Decision-Making Software for Implementing Stormwater Management Rules

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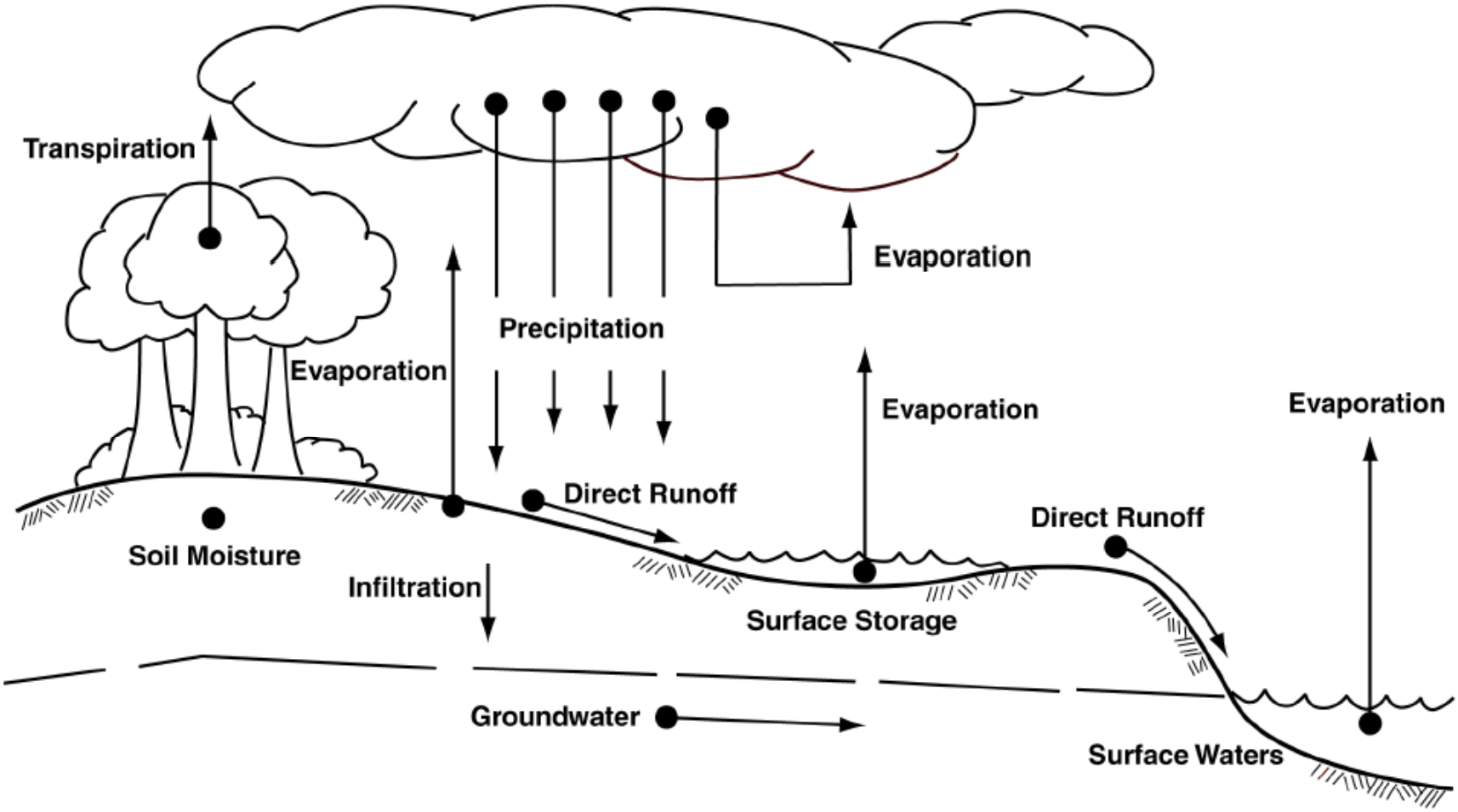
The Hydrologic Cycle (The Water Cycle)

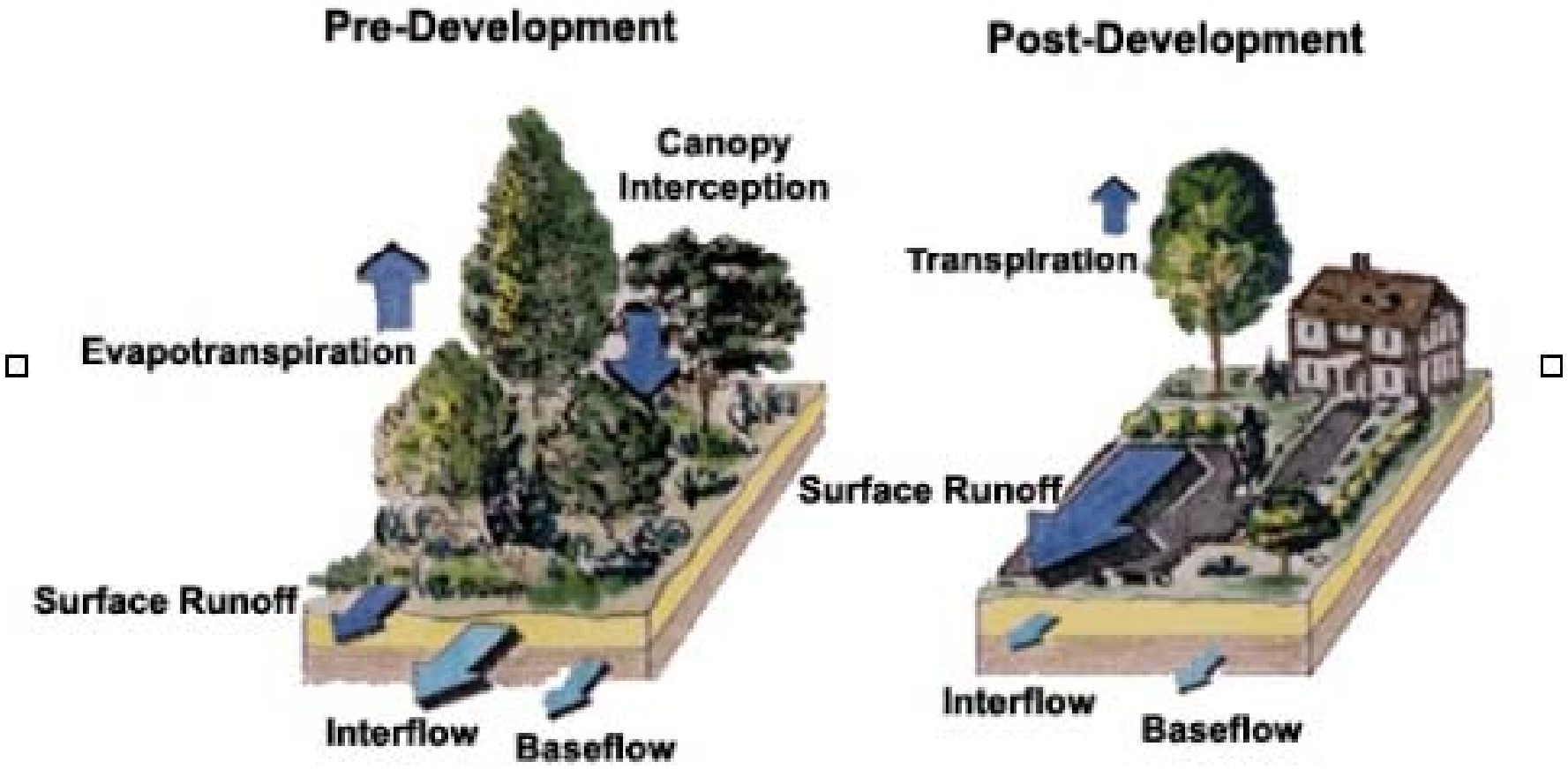


Source: Fundamentals of Urban Runoff Management.

(http://www.nj.gov/dep/stormwater/tier_A/pdf/NJ_SWBMP_5%20print.pdf)

Changes in Hydrology Due to Development

Water Balance



(http://www.webdesignpros.net/consult/infiltrationbmp.htm)

Research Project Rationale

The N. J. Department of Environmental Protection's Stormwater Management Rules has created more stringent storm water management standards for land developments in the state, including roadway and other transportation projects.

These Rules include requirements for groundwater recharge and both stormwater quality and quantity control.

A Stormwater Best Management Practices (BMP) Manual was developed by the NJDEP to assist regulated agencies such as the NJDOT with Rule compliance.

Research Project Rationale
(Continued)

However, the BMP Manual lacks sufficient guidance to properly lead engineers to identify applicable regulations and select appropriate storm water management measures for transportation projects.

As a result, NJDOT planners, designers, and maintenance personnel need a simplified process to navigate the Stormwater Management Rules and facilitate the selection of appropriate stormwater management measures.

Research Project Objectives

Determine applicable stormwater rules.

Identify the appropriate treatment train of non-structural and structural stormwater strategies and measures including manufactured treatment devices to comply with the Stormwater Rules.

Consider treatment capacity, footprint (Right of Way requirements), cost, frequency of maintenance and operating cost.

New Jersey Stormwater Management Rules (February 2004)

Water Quality Control

Runoff from new developments discharging into most common surface waters (Category 2 waters):
Requires 80 percent total suspended solids (TSS) annual removal

Runoff from new developments discharging into sensitive surface waters (Category 1 – Special protected waters):
Requires 95 percent TSS annual removal

Runoff from urban re-developments:
Requires 50 percent TSS annual removal

New Jersey Stormwater Management Rules (February 2004) (continued)

Groundwater Recharge

1. 100 percent of the average annual pre-developed groundwater recharge volume at a project site be maintained after development; or
2. 100 percent of the difference between the pre- and post-development 2-year runoff volumes at a project site be infiltrated.

New Jersey Stormwater Management Rules (February 2004) (continued)

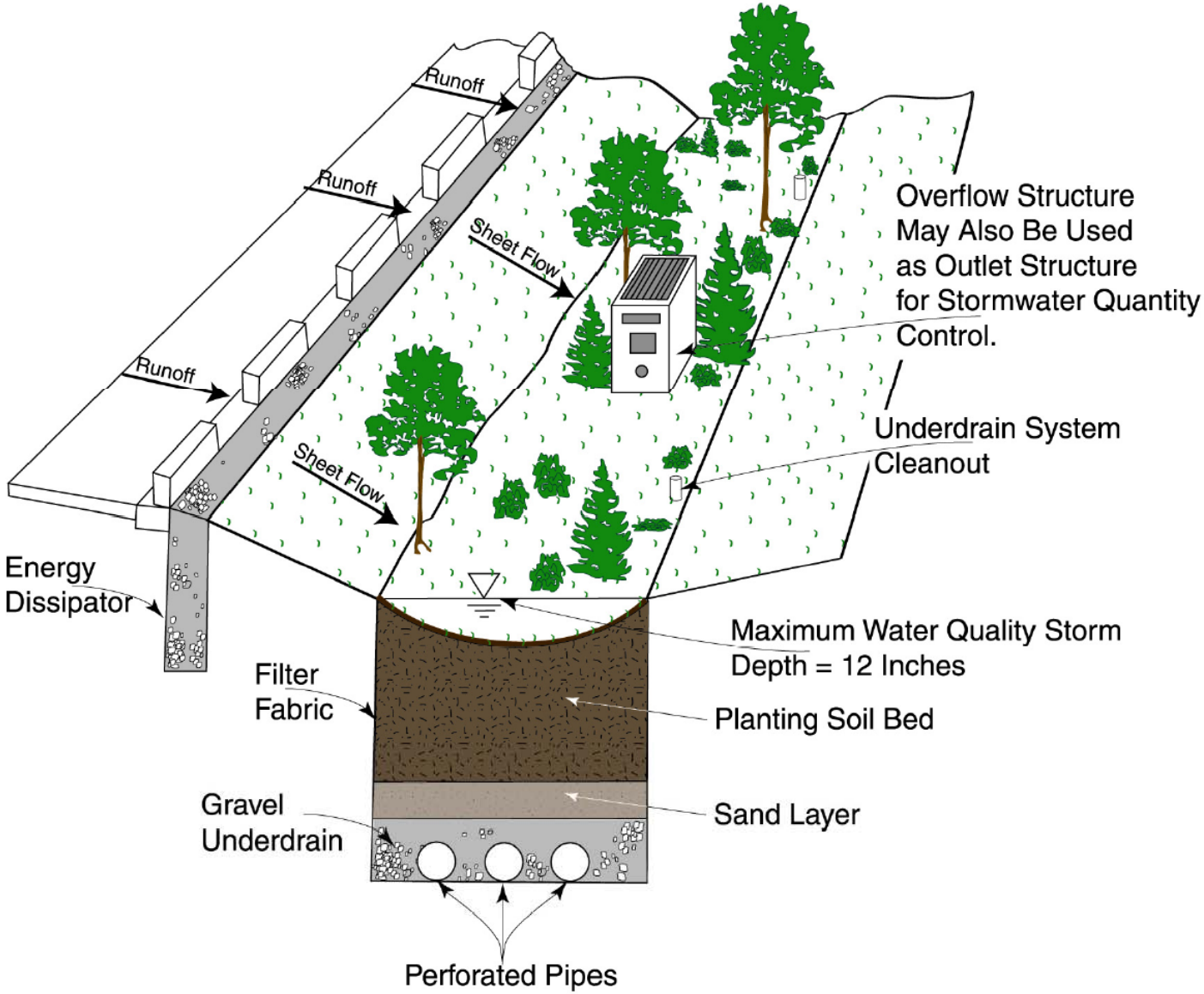
Flood Control

There are **reductions in the post-construction peak runoff rates** for the 2, 10, and 100 year storms for the runoff attributed to the portion of the site in the proposed project.

Stormwater Best Management Practices (BMPs):

Performance, Costs, and Constraints

Bioretention – A Stormwater BMP



(http://www.nj.gov/dep/stormwater/tier_A/pdf/NJ_SWBMP_9.1%20print.pdf)

TSS Removal Rates Assigned by NJDEP for Various Stormwater BMPs

Table 1. TSS Removal Rates for BMPs*

Best Management Practice (BMP)	Adopted TSS Removal Rate (%)
Bioretention System	90
Constructed Stormwater Wetland	90
Dry Well	Volume Reduction Only[1]
Extended Detention Basin	40 to 60[2]
Infiltration Structure	80
Manufactured Treatment Device	See N.J.A.C. 7:8-5.7(d)[3]
Pervious Paving System	Volume Reduction Or 80[4]
Sand Filter	80
Vegetative Filter	60-80
Wet Pond	50-90[5]

*Taken from Table 4-2, Ch. 9, of NJDEP manual.
[1]See NJDEP manual.
[2] Final rate based upon detention time. See Chapter 9 of NJDEP manual.
[3]To be determined through testing on a case-by-case basis.
[4]If system includes a runoff storage bed that functions as an infiltration basin.
[5]Final rate based upon pool volume and detention time.

(From Guo et al., FHWA-NJ-2007-023)

STORMWATER BMP ANALYSIS							
	Cost			BMP % of Drainage Area	Groundwater Separation	Minimum Distance to Drinking Wells	Soil Permeability
BMP	Per Cubic Foot of Water Storage	Per Acres-Foot	Maintenance		feet	feet	inches per hour
Infiltration Basin	$2.00 Ft^3 of Storage	-	5%-10% of Construction Cost	2%-3%	2-5	150	0.5-3.0
Porous Pavement	$3.00 Ft^3 of Pavement	-	-	-	2-5	100	0.5-3.0
Infiltration Trench	$5.00 Ft^3 of Stormwater Treated	-	5%-20% of Construction Cost	2%-3%	2-5	150	0.5-3.0
Bioretention	$6.80 Ft^3 of Water Storage	-	-	5%	-	-	-
Grassed Filter Strip	$0.70 Ft^3 of Sod	-	-	-	2-4	-	-
Sand and Organic Filter	$7.50 Ft^3 of Stormwater Treated	-	-	-	2	-	-
Dry Swales	$5.50 ft^3 of storage				2		
Wetlands	-	$57,100.00	3%-5% of Construction Cost	3%-5%	Can Intersect	-	-
Dry Extended Detention Pond	-	$41,600.00	3%-5% of Construction Cost	2%-3%	Cannot Intersect	-	-
Wet Pond	-	$45,700.00	3%-5% of Construction Cost	2%-3%	-	-	-

*Data and Calculations from Stormwater Manager's Resource Center (SMRC), 2006 (accessed), www.stormwatercenter.net

(From Guo et al., FHWA-NJ-2007-023)

MINIMUM AND MAXIMUM VALUES FOR STORMWATER BMPs																				
	Bioretention System		Constructed Stormwater Wetlands		Dry Wells		Extended Detention Basins		Infilration Basins		Manufactured Treatment Devices		Pervious Paving Systems		Sand Filters		Vegetative Fliters		Wet Ponds	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
Depth to Top of Seasonal High Water Table	1 ft.				2 ft.		1 ft.		2 ft.				2 ft.							
Drainage Area (Acres)			10-25			1				10									20	
Maintenance	1/yr		4/yr		4/yr		4/yr		4/yr		4/yr				2/yr		2/yr		4/yr	
Distance from Septic System Leach Field			50 ft.																	
Distance from Septic Tank			25 ft.																	
Distance from Property Line			10 ft.																	
Distance from Private Well			50 ft.																	
Distance to Drinking Water Supply Well									100 ft.				100 ft.							

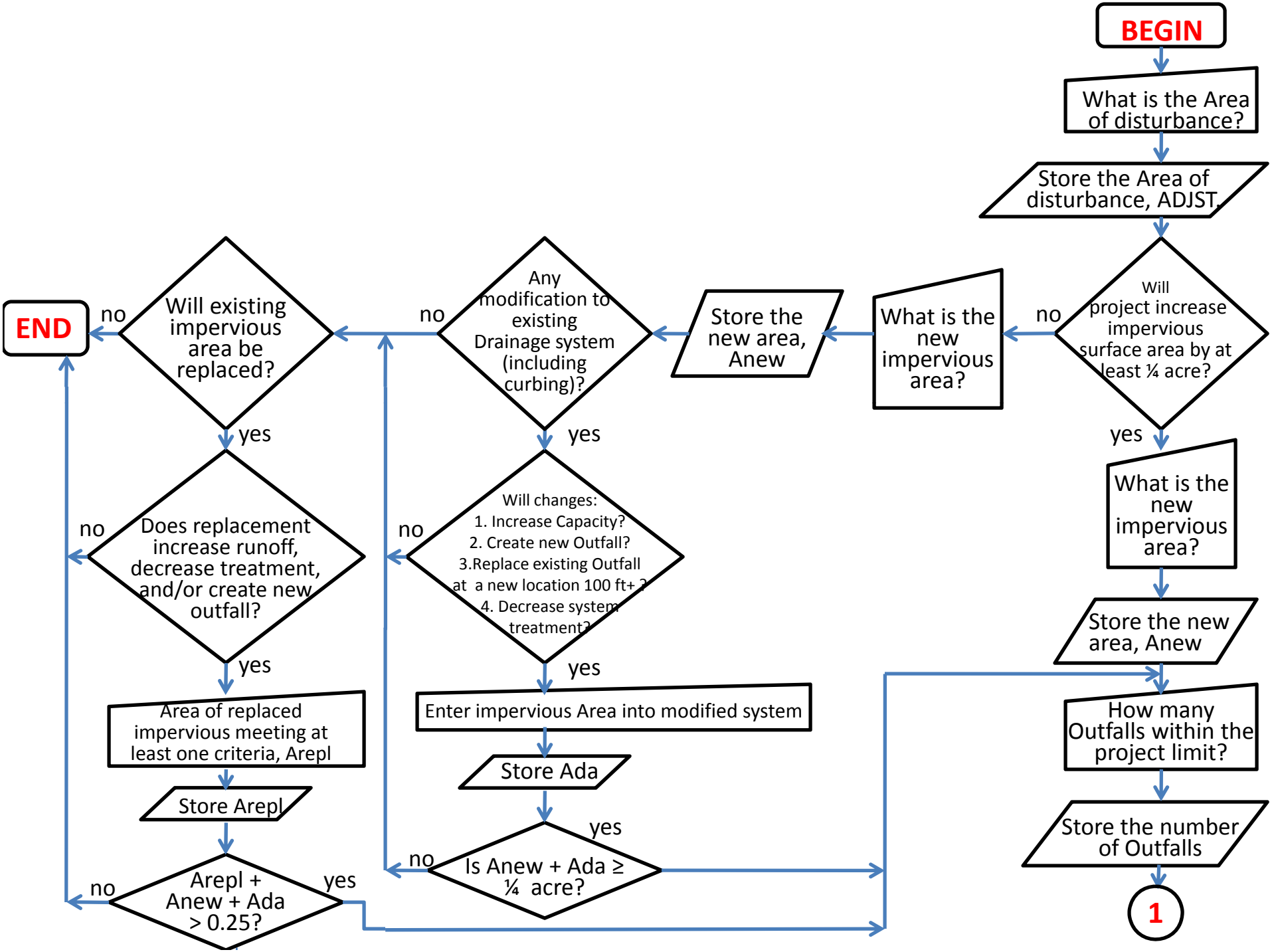
Sources:

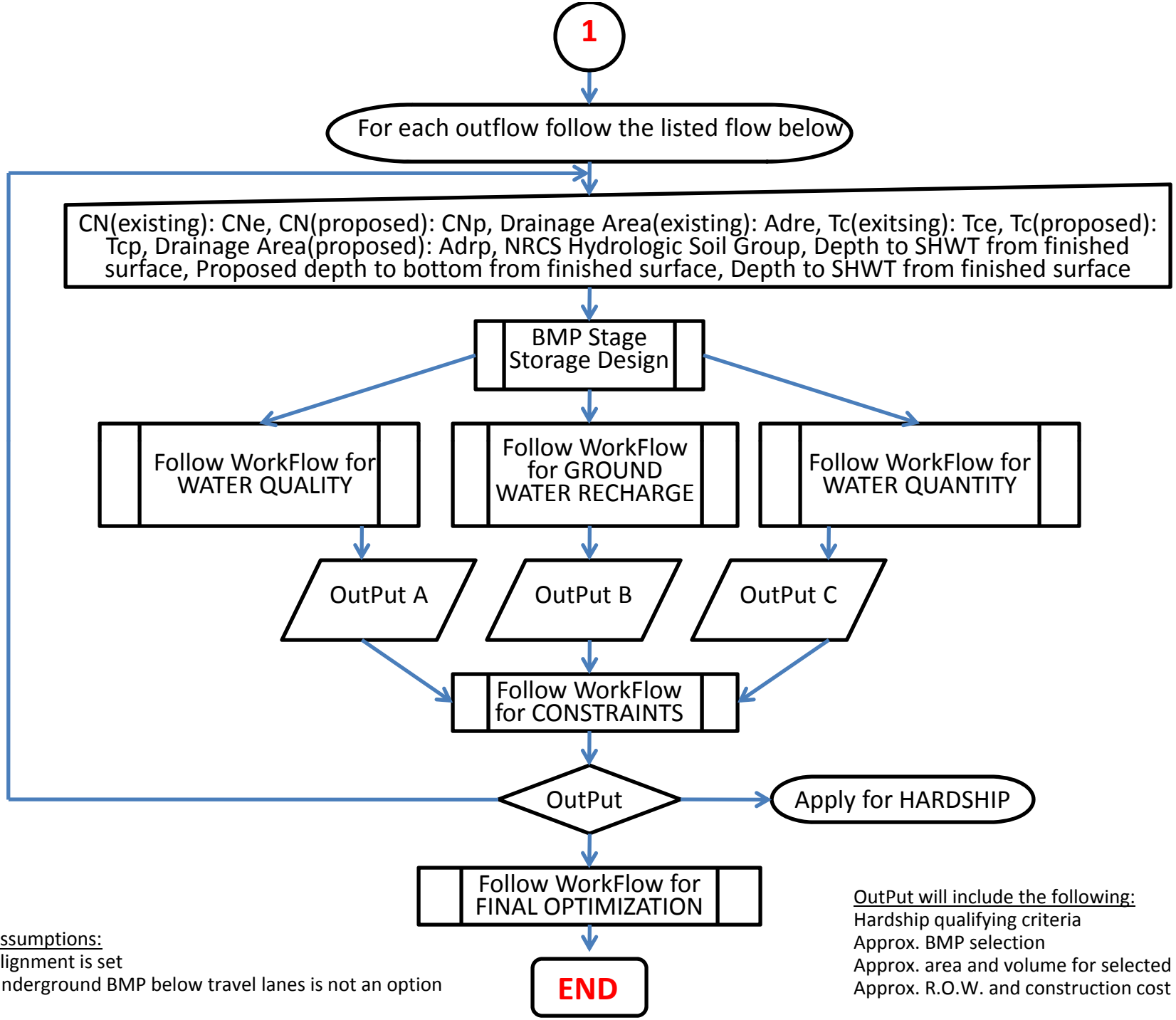
1. NJ Stormwater BMP Manual, NJDEP Department of Watershed Management, 2004

2. Stormwater Manager's Resource Center (SMRC), 2006 (accessed), www.stormwatercenter.net

(From Guo et al., FHWA-NJ-2007-023)

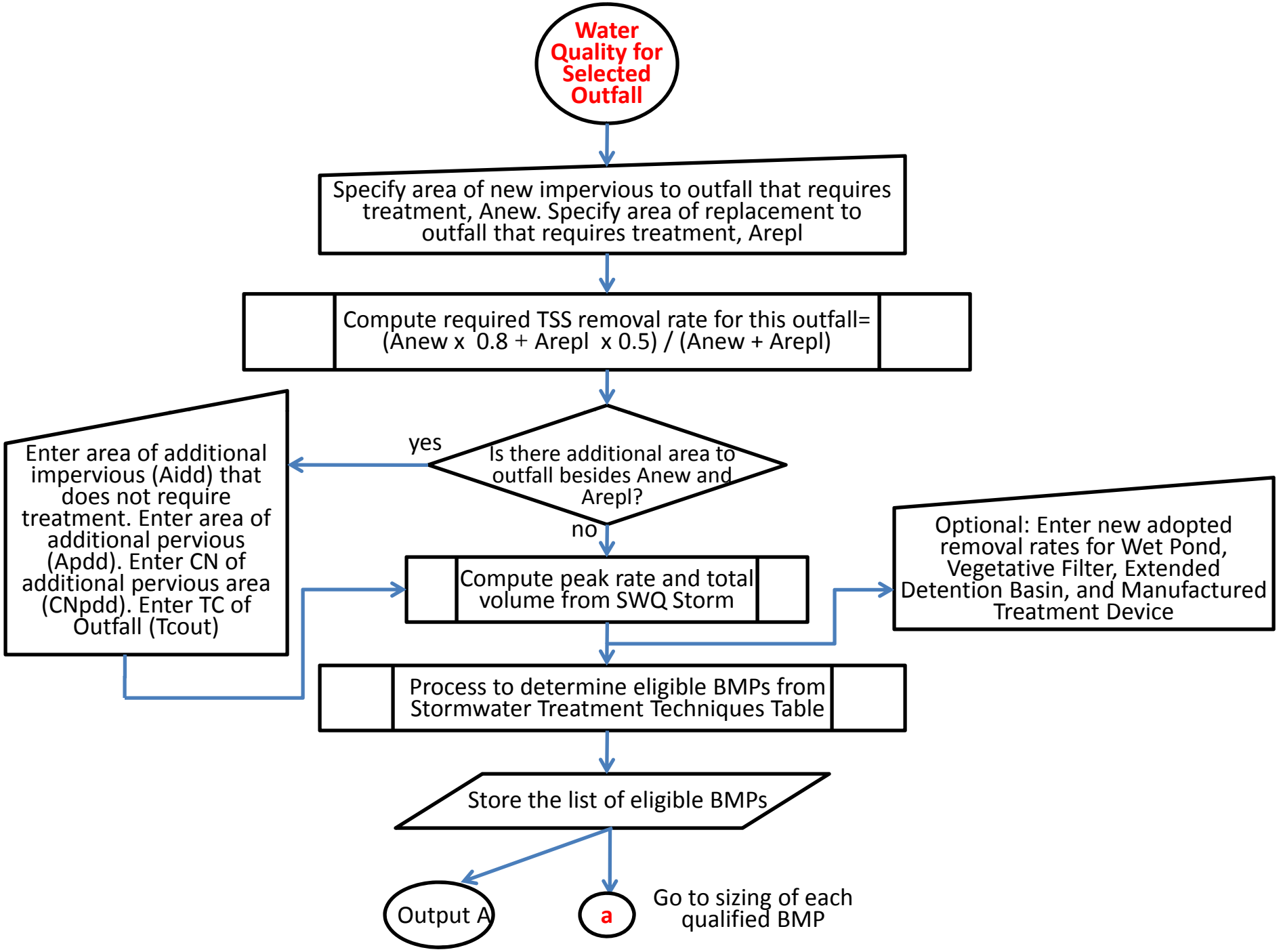
Stormwater Decision Matrix

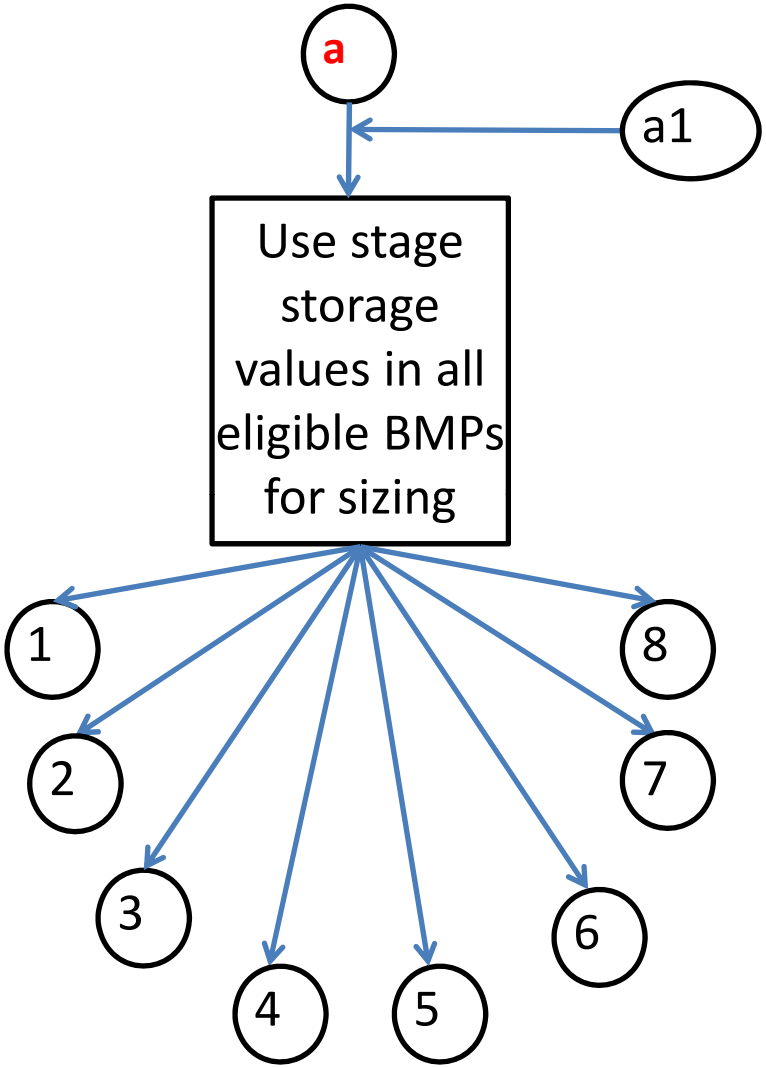

BEGIN
What is the Area of disturbance?
Store the Area of disturbance, ADJST.
Will project increase impervious surface area by at least ¼ acre?
no
yes
What is the new impervious area?
Store the new area, Anew
Any modification to existing Drainage system (including curbing)?
no
yes
Will changes:
1. Increase Capacity?
2. Create new Outfall?
3.Replace existing Outfall at a new location 100 ft+ ?
4. Decrease system treatment?
no
yes
Enter impervious Area into modified system
Store Ada
Is Anew + Ada ≥ ¼ acre?
no
yes
Will existing impervious area be replaced?
no
yes
Does replacement increase runoff, decrease treatment, and/or create new outfall?
no
yes
Area of replaced impervious meeting at least one criteria, Arepl
Store Arepl
Arepl + Anew + Ada > 0.25?
no
yes
END
What is the new impervious area?
Store the new area, Anew
How many Outfalls within the project limit?
Store the number of Outfalls
1

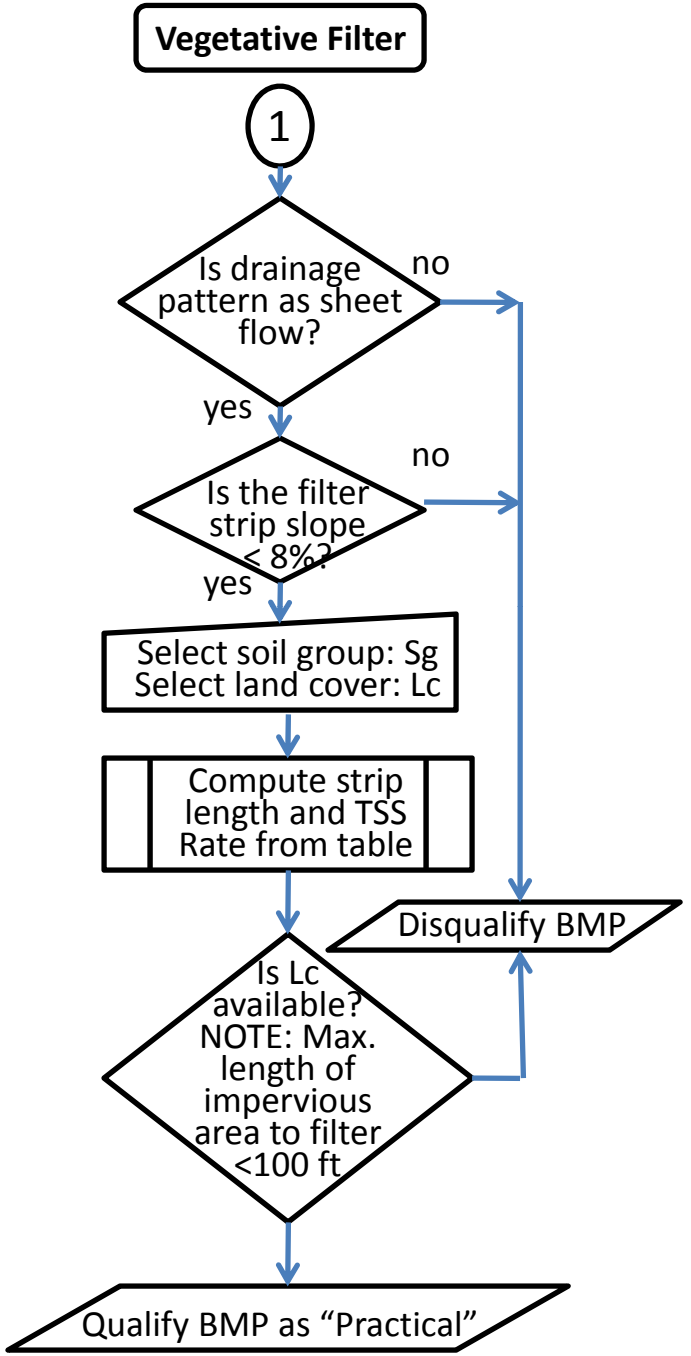


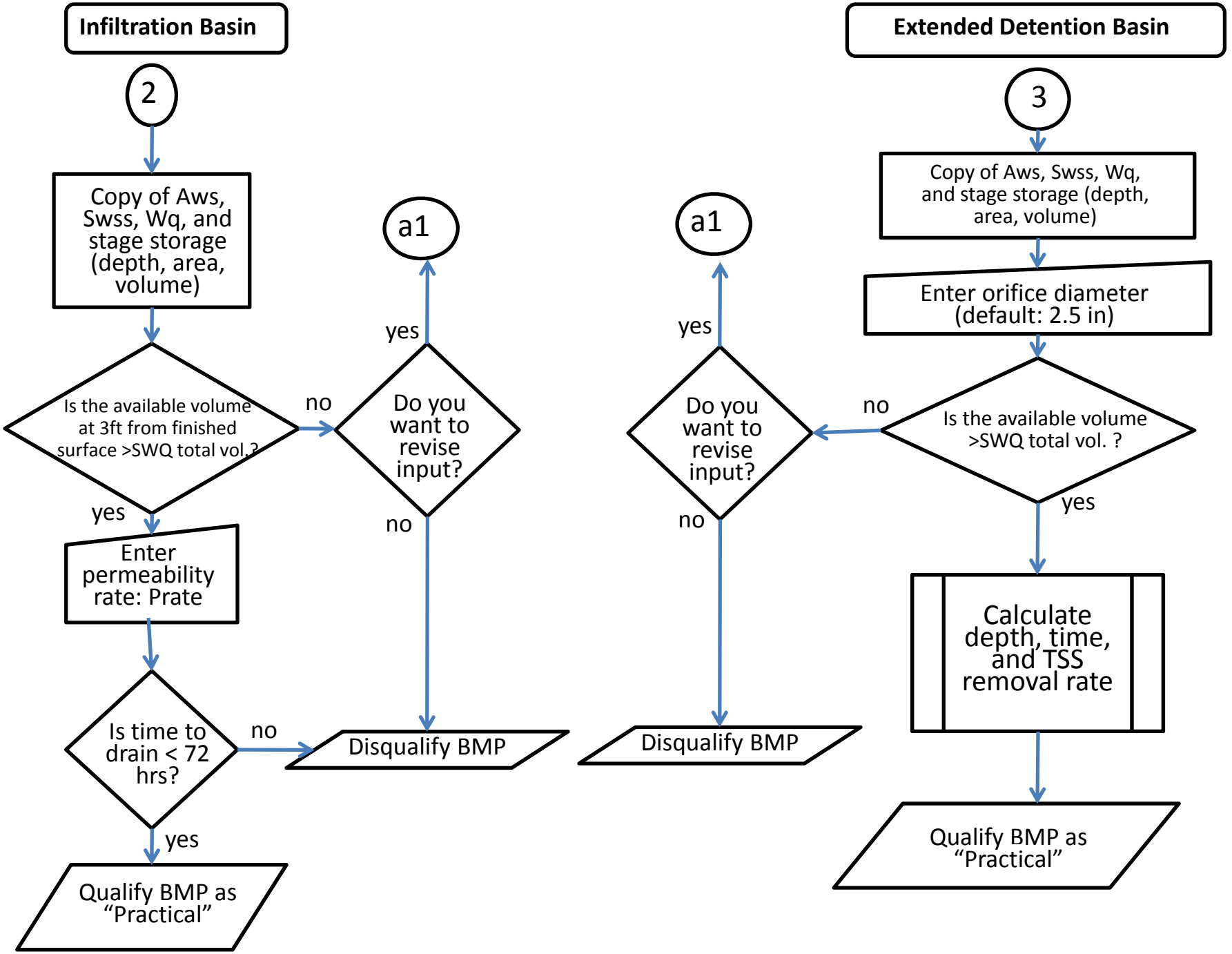
Assumptions:
Alignment is set
Underground BMP below travel lanes is not an option

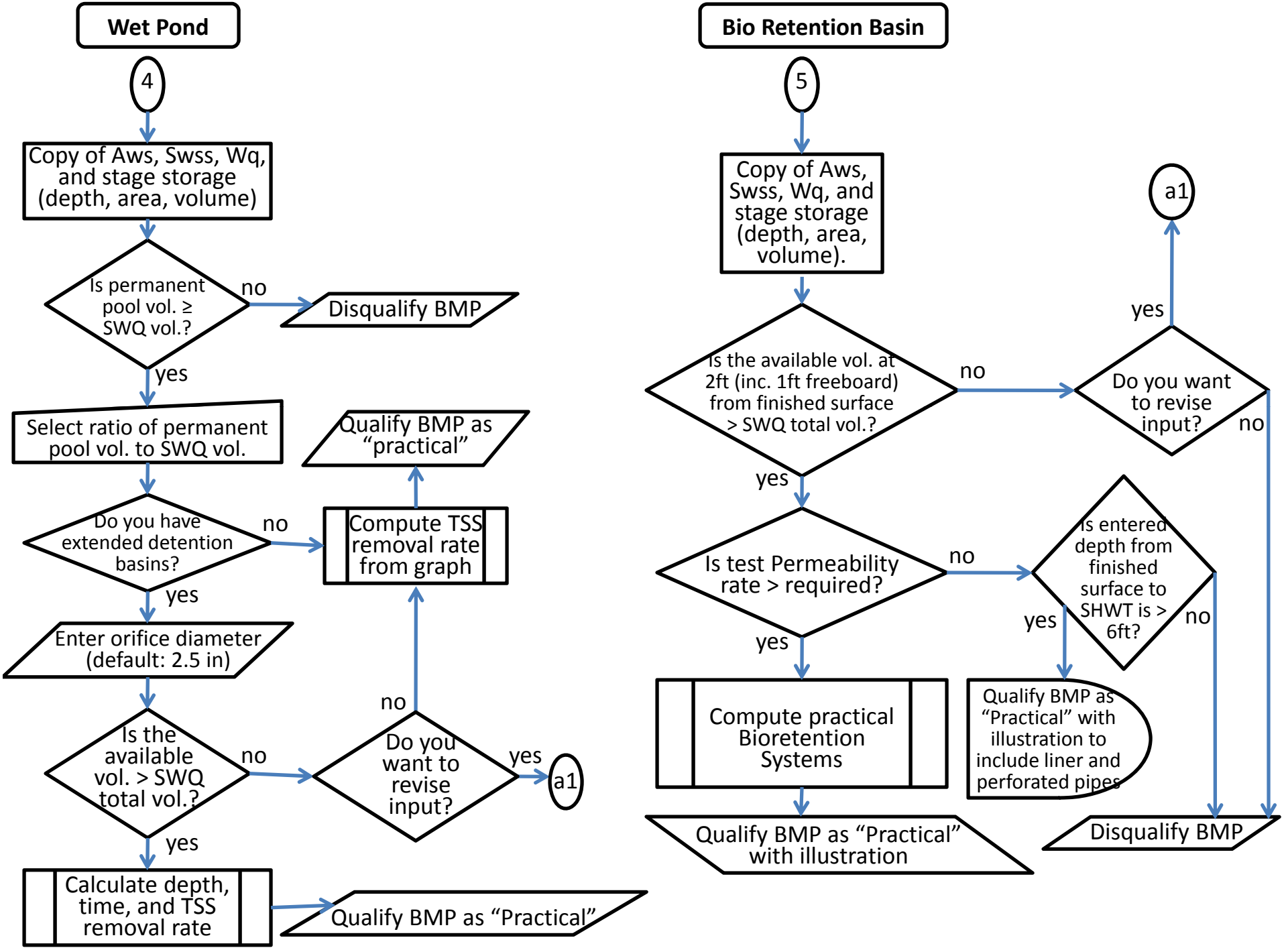
OutPut will include the following:
Hardship qualifying criteria
Approx. BMP selection
Approx. area and volume for selected BMPs
Approx. R.O.W. and construction cost

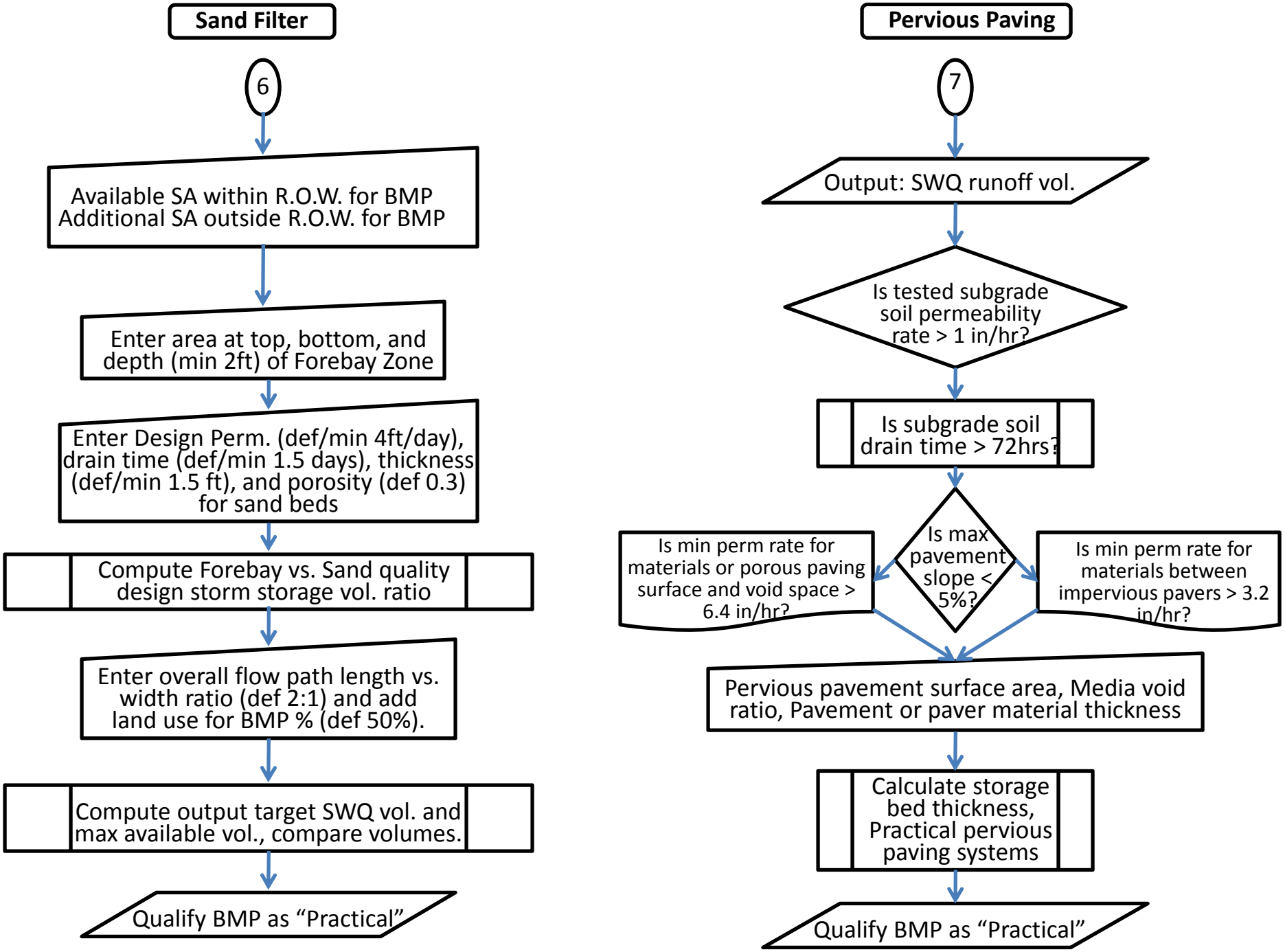

Water Quality for Selected Outfall
Specify area of new impervious to outfall that requires treatment, Anew. Specify area of replacement to outfall that requires treatment, Arepl
Compute required TSS removal rate for this outfall= (Anew x 0.8 + Arepl x 0.5) / (Anew + Arepl)
Is there additional area to outfall besides Anew and Arepl?
yes
Enter area of additional impervious (Aidd) that does not require treatment. Enter area of additional pervious (Apdd). Enter CN of additional pervious area (CNpdd). Enter TC of Outfall (Tcout)
no
Compute peak rate and total volume from SWQ Storm
Optional: Enter new adopted removal rates for Wet Pond, Vegetative Filter, Extended Detention Basin, and Manufactured Treatment Device
Process to determine eligible BMPs from Stormwater Treatment Techniques Table
Store the list of eligible BMPs
Output A
a
Go to sizing of each qualified BMP


a
a1
Use stage storage values in all eligible BMPs for sizing
1
2
3
4
5
6
7
8

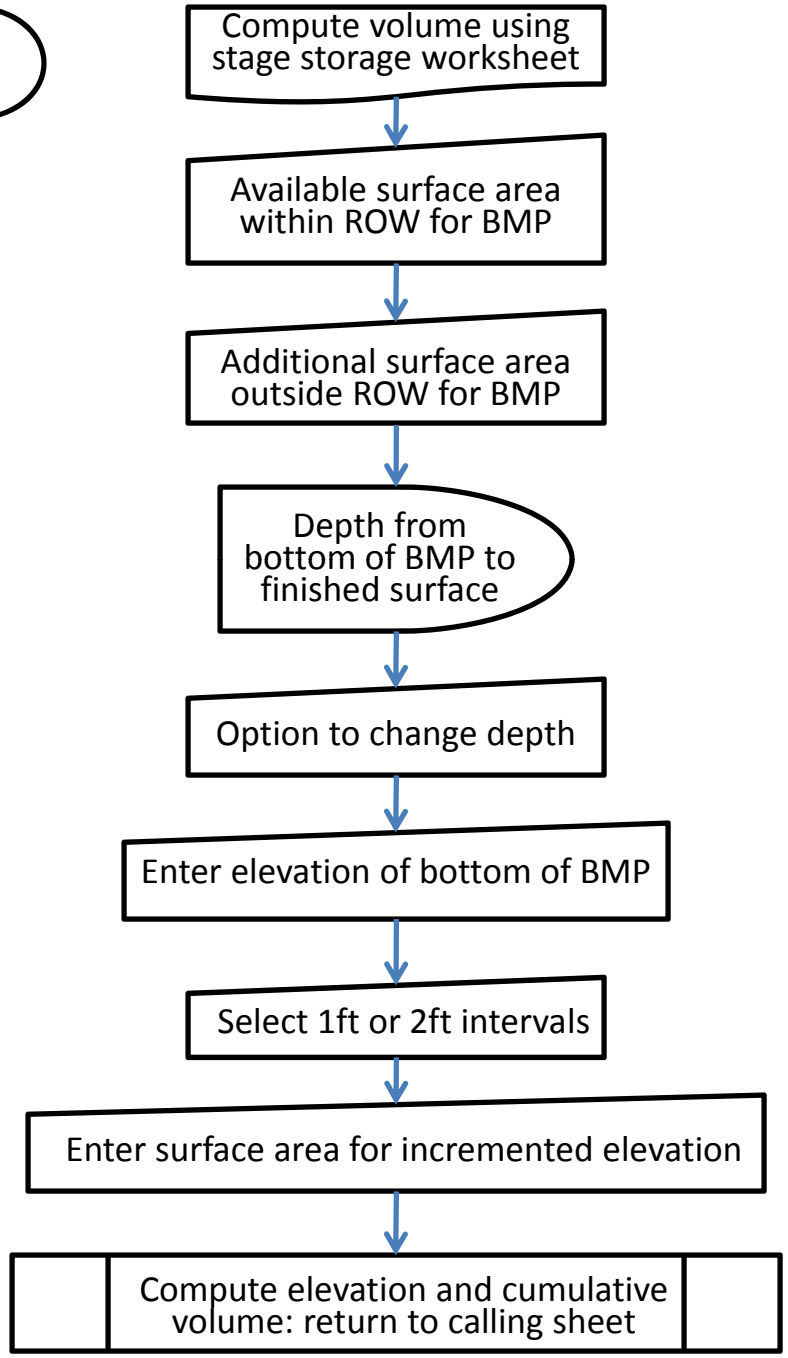

Vegetative Filter
1
Is drainage pattern as sheet flow?
no
yes
Is the filter strip slope < 8%?
no
yes
Select soil group: Sg
Select land cover: Lc
Compute strip length and TSS Rate from table
Disqualify BMP
Is Lc available? NOTE: Max. length of impervious area to filter <100 ft
Qualify BMP as "Practical"

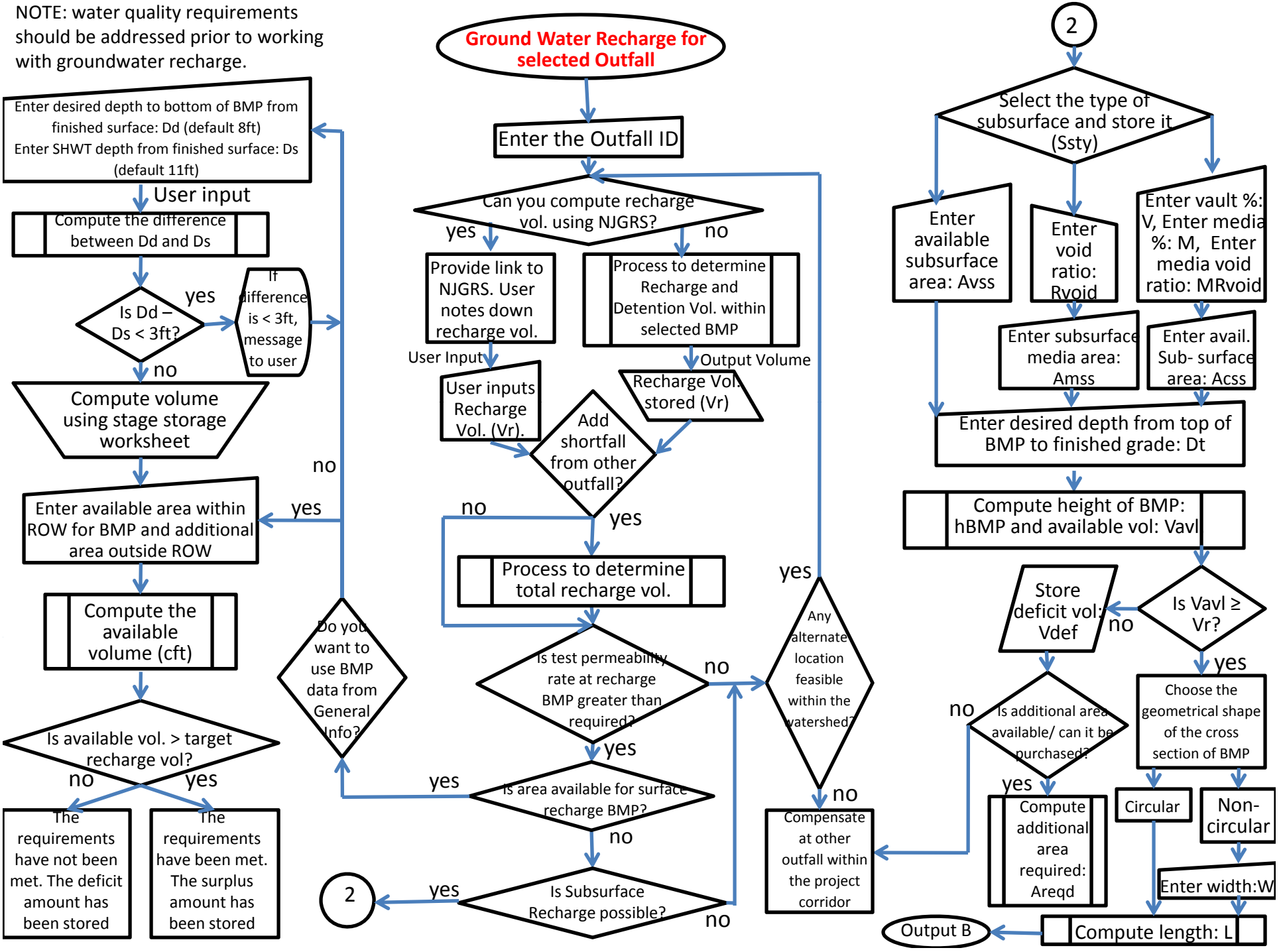

Infiltration Basin
2
Copy of Aws, Swss, Wq, and stage storage (depth, area, volume)
Is the available volume at 3ft from finished surface >SWQ total vol.?
no
Do you want to revise input?
yes
a1
yes
Enter permeability rate: Prate
no
Is time to drain < 72 hrs?
no
Disqualify BMP
yes
Qualify BMP as "Practical"
Extended Detention Basin
3
Copy of Aws, Swss, Wq, and stage storage (depth, area, volume)
Enter orifice diameter (default: 2.5 in)
Is the available volume >SWQ total vol. ?
no
Do you want to revise input?
yes
a1
yes
no
Disqualify BMP
Calculate depth, time, and TSS removal rate
Qualify BMP as "Practical"

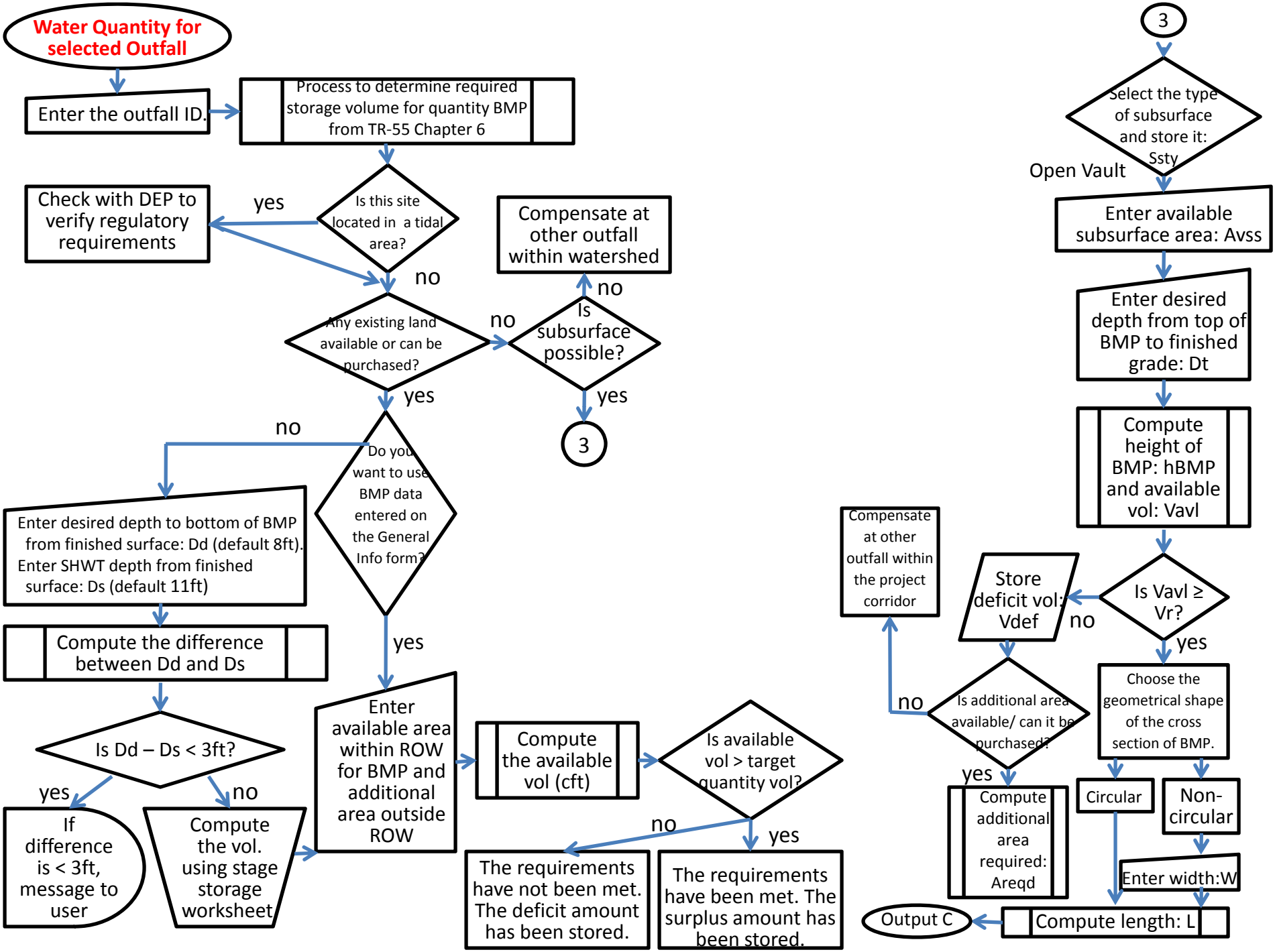

Wet Pond
4
Copy of Aws, Swss, Wq, and stage storage (depth, area, volume)
Is permanent pool vol. ≥ SWQ vol.?
no
Disqualify BMP
yes
Select ratio of permanent pool vol. to SWQ vol.
Do you have extended detention basins?
no
Compute TSS removal rate from graph
Qualify BMP as "practical"
yes
Enter orifice diameter (default: 2.5 in)
Is the available vol. > SWQ total vol.?
no
Do you want to revise input?
no
yes
a1
yes
Calculate depth, time, and TSS removal rate
Qualify BMP as "Practical"
Bio Retention Basin
5
Copy of Aws, Swss, Wq, and stage storage (depth, area, volume).
Is the available vol. at 2ft (inc. 1ft freeboard) from finished surface > SWQ total vol.?
no
Do you want to revise input?
yes
a1
no
yes
Is test Permeability rate > required?
no
Is entered depth from finished surface to SHWT is > 6ft?
yes
no
yes
Compute practical Bioretention Systems
Qualify BMP as "Practical" with illustration to include liner and perforated pipes
Qualify BMP as "Practical" with illustration
Disqualify BMP

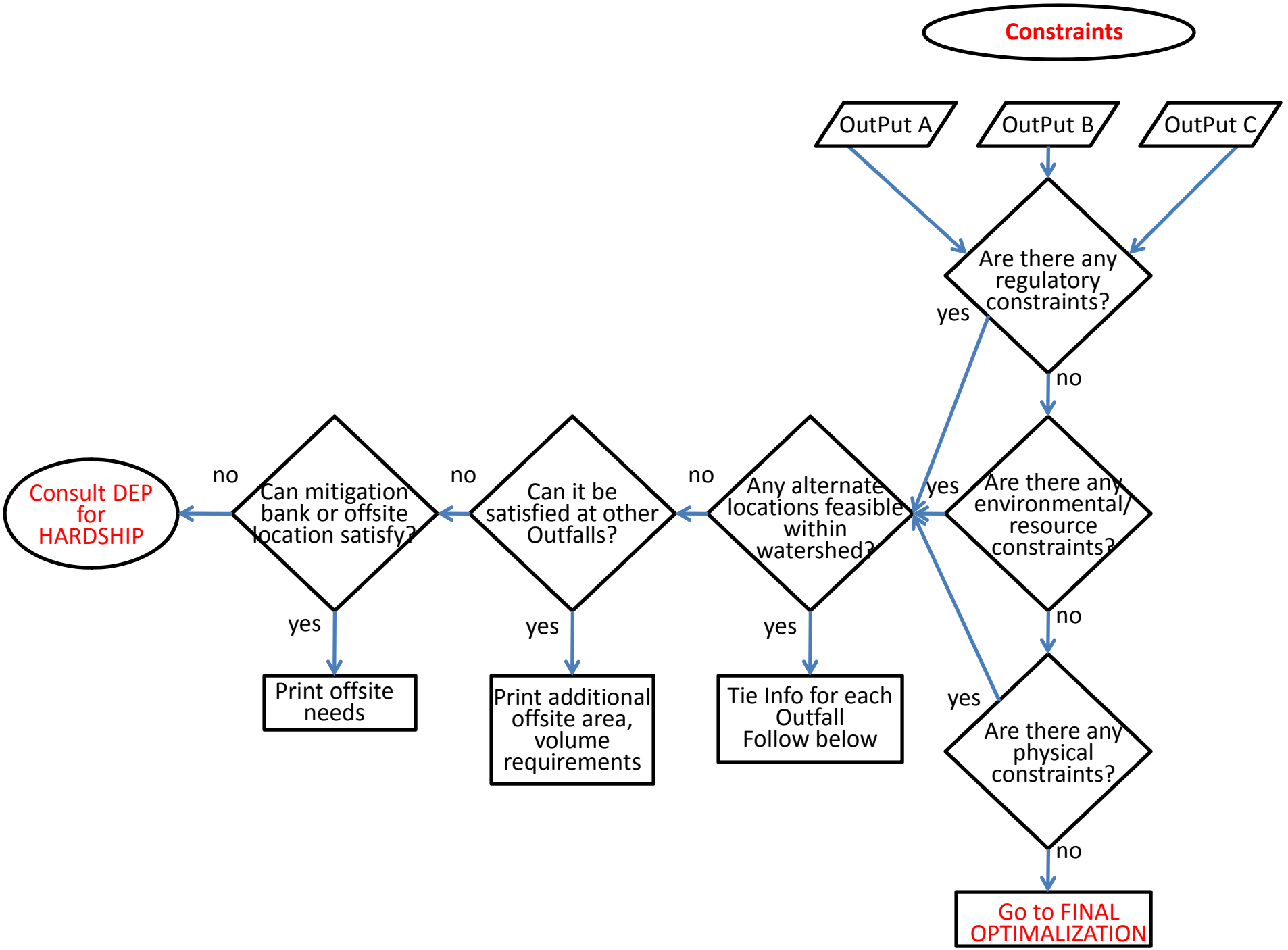

Sand Filter
6
Available SA within R.O.W. for BMP
Additional SA outside R.O.W. for BMP
Enter area at top, bottom, and depth (min 2ft) of Forebay Zone
Enter Design Perm. (def/min 4ft/day), drain time (def/min 1.5 days), thickness (def/min 1.5 ft), and porosity (def 0.3) for sand beds
Compute Forebay vs. Sand quality design storm storage vol. ratio
Enter overall flow path length vs. width ratio (def 2:1) and add land use for BMP % (def 50%).
Compute output target SWQ vol. and max available vol., compare volumes.
Qualify BMP as "Practical"
Pervious Paving
7
Output: SWQ runoff vol.
Is tested subgrade soil permeability rate > 1 in/hr?
Is subgrade soil drain time > 72hrs?
Is max pavement slope < 5%?
Is min perm rate for materials or porous paving surface and void space > 6.4 in/hr?
Is min perm rate for materials between impervious pavers > 3.2 in/hr?
Pervious pavement surface area, Media void ratio, Pavement or paver material thickness
Calculate storage bed thickness, Practical pervious paving systems
Qualify BMP as "Practical"

Stage Storage

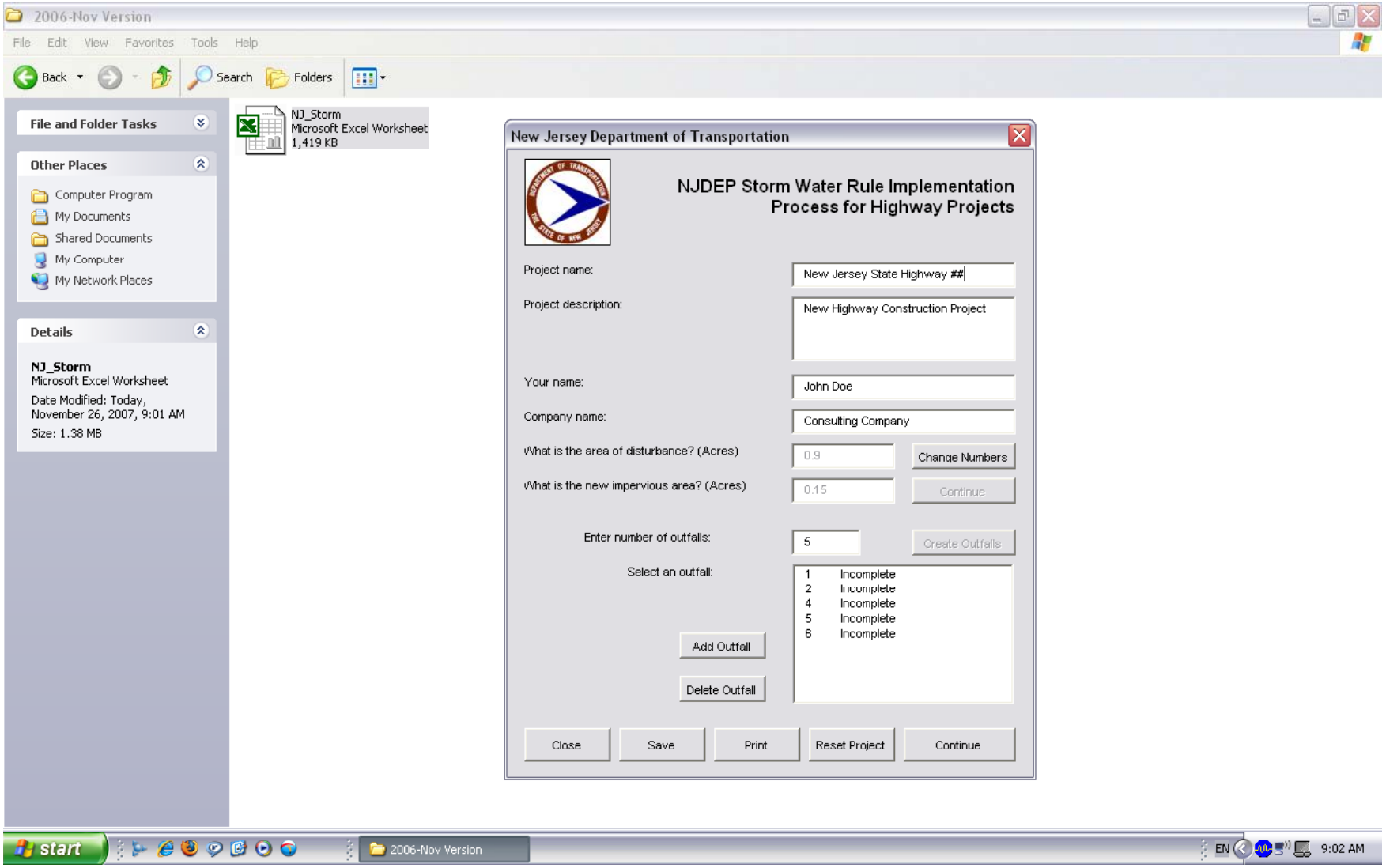



NOTE: water quality requirements should be addressed prior to working with groundwater recharge.
Ground Water Recharge for selected Outfall
Enter the Outfall ID
Can you compute recharge vol. using NJGRS?
yes
no
Provide link to NJGRS. User notes down recharge vol.
Process to determine Recharge and Detention Vol. within selected BMP
User Input
Output Volume
User inputs Recharge Vol. (Vr).
Recharge Vol. stored (Vr)
Add shortfall from other outfall?
yes
no
Process to determine total recharge vol.
Is test permeability rate at recharge BMP greater than required?
yes
no
Is area available for surface recharge BMP?
yes
no
Is Subsurface Recharge possible?
yes
no
2
Any alternate location feasible within the watershed?
yes
no
Compensate at other outfall within the project corridor
Do you want to use BMP data from General Info?
yes
no
Enter desired depth to bottom of BMP from finished surface: Dd (default 8ft)
Enter SHWT depth from finished surface: Ds (default 11ft)
User input
Compute the difference between Dd and Ds
Is Dd – Ds < 3ft?
yes
no
If difference is < 3ft, message to user
Compute volume using stage storage worksheet
Enter available area within ROW for BMP and additional area outside ROW
Compute the available volume (cft)
Is available vol. > target recharge vol?
no
yes
The requirements have not been met. The deficit amount has been stored
The requirements have been met. The surplus amount has been stored
2
Select the type of subsurface and store it (Ssty)
Enter available subsurface area: Avss
Enter void ratio: Rvoid
Enter vault %: V, Enter media %: M, Enter media void ratio: MRvoid
Enter subsurface media area: Amss
Enter avail. Sub- surface area: Acss
Enter desired depth from top of BMP to finished grade: Dt
Compute height of BMP: hBMP and available vol: Vavl
Is Vavl ≥ Vr?
yes
no
Store deficit vol: Vdef
Is additional area available/ can it be purchased?
yes
no
Compute additional area required: Areqd
Choose the geometrical shape of the cross section of BMP
Circular
Non-circular
Enter width:W
Compute length: L
Output B


Water Quantity for selected Outfall
Enter the outfall ID.
Process to determine required storage volume for quantity BMP from TR-55 Chapter 6
Is this site located in a tidal area?
yes
Check with DEP to verify regulatory requirements
no
Any existing land available or can be purchased?
no
Is subsurface possible?
no
Compensate at other outfall within watershed
yes
3
yes
Do you want to use BMP data entered on the General Info form?
no
Enter desired depth to bottom of BMP from finished surface: Dd (default 8ft).
Enter SHWT depth from finished surface: Ds (default 11ft)
Compute the difference between Dd and Ds
Is Dd – Ds < 3ft?
yes
If difference is < 3ft, message to user
no
Compute the vol. using stage storage worksheet
yes
Enter available area within ROW for BMP and additional area outside ROW
Compute the available vol (cft)
Is available vol > target quantity vol?
no
The requirements have not been met. The deficit amount has been stored.
yes
The requirements have been met. The surplus amount has been stored.
3
Select the type of subsurface and store it: Ssty
Open Vault
Enter available subsurface area: Avss
Enter desired depth from top of BMP to finished grade: Dt
Compute height of BMP: hBMP and available vol: Vavl
Is Vavl ≥ Vr?
yes
Choose the geometrical shape of the cross section of BMP.
Circular
Non-circular
Enter width:W
Compute length: L
Output C
no
Store deficit vol: Vdef
Is additional area available/ can it be purchased?
no
Compensate at other outfall within the project corridor
yes
Compute additional area required: Areqd


Constraints
OutPut A
OutPut B
OutPut C
Are there any regulatory constraints?
yes
no
Are there any environmental/ resource constraints?
yes
no
Are there any physical constraints?
yes
no
Go to FINAL OPTIMALIZATION
Any alternate locations feasible within watershed?
yes
Tie Info for each Outfall Follow below
Can it be satisfied at other Outfalls?
no
yes
Print additional offsite area, volume requirements
Can mitigation bank or offsite location satisfy?
no
yes
Print offsite needs
Consult DEP for HARDSHIP

Stormwater Decision Software



Acknowledgments

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