	1409.0	1409.0	0.00	205.85
20.500	3.00	6.0	1415.0	1415.0	0.00	205.87
20.600	3.00	6.0	1421.0	1421.0	0.00	205.90
20.700	3.00	6.0	1427.0	1427.0	0.00	205.92
20.800	3.00	6.0	1433.0	1433.0	0.00	205.94
20.900	3.00	6.0	1439.0	1439.0	0.00	205.96
21.000	2.00	5.0	1444.0	1444.0	0.00	205.98
21.100	2.00	4.0	1448.0	1448.0	0.00	205.99
21.200	2.00	4.0	1452.0	1452.0	0.00	206.01
21.300	2.00	4.0	1456.0	1456.0	0.00	206.02
21.400	2.00	4.0	1460.0	1460.0	0.00	206.04
21.500	2.00	4.0	1464.0	1464.0	0.00	206.05
21.600	2.00	4.0	1468.0	1468.0	0.00	206.07
21.700	2.00	4.0	1472.0	1472.0	0.00	206.08
21.800	2.00	4.0	1476.0	1476.0	0.00	206.09
21.900	2.00	4.0	1480.0	1480.0	0.00	206.11
22.000	2.00	4.0	1484.0	1484.0	0.00	206.12
22.100	2.00	4.0	1488.0	1488.0	0.00	206.14
22.200	2.00	4.0	1492.0	1492.0	0.00	206.15
22.300	2.00	4.0	1496.0	1496.0	0.00	206.16
22.400	2.00	4.0	1500.0	1500.0	0.00	206.18
22.500	2.00	4.0	1504.0	1504.0	0.00	206.19
22.600	2.00	4.0	1508.0	1508.0	0.00	206.21
22.700	2.00	4.0	1512.0	1512.0	0.00	206.22
22.800	2.00	4.0	1516.0	1516.0	0.00	206.24
22.900	2.00	4.0	1520.0	1520.0	0.00	206.25
23.000	2.00	4.0	1524.0	1524.0	0.00	206.26
23.100	1.00	3.0	1527.0	1527.0	0.00	206.27
23.200	1.00	2.0	1529.0	1529.0	0.00	206.28
23.300	1.00	2.0	1531.0	1531.0	0.00	206.29
23.400	1.00	2.0	1533.0	1533.0	0.00	206.30
23.500	1.00	2.0	1535.0	1535.0	0.00	206.30
23.600	1.00	2.0	1537.0	1537.0	0.00	206.31
23.700	1.00	2.0	1539.0	1539.0	0.00	206.32
23.800	1.00	2.0	1541.0	1541.0	0.00	206.32
23.900	1.00	2.0	1543.0	1543.0	0.00	206.33
24.000	1.00	2.0	1545.0	1545.0	0.00	206.34
24.100	1.00	2.0	1547.0	1547.0	0.00	206.35
24.200	1.00	2.0	1549.0	1549.0	0.00	206.35
24.300	1.00	2.0	1551.0	1551.0	0.00	206.36
24.400	1.00	2.0	1553.0	1553.0	0.00	206.37
24.500	1.00	2.0	1555.0	1555.0	0.00	206.37
24.600	1.00	2.0	1557.0	1557.0	0.00	206.38

8 AB

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH | ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	1.00	2.0	1559.0	1559.0	0.00	206.39
24.800	1.00	2.0	1561.0	1561.0	0.00	206.39
24.900	1.00	2.0	1563.0	1563.0	0.00	206.40
25.000	0.00	1.0	1564.0	1564.0	0.00	206.41
25.100	0.00	0.0	1564.0	1564.0	0.00	206.41
25.200	0.00	0.0	1564.0	1564.0	0.00	206.41
25.300	0.00	0.0	1564.0	1564.0	0.00	206.41
25.400	0.00	0.0	1564.0	1564.0	0.00	206.41
25.500	0.00	0.0	1564.0	1564.0	0.00	206.41
25.600	0.00	0.0	1564.0	1564.0	0.00	206.41
25.700	0.00	0.0	1564.0	1564.0	0.00	206.41
25.800	0.00	0.0	1564.0	1564.0	0.00	206.41
25.900	0.00	0.0	1564.0	1564.0	0.00	206.41

POND-2 Version: 5.20 S/N: 1903052001
EXECUTED: 12-27-2001 09:19:03

Page 6

****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

Starting Pond W.S. Elevation = 200.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 70.00 cfs
Peak Outflow = 0.00 cfs — No outflow ∴ OK.
Peak Elevation = 206.41 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0 cu-ft
Peak Storage From Storm = 281,520 cu-ft

Total Storage in Pond = 281,520 cu-ft

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.20 S/N: 1903052001 Page 7

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Pond File:           WAKESB-1.PND
Inflow Hydrograph:   MRCDCONS.HYD
Outflow Hydrograph:  OUT     .HYD
                                                    EXECUTED: 12-27-2001
Peak Inflow    =    70.00 cfs                                   09:19:03
Peak Outflow   =     0.00 cfs
Peak Elevation =   206.41 ft
```

```
                                                              Flow (cfs)
      0.0   7.0  14.0  21.0  28.0  35.0  42.0  49.0  56.0  63.0  70.0  77.0
      .------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-
      |
11.5 -|x
      |x
11.6 -|x
      |x
11.7 -|x
      |x
11.8 -|x*
      |x*
11.9 -|x*
      |x   *
12.0 -|x      *
      |x                *
12.1 -|x                          *
      |x                                        *
12.2 -|x                                                      *
      |x                                                        *
12.3 -|x                                                           *
      |x                                                     *
12.4 -|x                                              *
      |x                                      *
12.5 -|x                               *
      |x                          *
12.6 -|x                      *
      |x                    *
12.7 -|x                 *
      |x               *
12.8 -|x              *
      |x             *
12.9 -|x            *
      |x           *
13.0 -|x          *
      |x          *
13.1 -|x         *
      |x         *
13.2 -|x        *
      |x        *
13.3 -|x        *
      |x       *
13.4 -|x       *
      |
```

TIME
(hrs)

```
*  File:  MRCDCONS.HYD   Qmax =    70.0 cfs
x  File:  OUT     .HYD   Qmax =     0.0 cfs
```

POND-2 Version: 5.20 S/N: 1903052001 Page 1
EXECUTED: 12-27-2001 09:40:33

```
**********************************************************************
*                                                                    *
*                     MR, LLC C&D LANDFILL                           *
*                     BROWNFIELD ROAD SITE                           *
*          ROUTE 10-YR 24-HR STORM RUNOFF THROUGH SB-1               *
*  ASSUME SEDIMENT ACCUMULATION AT CLEANOUT LEVEL AT START OF EVENT  *
*  Construction Conditions                                           *
**********************************************************************
```

Inflow Hydrograph: MRCDCONS.HYD
Rating Table file: WAKESB-1.PND

----INITIAL CONDITIONS----
Elevation = 203.25 ft ← Cleanout Level
Outflow = 0.00 cfs
Storage = 131,896 cu-ft

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)	2S/t (cfs)	2S/t + 0 (cfs)
200.00	0.0	0	0.0	0.0
200.50	0.0	18,856	104.8	104.8
201.00	0.0	38,228	212.4	212.4
201.50	0.0	58,123	322.9	322.9
202.00	0.0	78,548	436.4	436.4
202.50	0.0	99,488	552.7	552.7
203.00	0.0	120,925	671.8	671.8
203.50	0.0	142,866	793.7	793.7
204.00	0.0	165,317	918.4	918.4
204.50	0.0	188,318	1046.2	1046.2
205.00	0.0	211,913	1177.3	1177.3
205.50	0.0	236,108	1311.7	1311.7
206.00	0.0	260,911	1449.5	1449.5
206.50	0.0	286,331	1590.7	1590.7
207.00	18.3	312,367	1735.4	1753.7
207.50	51.8	339,019	1883.4	1935.2
208.00	95.2	366,295	2035.0	2130.2
208.50	133.7	394,142	2189.7	2323.4
209.00	149.5	422,508	2347.3	2496.8
209.50	163.8	451,397	2507.8	2671.6

Time increment (t) = 0.100 hrs.

POND-2 Version: 5.20 S/N: 1903052001 Page 2
EXECUTED: 12-27-2001 09:40:33

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH ROUTING COMPUTATIONS

JLB

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	0.00	-----	732.8	732.8	0.00	203.25
11.100	0.00	0.0	732.8	732.8	0.00	203.25
11.200	0.00	0.0	732.8	732.8	0.00	203.25
11.300	0.00	0.0	732.8	732.8	0.00	203.25
11.400	0.00	0.0	732.8	732.8	0.00	203.25
11.500	0.00	0.0	732.8	732.8	0.00	203.25
11.600	0.00	0.0	732.8	732.8	0.00	203.25
11.700	0.00	0.0	732.8	732.8	0.00	203.25
11.800	1.00	1.0	733.8	733.8	0.00	203.25
11.900	1.00	2.0	735.8	735.8	0.00	203.26
12.000	8.00	9.0	744.8	744.8	0.00	203.30
12.100	31.00	39.0	783.8	783.8	0.00	203.46
12.200	64.00	95.0	878.8	878.8	0.00	203.84
12.300	70.00	134.0	1012.8	1012.8	0.00	204.37
12.400	55.00	125.0	1137.8	1137.8	0.00	204.85
12.500	37.00	92.0	1229.8	1229.8	0.00	205.20
12.600	27.00	64.0	1293.8	1293.8	0.00	205.43
12.700	21.00	48.0	1341.8	1341.8	0.00	205.61
12.800	17.00	38.0	1379.8	1379.8	0.00	205.75
12.900	15.00	32.0	1411.8	1411.8	0.00	205.86
13.000	13.00	28.0	1439.8	1439.8	0.00	205.96
13.100	12.00	25.0	1464.8	1464.8	0.00	206.05
13.200	11.00	23.0	1487.8	1487.8	0.00	206.14
13.300	10.00	21.0	1508.8	1508.8	0.00	206.21
13.400	9.00	19.0	1527.8	1527.8	0.00	206.28
13.500	9.00	18.0	1545.8	1545.8	0.00	206.34
13.600	9.00	18.0	1563.8	1563.8	0.00	206.40
13.700	8.00	17.0	1580.8	1580.8	0.00	206.46
13.800	8.00	16.0	1595.4	1596.8	0.68	206.52
13.900	8.00	16.0	1606.8	1611.4	2.32	206.56
14.000	7.00	15.0	1614.8	1621.8	3.48	206.60
14.100	7.00	14.0	1620.2	1628.8	4.27	206.62
14.200	6.00	13.0	1623.7	1633.2	4.77	206.63
14.300	6.00	12.0	1625.6	1635.7	5.05	206.64
14.400	6.00	12.0	1627.1	1637.6	5.26	206.64
14.500	6.00	12.0	1628.2	1639.1	5.43	206.65
14.600	6.00	12.0	1629.1	1640.2	5.56	206.65
14.700	6.00	12.0	1629.8	1641.1	5.66	206.65
14.800	6.00	12.0	1630.3	1641.8	5.73	206.66
14.900	5.00	11.0	1630.0	1641.3	5.68	206.66
15.000	5.00	10.0	1628.9	1640.0	5.53	206.65
15.100	5.00	10.0	1628.1	1638.9	5.41	206.65
15.200	5.00	10.0	1627.4	1638.1	5.32	206.65
15.300	5.00	10.0	1626.9	1637.4	5.25	206.64
15.400	5.00	10.0	1626.6	1636.9	5.19	206.64

POND-2 Version: 5.20 S/N: 1903052001 Page 3
EXECUTED: 12-27-2001 09:40:33

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH | ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	5.00	10.0	1626.3	1636.6	5.15	206.64
15.600	5.00	10.0	1626.0	1636.3	5.11	206.64
15.700	5.00	10.0	1625.9	1636.0	5.09	206.64
15.800	4.00	9.0	1625.0	1634.9	4.96	206.64
15.900	4.00	8.0	1623.5	1633.0	4.74	206.63
16.000	4.00	8.0	1622.3	1631.5	4.58	206.63
16.100	4.00	8.0	1621.4	1630.3	4.45	206.62
16.200	4.00	8.0	1620.7	1629.4	4.35	206.62
16.300	4.00	8.0	1620.2	1628.7	4.27	206.62
16.400	4.00	8.0	1619.8	1628.2	4.21	206.61
16.500	4.00	8.0	1619.5	1627.8	4.16	206.61
16.600	4.00	8.0	1619.2	1627.5	4.12	206.61
16.700	4.00	8.0	1619.0	1627.2	4.10	206.61
16.800	4.00	8.0	1618.9	1627.0	4.08	206.61
16.900	4.00	8.0	1618.7	1626.9	4.06	206.61
17.000	4.00	8.0	1618.7	1626.7	4.05	206.61
17.100	4.00	8.0	1618.6	1626.7	4.04	206.61
17.200	4.00	8.0	1618.5	1626.6	4.03	206.61
17.300	4.00	8.0	1618.5	1626.5	4.02	206.61
17.400	4.00	8.0	1618.5	1626.5	4.02	206.61
17.500	4.00	8.0	1618.4	1626.5	4.01	206.61
17.600	4.00	8.0	1618.4	1626.4	4.01	206.61
17.700	4.00	8.0	1618.4	1626.4	4.01	206.61
17.800	3.00	7.0	1617.6	1625.4	3.89	206.61
17.900	3.00	6.0	1616.2	1623.6	3.69	206.60
18.000	3.00	6.0	1615.2	1622.2	3.54	206.60
18.100	3.00	6.0	1614.3	1621.2	3.42	206.59
18.200	3.00	6.0	1613.7	1620.3	3.32	206.59
18.300	3.00	6.0	1613.2	1619.7	3.25	206.59
18.400	3.00	6.0	1612.8	1619.2	3.19	206.59
18.500	3.00	6.0	1612.5	1618.8	3.15	206.59
18.600	3.00	6.0	1612.2	1618.5	3.12	206.59
18.700	3.00	6.0	1612.1	1618.2	3.09	206.58
18.800	3.00	6.0	1611.9	1618.1	3.07	206.58
18.900	3.00	6.0	1611.8	1617.9	3.05	206.58
19.000	3.00	6.0	1611.7	1617.8	3.04	206.58
19.100	3.00	6.0	1611.7	1617.7	3.03	206.58
19.200	3.00	6.0	1611.6	1617.7	3.03	206.58
19.300	3.00	6.0	1611.6	1617.6	3.02	206.58
19.400	3.00	6.0	1611.5	1617.6	3.02	206.58
19.500	3.00	6.0	1611.5	1617.5	3.01	206.58
19.600	3.00	6.0	1611.5	1617.5	3.01	206.58
19.700	3.00	6.0	1611.5	1617.5	3.01	206.58
19.800	3.00	6.0	1611.5	1617.5	3.01	206.58
19.900	3.00	6.0	1611.5	1617.5	3.00	206.58
20.000	3.00	6.0	1611.5	1617.5	3.00	206.58

POND-2 Version: 5.20 S/N: 1903052001 Page 4
EXECUTED: 12-27-2001 09:40:33

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD

Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	3.00	6.0	1611.5	1617.5	3.00	206.58
20.200	3.00	6.0	1611.5	1617.5	3.00	206.58
20.300	3.00	6.0	1611.5	1617.5	3.00	206.58
20.400	3.00	6.0	1611.4	1617.5	3.00	206.58
20.500	3.00	6.0	1611.4	1617.4	3.00	206.58
20.600	3.00	6.0	1611.4	1617.4	3.00	206.58
20.700	3.00	6.0	1611.4	1617.4	3.00	206.58
20.800	3.00	6.0	1611.4	1617.4	3.00	206.58
20.900	3.00	6.0	1611.4	1617.4	3.00	206.58
21.000	2.00	5.0	1610.7	1616.4	2.89	206.58
21.100	2.00	4.0	1609.3	1614.7	2.69	206.57
21.200	2.00	4.0	1608.2	1613.3	2.53	206.57
21.300	2.00	4.0	1607.4	1612.2	2.41	206.57
21.400	2.00	4.0	1606.8	1611.4	2.32	206.56
21.500	2.00	4.0	1606.3	1610.8	2.25	206.56
21.600	2.00	4.0	1605.9	1610.3	2.19	206.56
21.700	2.00	4.0	1605.6	1609.9	2.15	206.56
21.800	2.00	4.0	1605.3	1609.6	2.12	206.56
21.900	2.00	4.0	1605.2	1609.3	2.09	206.56
22.000	2.00	4.0	1605.0	1609.2	2.07	206.56
22.100	2.00	4.0	1604.9	1609.0	2.05	206.56
22.200	2.00	4.0	1604.8	1608.9	2.04	206.56
22.300	2.00	4.0	1604.8	1608.8	2.03	206.56
22.400	2.00	4.0	1604.7	1608.8	2.03	206.56
22.500	2.00	4.0	1604.7	1608.7	2.02	206.56
22.600	2.00	4.0	1604.6	1608.7	2.02	206.56
22.700	2.00	4.0	1604.6	1608.6	2.01	206.55
22.800	2.00	4.0	1604.6	1608.6	2.01	206.55
22.900	2.00	4.0	1604.6	1608.6	2.01	206.55
23.000	2.00	4.0	1604.6	1608.6	2.01	206.55
23.100	1.00	3.0	1603.8	1607.6	1.89	206.55
23.200	1.00	2.0	1602.4	1605.8	1.69	206.55
23.300	1.00	2.0	1601.3	1604.4	1.54	206.54
23.400	1.00	2.0	1600.5	1603.3	1.42	206.54
23.500	1.00	2.0	1599.9	1602.5	1.32	206.54
23.600	1.00	2.0	1599.4	1601.9	1.25	206.53
23.700	1.00	2.0	1599.0	1601.4	1.19	206.53
23.800	1.00	2.0	1598.7	1601.0	1.15	206.53
23.900	1.00	2.0	1598.4	1600.7	1.12	206.53
24.000	1.00	2.0	1598.3	1600.4	1.09	206.53
24.100	1.00	2.0	1598.1	1600.3	1.07	206.53
24.200	1.00	2.0	1598.0	1600.1	1.05	206.53
24.300	1.00	2.0	1597.9	1600.0	1.04	206.53
24.400	1.00	2.0	1597.9	1599.9	1.03	206.53
24.500	1.00	2.0	1597.8	1599.9	1.03	206.53
24.600	1.00	2.0	1597.8	1599.8	1.02	206.53

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	1.00	2.0	1597.7	1599.8	1.02	206.53
24.800	1.00	2.0	1597.7	1599.7	1.01	206.53
24.900	1.00	2.0	1597.7	1599.7	1.01	206.53
25.000	0.00	1.0	1596.9	1598.7	0.89	206.52
25.100	0.00	0.0	1595.5	1596.9	0.69	206.52
25.200	0.00	0.0	1594.4	1595.5	0.54	206.51
25.300	0.00	0.0	1593.6	1594.4	0.42	206.51
25.400	0.00	0.0	1593.0	1593.6	0.32	206.51
25.500	0.00	0.0	1592.5	1593.0	0.25	206.51
25.600	0.00	0.0	1592.1	1592.5	0.19	206.51
25.700	0.00	0.0	1591.8	1592.1	0.15	206.50
25.800	0.00	0.0	1591.5	1591.8	0.12	206.50
25.900	0.00	0.0	1591.4	1591.5	0.09	206.50

POND-2 Version: 5.20 S/N: 1903052001
EXECUTED: 12-27-2001 09:40:33

****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

Starting Pond W.S. Elevation = 203.25 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 70.00 cfs
Peak Outflow = 5.73 cfs <12 cfs : OK
Peak Elevation = 206.66 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 131,896 cu-ft
Peak Storage From Storm = 162,593 cu-ft

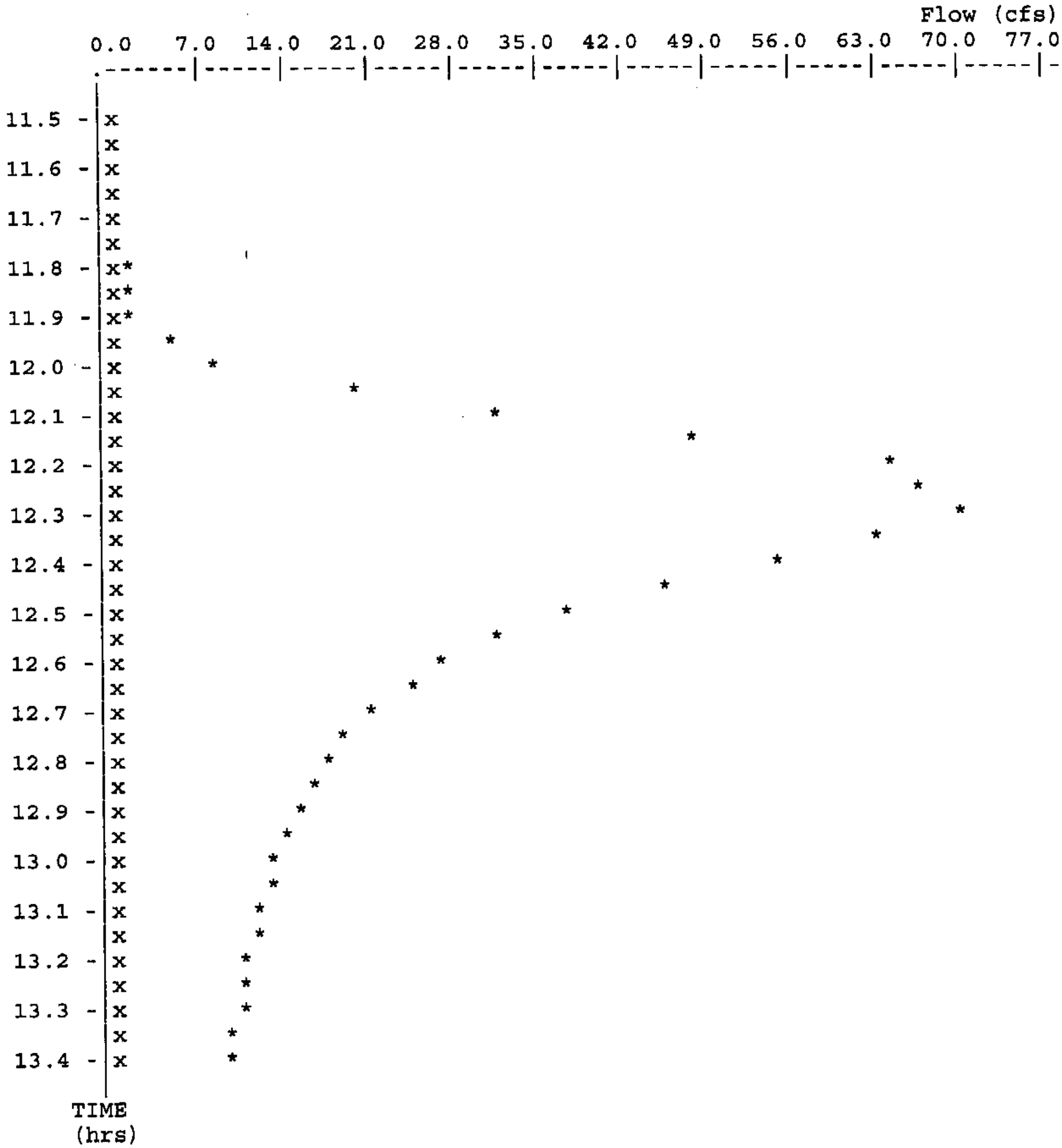
Total Storage in Pond = 294,489 cu-ft

POND-2 Version: 5.20 S/N: 1903052001 Page 7

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDCONS.HYD
Outflow Hydrograph: OUT .HYD

EXECUTED: 12-27-2001
09:40:33

Peak Inflow = 70.00 cfs
Peak Outflow = 5.73 cfs
Peak Elevation = 206.66 ft



* File: MRCDCONS.HYD Qmax = 70.0 cfs

x File: OUT .HYD Qmax = 5.7 cfs

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:57:42
Watershed file: --> MRCDPOST.WSD
Hydrograph file: --> MRCDPOST.HYD

MR, LLC C&D North Disposal Area
Post developed Conditions
10-YR 24-HR Storm

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
1	47.80	49.0	0.30	0.00	5.80	0.98	.36 .30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 47.80 acres or 0.07469 sq.mi
Peak discharge = 42 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
1	0.33	0.00	0.30	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 2

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:57:42
Watershed file: --> MRCDPOST.WSD
Hydrograph file: --> MRCDPOST.HYD

MR, LLC C&D North Disposal Area
Post_developed Conditions
10-YR 24-HR Storm

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
1	42	12.3
Composite Watershed	42	12.3

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 3

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:57:42
Watershed file: --> MRCDPOST.WSD
Hydrograph file: --> MRCDPOST.HYD

MR, LLC C&D North Disposal Area
Post_developed Conditions
10-YR 24-HR Storm

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
1	0	0	0	1	5	18	38	42	33
Total (cfs)	0	0	0	1	5	18	38	42	33

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
1	22	16	13	10	8	6	6	5	5
Total (cfs)	22	16	13	10	8	6	6	5	5

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
1	4	4	3	3	3	3	2	2	2
Total (cfs)	4	4	3	3	3	3	2	2	2

Subarea	18.0	19.0	20.0	22.0	26.0

8Ak

Description	hr	hr	hr	hr	hr
1	2	2	2	1	0
Total (cfs)	2	2	2	1	0

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 4

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:57:42
Watershed file: --> MRCDPOST.WSD
Hydrograph file: --> MRCDPOST.HYD

MR, LLC C&D North Disposal Area
Post_developed Conditions
10-YR 24-HR Storm

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	3
11.1	0	14.9	3
11.2	0	15.0	3
11.3	0	15.1	3
11.4	0	15.2	3
11.5	0	15.3	3
11.6	0	15.4	3
11.7	0	15.5	3
11.8	1	15.6	3
11.9	1	15.7	3
12.0	5	15.8	3
12.1	18	15.9	3
12.2	38	16.0	3
12.3	42	16.1	3
12.4	33	16.2	3
12.5	22	16.3	2
12.6	16	16.4	2
12.7	13	16.5	2
12.8	10	16.6	2
12.9	9	16.7	2
13.0	8	16.8	2
13.1	7	16.9	2
13.2	6	17.0	2
13.3	6	17.1	2
13.4	6	17.2	2
13.5	6	17.3	2
13.6	5	17.4	2
13.7	5	17.5	2
13.8	5	17.6	2
13.9	4	17.7	2
14.0	4	17.8	2

14.1	4	17.9	2
14.2	4	18.0	2
14.3	4	18.1	2
14.4	4	18.2	2
14.5	3	18.3	2
14.6	3	18.4	2
14.7	3	18.5	2

Quick TR-55 Version: 5.46 S/N: 1803000008 Page 5

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 12-21-2001 16:57:42
Watershed file: --> MRCDPOST.WSD
Hydrograph file: --> MRCDPOST.HYD

MR, LLC C&D North Disposal Area
Post_developed Conditions
10-YR 24-HR Storm

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	2	22.4	1
18.7	2	22.5	1
18.8	2	22.6	1
18.9	2	22.7	1
19.0	2	22.8	1
19.1	2	22.9	1
19.2	2	23.0	1
19.3	2	23.1	1
19.4	2	23.2	1
19.5	2	23.3	1
19.6	2	23.4	1
19.7	2	23.5	1
19.8	2	23.6	1
19.9	2	23.7	1
20.0	2	23.8	1
20.1	2	23.9	1
20.2	2	24.0	0
20.3	2	24.1	0
20.4	2	24.2	0
20.5	2	24.3	0
20.6	2	24.4	0
20.7	2	24.5	0
20.8	2	24.6	0
20.9	2	24.7	0
21.0	2	24.8	0
21.1	1	24.9	0
21.2	1	25.0	0
21.3	1	25.1	0
21.4	1	25.2	0
21.5	1	25.3	0
21.6	1	25.4	0

JPB

21.7	1	25.5	0
21.8	1	25.6	0
21.9	1	25.7	0
22.0	1	25.8	0
22.1	1	25.9	0
22.2	1		
22.3	1		

JPL

POND-2 Version: 5.20 S/N: 1903052001 Page 1
EXECUTED: 12-22-2001 10:37:08

```
**********************************************************************
*                                                                    *
*                      MR, LLC C&D LANDFILL                          *
*                      BROWNFIELD ROAD SITE                          *
*            ROUTE 10-YR 24-HR STORM RUNOFF THROUGH SB-1             *
*  ASSUMES NO SEDIMENT ACCUMULATION; STARTING ELEV IS POND BOTTOM    *
*                                                                    *
**********************************************************************
```

Inflow Hydrograph: MRCDPOST.HYD
Rating Table file: WAKESB-1.PND

----INITIAL CONDITIONS----
Elevation = 200.00 ft
Outflow = 0.00 cfs
Storage = 0 cu-ft

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)	2S/t (cfs)	2S/t + 0 (cfs)
200.00	0.0	0	0.0	0.0
200.50	0.0	18,856	104.8	104.8
201.00	0.0	38,228	212.4	212.4
201.50	0.0	58,123	322.9	322.9
202.00	0.0	78,548	436.4	436.4
202.50	0.0	99,488	552.7	552.7
203.00	0.0	120,925	671.8	671.8
203.50	0.0	142,866	793.7	793.7
204.00	0.0	165,317	918.4	918.4
204.50	0.0	188,318	1046.2	1046.2
205.00	0.0	211,913	1177.3	1177.3
205.50	0.0	236,108	1311.7	1311.7
206.00	0.0	260,911	1449.5	1449.5
206.50	0.0	286,331	1590.7	1590.7
207.00	18.3	312,367	1735.4	1753.7
207.50	51.8	339,019	1883.4	1935.2
208.00	95.2	366,295	2035.0	2130.2
208.50	133.7	394,142	2189.7	2323.4
209.00	149.5	422,508	2347.3	2496.8
209.50	163.8	451,397	2507.8	2671.6

Time increment (t) = 0.100 hrs.

POND-2 Version: 5.20 S/N: 1903052001 Page 2
EXECUTED: 12-22-2001 10:37:08

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH ROUTING COMPUTATIONS

JPK

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	0.00	-----	0.0	0.0	0.00	200.00
11.100	0.00	0.0	0.0	0.0	0.00	200.00
11.200	0.00	0.0	0.0	0.0	0.00	200.00
11.300	0.00	0.0	0.0	0.0	0.00	200.00
11.400	0.00	0.0	0.0	0.0	0.00	200.00
11.500	0.00	0.0	0.0	0.0	0.00	200.00
11.600	0.00	0.0	0.0	0.0	0.00	200.00
11.700	0.00	0.0	0.0	0.0	0.00	200.00
11.800	1.00	1.0	1.0	1.0	0.00	200.00
11.900	1.00	2.0	3.0	3.0	0.00	200.01
12.000	5.00	6.0	9.0	9.0	0.00	200.04
12.100	18.00	23.0	32.0	32.0	0.00	200.15
12.200	38.00	56.0	88.0	88.0	0.00	200.42
12.300	42.00	80.0	168.0	168.0	0.00	200.79
12.400	33.00	75.0	243.0	243.0	0.00	201.14
12.500	22.00	55.0	298.0	298.0	0.00	201.39
12.600	16.00	38.0	336.0	336.0	0.00	201.56
12.700	13.00	29.0	365.0	365.0	0.00	201.69
12.800	10.00	23.0	388.0	388.0	0.00	201.79
12.900	9.00	19.0	407.0	407.0	0.00	201.87
13.000	8.00	17.0	424.0	424.0	0.00	201.95
13.100	7.00	15.0	439.0	439.0	0.00	202.01
13.200	6.00	13.0	452.0	452.0	0.00	202.07
13.300	6.00	12.0	464.0	464.0	0.00	202.12
13.400	6.00	12.0	476.0	476.0	0.00	202.17
13.500	6.00	12.0	488.0	488.0	0.00	202.22
13.600	5.00	11.0	499.0	499.0	0.00	202.27
13.700	5.00	10.0	509.0	509.0	0.00	202.31
13.800	5.00	10.0	519.0	519.0	0.00	202.36
13.900	4.00	9.0	528.0	528.0	0.00	202.39
14.000	4.00	8.0	536.0	536.0	0.00	202.43
14.100	4.00	8.0	544.0	544.0	0.00	202.46
14.200	4.00	8.0	552.0	552.0	0.00	202.50
14.300	4.00	8.0	560.0	560.0	0.00	202.53
14.400	4.00	8.0	568.0	568.0	0.00	202.56
14.500	3.00	7.0	575.0	575.0	0.00	202.59
14.600	3.00	6.0	581.0	581.0	0.00	202.62
14.700	3.00	6.0	587.0	587.0	0.00	202.64
14.800	3.00	6.0	593.0	593.0	0.00	202.67
14.900	3.00	6.0	599.0	599.0	0.00	202.69
15.000	3.00	6.0	605.0	605.0	0.00	202.72
15.100	3.00	6.0	611.0	611.0	0.00	202.74
15.200	3.00	6.0	617.0	617.0	0.00	202.77
15.300	3.00	6.0	623.0	623.0	0.00	202.80
15.400	3.00	6.0	629.0	629.0	0.00	202.82

POND-2 Version: 5.20 S/N: 1903052001 Page 3
EXECUTED: 12-22-2001 10:37:08

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH — ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	3.00	6.0	635.0	635.0	0.00	202.85
15.600	3.00	6.0	641.0	641.0	0.00	202.87
15.700	3.00	6.0	647.0	647.0	0.00	202.90
15.800	3.00	6.0	653.0	653.0	0.00	202.92
15.900	3.00	6.0	659.0	659.0	0.00	202.95
16.000	3.00	6.0	665.0	665.0	0.00	202.97
16.100	3.00	6.0	671.0	671.0	0.00	203.00
16.200	3.00	6.0	677.0	677.0	0.00	203.02
16.300	2.00	5.0	682.0	682.0	0.00	203.04
16.400	2.00	4.0	686.0	686.0	0.00	203.06
16.500	2.00	4.0	690.0	690.0	0.00	203.07
16.600	2.00	4.0	694.0	694.0	0.00	203.09
16.700	2.00	4.0	698.0	698.0	0.00	203.11
16.800	2.00	4.0	702.0	702.0	0.00	203.12
16.900	2.00	4.0	706.0	706.0	0.00	203.14
17.000	2.00	4.0	710.0	710.0	0.00	203.16
17.100	2.00	4.0	714.0	714.0	0.00	203.17
17.200	2.00	4.0	718.0	718.0	0.00	203.19
17.300	2.00	4.0	722.0	722.0	0.00	203.21
17.400	2.00	4.0	726.0	726.0	0.00	203.22
17.500	2.00	4.0	730.0	730.0	0.00	203.24
17.600	2.00	4.0	734.0	734.0	0.00	203.26
17.700	2.00	4.0	738.0	738.0	0.00	203.27
17.800	2.00	4.0	742.0	742.0	0.00	203.29
17.900	2.00	4.0	746.0	746.0	0.00	203.30
18.000	2.00	4.0	750.0	750.0	0.00	203.32
18.100	2.00	4.0	754.0	754.0	0.00	203.34
18.200	2.00	4.0	758.0	758.0	0.00	203.35
18.300	2.00	4.0	762.0	762.0	0.00	203.37
18.400	2.00	4.0	766.0	766.0	0.00	203.39
18.500	2.00	4.0	770.0	770.0	0.00	203.40
18.600	2.00	4.0	774.0	774.0	0.00	203.42
18.700	2.00	4.0	778.0	778.0	0.00	203.44
18.800	2.00	4.0	782.0	782.0	0.00	203.45
18.900	2.00	4.0	786.0	786.0	0.00	203.47
19.000	2.00	4.0	790.0	790.0	0.00	203.48
19.100	2.00	4.0	794.0	794.0	0.00	203.50
19.200	2.00	4.0	798.0	798.0	0.00	203.52
19.300	2.00	4.0	802.0	802.0	0.00	203.53
19.400	2.00	4.0	806.0	806.0	0.00	203.55
19.500	2.00	4.0	810.0	810.0	0.00	203.57
19.600	2.00	4.0	814.0	814.0	0.00	203.58
19.700	2.00	4.0	818.0	818.0	0.00	203.60
19.800	2.00	4.0	822.0	822.0	0.00	203.61
19.900	2.00	4.0	826.0	826.0	0.00	203.63
20.000	2.00	4.0	830.0	830.0	0.00	203.65

POND-2 Version: 5.20 S/N: 1903052001 Page 4
EXECUTED: 12-22-2001 10:37:08

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD

Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH

ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	2.00	4.0	834.0	834.0	0.00	203.66
20.200	2.00	4.0	838.0	838.0	0.00	203.68
20.300	2.00	4.0	842.0	842.0	0.00	203.69
20.400	2.00	4.0	846.0	846.0	0.00	203.71
20.500	2.00	4.0	850.0	850.0	0.00	203.73
20.600	2.00	4.0	854.0	854.0	0.00	203.74
20.700	2.00	4.0	858.0	858.0	0.00	203.76
20.800	2.00	4.0	862.0	862.0	0.00	203.77
20.900	2.00	4.0	866.0	866.0	0.00	203.79
21.000	2.00	4.0	870.0	870.0	0.00	203.81
21.100	1.00	3.0	873.0	873.0	0.00	203.82
21.200	1.00	2.0	875.0	875.0	0.00	203.83
21.300	1.00	2.0	877.0	877.0	0.00	203.83
21.400	1.00	2.0	879.0	879.0	0.00	203.84
21.500	1.00	2.0	881.0	881.0	0.00	203.85
21.600	1.00	2.0	883.0	883.0	0.00	203.86
21.700	1.00	2.0	885.0	885.0	0.00	203.87
21.800	1.00	2.0	887.0	887.0	0.00	203.87
21.900	1.00	2.0	889.0	889.0	0.00	203.88
22.000	1.00	2.0	891.0	891.0	0.00	203.89
22.100	1.00	2.0	893.0	893.0	0.00	203.90
22.200	1.00	2.0	895.0	895.0	0.00	203.91
22.300	1.00	2.0	897.0	897.0	0.00	203.91
22.400	1.00	2.0	899.0	899.0	0.00	203.92
22.500	1.00	2.0	901.0	901.0	0.00	203.93
22.600	1.00	2.0	903.0	903.0	0.00	203.94
22.700	1.00	2.0	905.0	905.0	0.00	203.95
22.800	1.00	2.0	907.0	907.0	0.00	203.95
22.900	1.00	2.0	909.0	909.0	0.00	203.96
23.000	1.00	2.0	911.0	911.0	0.00	203.97
23.100	1.00	2.0	913.0	913.0	0.00	203.98
23.200	1.00	2.0	915.0	915.0	0.00	203.99
23.300	1.00	2.0	917.0	917.0	0.00	203.99
23.400	1.00	2.0	919.0	919.0	0.00	204.00
23.500	1.00	2.0	921.0	921.0	0.00	204.01
23.600	1.00	2.0	923.0	923.0	0.00	204.02
23.700	1.00	2.0	925.0	925.0	0.00	204.03
23.800	1.00	2.0	927.0	927.0	0.00	204.03
23.900	1.00	2.0	929.0	929.0	0.00	204.04
24.000	0.00	1.0	930.0	930.0	0.00	204.05
24.100	0.00	0.0	930.0	930.0	0.00	204.05
24.200	0.00	0.0	930.0	930.0	0.00	204.05
24.300	0.00	0.0	930.0	930.0	0.00	204.05
24.400	0.00	0.0	930.0	930.0	0.00	204.05
24.500	0.00	0.0	930.0	930.0	0.00	204.05
24.600	0.00	0.0	930.0	930.0	0.00	204.05

J.P.B.

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.00	0.0	930.0	930.0	0.00	204.05
24.800	0.00	0.0	930.0	930.0	0.00	204.05
24.900	0.00	0.0	930.0	930.0	0.00	204.05
25.000	0.00	0.0	930.0	930.0	0.00	204.05
25.100	0.00	0.0	930.0	930.0	0.00	204.05
25.200	0.00	0.0	930.0	930.0	0.00	204.05
25.300	0.00	0.0	930.0	930.0	0.00	204.05
25.400	0.00	0.0	930.0	930.0	0.00	204.05
25.500	0.00	0.0	930.0	930.0	0.00	204.05
25.600	0.00	0.0	930.0	930.0	0.00	204.05
25.700	0.00	0.0	930.0	930.0	0.00	204.05
25.800	0.00	0.0	930.0	930.0	0.00	204.05
25.900	0.00	0.0	930.0	930.0	0.00	204.05

POND-2 Version: 5.20 S/N: 1903052001 Page 6
EXECUTED: 12-22-2001 10:37:08

****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

Starting Pond W.S. Elevation = 200.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 42.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 204.05 ft

(all runoff is stored below weir crest; no outflow)

***** Summary of Approximate Peak Storage *****

Initial Storage	=	0 cu-ft
Peak Storage From Storm	=	167,400 cu-ft
Total Storage in Pond	=	167,400 cu-ft

\>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

\>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.20 S/N: 1903052001 Page 7

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Pond File:            WAKESB-1.PND
Inflow Hydrograph:    MRCDPOST.HYD
Outflow Hydrograph:   OUT     .HYD
                                              EXECUTED: 12-22-2001
                                                          10:37:08
Peak Inflow    =    42.00 cfs
Peak Outflow   =     0.00 cfs
Peak Elevation =   204.05 ft

                                                         Flow (cfs)
      0.0    4.2   8.4  12.6  16.8  21.0  25.2  29.4  33.6  37.8  42.0  46.2
      .------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-
      |
11.5 -|x
      |x
11.6 -|x
      |x
11.7 -|x
      |x*
11.8 -|x*
      |x*
11.9 -|x*
      |x   *
12.0 -|x      *
      |x               *
12.1 -|x                         *
      |x                                       *
12.2 -|x                                                     *
      |x                                                        *
12.3 -|x                                                           *
      |x                                                     *
12.4 -|x                                              *
      |x                                      *
12.5 -|x                              *
      |x                          *
12.6 -|x                      *
      |x                    *
12.7 -|x                  *
      |x               *
12.8 -|x             *
      |x             *
12.9 -|x            *
      |x           *
13.0 -|x          *
      |x          *
13.1 -|x         *
      |x        *
13.2 -|x        *
      |x        *
13.3 -|x        *
      |x        *
13.4 -|x        *
      |
```

TIME
(hrs)

```
* File:  MRCDPOST.HYD   Qmax =    42.0 cfs
x File:  OUT      .HYD   Qmax =     0.0 cfs
```

8 of 8

POND-2 Version: 5.20 S/N: 1903052001 Page 1
EXECUTED: 12-22-2001 10:21:33

MR, LLC C&D LANDFILL
BROWN-FIELD ROAD SITE
ROUTE 10-YR 24-HR STORM RUNOFF THROUGH SB-1
ASSUME SEDIMENT ACCUMULATION AT CLEANOUT LEVEL

Inflow Hydrograph: MRCDPOST.HYD
Rating Table file: WAKESB-1.PND

----INITIAL CONDITIONS----
Elevation = 203.25 ft ← Cleanout Level
Outflow = 0.00 cfs
Storage = 131,832 cu-ft

GIVEN POND DATA / INTERMEDIATE ROUTING COMPUTATIONS

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)	2S/t (cfs)	2S/t + 0 (cfs)
203.25	0.0	131,832	732.4	732.4
203.75	0.0	154,027	855.7	855.7
204.25	0.0	176,744	981.9	981.9
204.75	0.0	200,041	1111.3	1111.3
205.25	0.0	223,935	1244.1	1244.1
205.75	0.0	248,433	1380.2	1380.2
206.25	0.0	273,544	1519.7	1519.7
206.75	6.5	299,272	1662.6	1669.1
207.25	33.7	325,615	1809.0	1842.7
207.75	72.4	352,578	1958.8	2031.2
208.25	106.7	380,154	2112.0	2218.7
208.75	139.3	408,260	2268.1	2407.4
209.25	156.8	436,887	2427.1	2583.9
209.75	170.4	466,039	2589.1	2759.5

Time increment (t) = 0.100 hrs.

POND-2 Version: 5.20 S/N: 1903052001 Page 2
EXECUTED: 12-22-2001 10:21:33

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH / ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	0.00	-----	732.4	732.4	0.00	203.25
11.100	0.00	0.0	732.4	732.4	0.00	203.25

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11.200	0.00	0.0	732.4	732.4	0.00	203.25
11.300	0.00	0.0	732.4	732.4	0.00	203.25
11.400	0.00	0.0	732.4	732.4	0.00	203.25
11.500	0.00	0.0	732.4	732.4	0.00	203.25
11.600	0.00	0.0	732.4	732.4	0.00	203.25
11.700	0.00	0.0	732.4	732.4	0.00	203.25
11.800	1.00	1.0	733.4	733.4	0.00	203.25
11.900	1.00	2.0	735.4	735.4	0.00	203.26
12.000	5.00	6.0	741.4	741.4	0.00	203.29
12.100	18.00	23.0	764.4	764.4	0.00	203.38
12.200	38.00	56.0	820.4	820.4	0.00	203.61
12.300	42.00	80.0	900.4	900.4	0.00	203.93
12.400	33.00	75.0	975.4	975.4	0.00	204.22
12.500	22.00	55.0	1030.4	1030.4	0.00	204.44
12.600	16.00	38.0	1068.4	1068.4	0.00	204.58
12.700	13.00	29.0	1097.4	1097.4	0.00	204.70
12.800	10.00	23.0	1120.4	1120.4	0.00	204.78
12.900	9.00	19.0	1139.4	1139.4	0.00	204.86
13.000	8.00	17.0	1156.4	1156.4	0.00	204.92
13.100	7.00	15.0	1171.4	1171.4	0.00	204.98
13.200	6.00	13.0	1184.4	1184.4	0.00	205.03
13.300	6.00	12.0	1196.4	1196.4	0.00	205.07
13.400	6.00	12.0	1208.4	1208.4	0.00	205.12
13.500	6.00	12.0	1220.4	1220.4	0.00	205.16
13.600	5.00	11.0	1231.4	1231.4	0.00	205.20
13.700	5.00	10.0	1241.4	1241.4	0.00	205.24
13.800	5.00	10.0	1251.4	1251.4	0.00	205.28
13.900	4.00	9.0	1260.4	1260.4	0.00	205.31
14.000	4.00	8.0	1268.4	1268.4	0.00	205.34
14.100	4.00	8.0	1276.4	1276.4	0.00	205.37
14.200	4.00	8.0	1284.4	1284.4	0.00	205.40
14.300	4.00	8.0	1292.4	1292.4	0.00	205.43
14.400	4.00	8.0	1300.4	1300.4	0.00	205.46
14.500	3.00	7.0	1307.4	1307.4	0.00	205.48
14.600	3.00	6.0	1313.4	1313.4	0.00	205.50
14.700	3.00	6.0	1319.4	1319.4	0.00	205.53
14.800	3.00	6.0	1325.4	1325.4	0.00	205.55
14.900	3.00	6.0	1331.4	1331.4	0.00	205.57
15.000	3.00	6.0	1337.4	1337.4	0.00	205.59
15.100	3.00	6.0	1343.4	1343.4	0.00	205.61
15.200	3.00	6.0	1349.4	1349.4	0.00	205.64
15.300	3.00	6.0	1355.4	1355.4	0.00	205.66
15.400	3.00	6.0	1361.4	1361.4	0.00	205.68

POND-2 Version: 5.20 S/N: 1903052001 Page 3
EXECUTED: 12-22-2001 10:21:33

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH — ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	3.00	6.0	1367.4	1367.4	0.00	205.70

15.600	3.00	6.0	1373.4	1373.4	0.00	205.73
15.700	3.00	6.0	1379.4	1379.4	0.00	205.75
15.800	3.00	6.0	1385.4	1385.4	0.00	205.77
15.900	3.00	6.0	1391.4	1391.4	0.00	205.79
16.000	3.00	6.0	1397.4	1397.4	0.00	205.81
16.100	3.00	6.0	1403.4	1403.4	0.00	205.83
16.200	3.00	6.0	1409.4	1409.4	0.00	205.85
16.300	2.00	5.0	1414.4	1414.4	0.00	205.87
16.400	2.00	4.0	1418.4	1418.4	0.00	205.89
16.500	2.00	4.0	1422.4	1422.4	0.00	205.90
16.600	2.00	4.0	1426.4	1426.4	0.00	205.92
16.700	2.00	4.0	1430.4	1430.4	0.00	205.93
16.800	2.00	4.0	1434.4	1434.4	0.00	205.94
16.900	2.00	4.0	1438.4	1438.4	0.00	205.96
17.000	2.00	4.0	1442.4	1442.4	0.00	205.97
17.100	2.00	4.0	1446.4	1446.4	0.00	205.99
17.200	2.00	4.0	1450.4	1450.4	0.00	206.00
17.300	2.00	4.0	1454.4	1454.4	0.00	206.02
17.400	2.00	4.0	1458.4	1458.4	0.00	206.03
17.500	2.00	4.0	1462.4	1462.4	0.00	206.04
17.600	2.00	4.0	1466.4	1466.4	0.00	206.06
17.700	2.00	4.0	1470.4	1470.4	0.00	206.07
17.800	2.00	4.0	1474.4	1474.4	0.00	206.09
17.900	2.00	4.0	1478.4	1478.4	0.00	206.10
18.000	2.00	4.0	1482.4	1482.4	0.00	206.12
18.100	2.00	4.0	1486.4	1486.4	0.00	206.13
18.200	2.00	4.0	1490.4	1490.4	0.00	206.15
18.300	2.00	4.0	1494.4	1494.4	0.00	206.16
18.400	2.00	4.0	1498.4	1498.4	0.00	206.17
18.500	2.00	4.0	1502.4	1502.4	0.00	206.19
18.600	2.00	4.0	1506.4	1506.4	0.00	206.20
18.700	2.00	4.0	1510.4	1510.4	0.00	206.22
18.800	2.00	4.0	1514.4	1514.4	0.00	206.23
18.900	2.00	4.0	1518.4	1518.4	0.00	206.25
19.000	2.00	4.0	1522.2	1522.4	0.12	206.26
19.100	2.00	4.0	1525.6	1526.2	0.28	206.27
19.200	2.00	4.0	1528.7	1529.6	0.43	206.28
19.300	2.00	4.0	1531.6	1532.7	0.57	206.29
19.400	2.00	4.0	1534.2	1535.6	0.69	206.30
19.500	2.00	4.0	1536.6	1538.2	0.81	206.31
19.600	2.00	4.0	1538.8	1540.6	0.91	206.32
19.700	2.00	4.0	1540.8	1542.8	1.00	206.33
19.800	2.00	4.0	1542.6	1544.8	1.09	206.33
19.900	2.00	4.0	1544.3	1546.6	1.17	206.34
20.000	2.00	4.0	1545.8	1548.3	1.24	206.35

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)

20.100	2.00	4.0	1547.2	1549.8	1.31	206.35
20.200	2.00	4.0	1548.4	1551.2	1.37	206.36
20.300	2.00	4.0	1549.6	1552.4	1.42	206.36
20.400	2.00	4.0	1550.6	1553.6	1.47	206.36
20.500	2.00	4.0	1551.6	1554.6	1.52	206.37
20.600	2.00	4.0	1552.5	1555.6	1.56	206.37
20.700	2.00	4.0	1553.3	1556.5	1.60	206.37
20.800	2.00	4.0	1554.0	1557.3	1.63	206.38
20.900	2.00	4.0	1554.7	1558.0	1.67	206.38
21.000	2.00	4.0	1555.3	1558.7	1.70	206.38
21.100	1.00	3.0	1554.9	1558.3	1.68	206.38
21.200	1.00	2.0	1553.7	1556.9	1.62	206.37
21.300	1.00	2.0	1552.5	1555.7	1.57	206.37
21.400	1.00	2.0	1551.5	1554.5	1.52	206.37
21.500	1.00	2.0	1550.6	1553.5	1.47	206.36
21.600	1.00	2.0	1549.7	1552.6	1.43	206.36
21.700	1.00	2.0	1548.9	1551.7	1.39	206.36
21.800	1.00	2.0	1548.2	1550.9	1.36	206.35
21.900	1.00	2.0	1547.6	1550.2	1.33	206.35
22.000	1.00	2.0	1547.0	1549.6	1.30	206.35
22.100	1.00	2.0	1546.4	1549.0	1.27	206.35
22.200	1.00	2.0	1545.9	1548.4	1.25	206.35
22.300	1.00	2.0	1545.5	1547.9	1.23	206.34
22.400	1.00	2.0	1545.0	1547.5	1.21	206.34
22.500	1.00	2.0	1544.7	1547.0	1.19	206.34
22.600	1.00	2.0	1544.3	1546.7	1.17	206.34
22.700	1.00	2.0	1544.0	1546.3	1.16	206.34
22.800	1.00	2.0	1543.7	1546.0	1.14	206.34
22.900	1.00	2.0	1543.4	1545.7	1.13	206.34
23.000	1.00	2.0	1543.2	1545.4	1.12	206.34
23.100	1.00	2.0	1543.0	1545.2	1.11	206.34
23.200	1.00	2.0	1542.8	1545.0	1.10	206.33
23.300	1.00	2.0	1542.6	1544.8	1.09	206.33
23.400	1.00	2.0	1542.4	1544.6	1.08	206.33
23.500	1.00	2.0	1542.3	1544.4	1.08	206.33
23.600	1.00	2.0	1542.1	1544.3	1.07	206.33
23.700	1.00	2.0	1542.0	1544.1	1.06	206.33
23.800	1.00	2.0	1541.9	1544.0	1.06	206.33
23.900	1.00	2.0	1541.8	1543.9	1.05	206.33
24.000	0.00	1.0	1540.8	1542.8	1.00	206.33
24.100	0.00	0.0	1538.9	1540.8	0.92	206.32
24.200	0.00	0.0	1537.3	1538.9	0.84	206.31
24.300	0.00	0.0	1535.7	1537.3	0.76	206.31
24.400	0.00	0.0	1534.3	1535.7	0.70	206.30
24.500	0.00	0.0	1533.1	1534.3	0.64	206.30
24.600	0.00	0.0	1531.9	1533.1	0.58	206.29

POND-2 Version: 5.20 S/N: 1903052001 Page 5
EXECUTED: 12-22-2001 10:21:33

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH ROUTING COMPUTATIONS

JMB

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.00	0.0	1530.8	1531.9	0.53	206.29
24.800	0.00	0.0	1529.9	1530.8	0.49	206.29
24.900	0.00	0.0	1529.0	1529.9	0.44	206.28
25.000	0.00	0.0	1528.2	1529.0	0.40	206.28
25.100	0.00	0.0	1527.4	1528.2	0.37	206.28
25.200	0.00	0.0	1526.8	1527.4	0.34	206.28
25.300	0.00	0.0	1526.1	1526.8	0.31	206.27
25.400	0.00	0.0	1525.6	1526.1	0.28	206.27
25.500	0.00	0.0	1525.1	1525.6	0.26	206.27
25.600	0.00	0.0	1524.6	1525.1	0.23	206.27
25.700	0.00	0.0	1524.2	1524.6	0.21	206.27
25.800	0.00	0.0	1523.8	1524.2	0.20	206.27
25.900	0.00	0.0	1523.4	1523.8	0.18	206.26

POND-2 Version: 5.20 S/N: 1903052001 Page 6
EXECUTED: 12-22-2001 10:21:33

****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

Starting Pond W.S. Elevation = 203.25 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 42.00 cfs
Peak Outflow = 1.70 cfs < 12 cfs Pre-developed Peak Discharge ∴ O.K.
Peak Elevation = 206.38 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 131,832 cu-ft
Peak Storage From Storm = 148,422 cu-ft

Total Storage in Pond = 280,254 cu-ft

POND-2 Version: 5.20 S/N: 1903052001 Page 7

Pond File: WAKESB-1.PND
Inflow Hydrograph: MRCDPOST.HYD
Outflow Hydrograph: OUT .HYD

EXECUTED: 12-22-2001

Peak Inflow = 42.00 cfs
Peak Outflow = 1.70 cfs
Peak Elevation = 206.38 ft

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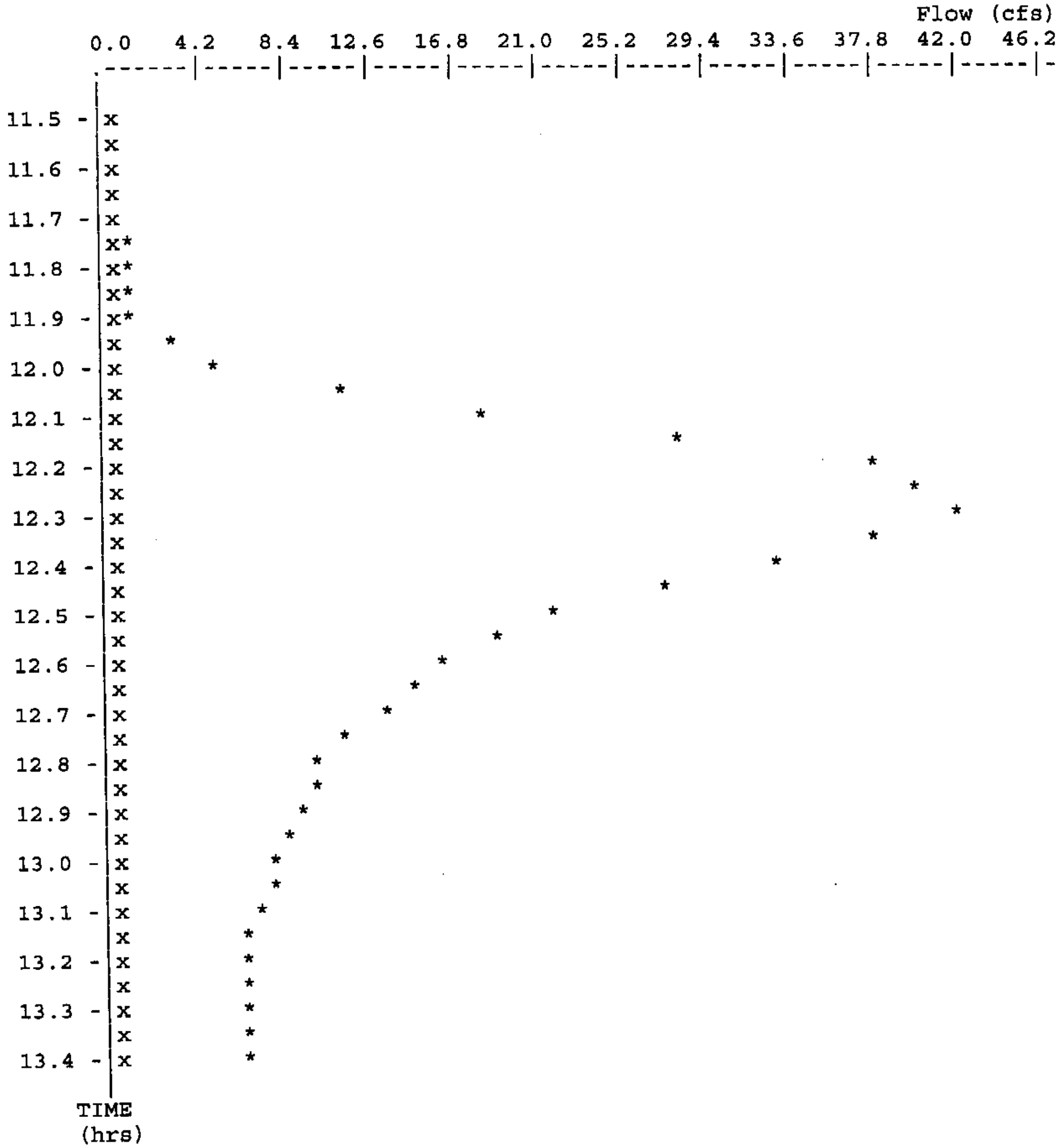

* File: MRCDPOST.HYD Qmax = 42.0 cfs
x File: OUT .HYD Qmax = 1.7 cfs

APPENDIX 5

Post Closure Inspection Forms

1. Post Closure Inspection Record

2. Groundwater Monitoring Well Maintenance Record

1. Post Closure Inspection Record

POST-CLOSURE INSPECTION RECORD

FACILITY:	____________	PERMIT NO.	____________
LOCATION:	____________	DATE:	____________
INSPECTOR:	____________	COMPANY:	____________

1. Access and Security Control

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

2. Erosion and Sediment Control

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

3. Drainage Control Requirements

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

4. Uncontrolled Escape of Leachate or Landfill Gas

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

5. Environmental Monitoring Systems

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

6. Miscellaneous

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

2. Groundwater Monitoring Well Maintenance Record

GROUNDWATER MONITORING WELL MAINTENANCE RECORD

FACILITY: ____________ PERMIT NO. ____________

LOCATION: ____________ DATE: ____________

INSPECTOR: ____________ COMPANY: ____________

---

1. Is surface water diverted away from the well head? ____________

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

3. Has surface water runoff undercut the concrete pad? ____________

4. Is the outer casing still secure and locked? ____________

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

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

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

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

7. Is the inner casing firmly grouted in place? ____________

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

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

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

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

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

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