Culvert and Pipe Phasing

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NCDOT Culvert Phasing Process

• Hydraulics Unit:
  • Culvert Survey Report (CSR)
  • Permit Drawings and Impact Summary

• Hydraulics and Roadside Environmental Units:
  • Develop Culvert Construction Sequence

• Roadside Environmental Unit:
  • Include Culvert Construction Sequence in Erosion Control Plans
Components of Culvert Phasings

• Stilling Basin or Silt Bag

• Impervious Dike

• Temporary Pipe

• Temporary Channel Change
Stilling Basin Design

- Volume ($ft^3$) = Width of Stream Channel (ft.) x (Length of Culvert (ft.) + 20 ft. (10 ft. on Each Side)) x (Depth of Water in Stream (ft.) + Undercut for Bottom of Culvert (ft.))

- Typically used for Volumes > 100 CY (2700 $ft^3$)

- Freeboard = 6 inches (Minimum)

- Design Permeable Stone Drain to Dewater at a Slow Rate

- Add Volume to Required Volume of Sediment Basins
NOTES

INSTALL COIR FIBER BAFFLES IN ACCORDANCE WITH ROADWAY STANDARD DRAWING NO. 1640.01.
INSTALL THE TOP OF THE COIR FIBER BAFFLE A MINIMUM OF 6" LOWER THAN THE TOP OF THE STILLING BASIN BERM.

USE THE TYPICAL SECTION SHOWN FOR THE STILLING BASIN AS A GUIDE. THE BASIN MAY HAVE ANY TYPE CONFIGURATION AS LONG AS SUFFICIENT VOLUME IS PROVIDED AND PROVISIONS ARE MADE FOR A PERMEABLE STONE DRAIN.

DO NOT EXCEED 5 FT. IN HEIGHT FOR THE EARTH DIKES REQUIRED FOR STILLING BASINS. ADDITIONAL DEPHTS MAY BE ATTAINED BY EXCAVATING BELOW THE NATURAL GROUND LEVEL.

THE STILLING BASIN SIZE IS VARIABLE AND DEPENDENT ON SPECIFIC SITE REQUIREMENTS AS WELL AS PROPOSED CONSTRUCTION OPERATIONS.

SUBMIT THE SIZE, LOCATION AND PERMEABLE STONE DRAIN MATERIAL FOR APPROVAL PRIOR TO CONSTRUCTION.

PUMP THE EFFLUENT INTO THE STILLING BASIN TO A MAXIMUM DEPTH OF 3 FEET.
Stilling Basin Volume Design

• Formula for Stilling Basin Volume:

\[
\text{Volume} = \frac{d}{3} \left[ W_{\text{top}} L_{\text{top}} + W_{\text{base}} L_{\text{base}} + \left( \frac{W_{\text{top}} L_{\text{base}} + W_{\text{base}} L_{\text{top}}}{2} \right) \right] + W_{\text{base}} L_{\text{base}} \times 1 \text{ ft.}
\]

• \(d = 3 - 5 \text{ ft.}\)
• Side Slope = 1.5:1
Stilling & Sediment Basin Design

• Example of Stilling Basin as Sediment Basin:

  • Required Volume for Sediment Basin = 1800 ft$^3$
  • Required Volume for Stilling Basin = 1500 ft$^3$
  • Provided Volume of Sediment Basin = 2820 ft$^3$

• Additional Volume Needed for Sediment Basin =

  $$1800 + 1500 - 2820 = 480 \text{ ft}^3$$
Stilling Basin Placement

• Inside Perimeter EC Devices

• Level Ground

• Locate to Avoid Pumping Across Stream

• Avoid Placing in Locations of Sediment Basins
Stilling Basin Construction

• Construct Above Ground with Length:Width Ratio of 2:1
• Install 3 Coir Fiber Baffles
• Excavate 1 ft. Below Ground for Permanent Pool
• Stabilize Interior and Exterior Slopes
• Use Small Grade Stone (NCDOT Class A & B, No. 57)
Stilling Basin
Stilling Basin with Geotextile Liner
Stilling Basin with Flashboard Riser
Flashboard Riser
Silt Bag Design & Placement

- Maximum Pumping Rate of 80 gal/min/sf

- Typically, Volumes less than 100 CY (2700 ft$^3$)

- Place Inside Perimeter EC Devices

- Place on Level Ground

- Locate to Avoid Pumping Across Stream
SPECIAL STILLING BASIN

EXISTING TERRAIN

15.0' to 20.0'

STREAM BANK

8" OF SEDIMENT CONTROL STONE

FILTRATION GEOTEXTILE

NOTES

USE NO. 5 OR NO. 57 STONE FOR SEDIMENT CONTROL STONE.

PROVIDE STABILIZED OUTLET TO STREAM BANK.

WOOD PALLETS MAY BE USED IN LIEU OF STONE AND GEOTEXTILE AS DIRECTED. A SUFFICIENT NUMBER OF PALLETS MUST BE PROVIDED TO ELEVATE THE ENTIRE SPECIAL STILLING BASIN ABOVE NATURAL GROUND.
Silt Bag Installation

• Install Geotextile (NCDOT Type 2) under Bag

• Place No. 57 Stone or Wood Pallets under Bag

• Always Keep Extra Bag(s) Onsite!

• Flocculants and Polymers will Clog Pores of Bag
Silt Bag
Impervious Dike

• Dike Types:
  • Sand Bags
  • Sheet Piling
  • Stone with Polypropylene

• Used in Stream Channel at Upstream and Downstream of Site

• Used to Anchor Temporary Pipes

• Used to Create Side of Temporary Channel
Sand Bags
Sheet Piles
Stone with Geotextile
Temporary Pipe Design & Construction

- Design to 5 times Average Daily Flow (ADF)

- Common Sizes: 15”, 18” and 24”

- Anchor Ends with Impervious Dikes

- Used Primarily for Culvert Extensions
Temporary Pipe
Temporary Channel Design

• Design to 5 times Average Daily Flow (ADF)

• Use Maximum of 2:1 Side Slopes

• Design as Base Ditch

• Don’t Design in Areas of Existing Fill Slopes!
Temporary Channel Construction

• Line with Geotextile (NCDOT Type 4)

• Protect Top of Channel with:
  • Berms
  • Silt Fence
  • Impervious Dike
Berm at Top of Temporary Diversion
Silt Fence with Temporary Diversion
Types of Culvert Phasings

• Pump and Dike

• Dike Only

• Dike and Pipe

• Dike and Temporary Channel
BEST MANAGEMENT PRACTICES FOR
CONSTRUCTION AND MAINTENANCE ACTIVITIES
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
August 2003
Phasing Per BMP Manual Note

INSTALL PIPE[S] IN JURISDICTIONAL AREAS ACCORDING TO NCDOT BEST MANAGEMENT PRACTICES FOR CONSTRUCTION AND MAINTENANCE ACTIVITIES MANUAL.
Pump and Dike

• Short Duration Process (Max. 5 days!)

• Use for Pipe Installation

• Include Pump-Around Detail in the Plans

• Reference BMP Manual with Note
MANAGING THE WATERCOURSE:
BYPASS PUMPING

NOTE:
ENSURE TO ANCHOR ALL
PUMPS AND PIPES SECURELY.
EXAMPLE OF PUMP-AROUND OPERATION

NOTES:
1. All excavation shall be performed in only dry or isolated areas of the work zone.
2. Impervious filters are to be used to reduce wash from streams when necessary.
3. Maintenance of proper flow conditions shall be maintained in the work zone. This includes point-source sheeting, drainag lines, pipes, pumps and hoses.
4. Pumps and hoses shall be of sufficient size to denoter the work area.

SPECIAL STELLING BASIN
(SHSE PROJECT SPECIAL PROVISIONS)
Utilize a Structural Outlet instead of a Spillway Stelling Basin if Piping Clean Water

PUMP-AROUND PUMP

INSPERIOUS OBEW [SEE PROJECT SPECIAL PROVISIONS]

TEMPORARY FLEXIBLE HOSE

EXISTING STREAM CHANNEL

PUMP-AROUND PUMP

INSPERIOUS OBEW [SEE PROJECT SPECIAL PROVISIONS]

SEQUENCE OF CONSTRUCTION FOR TOTAL WORK AREA
1. INSTALL SPECIAL STELLING BASIN.
2. INSTALL STREAM PUMP AND TEMPORARY FLEXIBLE HOSE.
3. PLACE IMPERVIOUS FOBS AND BEGIN PUMPING OPERATIONS (SEE SPECIAL PROVISIONS)
4. PLACE CHANNELING IMPERVIOUS FOBS AND PUMPING APPARATUS (REINFORCED CONCRETE) AREA TO BE DEMPARED, SHALL BE EQUAL TO ONE DAY'S WASTE
5. INITIAL PUMP IN ACCORDANCE WITH THE PLAN
6. PREVENT ANY ACCUMULATION (fil) AND DEWATERING DESIGNATION WITHOUT IMPERVIOUS FOBS, PUMPS, AND TEMPORARY FLEXIBLE HOSE (REINFORCED IMPERVIOUS FOBS)
7. REMOVE SPECIAL STELLING BAYNS AND BANKS. SURELY DEMPARED AREA WITH SED AND DREDGE.
Impervious Dike Phasing

- Short Duration Process
- Use for Pipe Installation/Culvert Extension
- Include Dewatering Details in Phasing
- Do not Block Channel with Dike!
Culvert Extension with Dike

1. CONSTRUCT STILLING BASIN (100 M3).
2. CONSTRUCT IMPERVIOUS DIKES A, DIVERTING FLOW THROUGH BARREL 1.
3. REMOVE EXISTING HEADWALL AND CONSTRUCT EXTENSIONS FOR BARRELS 2 AND 3.
4. CONSTRUCT PORTION OF PROPOSED HEADWALL AND PORTION OF INLET/OUTLET CHANNEL IMPROVEMENTS.
5. REMOVE IMPERVIOUS DIKES A.
6. CONSTRUCT IMPERVIOUS DIKES B, DIVERTING FLOW THROUGH BARRELS 2 AND 3.
7. CONSTRUCT EXTENSION FOR BARREL 1, REMAINDER OF PROPOSED HEADWALL, AND REMAINDER OF INLET/OUTLET CHANNEL IMPROVEMENTS.
8. REMOVE IMPERVIOUS DIKES B AND STILLING BASIN.
9. COMPLETE ROADWAY.
Temporary Pipe Phasing

- Use for Pipe Installation/Culvert Extension
- Can be Utilized for New Culverts
- Include Dewatering Details in Phasing
- Anchor Pipe(s) with Impervious Dike
Phasing with Pipe and Dike

1. Utilize special stilling basin(s) during culvert construction as needed.
2. Construct impervious dikes and install 18 inch temporary pipe, diverting flow through the temporary pipe.
3. Construct culvert extension.
4. Remove impervious dikes and temporary pipe.
5. Construct any necessary channel improvements.
6. Complete roadway.
MANAGING THE WATERCOURSE: SUSPENDED BYPASS PIPE

NOTE:
ENSURE TO ANCHOR ALL PUMPS AND PIPES SECURELY.

PROFILE VIEW

SUCTION HOSE TO DEWATERING DEVICE
SEAL AROUND PIPE
ANCHOR PIPE SECURELY

TOP OF BANK
IMPERVIOUS DIKE
PROJECT
FLOW
DEWATERING DEVICE
WORK AREA
IMPERVIOUS DIKE
PROJECT
FLOW
SUMP

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
AUGUST 2003
BMPs FOR CONSTRUCTION AND MAINTENANCE ACTIVITIES
Phasing with Temporary Channel

• Include Permit Impacts for Channel Tie-Ins

• Design/Build with Room to Install Wing Walls

• Include Channel Dimensions:
  • Base Width
  • Channel Depth
  • Side Slope Info
MANAGING THE WATERCOURSE:
FABRIC LINED DIVERSION CHANNEL

ENERGY DISSIPATION

FABRIC OVERLAPPING BANK AND SECURED

FABRIC LINED DIVERSION CHANNEL

IMPERVIOUS DIKE

FLOW

FLOW

DEWATERING DEVICE

NOTE:
ENSURE TO ANCHOR ALL PUMPS AND PIPES SECURELY.

TOP OF BANK

IMPERVIOUS DIKE

PROJECT

WORK AREA

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
BMPs FOR CONSTRUCTION AND MAINTENANCE ACTIVITIES
AUGUST 2003
Phasing with Temporary Channel

1. CONSTRUCT STILLING BASIN (140 CY).
2. CONSTRUCT TEMPORARY CHANNEL CHANGE WITH LINER (2 FT. BASE, 3 FT. DEEP, 2:1 SIDE SLOPES).
3. CONSTRUCT IMPERVIOUS DIKES, DIVERTING FLOW THROUGH TEMPORARY CHANNEL CHANGE.
4. CONSTRUCT PROPOSED CULVERT AND INLET/OUTLET CHANNEL IMPROVEMENTS.
5. REMOVE IMPERVIOUS DIKES AND TEMPORARY CHANNEL CHANGE, DIVERTING FLOW THROUGH PROPOSED CULVERT.
6. REMOVE STILLING BASIN, AND COMPLETE ROADWAY.
1. CONSTRUCT STILLING BASIN (160 M3).
2. CONSTRUCT IMPERVIOUS DIKE AND TEMPORARY CHANNEL CHANGE WITH LINER (2.5 M BASE, 1 M DEEP, 2:1 SIDE SLOPE), DIVERTING FLOW.
3. CONSTRUCT PROPOSED CULVERT.
4. REMOVE IMPERVIOUS DIKE AND TEMPORARY CHANNEL CHANGE, ALLOWING FLOW THROUGH CULVERT.
5. COMPLETE ANY NECESSARY INLET/OUTLET CHANNEL IMPROVEMENTS.
6. REMOVE STILLING BASIN.
7. COMPLETE ROADWAY.
Temporary Stream Crossing Design & Construction

• Design to Carry 2-yr Storm

• More than One Pipe can be Used

• Install Geotextile (Type 2) under Pipe(s) and Stone

• Use Class B and No. 57 Stone
PIPE(S) FOR TEMPORARY STREAM CROSSING SHALL BE DESIGNED TO PASS THE PEAK OR BANKFULL FLOW, WHICHEVER IS LESS, FROM A 2-YEAR PEAK STORM, WITHOUT OVER TOPPING.
Stream Crossing at Diversion
Stabilization for Culverts

- Seed and Mat in Timely Manner
- Mat Slopes (Straw, Excelsior, Permanent)
- Place Coir Fiber Mat on Stream Banks at Inlet
- Protect Seeded Area with Temporary EC Devices
Stabilized Slopes
Enhancements for Stilling Basins

• Coir Fiber Baffles

• Pumping Water from Top of Basin Water

• Permanent Pool

• Flocculants
Flocculant Incorporation
Flocculant Incorporation
Considerations for Culvert Phasing

- Develop in Conjunction with EC Plan

- Culvert Phasing a Recommendation and Dependent on:
  - Contractor
  - Site Conditions

- Include Details in Construction Sequence
NCDOT Web Site Links

- REU Soil & Water Engineering Section
  http://www.ncdot.org/doh/operations/dp_chief_eng/roadside/soil_water/

- NCDOT BMP Manual
  http://www.ncdot.gov/doh/forms/files/BMPMANUAL.pdf

- NCDOT Hydraulics Unit
  http://www.ncdot.org/doh/preconstruct/highway/hydro/
Questions?