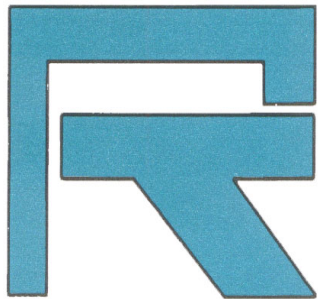


# STORMWATER MANAGEMENT

## Special Management Areas

By: Gary R. Brown, P.E.  
President



RT ENVIRONMENTAL SERVICES, INC.  
215 WEST CHURCH ROAD  
KING OF PRUSSIA, PA 19406  
(610) 265-1510

# HISTORICAL PERSPECTIVE

- Point Source Regulation
- Non Point Source Deferrals
- Environmentalist Lawsuits
- Early 1990's – Regulation Finally Begins

# ENGINEERING SITE DESIGN

- Detention/Retention
- “Design” Storms/Recurrence Intervals
- Peak Overflows Simultaneously in Basins
- Erosion Avoidance
- 90% of Rainfall Volume (Rainfall 1” or Less)

# RECENT ISSUES

- Balanced Stormwater Management (Annual Average Infiltration Approach – Quantity)
- “No Exposure” or Monitoring/Treatment – Quality
- Stormwater Temperature
- Waivers for Certain Sites

# BEST MANAGEMENT PRACTICES

- Vary By Site Conditions
- Structural and Non-Structural
- Brownfields
- Highways/Roads/Rest Areas
- Karst Areas
- Mined Lands

# NON-STRUCTURAL

- Cleaning – Vacuuming
- Storage Under Roof, Canopy or Tarp
- Maintenance

# BROWNFIELDS SITES

- Concentrated Infiltration Not Acceptable
- Natural Attenuation/Can Exacerbate Groundwater Impacts and Containment Migration
- Focus on Quality BMPs
- Waivers From Quality BMPs Common
- Perimeter BMPs Preferred

# KARST AREAS

- Typically Requires Proof of Void Conditions On-Site
- Incidence Of and Actual Potential for Settlement Matters
- Maximum Focus on Quality BMPs
- Waivers From Infiltration BMPs Possible



# URBAN AREAS

- Limited Options Due to Physical Constraints
- BMPs Successfully Implemented
- Porous Pavement/Pervious Concrete
- Infiltration Trenches
- Green Roofs
- Manufactured Proprietary BMPs

# BUFFER ZONES

- Usable in PA for BMPs
- Grassed Waterways
- Rain Gardens

# EXTENDED DETENTION BASINS

- Part of Some Regulatory Programs for Years
- Settle Fine Particles
- Enhanced Removal of Nutrients/Herbicides/Pesticides

# EXTENDED DETENTION BASINS CONT.

- Good Candidates for Enhanced Infiltration
- Good Candidates for Discharge Rate Modification
- Potential Candidates for Irrigation Return

# POROUS PAVEMENT/ PERMEABLE CONCRETE

- Well Proven BMP Approach
- Limitations Now Understood
- University of New Hampshire Study
- Can Be Used In Combination With Reservoir Course and/or Liner

# SUBPAVEMENT RESERVOIRS

- A Separate BMP From Porous Pavement/  
Pervious Concrete
- Stone More Costly Than Arches or Plastic  
Media
- Non-Disturbance of Exposed Earth Critical

# SUBPAVEMENT RESERVOIRS CONT.

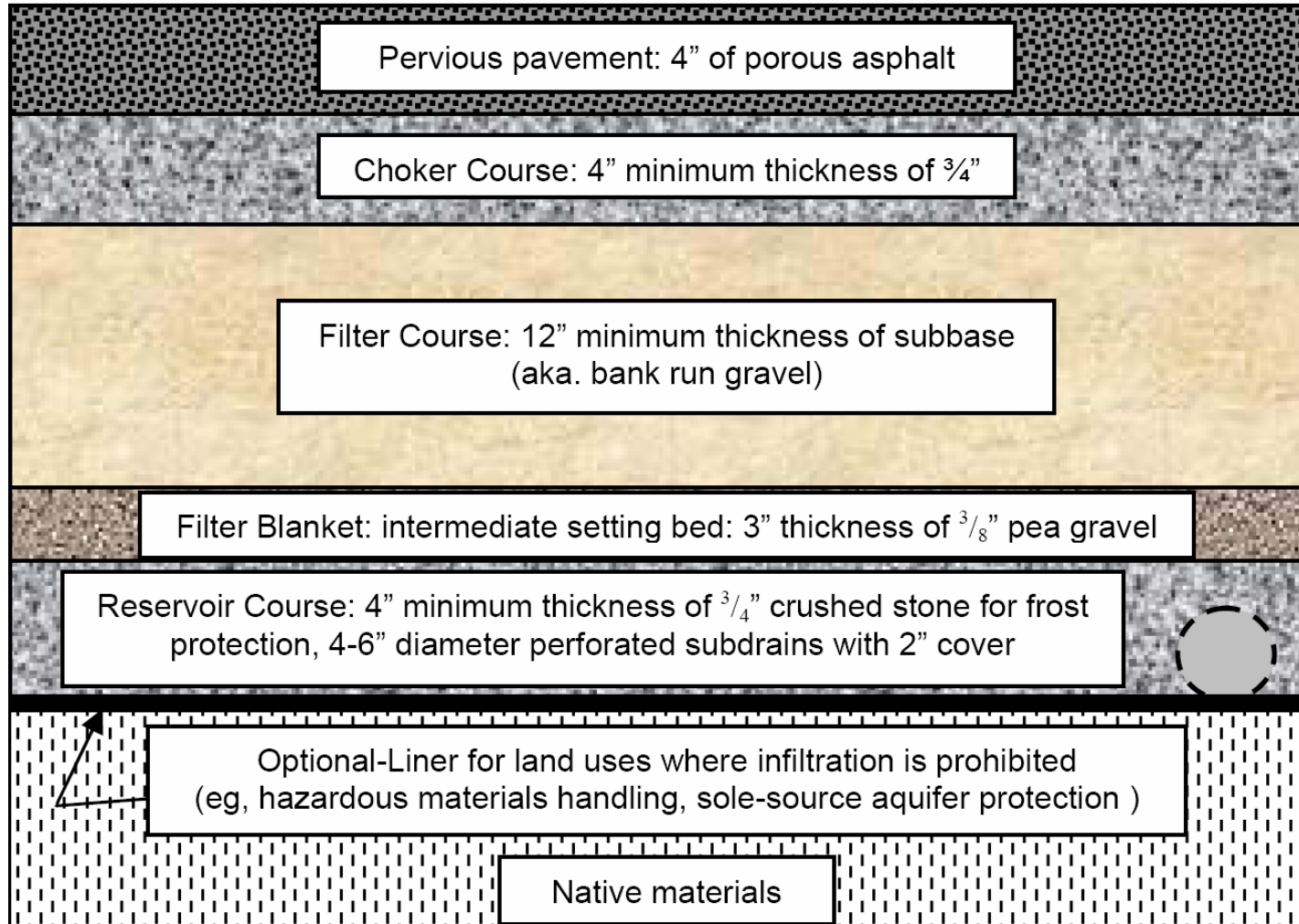
- Avoid Fabric Where Possible
- Not Practical In Areas With Low Infiltration or In Sloped Areas
- Day Lighting Overflow Critical

# UNDERGROUND DETENTION

- Pipe Networks
- Arches
- Vaults



# Typical Cross-Section for Pervious Pavement System



# UNDERGROUND DETENTION CONT.

- Usually Combined With Treatment
- Maintenance/Cleanout Need
- Plastic Media (Recent Attention)

# GRASSED WATERWAYS

- Filtration/Can Be Combined With Filter Strips
- Temperature
- Need Slope – 1% Recommended

# GRASSED WATERWAYS CONT.

- Ease of Maintenance
- Lower Cost Than Storm Drains
- Can Use Weirs to Enhance Performance

# INFILTRATION TRENCHES

- Use Liquid Ring Tests if Permeability Low
- Can be Installed in Existing Detention Basins
- Typically Drain In Several Hours But Can Extend

# INFILTRATION TRENCHES CONT.

- Upland Areas Usually Best Location
- Can “Flood First” With Roof Runoff

# RAIN GARDENS

- Provide BMPs for Treatment and Detention
- Attractive/Popular in CA
- More Aesthetically Appealing Than Basins
- Combination BMP is Very Cost Effective

# RAIN GARDENS CONT.

- Need Robust Species to Accommodate Flooding
- Can Be Located in Buffer Areas
- More Appealing to Regulators (Enforcement)



# GREEN ROOFS

- Washington, DC Study – Effective
- Makes Use of Otherwise Unused Area
- Roofing Warranty Critical

# HAY BALES

- Fixed Rack Approach
- Maintenance /Change-Out Need Visually Apparent
- Low Tech – Parking Lot, Salvage Yards, Yard Storage Area Retrofits

# HAY BALES CONT.

- Stormwater Filtration
- Incidental Oil Filtration
- Aggregate/Stone/Sand Material Recycling

# RUNOFF TREATMENT

- Terre Clean
- Perfect for Service Areas
- Swirl Concentrators

# SPRAY IRRIGATION

- Often Forgotten – Can Address Quantity
- Can Mean Just Operate More
- The Little Engine That Could (Sites With Limited Infiltration Capability)

# CANOPIES

- Eliminate Exposure of Potentially Contaminating Materials or Equipment With Rainwater
- Modular Design/Costs Have Come Down
- Typical Paybacks – 2 to 4 Years

# CANOPIES CONT.

- “Lean To” Canopies An Option
- Must “Right Size”

# BROWNFIELDS SITES

- Ok To Infiltrate, But Cannot Retain/Detain/Concentrate Infiltration
- BMPs That Can Be Used Are Discretionary



# BROWNFIELDS SITES CONT.

- Perimeter BMPs Without Detention Typically Used
- Porous Pavement Frequently Used
- Exemptions at Discretion of State Environmental Agency/Engineer

# CASE STUDIES

# PHILADELPHIA BROWNFIELDS SITE

- Project Shut Down
- Historical Fill (Lead, Arsenic, PAHs)
- Porous Pavement

# PHILADELPHIA BROWNFIELDS SITE

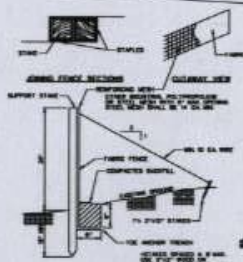
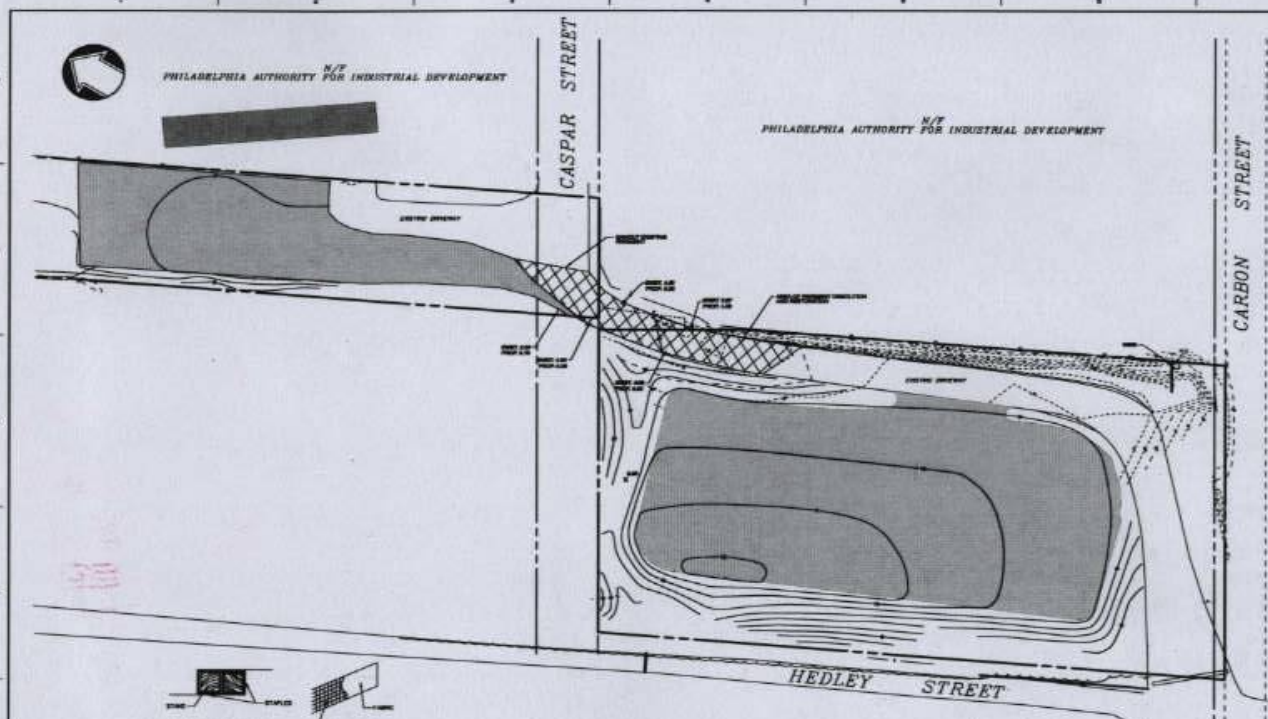
- Filter Strips
- Grassed Waterway/Ditch Upgrade
- Weir Installation
- Regional Engineer Approval



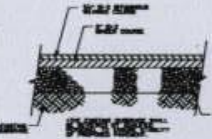


PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT

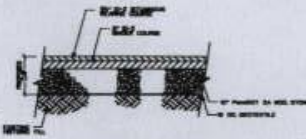
PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT



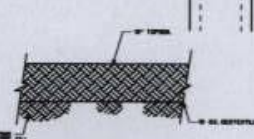
REINFORCED FILTER FABRIC FENCE (30" HIGH)



PAVEMENT RESTORATION DETAIL



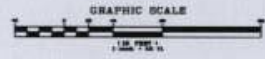
TYPICAL SECTION PAVEMENT CAP



TYPICAL SECTION UNPAVED AREAS

NOTES: 1. THIS GRADING PLAN IS THE PROPERTY OF THE PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT... 2. THE PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT HAS REVIEWED THIS PLAN AND APPROVES IT FOR THE PHILADELPHIA CITY AND COUNTY DEPARTMENT OF PUBLIC WORKS... 3. THE PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT HAS REVIEWED THIS PLAN AND APPROVES IT FOR THE PHILADELPHIA CITY AND COUNTY DEPARTMENT OF PUBLIC WORKS... 4. THE PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT HAS REVIEWED THIS PLAN AND APPROVES IT FOR THE PHILADELPHIA CITY AND COUNTY DEPARTMENT OF PUBLIC WORKS...

LEGEND table with symbols for: EXISTING GRADE, PROPOSED GRADE, PROPOSED PAVEMENT RESTORATION, PROPOSED SIDE OF PAVEMENT, PROPOSED PAVEMENT CAP.



Revision table with columns for NO., DATE, and DESCRIPTION.

PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT

GRADING PLAN  
REPUBLIC SERVICES OF PENNSYLVANIA LLC  
400 BATH STREET  
6TH WARD  
PHILADELPHIA  
CITY OF PHILADELPHIA, PENNSYLVANIA

Project information table with fields for: SHEET NO. (3008-034), DATE (7/7/08), SHEET (012), TOTAL SHEETS (085).

1 of 1

PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT, 1500 MARKET STREET, PHILADELPHIA, PA 19102. THE PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT IS AN EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER. THE PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT IS AN EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER. THE PHILADELPHIA AUTHORITY FOR INDUSTRIAL DEVELOPMENT IS AN EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER.













# MANHEIM, PA RAIN GARDEN RETROFIT

- Asbestos Mill Closure
- Brownfields Redevelopment
- Floodplain Restoration
- State Grant Funds



04/27/2009



04/27/2009





04/28/2009





04/28/2009



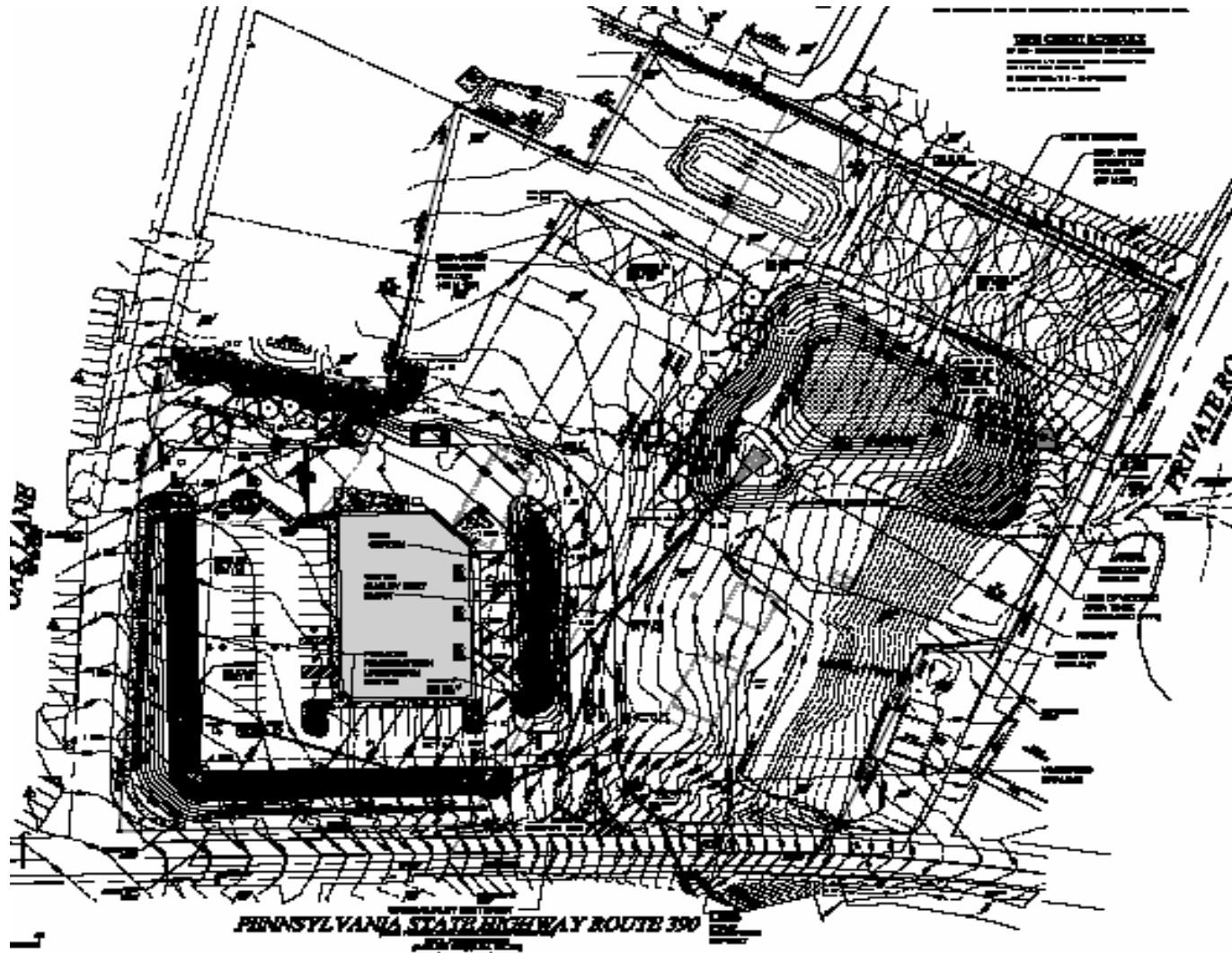
# POCONOS RETAIL PHARMACY SITE

- Roof Downspout Disconnection
- Porous Pavement
- Forebay/Extended Detention

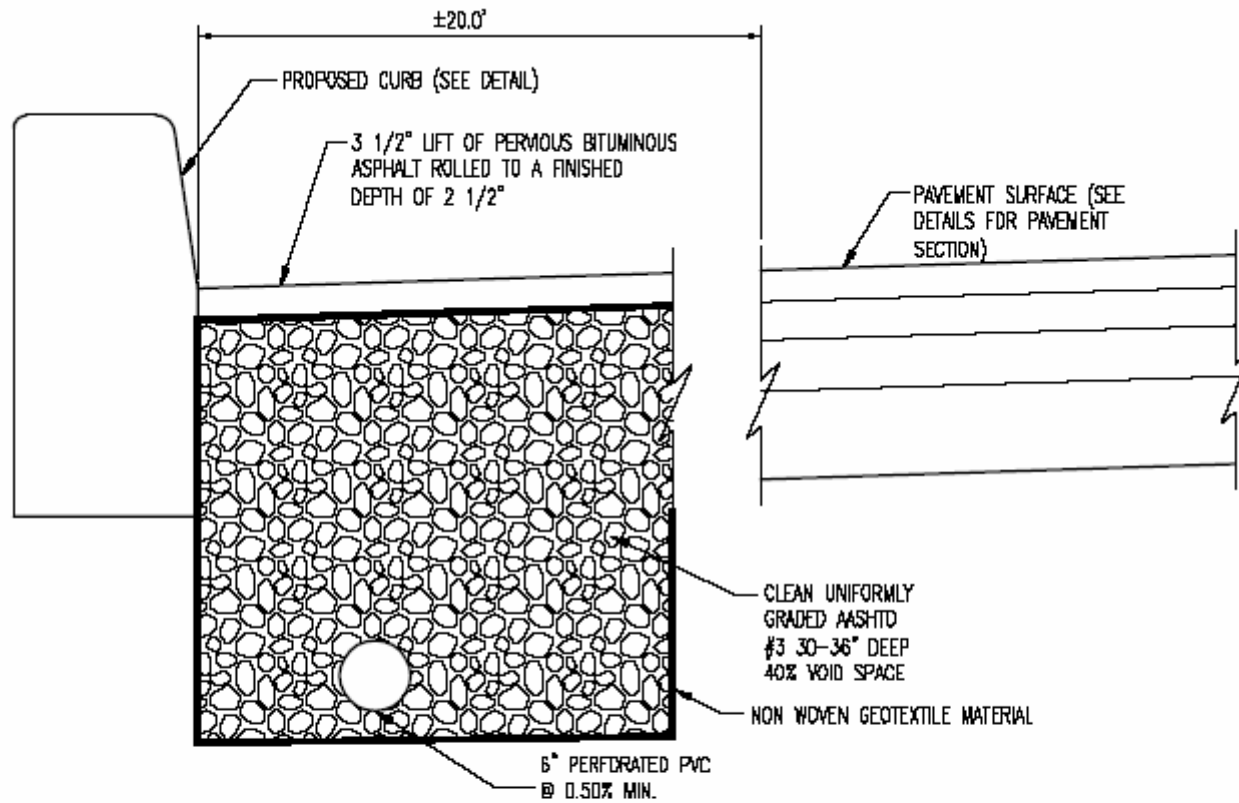
# POCONOS RETAIL PHARMACY SITE CONT.

- Grassed Waterway
- Spray Irrigation

# Stormwater Best Management Practices Cont.



# Stormwater Best Management Practices Cont.



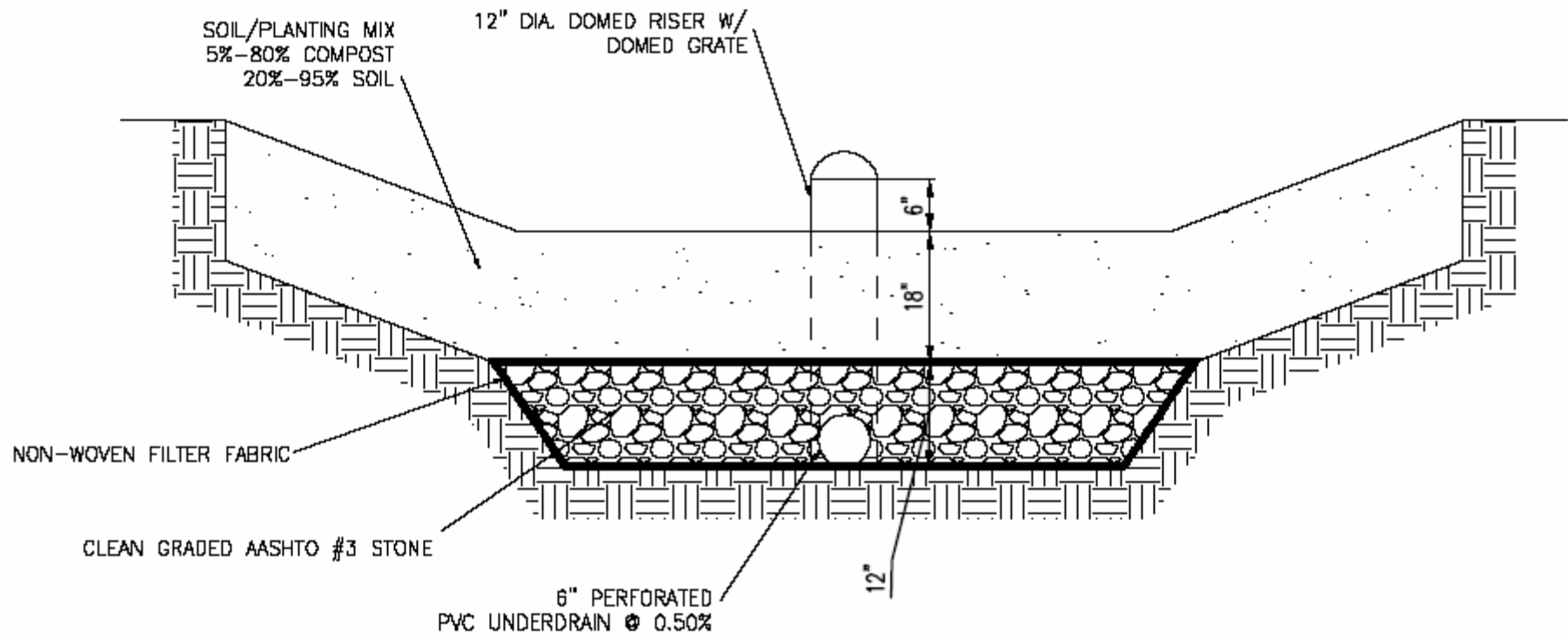
## PERVIOUS PAVEMENT DETAIL

N.T.S.

### NOTES:

1. DEPTH TO SOIL RESTRICTIVE LAYER (WmB, WpB): 53 cm (20.87')
2. DEPTH TO WATER TABLE (WmB, WpB): 38 cm (14.96')
3. DISTANCE TO EXISTING SEPTIC FIELD: 193.5'
4. INFILTRATION BED SHOULD BE LEVEL OR STEPPED LEVEL SECTIONS

# Stormwater Best Management Practices Cont.



**PROPOSED RAIN GARDEN DETAIL**

N.T.S.

# BUCKS COUNTY STORMWATER DESIGN UPGRADE

- 3 Year Old Flex Space/Underground Detention Design
- Awaiting Improvement in Economy Prior to Construction
- Current BMP Review Completed
- Removed Some Curbs



# BUCKS COUNTY STORMWATER DESIGN UPGRADE CONT.

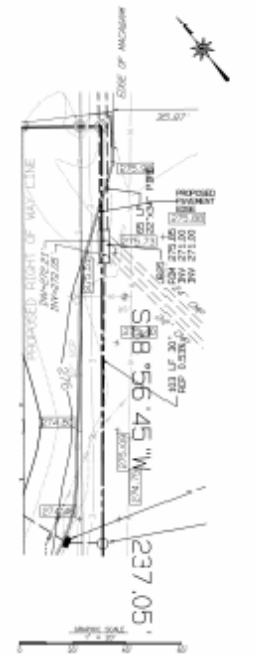
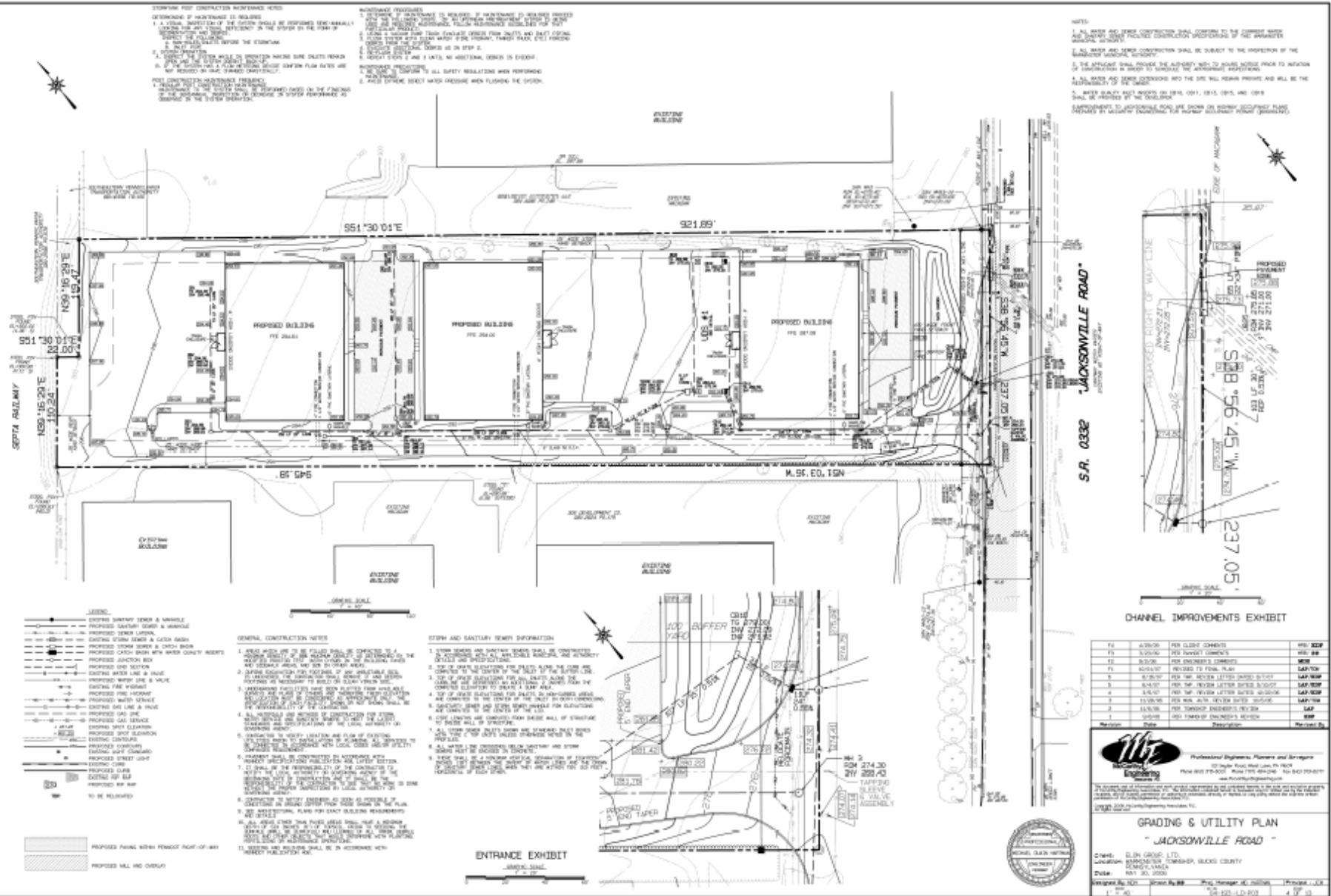
- From 2 to 1 Underground Detention Areas
- Grassed Waterways Added
- Changed to Plastic Media
- Selected Porous Pavement Areas Added
- Rain Garden Added
- Savings \$200,000

STORMWATER CONSTRUCTION IMPROVEMENTS

- REVISIONS TO MAINTENANCE IS REQUIRED**
1. FROM INSPECTION OF THE CONTRACT SHALL BE OBTAINED REGULARLY DURING THE CONSTRUCTION PERIOD IN THE EVENT OF THE OCCURRENCE OF ANY CHANGES TO THE CONTRACT.
  2. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.
  3. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.
  4. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.

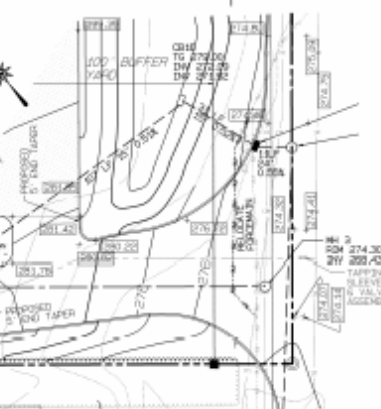
- NOTIFICATION REQUIREMENTS**
1. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IN WRITING OF ANY CHANGES TO THE CONTRACT AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF SUCH WORK.
  2. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IN WRITING OF ANY CHANGES TO THE CONTRACT AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF SUCH WORK.
  3. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IN WRITING OF ANY CHANGES TO THE CONTRACT AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF SUCH WORK.

- NOTES**
1. ALL WORK AND OTHER CONSTRUCTION SHALL CONFORM TO THE LATEST EDITIONS OF THE APPROPRIATE SPECIFICATIONS AND STANDARDS.
  2. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.
  3. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.



- GENERAL CONSTRUCTION NOTES**
1. ALL WORK SHALL BE IN ACCORDANCE WITH THE LATEST EDITIONS OF THE APPROPRIATE SPECIFICATIONS AND STANDARDS.
  2. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.
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  4. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.

- STORM AND SANITARY SEWER INFORMATION**
1. STORM SEWER SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE LATEST EDITIONS OF THE APPROPRIATE SPECIFICATIONS AND STANDARDS.
  2. SANITARY SEWER SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE LATEST EDITIONS OF THE APPROPRIATE SPECIFICATIONS AND STANDARDS.
  3. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.
  4. THE CONTRACTOR SHALL MAINTAIN RECORDS OF ALL CHANGES TO THE CONTRACT AND SUBMIT THEM TO THE ENGINEER FOR APPROVAL.



ITEM	DESCRIPTION	QUANTITY	UNIT
1	PER CONC RET.	150.00	CU YD
2	PER CONC RET.	150.00	CU YD
3	PER CONC RET.	150.00	CU YD
4	PER CONC RET.	150.00	CU YD
5	PER CONC RET.	150.00	CU YD
6	PER CONC RET.	150.00	CU YD
7	PER CONC RET.	150.00	CU YD
8	PER CONC RET.	150.00	CU YD
9	PER CONC RET.	150.00	CU YD
10	PER CONC RET.	150.00	CU YD

**Professional Engineer, Planner and Surveyor**

**1166 Engineering**

102 Maple Road, West Lake, FL 32909  
Phone: 888-775-2027 Fax: 888-775-2028

**GRADING & UTILITY PLAN**  
- JACKSONVILLE ROAD -

Client: D.B. GROUP, LTD.  
Location: BROWARD COUNTY, BROWARD COUNTY  
Date: MAY 20, 2020  
Project: L&A  
Scale: AS SHOWN

# BMP Applicability

	Industrial Yards	Brown- fields	Highway/ Road	Karst Areas	Mined Lands	Special Protection/ Exceptional Value Waters
Porous Pavement	N	Y	N	Y	Y	Y
* Res. Course	N	Y	N	N	N	Y
Pervious Concrete	N	Y	N	Y	Y	Y
* Res. Course	N	Y	N	N	N	Y
Underground Detention	N	N	Y	N	N	Y
Canopies	Y	Y	N	Y	Y	Y
Green Roofs	Y	Y	Y	Y	Y	Y
Extended Detention	Y	L	Y	L	N	Y
Spray Irrigation	N	N	N	Y	Y	Y
Infiltration Trenches	N	N	Y	N	N	Y
Grassed Waterways	Y	Y	Y	N		Y
Rain Gardens	Y	Y	Y	N	Y	Y
Hay Bales	Y	Y	--	--	--	--

Y = Yes

N = No

L = With Liner