Fac/Perm/Co ID #	Date	Doc ID#
BC	01/04/11	DIN

Prepared for:

Coble Sandrock, Inc.
5833 Foster Store Road
Liberty, North Carolina 27298

JEI PROJECT NO. 419.00, TASK 20

COBLE'S SANDROCK, INC.
ALAMANCE COUNTY, NORTH CAROLINA
CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL

VOLUME II
CONSTRUCTION PLAN APPLICATION
PHASE 3

MARCH 2006

Prepared by:

JOYCE
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(336) 323-0092

TABLE OF CONTENTS

FIGURES

DRAWINGS

APPENDICES

STATEMENT OF COMPLIANCE WITH SITE APPLICATION REQUIREMENTS

It is our opinion that the information and design described in this Construction Plan Application for the proposed expansion of the Coble's Sandrock, Inc. 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.

Evan Andrews, P.E.
Technical Consultant

1.0 GENERAL

Coble's Sandrock, Inc. requests a permit to construct a new 5-year phase (Phase 3) for its construction and demolition debris (C&D) landfill. Joyce Engineering, Inc. (JEI) has prepared this permit application on behalf of Coble's Sandrock and presents the following information in support of this request.

1.1 Existing Conditions

Currently DENR has approved site suitability for a 39.6 acre facility. Permits to Operate have been issued for Phase 1 (7.0 acres), Phase 2A (1.1 acres) and Phase 2B (4.76 acres), and a land clearing and inert debris (LCID) disposal area of about 4 acres. These permitted areas are shown on Drawing 2. The site is located in southwest Alamance County just north of Alamance Church Road, in between Foster Store Road and Kimesville Road. Poppaw Creek flows south to north along the north western border of the property. The Poppaw Creek 100-year floodplain extends into approximately 8 acres of the northwest portion of the site.

2.0 CONSTRUCTION PLAN

The purpose of this section is to satisfy the requirements of .0504 (2)(h), which requires a written report that addresses the proposed development, the projected capacity and life, and general operating and waste management procedures of for the proposed 5-year phase.

2.1 Proposed C&D Expansion Areas

The proposed C&D expansion includes two areas—Phase 3A, a 6.3 acre area to the northeast and east of Phase 1, and Phase 3B, a 5.8 acre area to the south of Phase 2B. (See Drawing 3). The expansion areas extend outside of the currently permitted facility boundary, however, a Site Application for site suitability of an additional 114.4 acres (for a total Facility area of 154 acres) is included in Volume I of this submittal. The proposed Phase 3 expansion areas comply with all relevant buffers as shown on Drawing 3.

2.2 Base Grading Plan

The base grade of the proposed C&D landfill will consist of the existing underlying soils. Base grades have been designed to be a minimum of four feet above the seasonal high groundwater table and bedrock elevations. If unsuitable soils are identified during preparation of the site, they will be removed and replaced with suitable compacted material before construction of the base grades begins. 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.

See Volume I, Section 2 for a detailed discussion of the hydrogeologic evaluation of this area with regards to the seasonal high groundwater location. Proposed base grades are illustrated on Drawing 4.

2.3 Final Cover System

Proposed final grades for Phase 3 are shown on Drawing 5. Final grades have been designed with post-settlement surface slopes of at least five percent at the top of the landfill, and a maximum of 3 horizontal to 1 vertical (3H:1V) on the side slopes. Cross sectional details of the proposed final grades are provided on Drawing 9.

The cap system will consist of: a 12 inch intermediate cover and leveling course, an 18 inch compacted soil layer, and a 6 inch vegetative layer. See Section 4.3 for a detailed discussion of the cap system.

2.4 C&D Waste Stream

Service Area: The Alamance County Franchise Agreement limits the service area to be served by the Coble's Sandrock Landfill to customers within 25 miles from the site. (See Appendix II of Volume I, Section 1). Existing customers outside the 25-mile service limitation are grandfathered under the Franchise Agreement and Coble's Sandrock may continue to accept wastes from these customers. Coble's Sandrock may also accept waste from new customers outside the 25-mile service area to replace existing customers outside the service area; however, first priority in terms of disposal capacity is to be given to waste generated within Alamance County.

Types of Waste Specified for Disposal: Only construction/demolition debris will be accepted at the C&D landfill, and only land clearing/inert debris (LCID) will be accepted in permitted LCID areas. 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. LCID is waste that is generated from land clearing activities.

Disposal Rates:	2005	55,405 tons of C&D waste
	2004	59,041 tons of C&D waste
	2003	65,000 tons of C&D waste
	2002	34,404 tons of C&D waste
	2001	36,012 tons of C&D waste

2.5 Landfill Capacity and Soil Balance

To evaluate the air space requirement for a new 5-year phase, a best-fit line was applied to tonnage data from the past five years and projected foreward through 2011 (See Figure 1). The projected total tonnage for the next 5-year phase is 440,130 tons (See Figure 1). Assuming an in-place waste density of 1050 lbs per cubic yard, the required air space for waste for the 5-year phase is 836,250 cubic yards. Also, assuming that a 6-inch lift of cover soil will be placed on the working face once per week, an additional 10% (83,625 cubic yards) of air space will be required. Therefore, the total air space required, not including the intermediate or final cap, is 919,875 cubic yards.

Using Autodesk Land Desktop 2006, the total designed air space for Phase 3, not including intermediate or final cover, is 900,200 cubic yards, giving Phase 3 an estimated lifetime of 4.9 years.

The base grading plan for Phase 3 results 150,200 cubic yards (net) of cut. The cut material will be stockpiled for use as weekly cover and final cover. The weekly cover required for Phase 3 is estimated to be 83,625 cubic yards and the final cover volume is 30,110 cubic yards. No outside soil material will need to be imported.

2.6 Waste Management Procedures

During operating hours, traffic is routed from the entrance gate and scalehouse to a gravel road leading to the disposal area. C&D waste and land clearing and inert debris will be identified at the scale house and directed to the appropriate disposal area.

Materials other than C&D waste, such as metal recyclables and cardboard are managed separately. Coble's Sandrock deconstructs mobile trailer homes at the working face of the C&D landfill. Identified C&D waste material removed from the deconstruction process is placed into the landfill. Metal material that is removed from the trailer homes is temporarily stored adjacent to the deconstruction area on the working face. Approximately 70 cubic yards of metal material is removed from the site weekly. The scrap metal is removed from the site and taken to D.H. Griffin Wrecking Co. Inc. Cardboard is also removed from the waste stream and is temporarily stored in a 40-yard container that is located adjacent to the working face. Federal Paper Board removes the cardboard material from the site when the 40-yard container becomes full. See Appendix I for information regarding the end-users of the metal and cardboard material.

The locations of the mobile trailer home deconstruction area and the metals and cardboard temporary storage containers follow the location of the working face as it progresses across the landfill.

3.0 OPERATION PLAN

This operation plan describes how the design and construction plans will be implemented during the life of the facility.

3.1 General Operating Conditions

3.1.1 Facility Contact

The owner and operator of the site is:

Kent Coble
5833 Foster Store Road
Liberty, North Carolina 27298
Phone Number: (336)-565-4750
Fax Number: (336)-565-4752

3.1.2 Hours of Operation

The landfill is expected to be open to private waste haulers and the public from 6:30 a.m. – 4:30 p.m. Monday through Friday, and closed on Saturday. The facility will be closed on the following major holidays: New Years Day, Good Friday, Memorial Day, Independence Day, Thanksgiving Day, Christmas Eve, and Christmas Day.

3.1.3 Site Access and Safety

Access to the facility is controlled through a single access road. A metal gate prevents access after operating hours. A sign containing the information required in Rule .0566 (16) is posted at the facility entrance. Traffic moves from the entrance gate to the landfill via a gravel haul road that extends approximately 0.25 mile from the facility entrance. The entrance is planned to remain at its present location. The gravel haul roads may be rerouted as needed to access the proposed C&D expansion area.

3.1.4 Waste Acceptance

Only construction/demolition and land clearing/inert debris is proposed for disposal at the landfill in their respective permitted areas. 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.

3.1.5 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, 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.

Coble Sandrock will notify the NC Division of Waste Management within 24 hours of attempted disposal of hazardous waste and other waste the landfill is not permitted to receive. The waste-screening program is described later in Section 3.2.

3.1.6 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.

3.1.7 Air Quality

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

3.1.8 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, the waste will be removed or segregated from other waste in the disposal area if possible. Following segregation, the situation will be reevaluated to determine whether emergency personnel should be notified. If necessary, the Snow Camp and/or E.M. Holt Volunteer Fire Departments will be called to render assistance and provide support in fighting any fires that occur at this site. Water in sedimentation ponds and nearby creeks can be used by firefighters to extinguish larger fires. See Appendix II for written assistance notification from the local fire departments.

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 the fire extinguishers carried on the landfill equipment.

3.2 Random Waste Screening Program

3.2.1 Authority

In order to prevent the acceptance of prohibited wastes, a random waste screening program is proposed in accordance with the North Carolina's Solid Waste Management Regulations, Rule .1626(1)(f). 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
> - 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 made on a regular basis. At least one vehicle per week will be randomly selected, at the working face, by the personnel conducting the inspection. A random truck number and time will be selected (e.g., the tenth load after 10:00 a.m.) on the day of inspections.

3.2.3 Record Keeping

Appropriate forms indicating the results of each inspection will be completed. All reports and resulting correspondence will be maintained at the facility 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 municipal solid waste, and hazardous and liquid waste.

3.2.5 Location

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

3.2.6 Contingency/Action Plan

The following contingency/action plan details the procedure currently used at Coble's Sandrock for conducting random waste inspections:

1) Upon weigh-in, drivers are asked about the contents of their load and sign an invoice stating that they are not discharging hazardous materials, liquid wastes or any other unacceptable materials into the landfill. Although all loads are visually inspected upon weigh-in, the complete contents of a load cannot be determined until the load is discharged by the driver and pushed back by Coble's Sandrock.

2) The dumped material is examined for safety hazards and waste excluded by the operating permit which include:

- 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 waste
- Tires.

Loads that include large closed containers will be handled carefully to avoid possible rupturing of the containers.

3) Take the following action as appropriate:

- Incorporate acceptable waste into working face.
- Haul MSW to a transfer facility or to a MSW landfill for disposal.
- If necessary, hold suspected unauthorized waste for identification by on-site personnel and confirmation by others, such as a contract laboratory or regulator.
- Interview driver and hauler to identify the source of waste in the load.
- Hold rejected hazardous or liquid waste for generator, or
- Arrange for hazardous or liquid waste collection by licensed collector.

5) Document Actions:

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

6) Should any materials be discharged into the landfills that are unacceptable, Coble's Sandrock may impose a clean-up fee to cover the cost of properly disposing of the unacceptable waste.

7) Should the unacceptable materials pose an immediate threat to the health and safety of individuals, the area will be secured. The material/wastes shall be handled by a licensed handler of hazardous waste and disposed of at a facility licensed to accept that material. The appropriate officials will be notified.

3.3 Waste Compaction And Equipment

3.3.1 Filling Operation

The area method of filling will be used in accordance with the approved filling sequence. Each lift shall be approximately 10 feet thick, including an allowance for weekly cover. The proposed waste to soil volume ratio is 9:1. The debris shall be spread and compacted by a self-propelled landfill compactor. The compactor, prior to the placement of a subsequent layer of debris, shall make at least 4 to 6 passes in orthogonal directions.

3.3.2 Landfill Equipment

Coble Sandrock proposes to operate the following equipment at the C&D landfill:

- Front End Track Loaders (2)
- Grapple Track Hoe (1)
- Bucket Track Hoe (1)
- Electric Magnet Track Hoe (1)
- Cat Compactor (1)
- Rex Compactors (2)
- Pans – TX 14 y (2)
- Rubber Tire Loader (1)
- Screener (1)
- Grinder (1)
- 60 y Container (3)
- 40' Steel Trailer (2)
- Road Tractor (1)
- Off Road Truck (1)

Additional equipment may be added, depending on the actual quantity of waste accepted.

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 (proposed waste to soil volume ratio of 9:1). 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 Erosion and Sediment Control

The facility Erosion and Sediment Control Plan is included as Appendix III and will be submitted to the Division of Land Quality for approval.

As required, the operator shall not cause a discharge of pollutants into waters of the United States, including wetlands, that violates any 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 nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirement of an area-wide or State-wide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended. Surface water shall be diverted from the operational area and shall not be impounded over or in waste.

Embankment slopes will be regularly inspected for erosion. The vegetation on these slopes will be mowed at least once a year. These slopes will be maintained with reseeding, fertilizer, and other means, as necessary, to promote a healthy stand of vegetation. All vegetative and structural erosion and sediment control devices will maintained according to the North Carolina Erosion and Sediment Control Planning and Design Manual (NCESCPDM). Channels and basins shall be kept free of debris and sediment.

In-place erosion and sediment control measures, including stormwater conveyance channels and a sediment basin to the northwest of the landfill, will continue to serve the existing C&D landfill as well as the proposed expansion area. Additional stormwater conveyance channels and an additional sediment basin to be located to the northeast of the landfill are proposed (See Drawing 10).

3.5 Record Keeping Requirements

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

- The landfill's operating permit and pertinent correspondence;
- 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;

4.0 CLOSURE PLAN

4.1 General

The site will be closed incrementally as filling 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, which will serve to minimize infiltration of stormwater, and will provide a vegetative cover. The site will be closed in accordance with the requirements of Rule .1627. No specific post-closure uses are proposed at this time, other than agricultural green space.

4.2 Area To Receive Final Cover

The proposed C&D landfill footprint is shown on Drawing 5. The final cover will be constructed over the area of the footprint that accepts waste. If waste is placed throughout the entire footprint, the final cap will be approximately 25 acres in size.

4.3 Cover Design

Projected final grading contours for the proposed C&D Landfill are shown on Drawing 5. 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 9. The following components are proposed as shown on the detail:

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

b. Cohesive Soil Layer – The cohesive soil layer is proposed to consist of a minimum of 18-inches of compacted soil with a permeability no greater than $1x10^{-5}$ cm/sec. The permeability requirement will be achieved using laboratory test data for borrow soil material and construction specifications developed prior to construction.

c. Protective Soil/Topsoil Layer: A protective layer consisting of at least 6 inches of local soil will be placed on top of the compacted soil layer. The topsoil will not be heavily compacted so that vegetative growth will be promoted.

d. Vegetative Cover: After placement of the organic soil 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. Seeding, mulch, and erosion matting will be used as needed to control erosion.

Design of sediment and erosion control features will be in accordance with applicable sections of the "North Carolina Erosion and Sediment Control Planning and Design Manual". Stormwater will be carried off the cap with a series of channels and slope drains.

4.4 Cap Construction

Once final grades are established, a detailed design for the closure cap and associated stormwater management structures will be provided. Plans and specifications will be prepared, as well as the

construction quality assurance plan needed to ensure that the cover is constructed as designed. Soil for the future cap construction is expected to come from onsite grading activities. If there is an insufficient quantity of suitable soil on-site, the owner will locate appropriate material at an off-site source, and haul the material to the landfill to construct the cap.

5.0 POST-CLOSURE CARE

5.1 General

After closure, access to the site will continue to be controlled by the use of a gate at the entrance. Landfill personnel will continue to conduct maintenance, inspections and monitoring at the site as required by the Division of Waste Management and Alamance County. The primary land use for the site after closure of the landfill will be open dormant green space.

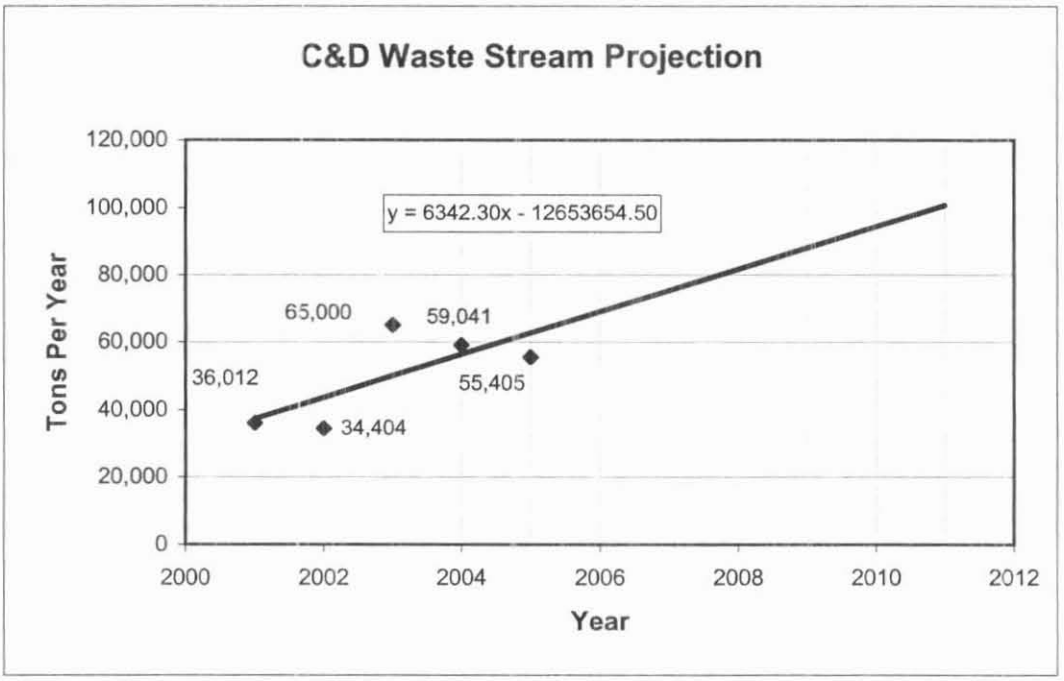
5.2 Maintenance

Stormwater management structures will be designed to function throughout the post-closure care period. Drainage ditches and sediment ponds will be inspected and maintained as needed to control surface water runoff and erosion. The cap will be inspected regularly and repaired as needed to maintain its integrity. Vegetation will be mowed as needed, and fertilized and reseeded as necessary to maintain a good vegetative cover on the landfill.

5.3 Environmental Monitoring

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

(End)



Estimation of Required Air Space for 5-Year Phase

		Rqd Air Space (cy)		
	Projected Tons	Waste	Soil Cover	Total
2007	75,342	143,149	14,315	157,464
2008	81,684	155,199	15,520	170,719
2009	88,026	167,250	16,725	183,975
2010	94,369	179,300	17,930	197,230
2011	100,711	191,351	19,135	210,486
				919,874 **total**

1 cy	*	2000 lbs
1050 lbs		1 ton

Assume 10% of total
air space taken up with soil

Evaluation of Design Air Space

Phase 3 volume, not including intermediate or final soil cover = 900,200 cy. (AutoCAD generated)

Estimated Phase 3 lifetime: 4.9 years

D.H. GRIFFIN WRECKING CO., INC.

June 20, 2001

Sent Via Fax (336) 565-4752

Mr. Kent Coble
Coble Sandrock Inc.
5833 Foster Store Road
Liberty, NC 27298

RE: Scrap Metal Reclamation
C&D Landfill, Liberty, NC

Dear Mr. Coble:

Thank you again for giving D. H. Griffin Wrecking Co., Inc. (DHG) the opportunity to provide Coble Sandrock, Inc. with roll-off containers for scrap reclamation. DHG will purchase the material based on the current market value and transportation costs. As you know, DHG is one of the states largest scrap recyclers and we will continue to provide your company with the best service possible.

Sincerely,

D. H. GRIFFIN WRECKING CO., INC.

David H. Deatherage
Senior Estimator

CORPORATE OFFICE:
4700 Hilltop Road (27407) • P.O. Box 7657 • Greensboro, NC 27417-0657
(336) 855-7030 • Fax (336) 855-9309
"If It's Wrecking — Call Us"

FEDERAL WASTE PAPER COMPANY

1763 WEST WEBB AVENUE
BURLINGTON, NC 27215
336-228-0692
Fax: 336-228-0820

June 22, 2001

Mr. Kent Coble
Coble Sandrock Inc.
5833 Foster Store Road
Liberty, NC 27298

Dear Mr. Coble:

Thank you for giving Federal Waste Paper the opportunity to serve you recycling needs. We will be glad to accept the cardboard generated at your facility to the extent that it is recyclable or otherwise acceptable.

We appreciate your business. If you have any questions or additional service needs, please give us a call.

Regards,

Rodney Foust
Plant Manager

ALAMANCE COUNTY
OFFICE OF THE FIRE MARSHAL

D. Drew Sharpe

Fire Marshal

Emergency Management Coordinator

INSPECTION REPORT

Date: September 18, 1998

Name of Facility: Coble Sand Rock
5833 Foster Store Rd.
Liberty, NC 27298

1) This facility is covered by Snow Camp and E.M. Holt Volunteer Fire Departments on a automatic first alarm dispatch to the business.

2) There is a pond on the property that will give ample water for fire protection, but this pond must have a drive that is accessible in all types of weather.

3) The company has several large soil moving pieces of equipment that can be used to help the fire department to contain/extinguish a fire.

4) The waste wood products need to be covered, at least weekly, with soil to help in keeping the fire load down.

Signed: Jerry A. Beeler
Jerry A. Beeler, Alamance County Chemical Planner

TABLE OF CONTENTS

DRAWINGS

Drawing 0	Title Sheet
Drawing 1	Drawing Index, Notes and Legend
Drawing 2	Existing Site Conditions
Drawing 3	Sediment and Erosion Control Plan
(Drawing 10 of Phase 3 Construction Plans)	
Drawing 4	Details
(Drawing 11 of Phase 3 Construction Plans)	
Drawing 5	Details
(Drawing 12 of Phase 3 Construction Plans)	
Drawing 6	Details
(Drawing 13 of Phase 3 Construction Plans)	

APPENDICES

Appendix 1	Seeding Specifications
Appendix 2	Design Calculations
Appendix 3	Financial Responsibility/Ownership Form

1.0 PROJECT DESCRIPTION

The site is located in south central Alamance County, North Carolina, approximately 8 miles south-southwest of Burlington. The facility is owned by Coble's Sandrock, Inc., and will be operated by the owner. Under Permit No. 01-05, Coble's Sandrock, Inc., was granted site suitability by the North Carolina Department of Environment and Natural Resources (NCDENR) for 39.60 acres of C&D waste disposal. A Site Application has been submitted for site suitability of an additional 114.4 acres.

The proposed Phase 3 Expansion will consist of the construction of two new cells—Phase 3A a 6.3 acre area to the east of Phase 2A, and Phase 3B a 5.8 acre area to the south of Phase 2B. This erosion and sediment control plan is for the Proposed Phase 3 Expansion.

2.0 EXISTING SITE CONDITIONS

The facility is located on the west side of Foster Store Road and east of West Greensboro-Chapel Hill Road in south-central Alamance County, North Carolina. Access to the site will be through an existing entrance road off of Foster-Store Road. The entire facility property encompasses approximately 160 acres, and includes a permitted C&D landfill, a closed LCID landfill, an active LCID landfill, a pond, open fields used for cattle gazing, and wooded areas. The northern and western sides of the property are bounded by Poppaw Creek

3.0 ADJACENT AREAS

The site is bounded to the north and west by Poppaw Creek: Foster Store Road bounds the property to the east. Properties adjacent to the site are generally rural farmland.

4.0 SOIL

According to the soil survey map for Alamance County, North Carolina, (USDA Natural Resources Conservation Service, 1998), the surficial soils at the site belong to the Helena group. These soils are characteristic of Piedmont uplands where poor to moderate drained soils with a coarse sandy loam surface layer predominate on gently sloping to sloping land

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 basins to minimize the potential impact of sediment leaving the disposal area.

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 new permanent sediment basin, SB-1, is proposed to receive flow from the northeastern and eastern portions of the landfill. Flow from the northwest, west and south sides of the landfill will be directed to an existing permanent sediment basin that is sufficiently large to handle the flow.

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 waste filling progresses, the diversion berms will be relocated to allow for continued filling within the cell. As subsequent portions of the cell are opened in the planned sequence, uncontaminated stormwater will be diverted around the active portions of the cells for collection and removal.

6.3 Silt Fence (Reference NCESCPDM 6.62)

Silt fences will be provided at the locations shown on the drawings to minimize the transport of sediments off-site during construction. The silt fence may be removed following stabilization of the contributing drainage areas in accordance with NCESCPDM 6.62.

6.4 Grass-Lined Channels (Reference NCESCPDM 6.30)

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

6.5 Rip-Rap Lined Channels (Reference NCESCPDM 6.31)

Rip-rap-lined channels will be constructed at the locations shown on the drawings to direct stormwater runoff to the existing sediment basin or the proposed sediment basin. See supporting calculations.

6.6 Slope Drains (Reference NCESCPDM 6.32)

Slope drains will be used as shown on the drawings to prevent formation of erosion rills from concentrated flow on steep slopes.

6.7 Outlet Protection (Reference NCESCPDM 6.41)

Outlet protection will be used at the outlets of all slope drains and culverts to dissipate energy and prevent erosion.

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

The sediment basins 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 embankments, spillways, and outlets 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.

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.

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. Install stormwater conveyance channels, silt fence, sediment basin and other measures shown on the approved plan that are required to support the next annual phase of landfilling operations. Clear only as necessary to install these devices. Seed berms and basins immediately after construction.

3. 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.

4. Begin construction. Stockpile excess soil.

5. Stabilize the site as areas are brought to finish grade. Use vegetation, ditch linings, etc. Seed and mulch denuded areas within fifteen (15) days following completion of construction.

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

7. Prior to the end of landfilling activities for each stage of development, construct erosion control features that will serve the next phase of construction and landfilling operations. Begin construction of the next phase of development. Stockpile excess soil.

8. Begin landfilling activities in the newly constructed disposal area after all required approvals are obtained from the regulatory authorities.

9. Seed and stabilize all denuded areas immediately after grading is completed.

11.0 CHECKLIST

See following page.

[END]

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES
LAND QUALITY SECTION

EROSION & SEDIMENTATION CONTROL PLAN APPLICATION CHECKLIST

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

LOCATION INFORMATION

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

GENERAL SITE FEATURES (Plan elements)

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

EROSION CONTROL MEASURES (on plan)

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

SITE DRAINAGE FEATURES

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

STORMWATER CALCULATIONS

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

VEGETATIVE STABILIZATION

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

NOTE: Plan should include provisions for groundcover on exposed slopes within 15 working days or 30 calendar days (whichever is shorter), following completion of any phase of grading; permanent groundcover for all disturbed areas within 15 working days or 90 calendar days (whichever is shorter) following completion of construction or development.

FINANCIAL RESPONSIBILITY/OWNERSHIP FORM

_____ Completed, signed & notarized FR/O Form
_____ Accurate application fee ($50.00 per acre rounded up the next acre with no ceiling amount)
_____ Certificate of assumed name, if the owner is a partnership
_____ Name of Registered Agent (if applicable)
_____ Copy of the most current Deed for the site

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

NARRATIVE AND CONSTRUCTION SEQUENCE

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

SEEDING SPECIFICATIONS

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.

SEEDBED PREPARATION

A. Prepare seedbed to a depth of 4 to 6 inches.

B. Remove loose rocks, roots and other obstructions so that they will not interfere with the establishment and maintenance of vegetation.

TEMPORARY SEEDING

A. Provide temporary seeding on any cleared, un-vegetated, 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. Seed in accordance with the following schedule and application rates:

Seeding Dates	Seeding Mixture Species	Rate (lbs./acre)
Jun. 15 – Dec. 30	Rye (grain)	120

C. To amend soil, follow recommendations of soil tests or apply 4,000 lbs./acre ground agricultural limestone and 1,000 lbs./acre 10-10-10 fertilizer.

D. Mulch with 3-inch straw applied at the rate of 4,000 lbs./acre and anchor by tacking with asphalt, netting, or roving or crimping with a mulch anchoring tool or disk set nearly straight.

E. Refertilize if growth is not fully adequate.

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

PERMANENT SEEDING

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

Seeding Dates	Seeding Mixture Species	Rate (lbs./acre)
Jan. 1 – April 15	Tall Fescue	80
	Sericia lespedeza	30
	Rye (grain)	40
April 15 – June. 15	Tall Fescue	80
	Sericia lespedeza	30
	Bermudagrass	15
	German millet	10

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 or disk set nearly straight.

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

FINANCIAL RESPONSIBILITY/OWNERSHIP FORM
SEDIMENTATION POLLUTION CONTROL ACT
EXPRESS PERMITTING OPTION

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

Part A.

1. Project Name_____

2. Location of land-disturbing activity: County_____City or Township_____

   Highway/Street_____Latitude_____Longitude_____

3. Approximate date land-disturbing activity will commence:_____

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

5. Total acreage disturbed or uncovered (including off-site borrow and waste areas):_____

6. Amount of fee enclosed: $_____. The Express Permitting application fee is a dual charge. The normal fee of $50.00 per acre (rounded up to the next acre) is assessed without a ceiling amount. In addition, the Express Permitting supplement is $250.00 per acre up to eight acres, after which the Express Permitting supplemental fee is a fixed $2,000.00 (Example: 9 acres total is $2,450).

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

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

   Name_____ E-mail Address_____

   Telephone_____ Cell #_____ Fax # _____

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

   _____ _____ _____
   Name Telephone Fax Number

   _____ _____
   Current Mailing Address Current Street Address

   _____ _____
   City State Zip City State Zip

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

Part B.

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

   _____ _____
   Name E-mail Address

   _____ _____
   Current Mailing Address Current Street Address

   _____ _____
   City State Zip City State Zip

   Telephone_____ Fax Number_____

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

Name	E-mail Address
Current Mailing Address	Current Street Address
City State Zip	City State Zip
Telephone	Fax Number

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

Name of Registered Agent	E-mail Address
Current Mailing Address	Current Street Address
City State Zip	City State Zip
Telephone	Fax Number

(c) In order to facilitate **Express Permitting**, it is necessary to be able to contact the Engineer or other consultant who can assist in providing any necessary information regarding the plan and its preparation:

Engineering Firm or other consultant	E-mail Address	
Individual contact person (type or print)	Telephone	Fax Number

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

Type or print name	Title or Authority
Signature	Date

I, _____, a Notary Public of the County of _____

State of North Carolina, hereby certify that _____ appeared personally before me this day and being duly sworn acknowledged that the above form was executed by him.

Witness my hand and notarial seal, this _____day of _____, 20_____

_____
Notary

Seal

My commission expires_____

JOYCE ENGINEERING, INC.

Waste Industry Experts

Job _____

Job No. _____ Sheet No. ____ of ____

Calculated by _____ Date _____

Checked by _____ Date _____

Subject _____ Scale _____

Peak Flow Calculations

See attached T_c worksheets

$Q = CiA$

DA1: AREA (A) - 8.1 AC; FLOW LENGTH - 2090'; Δ ELEV - 110'; RUNOFF COEF. 'C' - .4

T_c - 8.5 min

i_{25} - 6.5 in/hr; i_{10} - 6.0 in/hr; i_2 - 4.0 in/hr

See attached IDF curves

Q_{25} - 21.1 cfs; Q_{10} - 19.4 cfs; Q_2 - 13.0 cfs

DA2: AREA - 10.8 AC; FLOW LENGTH - 2550'; Δ ELEV - 108'; RUNOFF COEF. 'C' - .4

T_c - 11.5 min; i_{25} - 6.0 in/hr; i_{10} - 5.2 in/hr; i_2 - 3.5 in/hr

Q_{25} - 25.9 cfs; Q_{10} - 22.5 cfs; Q_2 - 15.1 cfs

DA3: AREA - 4.9 AC; FLOW LENGTH - 370'; Δ ELEV - 124'; RUNOFF COEF. 'C' - .4

T_c - 5.0 min; i_{25} - 7.0 in/hr; i_{10} - 6.5 in/hr; i_2 - 4.5 in/hr

Q_{25} - 13.7 cfs; Q_{10} - 12.7 cfs; Q_2 - 8.8 cfs

DA4: AREA - 3.6 AC; FLOW LENGTH - 1150'; Δ ELEV. - 108'; RUNOFF COEF. 'C' - .4

T_c - 5.0 min; i_{25} - 7.0 in/hr; i_{10} - 6.5 in/hr; i_2 - 4.5 in/hr

Q_{25} - 10.1 cfs; Q_{10} - 9.4 cfs; Q_2 - 6.5 cfs

DA5: AREA - 1.2 AC; FLOW LENGTH - 580'; Δ ELEV. - 90'; RUNOFF COEF. 'C' - .4

T_c - 5.0 min; i_{25} - 7.0 in/hr; i_{10} - 6.5 in/hr; i_2 - 4.5 in/hr

Q_{25} - 3.4 cfs; Q_{10} - 3.1 cfs; Q_2 - 2.2 cfs

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Job _____

Job No. _____ Sheet No. ____ of ____

Calculated by _____ Date _____

Checked by _____ Date _____

Subject _____ Scale _____

DA 6: AREA - 5.4 AC
FLOW LENGTH - 1840'
Δ ELEV. - 60'
RUNOFF COEF. 'C' - .4

T_c - 9.5 min
i_{25} - 6.2 in/hr
i_{10} - 5.5 in/hr
i_2 - 3.8 in/hr

Q_{25} - 13.4 cfs
Q_{10} - 11.9 cfs
Q_2 - 8.2 cfs

DA 7: AREA - 9.0 AC
FLOW LENGTH - 1150'
Δ ELEV. - 54'
RUNOFF COEF. 'C' - .4

T_c - 6.0 min
i_{25} - 7.0
i_{10} - 6.1
i_2 - 4.3

Q_{25} - 25.2 cfs
Q_{10} - 22.0 cfs
Q_2 - 15.5 cfs

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Job _____

Job No. _____ Sheet No. ____ of ____

Calculated by _____ Date _____

Checked by _____ Date _____

Subject _____ Scale _____

Sediment Basins

EXISTING SED BASIN

* From Phase 2 construction, existing Sed Basin designed with area of 20,212 ft^2 and volume of 67,596 ft^3, with 48" riser and 30" discharge barrel.

Total flow to SB-1 = peak flow (Q_{10}) from SCC-4E + peak flow (Q_{10}) from SCC-3 + peak flows (Q_{10}) from SD-7C + sheet flow.

sheet flow area = 1.8 AC, $Q = CiA$ (based on T_c of 5 min)

$= (.4)(6.5)(1.8) = 4.7$ cfs

SCC-4E = 18.56 cfs
SCC-3 = 8.18 cfs
SD-7C = 8.16 cfs
sheet = 4.7 cfs
39.6 cfs

Total Drainage Area = 15.7 acres

Required storage = 1800 cf/acre * 15.7 acre = 28,302 ft^3 ✓ OK

Required surface area = .01 * 39.6 = .396 acre
= 17,250 ft^2 ✓ OK

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Job _____

Job No. _____ Sheet No. ____ of ____

Calculated by _____ Date _____

Checked by _____ Date _____

Subject _____ Scale _____

Riser must pass Q_{25}.

SCC-4E = 19.98
SCC-3 = 8.81
SD-7C = 8.79
Sheet = (.4)(7)(1.8) = 5.0
= 42.6 cfs

Design 25-yr water level is 1.5' of head over riser

A 48" riser will flow 42.6 cfs w/ 1.05' of head. ✓ ok

SB-1 is adequate as is

SB-1.

Design area = 27,024 ft²
volume = 93,053 ft³

Q_{10} to SB2 = Q_{10} from SCC-1D + Q_{10} from SCC-2
= 24.56 + 2.46
= 27.02 cfs

Q_{25} to SB2 = 26.47 + 2.65
= 29.12 cfs

Total drainage area = 11 acres

* Required storage = 1800 cf/acre * 11 acre = 19,800 ft³ ✓ ok

* Required area = .01 * Q_{10} = .01 * 27.02 = .27 acre
= 11,770 ft² ✓ ok

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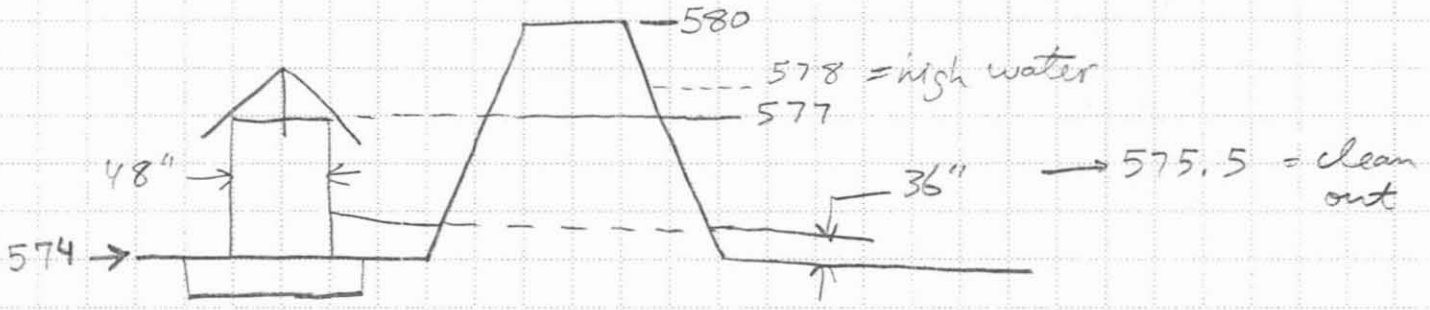
Job _____

Job No. _____ Sheet No. ____ of ____

Calculated by _____ Date _____

Checked by _____ Date _____

Subject _____ Scale _____



Size riser to pass Q_{25} of 29.12 cfs

Use 48" riser, which will pass 29.12 cfs with .9' head

Use 36" discharge barrel

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Job _____

Job No. _____ Sheet No. ____ of ____

Calculated by _____ Date _____

Checked by _____ Date _____

Subject _____ Scale _____

Anti floatation Device

riser diam. = 48"
riser height = 36"

volume riser = $\frac{1}{4}\pi d^2 * h = \frac{1}{4}\pi 4^2 * 3 = 37.7 ft^3$

weight water displaced = $37.7 ft^3 \times 62.4 \frac{lb}{ft^3} = 2353 lb$

min wt. of block = 1.1 x wt water displaced

use γ concrete = 150 pcf

use $6' * 6' * 1.5'$ block = $54 ft^3 * 150 \frac{lb}{ft^3} = 8100 lb$ ✓ OK

Basin Dewatering

$$A_o = \left(A_s \sqrt{2H}\right) / \left(T C_d 20,428\right)$$

A_s = surface area basin = 27,024 ft^2
H = head above dewatering hole = 2.5'
T = detention time = 10 hrs
C_d = = .6

$$A_o = \left(27,024 \sqrt{2 * 2.5}\right) / \left(10 * .6 * 20,428\right) = .493 ft^2$$

$= 71 in^2$

provide 3/4" holes area each hole = $.44 in^2$, ∴ need 161 holes

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Job _____

Job No. _____ Sheet No. ____ of ____

Calculated by _____ Date _____

Checked by _____ Date _____

Subject _____ Scale _____

Determine Number Anti-Seep Collars

determine length of barrel w/in saturated zone

$$L_s = Y(Z+4)\left(1 + \frac{S}{.25-S}\right)$$

Y = depth of water @ riser crest = 577 - 574 = 3'
Z = upstream embankment slope = 2
S = slope of barrel = .014

$$L_s = 3(2+4)\left(1 + \frac{.014}{.25-.014}\right) = 19.1 \text{ ft}$$

- space collars max of 14 * P, where P = width of collar = 3'

14 * 3 = 42 feet

use 1 collar

Trash Rack & Anti Vortex

for 48" riser use: 72" cylinder, 16 gage
21" height

support bar: 1 1/4 pipe or 1 1/4 * 1 1/4 * 1/4 angle

top: 14 gage (corrugated)
10 gage (flat)

Slope Drain Flows (10yr storm)

c'= 0.4
I'= 6.5

D.A.	D.A. for Section	Q10 for D.A. (cfs)	Q10 Total to Pipe Section (cfs)
1	0.73	1.90	1.90
2A	0.23	0.59	0.59
2B	0.64	1.66	2.25
3A	0.59	1.53	1.53
3B	0.93	2.42	3.95
3C	1.19	3.09	7.05
4A	0.14	0.35	0.35
4B	0.34	0.88	1.24
5A	0.24	0.62	0.62
5B	0.49	1.27	1.89
5C	0.85	2.21	4.10
6	0.29	0.75	0.75
7A	0.60	1.56	1.56
7B	1.36	3.54	5.10
7C	1.18	3.07	8.16
8A	0.14	0.36	0.36
8B	0.95	2.46	2.83
8C	1.13	2.94	5.76
9A	0.38	0.99	0.99
9B	0.74	1.92	2.91
10A	0.21	0.55	0.55
10B	0.62	1.61	2.16
11A	0.47	1.22	1.22
11B	0.93	2.41	3.63

Slope Drain Flows (25yr storm)

c'= 0.4
I'= 7

D.A.	D.A. for Section	Q25 for D.A. (cfs)	Q25 Total to Pipe Section (cfs)
1	0.73	2.04	2.04
2A	0.23	0.63	0.63
2B	0.64	1.79	2.42
3A	0.59	1.65	1.65
3B	0.93	2.60	4.26
3C	1.19	3.33	7.59
4A	0.14	0.38	0.38
4B	0.34	0.95	1.33
5A	0.24	0.66	0.66
5B	0.49	1.37	2.04
5C	0.85	2.38	4.42
6	0.29	0.81	0.81
7A	0.60	1.68	1.68
7B	1.36	3.81	5.49
7C	1.18	3.30	8.79
8A	0.14	0.39	0.39
8B	0.95	2.65	3.04
8C	1.13	3.16	6.21
9A	0.38	1.06	1.06
9B	0.74	2.07	3.14
10A	0.21	0.59	0.59
10B	0.62	1.74	2.32
11A	0.47	1.32	1.32
11B	0.93	2.59	3.91

Ditch Flows (10yr storm)

c	0.4
i	6.5

Ditch Section	Slope	D.A. for Section	Q10 for D.A. (cfs)	Q10 for flow from Slope Drains	Q10 Total to Ditch Section from D.A. and Slope Drains (cfs)	Q10 Total to Ditch including flow from upstream ditch sections (cfs)
1A	4.5%	0.21	0.55		0.55	0.55
1B	0.8%	1.13	2.94	3.63	6.57	7.11
1C	2.1%	1.83	4.76	4.15	8.91	16.02
1D	2.1%	0.58	1.50	7.05	8.54	24.56
2	1.7%	0.47	1.22	1.24	2.46	2.46
3	1.8%	1.28	3.33	4.85	8.18	8.18
4A	4.0%	0.45	1.17		1.17	1.17
4B	0.9%	1.64	4.26	5.07	9.33	10.50
4C	9.1%	0.20	0.52		0.52	11.02
4D	0.7%	0.55	1.43	5.76	7.19	18.22
4E	9.5%	0.13	0.34		0.34	18.56

Ditch Flows (25yr storm)

c	0.4
i	7

Ditch Section	Slope	D.A. for Section	Q25 for D.A. (cfs)	Q25 for flow from Slope Drains	Q25 Total to Ditch Section from D.A. and Slope Drains (cfs)	Q25 Total to Ditch including flow from upstream ditch sections (cfs)
1A	4.5%	0.21	0.59		0.59	0.59
1B	0.8%	1.13	3.16	3.91	7.07	7.66
1C	2.1%	1.83	5.12	4.47	9.59	17.25
1D	2.1%	0.58	1.62	7.59	9.21	26.47
2	1.7%	0.47	1.32	1.33	2.65	2.65
3	1.8%	1.28	3.58	5.23	8.81	8.81
4A	4.0%	0.45	1.26		1.26	1.26
4B	0.9%	1.64	4.59	5.46	10.05	11.31
4C	9.1%	0.20	0.56		0.56	11.87
4D	0.7%	0.55	1.54	6.21	7.75	19.62
4E	9.5%	0.13	0.36		0.36	19.98

DA1

$i_2 - 4.0$
$i_{10} - 6.0$
$i_{25} - 6.5$

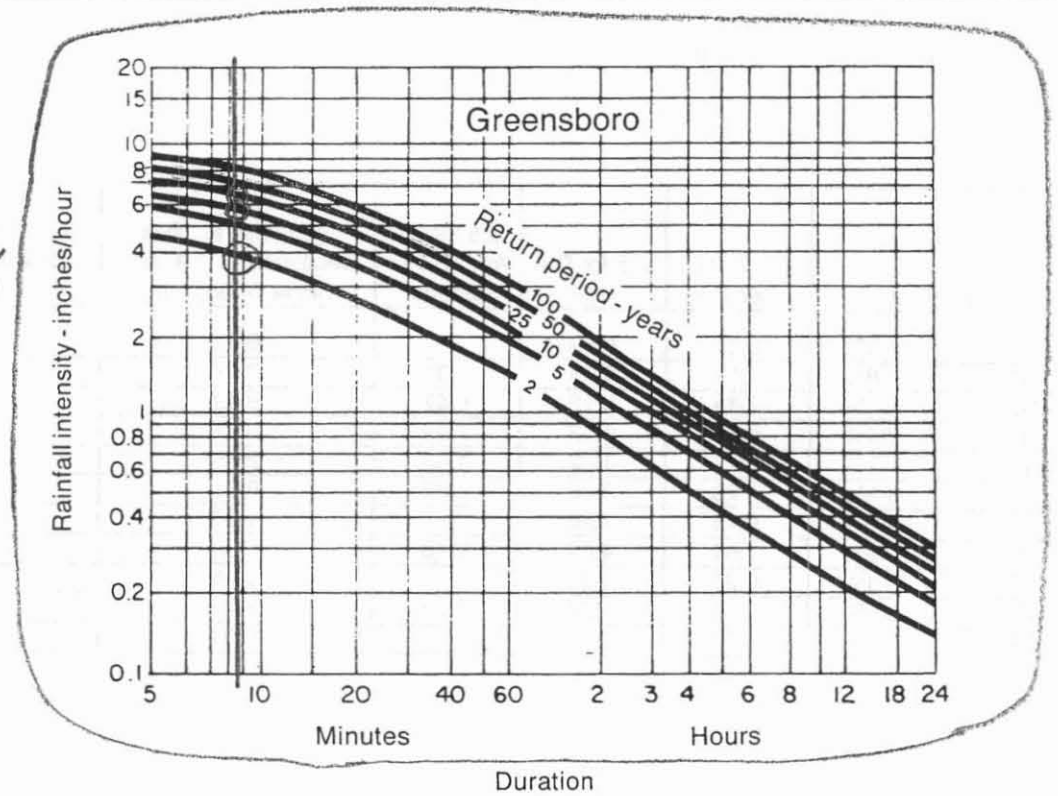


Figure 8.03d Rainfall intensity duration curves—Greensboro.

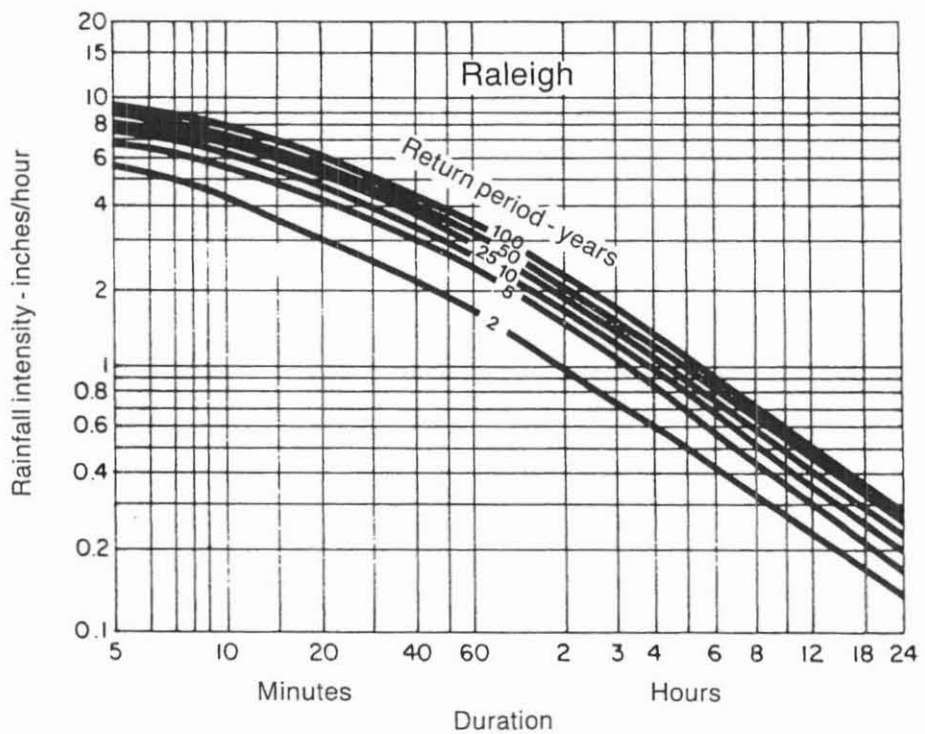


Figure 8.03e Rainfall intensity duration curves—Raleigh.

DA 2

$i_2 - 3.5$
$i_{10} - 5.2$
$i_{25} - 6.0$

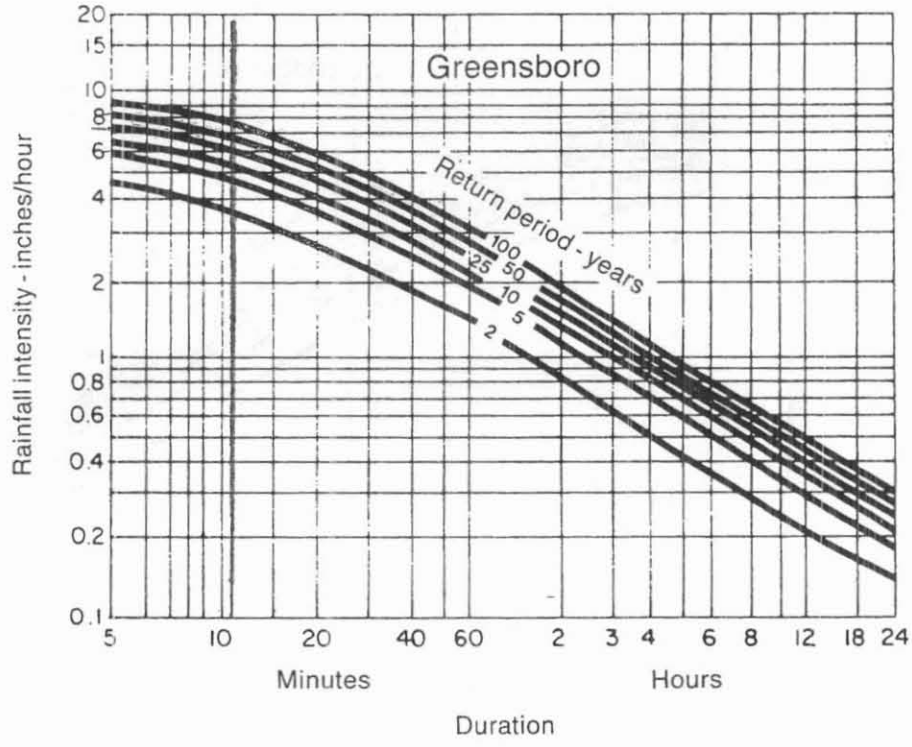


Figure 8.03d Rainfall intensity duration curves—Greensboro.

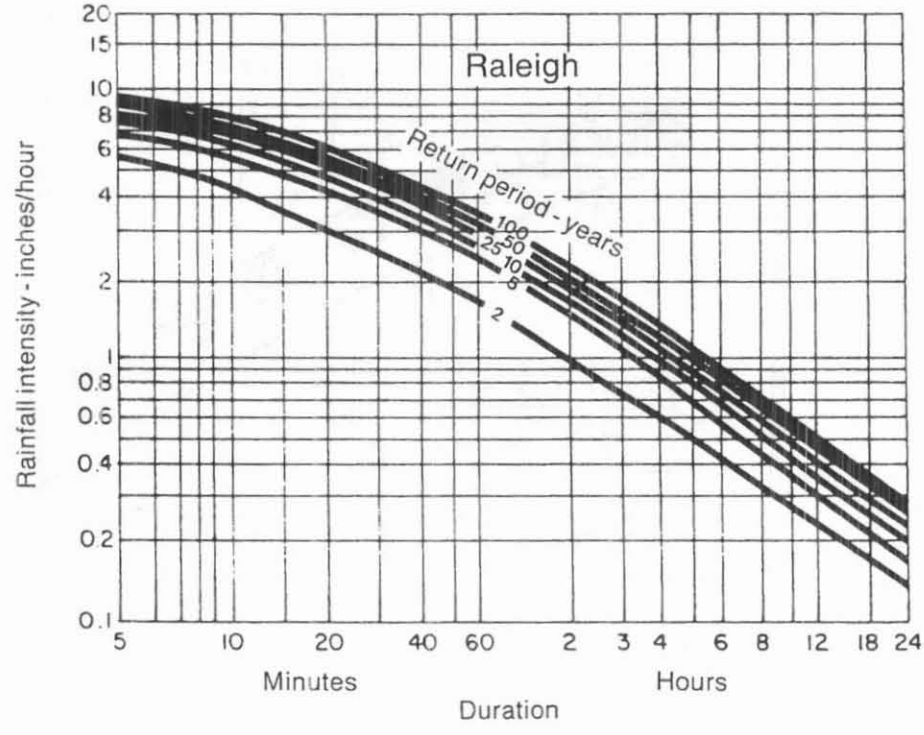


Figure 8.03e Rainfall intensity duration curves—Raleigh.

DA 3, 4 & 5

$i_2 - 4.5$
$i_{10} - 6.5$
$i_{25} - 7.0$

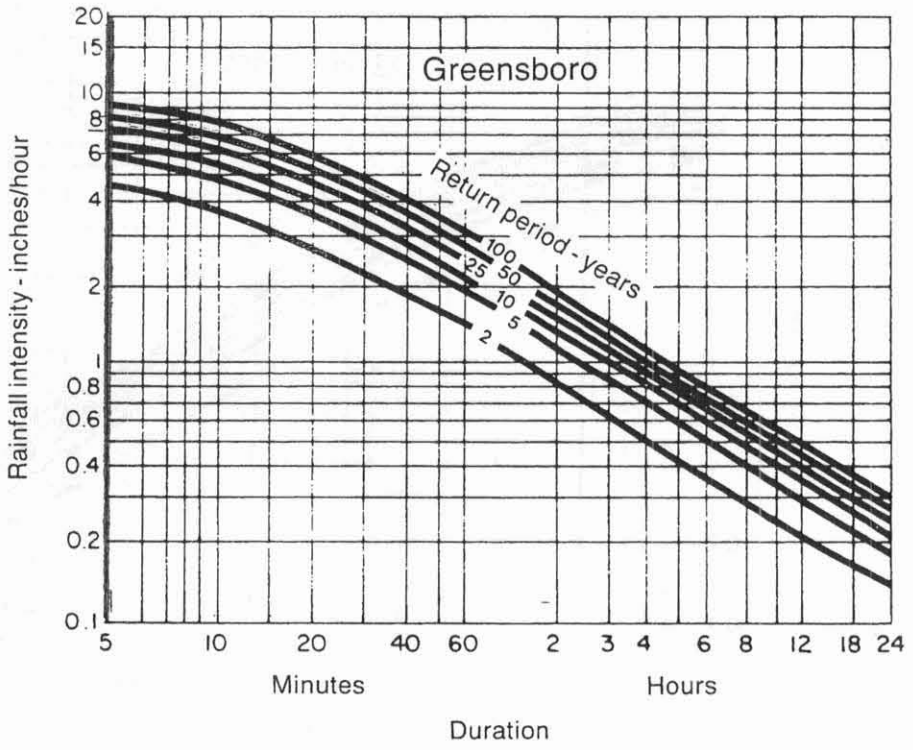


Figure 8.03d Rainfall intensity duration curves—Greensboro.

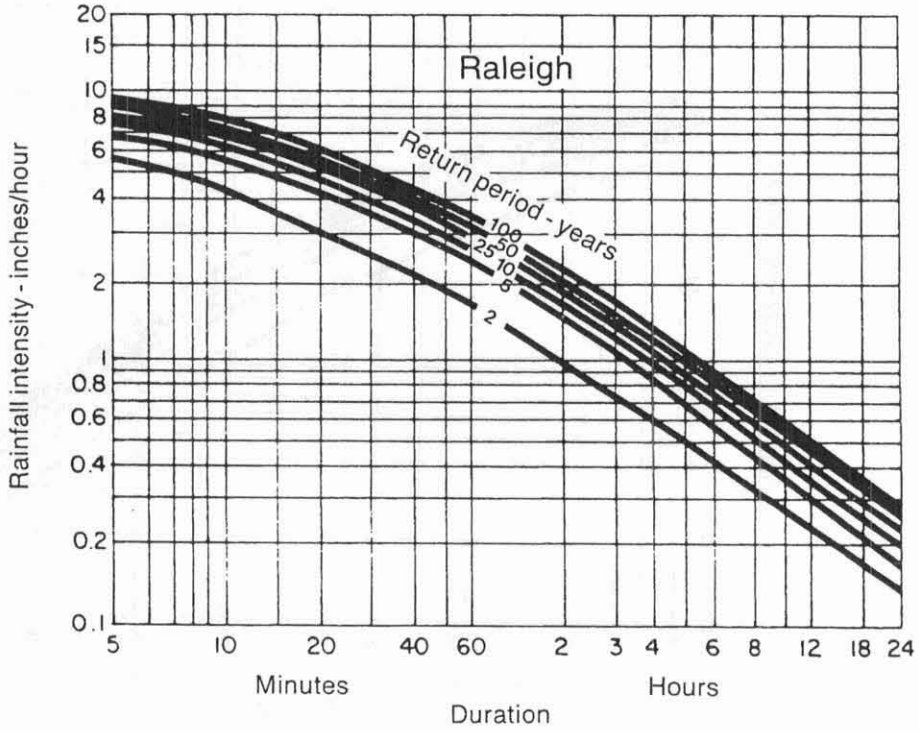


Figure 8.03e Rainfall intensity duration curves—Raleigh.

DA 6

$i_2 = 3.8$
$i_{10} = 5.5$
$i_{25} = 6.2$

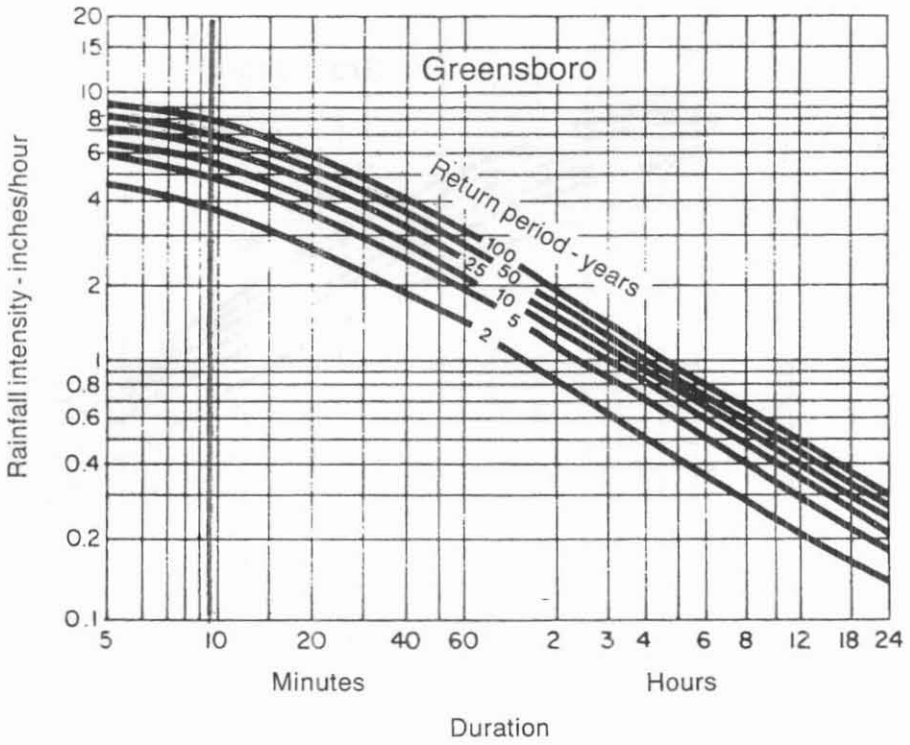


Figure 8.03d Rainfall intensity duration curves—Greensboro.

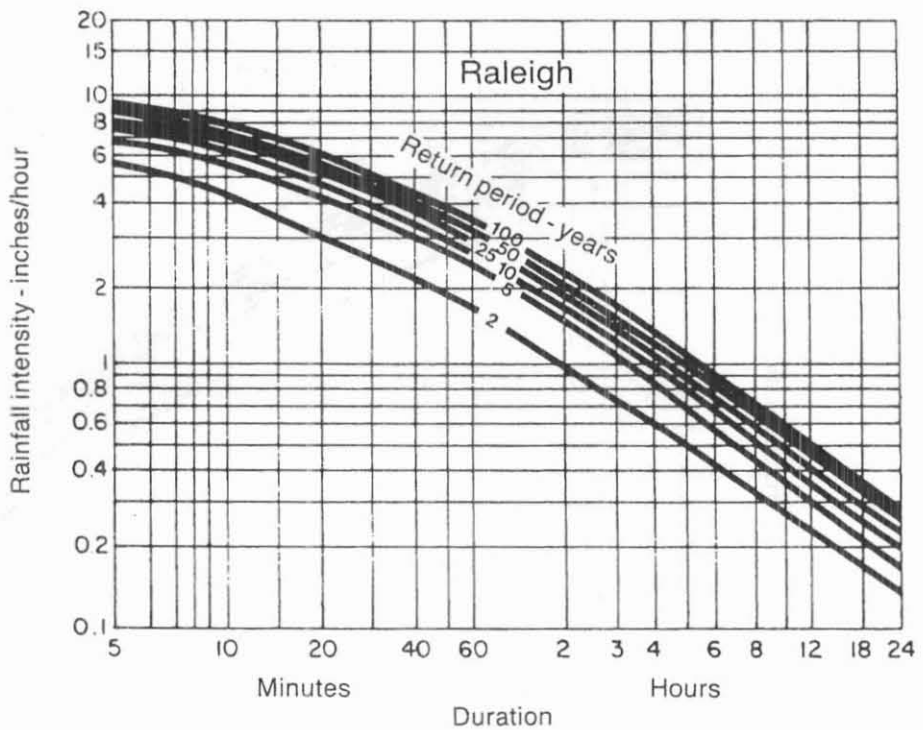


Figure 8.03e Rainfall intensity duration curves—Raleigh.

DA 7

$i_2 = 4.3$
$i_{10} = 6.1$
$i_{25} = 7.0$

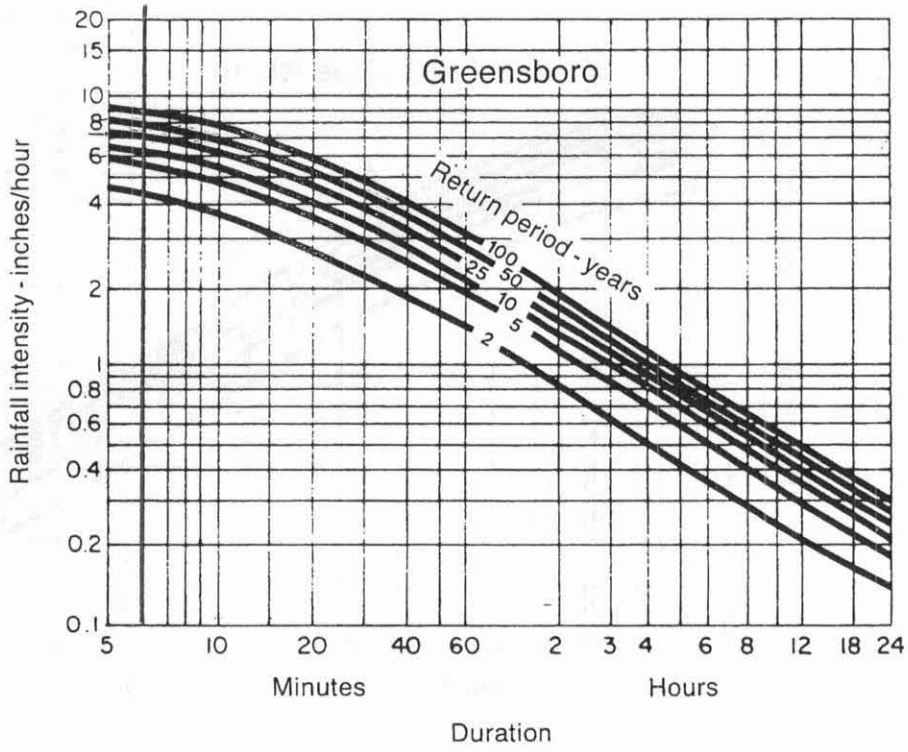


Figure 8.03d Rainfall intensity duration curves—Greensboro.

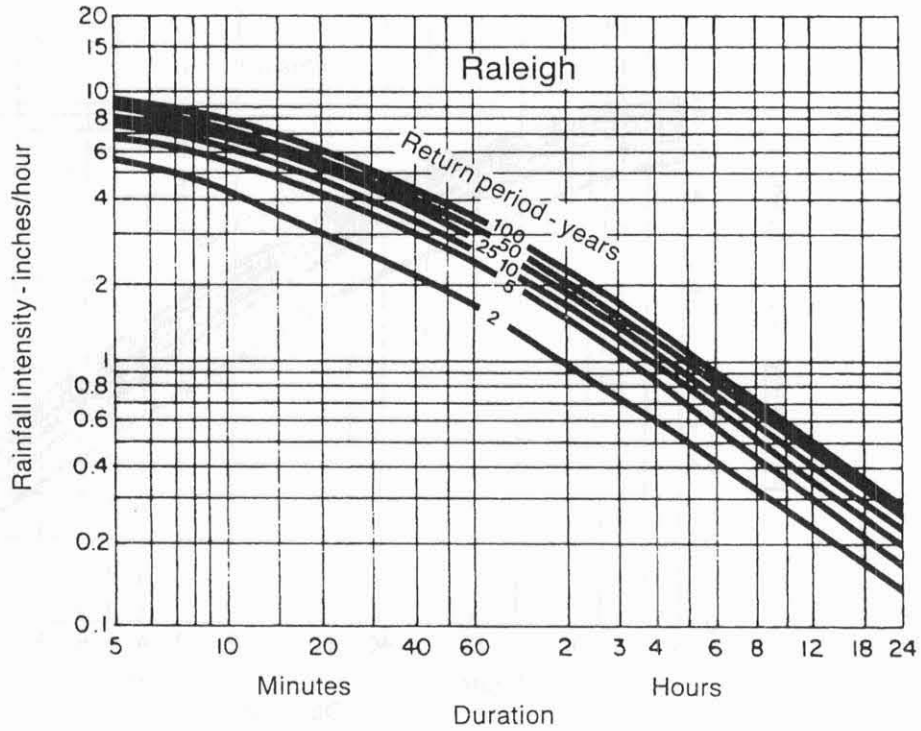
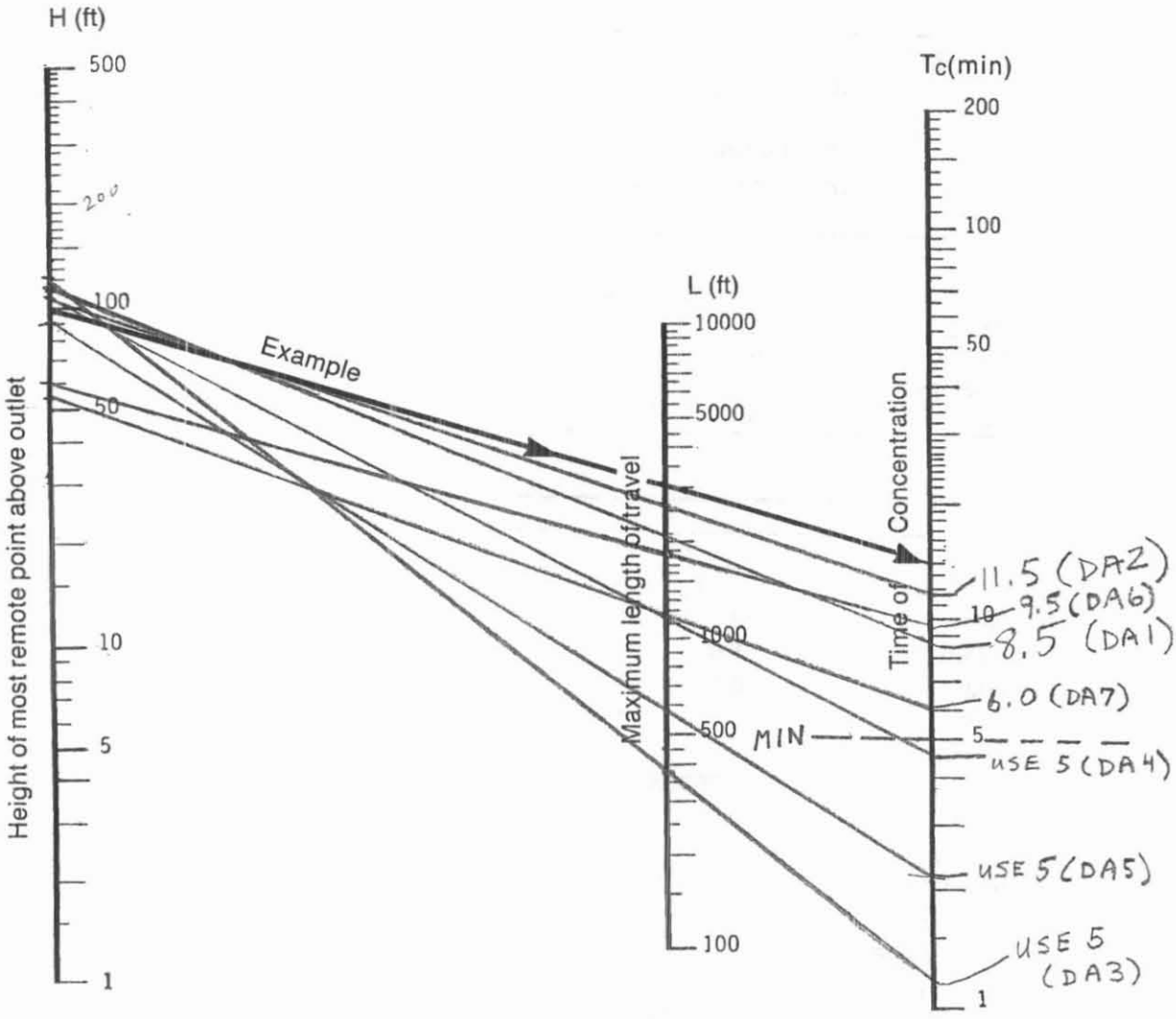


Figure 8.03e Rainfall intensity duration curves—Raleigh.

T_c WORKSHEET



Note:
Use nomograph T_c 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.

Figure 8.03a Time of concentration of small drainage basins.

SD1
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	1.90	cfs

Results		
Depth	6.2	in
Diameter	6.19	in
Flow Area	0.21	ft^2
Wetted Perimeter	1.62	ft
Top Width	0.00	ft
Critical Depth	0.51	ft
Percent Full	100.00	
Critical Slope	0.308883	ft/ft
Velocity	9.08	ft/s
Velocity Head	1.28	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	2.04	cfs
Full Flow Capacity	1.90	cfs
Full Flow Slope	0.330000	ft/ft

SD2A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	0.59	cfs

Results		
Depth	4.0	in
Diameter	3.99	in
Flow Area	0.09	ft²
Wetted Perimeter	1.05	ft
Top Width	0.00	ft
Critical Depth	0.33	ft
Percent Full	100.00	
Critical Slope	0.305901	ft/ft
Velocity	6.78	ft/s
Velocity Head	0.71	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	0.63	cfs
Full Flow Capacity	0.59	cfs
Full Flow Slope	0.330000	ft/ft

SD2B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	2.25	cfs

Results		
Depth	6.6	in
Diameter	6.60	in
Flow Area	0.24	ft^2
Wetted Perimeter	1.73	ft
Top Width	0.00	ft
Critical Depth	0.55	ft
Percent Full	100.00	
Critical Slope	0.309287	ft/ft
Velocity	9.47	ft/s
Velocity Head	1.39	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	2.42	cfs
Full Flow Capacity	2.25	cfs
Full Flow Slope	0.330000	ft/ft

SD3A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	1.53	cfs

Results		
Depth	5.7	in
Diameter	5.71	in
Flow Area	0.18	ft²
Wetted Perimeter	1.49	ft
Top Width	0.00	ft
Critical Depth	0.47	ft
Percent Full	100.00	
Critical Slope	0.308356	ft/ft
Velocity	8.60	ft/s
Velocity Head	1.15	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	1.65	cfs
Full Flow Capacity	1.53	cfs
Full Flow Slope	0.330000	ft/ft

SD3B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	3.95	cfs

Results		
Depth	8.1	in
Diameter	8.15	in
Flow Area	0.36	ft²
Wetted Perimeter	2.13	ft
Top Width	0.00	ft
Critical Depth	0.68	ft
Percent Full	100.00	
Critical Slope	0.310587	ft/ft
Velocity	10.91	ft/s
Velocity Head	1.85	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	4.25	cfs
Full Flow Capacity	3.95	cfs
Full Flow Slope	0.330000	ft/ft

SD3C
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	7.05	cfs

Results		
Depth	10.1	in
Diameter	10.13	in
Flow Area	0.56	ft²
Wetted Perimeter	2.65	ft
Top Width	0.19e-7	ft
Critical Depth	0.84	ft
Percent Full	100.00	
Critical Slope	0.311854	ft/ft
Velocity	12.60	ft/s
Velocity Head	2.47	ft
Specific Energy	3.31	ft
Froude Number	0.41e-3	
Maximum Discharge	7.58	cfs
Full Flow Capacity	7.05	cfs
Full Flow Slope	0.330000	ft/ft
Flow is subcritical.		

SD4A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	0.35	cfs

Results		
Depth	3.3	in
Diameter	3.28	in
Flow Area	0.06	ft²
Wetted Perimeter	0.86	ft
Top Width	0.00	ft
Critical Depth	0.27	ft
Percent Full	100.00	
Critical Slope	0.304491	ft/ft
Velocity	5.95	ft/s
Velocity Head	0.55	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	0.38	cfs
Full Flow Capacity	0.35	cfs
Full Flow Slope	0.330000	ft/ft

SD4B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	1.24	cfs

Results		
Depth	5.3	in
Diameter	5.28	in
Flow Area	0.15	ft^2
Wetted Perimeter	1.38	ft
Top Width	0.00	ft
Critical Depth	0.44	ft
Percent Full	100.00	
Critical Slope	0.307835	ft/ft
Velocity	8.16	ft/s
Velocity Head	1.04	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	1.33	cfs
Full Flow Capacity	1.24	cfs
Full Flow Slope	0.330000	ft/ft

SD5A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	0.62	cfs

Results		
Depth	4.1	in
Diameter	4.07	in
Flow Area	0.09	ft^2
Wetted Perimeter	1.07	ft
Top Width	0.87e-8	ft
Critical Depth	0.34	ft
Percent Full	100.00	
Critical Slope	0.306032	ft/ft
Velocity	6.86	ft/s
Velocity Head	0.73	ft
Specific Energy	1.07	ft
Froude Number	0.38e-3	
Maximum Discharge	0.67	cfs
Full Flow Capacity	0.62	cfs
Full Flow Slope	0.330000	ft/ft
Flow is subcritical.		

SD5B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	1.89	cfs

Results		
Depth	6.2	in
Diameter	6.18	in
Flow Area	0.21	ft²
Wetted Perimeter	1.62	ft
Top Width	0.00	ft
Critical Depth	0.51	ft
Percent Full	100.00	
Critical Slope	0.308870	ft/ft
Velocity	9.07	ft/s
Velocity Head	1.28	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	2.03	cfs
Full Flow Capacity	1.89	cfs
Full Flow Slope	0.330000	ft/ft

SD5C
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	4.10	cfs

Results		
Depth	8.3	in
Diameter	8.26	in
Flow Area	0.37	ft²
Wetted Perimeter	2.16	ft
Top Width	0.00	ft
Critical Depth	0.69	ft
Percent Full	100.00	
Critical Slope	0.310671	ft/ft
Velocity	11.01	ft/s
Velocity Head	1.88	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	4.41	cfs
Full Flow Capacity	4.10	cfs
Full Flow Slope	0.330000	ft/ft

SD6
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	0.75	cfs

Results		
Depth	4.4	in
Diameter	4.37	in
Flow Area	0.10	ft^2
Wetted Perimeter	1.14	ft
Top Width	0.00	ft
Critical Depth	0.36	ft
Percent Full	100.00	
Critical Slope	0.306550	ft/ft
Velocity	7.20	ft/s
Velocity Head	0.81	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	0.81	cfs
Full Flow Capacity	0.75	cfs
Full Flow Slope	0.330000	ft/ft

SD7A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	1.56	cfs

Results		
Depth	5.8	in
Diameter	5.75	in
Flow Area	0.18	ft^2
Wetted Perimeter	1.51	ft
Top Width	0.00	ft
Critical Depth	0.48	ft
Percent Full	100.00	
Critical Slope	0.308403	ft/ft
Velocity	8.64	ft/s
Velocity Head	1.16	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	1.68	cfs
Full Flow Capacity	1.56	cfs
Full Flow Slope	0.330000	ft/ft

SD7B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	5.10	cfs

Results		
Depth	9.0	in
Diameter	8.97	in
Flow Area	0.44	ft^2
Wetted Perimeter	2.35	ft
Top Width	0.00	ft
Critical Depth	0.74	ft
Percent Full	100.00	
Critical Slope	0.311155	ft/ft
Velocity	11.62	ft/s
Velocity Head	2.10	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	5.49	cfs
Full Flow Capacity	5.10	cfs
Full Flow Slope	0.330000	ft/ft

SD7C
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	8.16	cfs

Results		
Depth	10.7	in
Diameter	10.70	in
Flow Area	0.62	ft²
Wetted Perimeter	2.80	ft
Top Width	0.00	ft
Critical Depth	0.89	ft
Percent Full	100.00	
Critical Slope	0.312162	ft/ft
Velocity	13.07	ft/s
Velocity Head	2.66	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	8.78	cfs
Full Flow Capacity	8.16	cfs
Full Flow Slope	0.330000	ft/ft

SD8A

Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	0.36	cfs

Results		
Depth	3.3	in
Diameter	3.32	in
Flow Area	0.06	ft^2
Wetted Perimeter	0.87	ft
Top Width	0.00	ft
Critical Depth	0.27	ft
Percent Full	100.00	
Critical Slope	0.304568	ft/ft
Velocity	5.99	ft/s
Velocity Head	0.56	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	0.39	cfs
Full Flow Capacity	0.36	cfs
Full Flow Slope	0.330000	ft/ft

SD8B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	2.83	cfs

Results		
Depth	7.2	in
Diameter	7.19	in
Flow Area	0.28	ft^2
Wetted Perimeter	1.88	ft
Top Width	0.00	ft
Critical Depth	0.60	ft
Percent Full	100.00	
Critical Slope	0.309825	ft/ft
Velocity	10.03	ft/s
Velocity Head	1.56	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	3.04	cfs
Full Flow Capacity	2.83	cfs
Full Flow Slope	0.330000	ft/ft

SD8C

Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	5.76	cfs

Results		
Depth	9.4	in
Diameter	9.39	in
Flow Area	0.48	ft²
Wetted Perimeter	2.46	ft
Top Width	0.00	ft
Critical Depth	0.78	ft
Percent Full	100.00	
Critical Slope	0.311420	ft/ft
Velocity	11.98	ft/s
Velocity Head	2.23	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	6.20	cfs
Full Flow Capacity	5.76	cfs
Full Flow Slope	0.330000	ft/ft

SD9A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	0.99	cfs

Results		
Depth	4.9	in
Diameter	4.85	in
Flow Area	0.13	ft^2
Wetted Perimeter	1.27	ft
Top Width	0.00	ft
Critical Depth	0.40	ft
Percent Full	100.00	
Critical Slope	0.307266	ft/ft
Velocity	7.72	ft/s
Velocity Head	0.93	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	1.06	cfs
Full Flow Capacity	0.99	cfs
Full Flow Slope	0.330000	ft/ft

SD9B

Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	2.91	cfs

Results		
Depth	7.3	in
Diameter	7.27	in
Flow Area	0.29	ft^2
Wetted Perimeter	1.90	ft
Top Width	0.00	ft
Critical Depth	0.60	ft
Percent Full	100.00	
Critical Slope	0.309890	ft/ft
Velocity	10.10	ft/s
Velocity Head	1.59	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	3.13	cfs
Full Flow Capacity	2.91	cfs
Full Flow Slope	0.330000	ft/ft

SD10A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	0.55	cfs

Results		
Depth	3.9	in
Diameter	3.89	in
Flow Area	0.08	ft^2
Wetted Perimeter	1.02	ft
Top Width	0.00	ft
Critical Depth	0.32	ft
Percent Full	100.00	
Critical Slope	0.305714	ft/ft
Velocity	6.66	ft/s
Velocity Head	0.69	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	0.59	cfs
Full Flow Capacity	0.55	cfs
Full Flow Slope	0.330000	ft/ft

SD10B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	2.16	cfs

Results		
Depth	6.5	in
Diameter	6.50	in
Flow Area	0.23	ft²
Wetted Perimeter	1.70	ft
Top Width	0.00	ft
Critical Depth	0.54	ft
Percent Full	100.00	
Critical Slope	0.309190	ft/ft
Velocity	9.38	ft/s
Velocity Head	1.37	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	2.32	cfs
Full Flow Capacity	2.16	cfs
Full Flow Slope	0.330000	ft/ft

SD11A
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	1.22	cfs

Results		
Depth	5.2	in
Diameter	5.25	in
Flow Area	0.15	ft^2
Wetted Perimeter	1.37	ft
Top Width	0.00	ft
Critical Depth	0.43	ft
Percent Full	100.00	
Critical Slope	0.307794	ft/ft
Velocity	8.13	ft/s
Velocity Head	1.03	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	1.31	cfs
Full Flow Capacity	1.22	cfs
Full Flow Slope	0.330000	ft/ft

SD11B
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	I
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.330000	ft/ft
Discharge	3.63	cfs

Results		
Depth	7.9	in
Diameter	7.90	in
Flow Area	0.34	ft^2
Wetted Perimeter	2.07	ft
Top Width	0.00	ft
Critical Depth	0.65	ft
Percent Full	100.00	
Critical Slope	0.310396	ft/ft
Velocity	10.68	ft/s
Velocity Head	1.77	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	3.90	cfs
Full Flow Capacity	3.63	cfs
Full Flow Slope	0.330000	ft/ft

SCC1A

Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.045000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	0.59	cfs

Results		
Depth	0.09	ft
Flow Area	0.29	ft^2
Wetted Perimeter	3.41	ft
Top Width	3.36	ft
Critical Depth	0.10	ft
Critical Slope	0.029043	ft/ft
Velocity	2.03	ft/s
Velocity Head	0.06	ft
Specific Energy	0.16	ft
Froude Number	1.22	
Flow is supercritical.		

SCC1B
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	7.66	cfs

Results		
Depth	0.66	ft
Flow Area	2.83	ft^2
Wetted Perimeter	5.94	ft
Top Width	5.63	ft
Critical Depth	0.52	ft
Critical Slope	0.018747	ft/ft
Velocity	2.70	ft/s
Velocity Head	0.11	ft
Specific Energy	0.77	ft
Froude Number	0.67	
Flow is subcritical.		

SCC1C
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.021000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	17.25	cfs

Results		
Depth	0.78	ft
Flow Area	3.58	ft^2
Wetted Perimeter	6.50	ft
Top Width	6.13	ft
Critical Depth	0.83	ft
Critical Slope	0.016726	ft/ft
Velocity	4.82	ft/s
Velocity Head	0.36	ft
Specific Energy	1.14	ft
Froude Number	1.11	
Flow is supercritical.		

SCC1D
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.021000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	26.47	cfs

Results		
Depth	0.98	ft
Flow Area	4.87	ft^2
Wetted Perimeter	7.39	ft
Top Width	6.92	ft
Critical Depth	1.06	ft
Critical Slope	0.015797	ft/ft
Velocity	5.44	ft/s
Velocity Head	0.46	ft
Specific Energy	1.44	ft
Froude Number	1.14	
Flow is supercritical.		

SCC1D_10YR
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.021000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	24.56	cfs

Results		
Depth	0.94	ft
Flow Area	4.61	ft^2
Wetted Perimeter	7.22	ft
Top Width	6.78	ft
Critical Depth	1.01	ft
Critical Slope	0.015954	ft/ft
Velocity	5.32	ft/s
Velocity Head	0.44	ft
Specific Energy	1.38	ft
Froude Number	1.14	
Flow is supercritical.		

SCC2
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.017000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	2.65	cfs

Results		
Depth	0.29	ft
Flow Area	1.05	ft^2
Wetted Perimeter	4.31	ft
Top Width	4.17	ft
Critical Depth	0.27	ft
Critical Slope	0.022128	ft/ft
Velocity	2.52	ft/s
Velocity Head	0.10	ft
Specific Energy	0.39	ft
Froude Number	0.89	
Flow is subcritical.		

SCC3
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.018000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	8.81	cfs

Results		
Depth	0.57	ft
Flow Area	2.35	ft^2
Wetted Perimeter	5.54	ft
Top Width	5.27	ft
Critical Depth	0.56	ft
Critical Slope	0.018369	ft/ft
Velocity	3.75	ft/s
Velocity Head	0.22	ft
Specific Energy	0.79	ft
Froude Number	0.99	
Flow is subcritical.		

SCC4A
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.040000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	1.26	cfs

Results		
Depth	0.15	ft
Flow Area	0.49	ft^2
Wetted Perimeter	3.66	ft
Top Width	3.59	ft
Critical Depth	0.17	ft
Critical Slope	0.025184	ft/ft
Velocity	2.58	ft/s
Velocity Head	0.10	ft
Specific Energy	0.25	ft
Froude Number	1.24	
Flow is supercritical.		

SCC4B
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.009000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	11.31	cfs

Results		
Depth	0.78	ft
Flow Area	3.58	ft^2
Wetted Perimeter	6.51	ft
Top Width	6.14	ft
Critical Depth	0.65	ft
Critical Slope	0.017728	ft/ft
Velocity	3.16	ft/s
Velocity Head	0.15	ft
Specific Energy	0.94	ft
Froude Number	0.73	
Flow is subcritical.		

SCC4C

Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.frn2
Worksheet	ditches
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.091000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	11.87	cfs

Results		
Depth	0.43	ft
Flow Area	1.65	ft^2
Wetted Perimeter	4.91	ft
Top Width	4.71	ft
Critical Depth	0.67	ft
Critical Slope	0.017609	ft/ft
Velocity	7.21	ft/s
Velocity Head	0.81	ft
Specific Energy	1.24	ft
Froude Number	2.15	
Flow is supercritical.		

SCC4D
Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.007000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	19.62	cfs

Results		
Depth	1.12	ft
Flow Area	5.84	ft²
Wetted Perimeter	7.99	ft
Top Width	7.46	ft
Critical Depth	0.89	ft
Critical Slope	0.016438	ft/ft
Velocity	3.36	ft/s
Velocity Head	0.18	ft
Specific Energy	1.29	ft
Froude Number	0.67	
Flow is subcritical.		

SCC4E

Worksheet for Trapezoidal Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.095000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	3.00	ft
Discharge	19.98	cfs

Results		
Depth	0.56	ft
Flow Area	2.33	ft²
Wetted Perimeter	5.52	ft
Top Width	5.26	ft
Critical Depth	0.90	ft
Critical Slope	0.016398	ft/ft
Velocity	8.58	ft/s
Velocity Head	1.14	ft
Specific Energy	1.71	ft
Froude Number	2.27	
Flow is supercritical.		

Drainage Berms
Worksheet for Triangular Channel

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

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.010000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	3.54	cfs

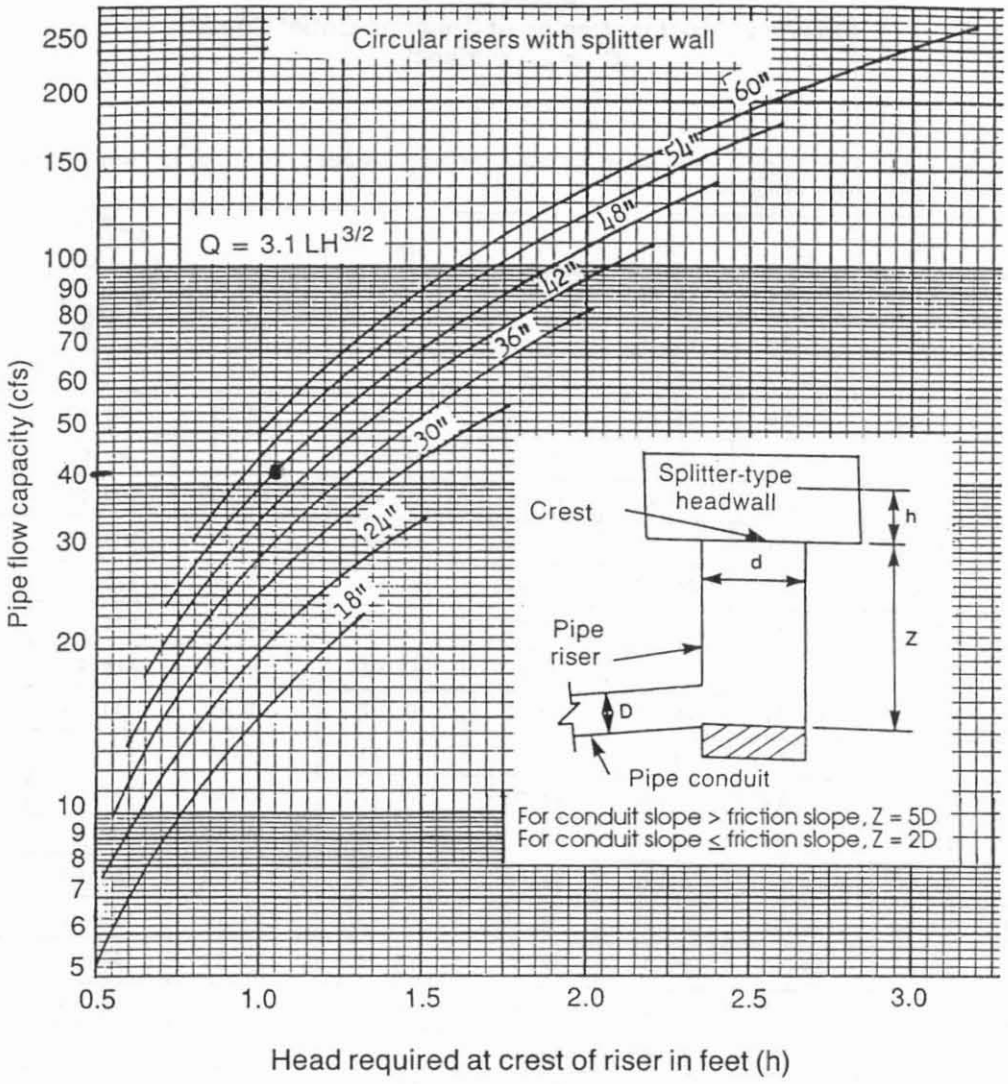
Results		
Depth	0.76	ft
Flow Area	1.44	ft^2
Wetted Perimeter	4.09	ft
Top Width	3.79	ft
Critical Depth	0.66	ft
Critical Slope	0.021026	ft/ft
Velocity	2.46	ft/s
Velocity Head	0.09	ft
Specific Energy	0.85	ft
Froude Number	0.71	
Flow is subcritical.		

Table 8.07b
Pipe Flow Chart for Design of Concrete Outlet Conduit
(Q in cubic ft/sec)

For R/C Drop Inlet, $K_e + K_b = 0.65$ with 70 feet of R/C conduit, n = .013. Note correction factors for other pipe lengths.

Dia. / H	12"	15"	18"	21"	24"	30"	36"	42"
2	4.54	8.01	11.74	16.60	22.44	36.74	54.65	76.02
3	5.56	9.81	14.39	20.33	27.49	45.00	66.94	93.11
4	6.42	11.33	16.61	23.48	31.74	51.96	77.30	107.52
5	7.18	12.66	18.57	26.25	35.49	58.09	86.42	120.21
6	7.87	13.86	20.34	28.75	38.87	63.63	94.65	131.66
7	8.50	14.98	21.98	31.06	41.99	68.74	102.27	142.25
8	9.08	16.01	23.49	33.20	44.88	73.47	109.30	152.03
9	9.64	17.00	24.92	35.22	47.61	77.94	115.95	161.28
10	10.16	17.91	26.26	37.12	50.18	82.15	122.21	169.99
11	10.65	18.78	27.55	38.94	52.64	86.18	128.20	178.32
12	11.13	19.62	28.77	40.67	54.97	89.99	133.88	186.22
13	11.58	20.42	29.95	42.33	57.23	93.68	139.37	193.86
14	12.01	21.18	31.07	43.93	59.37	97.19	144.59	201.12
15	12.44	21.93	32.17	45.47	61.46	100.62	149.69	208.21
16	12.85	22.65	33.22	46.96	63.48	103.92	154.60	215.04
17	13.24	23.35	34.24	48.40	65.43	107.12	159.35	221.65
18	13.63	24.03	35.24	49.81	67.34	110.23	163.99	228.10
19	14.00	24.68	36.21	51.17	69.18	113.25	168.48	234.34
20	14.36	25.32	37.14	52.50	70.97	116.18	172.84	240.41
21	14.72	25.95	38.07	53.80	72.73	119.07	177.13	246.38
22	15.06	26.56	38.96	55.06	74.43	121.85	181.27	252.13
23	15.40	27.16	39.84	56.31	76.11	124.60	185.36	257.83
24	15.73	27.74	40.69	57.51	77.75	127.28	189.35	263.37
25	16.06	28.32	41.53	58.70	79.35	129.90	193.25	268.80
L	Correction Factors For Other Pipe Lengths							
40	1.15	1.13	1.11	1.09	1.08	1.06	1.06	1.05
50	1.09	1.08	1.07	1.06	1.05	1.04	1.04	1.03
60	1.04	1.04	1.04	1.03	1.03	1.02	1.02	1.02
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	0.96	0.96	0.97	0.97	0.98	0.98	0.98	0.99
90	0.93	0.94	0.94	0.95	0.95	0.96	0.97	0.97
100	0.90	0.91	0.92	0.93	0.93	0.95	0.95	0.96

SB-1 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

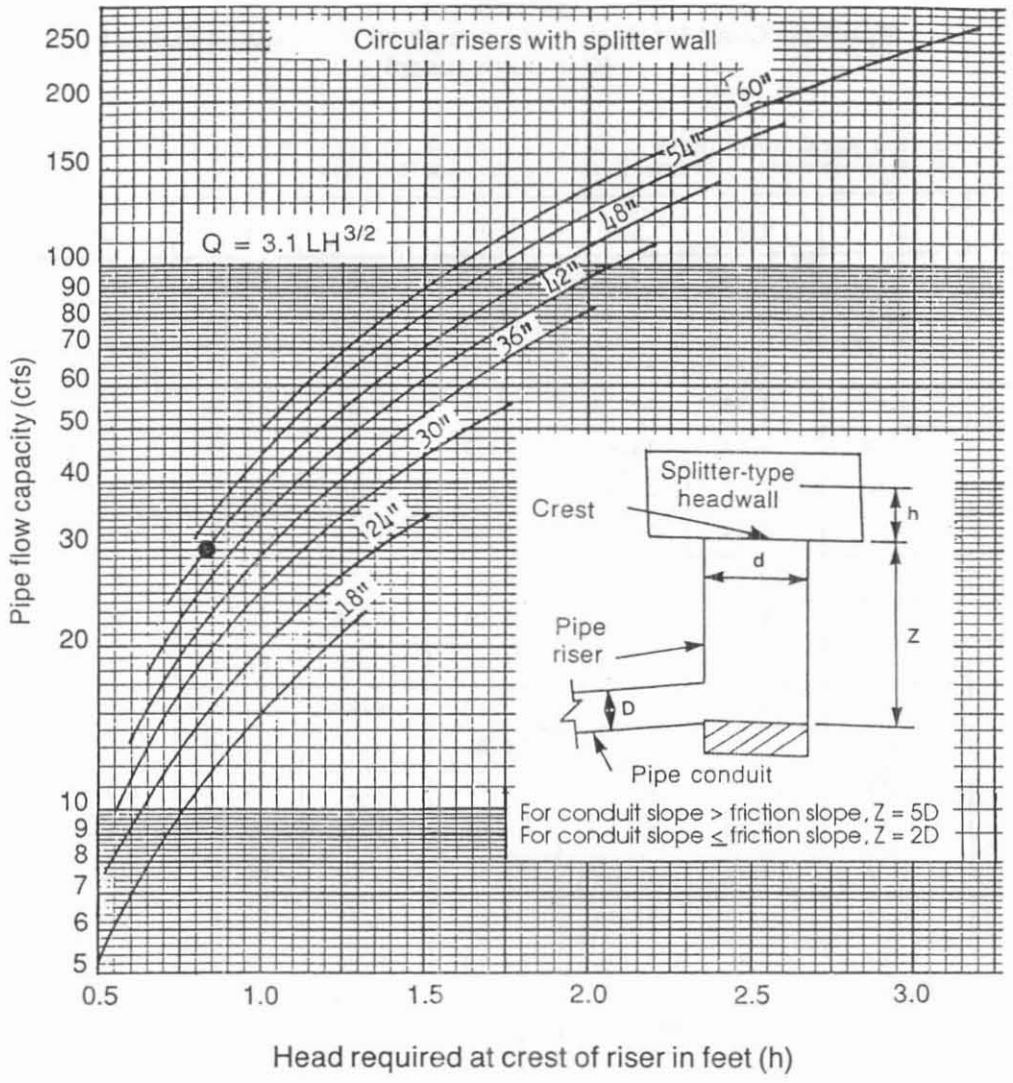
Pipe drop inlet spillway design:

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.

SB-2 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.

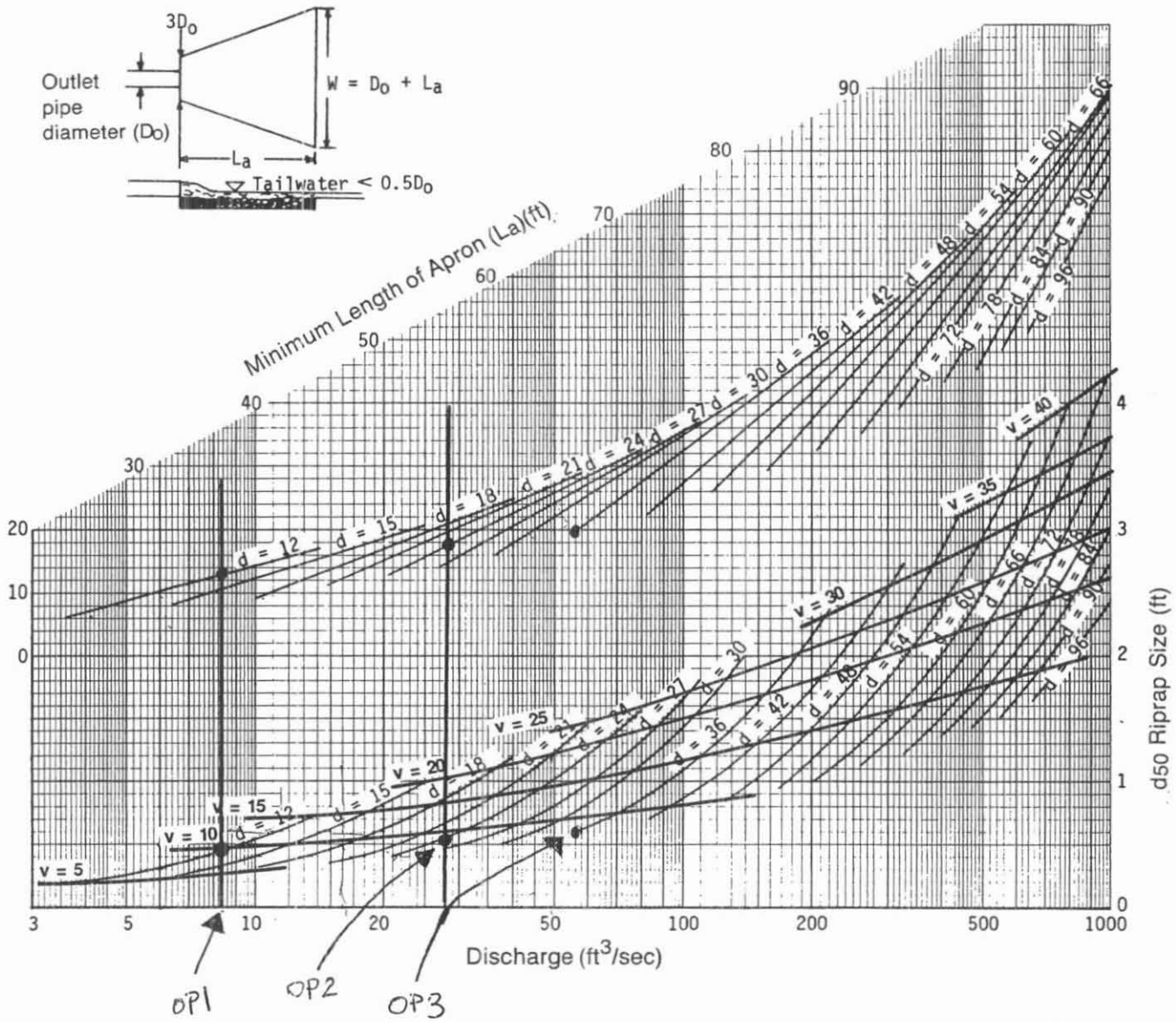
SB-2 BARREL

Table 8.07a
Pipe Flow Chart for Design of Corrugated Metal Outlet Conduit
(Q in cubic ft/sec)

For Corrugated Metal Pipe Inlet $K_e + K_b = 1.0$ and 70 feet of Corrugated Metal Pipe Conduit n = 0.025. Note correction factors for other pipe lengths.

Dia. / H	12"	15"	18"	21"	24"	30"	36"	42"
2	2.84	4.92	7.73	11.30	15.60	26.60	40.77	58.12
3	3.48	6.03	9.47	13.84	19.10	32.58	49.93	71.19
4	4.02	6.96	10.94	15.98	22.06	37.62	57.66	82.20
5	4.49	7.78	12.23	17.87	24.66	42.06	64.46	91.90
6	4.92	8.52	13.40	19.57	27.01	46.07	70.60	100.65
7	5.32	9.21	14.47	21.14	29.19	49.77	76.28	108.75
8	5.68	9.84	15.47	22.60	31.19	53.19	81.53	116.23
9	6.03	10.44	16.41	23.97	33.09	56.43	86.49	123.30
10	6.36	11.00	17.30	25.26	34.88	59.48	91.16	129.96
11	6.67	11.54	18.14	26.50	36.59	62.39	95.63	136.33
12	6.96	12.05	18.95	27.68	38.21	65.16	99.87	142.37
13	7.25	12.55	19.72	28.81	39.77	67.83	103.96	148.21
14	7.52	13.02	20.47	29.90	41.27	70.39	107.88	153.80
15	7.78	13.48	21.19	30.95	42.72	72.85	111.66	159.18
16	8.04	13.92	21.88	31.96	44.12	75.24	115.32	164.40
17	8.29	14.35	22.55	32.94	45.48	77.55	118.87	169.46
18	8.53	14.77	23.21	33.90	46.80	79.81	122.33	174.39
19	8.76	15.17	23.84	34.83	48.08	81.99	125.67	179.15
20	8.99	15.56	24.46	35.73	49.33	84.12	128.93	183.80
21	9.21	15.95	25.07	36.62	50.55	86.21	132.13	188.36
22	9.43	16.32	25.65	37.47	51.73	88.22	135.21	192.76
23	9.64	16.69	26.23	38.32	52.90	90.21	138.27	197.12
24	9.85	17.05	26.80	39.14	54.04	92.15	141.24	201.35
25	10.05	17.40	27.35	39.95	55.15	94.05	144.15	205.50
L	Correction Factors For Other Pipe Lengths							
40	1.23	1.22	1.20	1.19	1.16	1.14	1.13	1.11
50	1.14	1.13	1.12	1.11	1.10	1.09	1.08	1.07
60	1.07	1.06	1.06	1.05	1.05	1.04	1.04	1.03
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	0.95	0.95	0.95	0.96	0.96	0.96	0.97	0.97
90	0.90	0.91	0.91	0.92	0.92	0.93	0.94	0.94
100	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92

Outlet Protection



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).