SvR DESIGN COMPANY

MEMORANDUM #03

DATE: January 25, 2010

TO: Ed O'Brien, Department of Ecology
Kate Snider, Floyd/Snider

FROM: Tom von Schrader, PE LEED AP
Kathryn Gwilym, PE LEED AP
Amalia Leighton, PE
Lolly Kunkler, PE

RE: WWHM Modeling LID Comparison Analysis
Department of Ecology LID Technical Committee Presentation
SvR Project No. 09034

This memo is to summarize the modeling analysis for distribution to the DOE LID Technical Advisory Committee in preparation for the next meeting on January 25, 2010. The purpose of the analysis was to look at 5 density scenarios using three soil types and compare the results of LID technologies implemented on the site and in the ROW. This analysis is meant to be a relative comparison of the various densities. Provided with this memo is the following information:

1. Model Scenarios - Land Cover Assumptions for the 5 Scenario Areas (P2)
2. Modeling Assumptions for running the analyses and Description of the Modeling Runs A and B (P3-4)
3. Modeling Runs A and B Scenario Sketches (P5-7)
4. Graphs with Duration Curves for the Modeling Runs A and B (P8-16)
5. Annual Runoff Volume Comparison for the Modeling Runs (P17)
6. Modeling Run C– Native Vegetation Scenario Sketches (P18)
7. Modeling Assumptions for Modeling Runs C – Native Vegetation (19-20)
8. Graphs with Duration Curves for the Modeling Run C (21-23)

Please note, Modeling Run C utilizing native preservation for the 5 dwu/ac (Scenario 3) and 10 dwu/ac (Scenario 4) only. The following was assumed for the preserved native protection areas of the 1 acre developments:

- Scenario 3, 5dwu/1ac: 40% Preserved Native Vegetation Forest
- Scenario 4, 10dwu/1ac: 30% Preserved Native Vegetation Forest
- Same size for private on-site bioretention areas Modeling Run B
- Same assumptions for ROW as in Modeling Run B
- Shared driveways for the housing units
- Multi-story and multi-plexes for the housing footprints. Same number of single family units would not be feasible with these scenarios.

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Model Scenarios

Department of Ecology - Stormwater Management with Low Impact Development Techniques
SvR # 09034
12/18/2009 Revised 12/21/2009 Revised 1/6/2010

Prepared By:
Kathy Gwilym, PE
Amalia Leighton, PE
QA/QC - Tom von Schrader, PE

Scenario	1			2			3			4			5		
Density	1 DU/ 5 Acre			1 DU/ Acre			5 DU/ Acre			10 DU/ Acre			Commercial - 13 acre		
Land Area	217,800	sf/ parcel		43,560	sf/ parcel		8,712	sf/ parcel		4,356	sf/ lot		566,280	sf/ parcel	
	Frontage	200 Lf		Frontage	100 Lf		Frontage	75 Lf / lot	375 LF/ac	Frontage	50 Lf / lot	500 lf/ac	Frontage	800 LF	
Totals	100%	217,800	5	100%	43,560	1	97%	8,712	0.20	100%	4,356	0.10	100%	566,280	13
	Percent	*Area (sf)*	*Area (Acre)*	*Percent*	*Area (sf)*	*Area (Acre)*	*Percent*	*Area (sf)*	*Area (Acre)*	*Percent*	*Area (sf)*	*Area (Acre)*	*Percent*	*Area (sf)*	*Area (Acre)*
Land Cover															
Non-Vegetative Area Subtotals	***7.0%***	***15,246***	***0.350***	***16.3%***	***7,110***	***0.163***	***47.6%***	***4,146***	***0.095***	***73.8%***	***3,216***	***0.074***	***92.0%***	***520,978***	***11.960***
House and Accessory Buildings	4.0%	8,712	0.200	8.7%	3,800	0.087	20.0%	1,742	0.040	41.6%	1,811	0.042	30.0%	169,884	3.900
Patio/ Walks (pervious)	1.0%	2,178	0.050	1.0%	440	0.010	5.0%	436	0.010	5.1%	220	0.005	5.0%	28,314	0.650
Driveway/ Parking (pervious)	2.0%	4,356	0.100	2.0%	880	0.020	5.0%	436	0.010	5.1%	220	0.005	45.6%	257,980	5.922
ROW - Walks (pervious)	0.0%	0	0.000	1.2%	540	0.012	5.1%	444	0.010	5.5%	240	0.006	1.3%	7,600	0.174
ROW - Roads (varies)	0.0%	0	0.000	3.3%	1,450	0.033	12.5%	1,088	0.025	16.6%	725	0.017	5.1%	28,800	0.661
Commercial Delivery Truck Paving (varies)													5.0%	28,400	0.652
Vegetative Land Cover															
Pervious Subtotal	***93.0%***	***202,554***	***4.65***	***83.7%***	***36,450***	***0.84***	***48.9%***	***4,566***	***0.10***	***26.2%***	***1,140***	***0.03***	***8.0%***	***45,302***	***1.04***
Pasture	83.0%	180,774	4.150	0.0%	0	0.000	0.0%	0	0.000	0.0%	0	0.000	0.0%	0	0.000
Landscape/ Grass	10.0%	21,780	0.500	81.6%	35,550	0.816	43.9%	3,826	0.088	14.9%	650	0.015	3.0%	16,988	0.390
ROW - Landscape	0.0%	0	0.000	2.1%	900	0.021	5.0%	740	0.017	11.2%	490	0.011	5.0%	28,314	0.650
Bioretention Length for Private Site/lot	500			100			30			15			400		
Bioretention Length for Public ROW/lot	0			90			65			40			760		
Total Bioretention Length/lot	500			190			95			55			1160		
Dispersion?	Yes for Roof only			Yes for Roof only			No because assume 50' not provided			No because assume 50' not provided			No because assume 50' not provided		

SEE ATTACHED FOR MODELING ASSUMPTIONS AND MODELING RUNS DESCRIPTIONS

SvR DESIGN COMPANY

DOE TECHNICAL COMMITTEE
Modeling Assumptions for LID Comparison
January 19, 2010,

1.	All modeling done with WWHM3 - Free download from Ecology website.
2.	New development. Does not assume redevelopment for the sites.
3.	Integrated drainage plan for development.
4.	Sites are located in Lacey for rainfall type.
5.	Three soil infiltration rates: 0.02 in/hr (C); 0.25 in/hr (C); 2.0 in/hr (A/B).
6.	Analyze durations for 8 percent of the 2 year to the 50 year per DOE.
7.	Predeveloped condition to be moderate slope and forest with soil type based on infiltration rate.
8.	Developed condition to be flat with soil type based on infiltration rate. Type A/B for 2 in/hr, Type C for .02 in/hr and .25 in/hr infiltration rate.
9.	No run-on to porous pavements assumed for those being modeled as gravel trench.
10.	Public and private porous sidewalk to be modeled as impervious draining to gravel infiltration trench which overflow to bioretention facility.
11.	Public and private bioretention facility to be modeled as gravel infiltration trench facility in WWHM.
12.	Buildings and public and private landscape areas to drain to bioretention facility.
13.	Public non-porous road to be modeled as impervious and drain to bioretention.
14.	Bioretention to have 12 inches of ponding depth and 18 inches of bioretention soil; assume bioretention soil has long term infiltration rate of 1.5 in/hr with 40-percent porosity/voids space. Side slopes 2:1 and 3:1.
15.	Porous pavement for public walks to have 4 inches of storage subbase and for public roads/driveways to have 6 inches of storage subbase. Porous pavement to have 30-percent porosity/voids space in subbase. Storage in top paving layer not included. Private porous walks and driveways to have ½ inch of allowable ponding because assume walks and driveways on slope greater than 2-percent and interceptor dams not used everywhere on the site under the porous.
16.	For site with 2.0 in/hr infiltration rate in subgrade and 1.5 in/hr for bioretention soil, bioretention facility to be modeled with 12 inch ponding storage only and at a rate of 1.5 in/hr. No allowance for storage in the bioretention soil since it has slower infiltration rate then native subgrade.
17.	For estimating bioretention in Right-of-Way the width of 10-foot driveway was deleted from frontage length.
18.	Driveway length on site is intended to be similar in length to bioretention swale length adjacent to on-site driveway.
19.	For scenario 2, 3 and 4, it is assumed the site fronts a Right-of-Way and each parcel is responsible for half the Right-of-Way improvements. It is assumed for these scenarios that the half street improvements include 14-foot road, 10-foot planting zone for bioretention and 6-foot sidewalk. Total Right-of-Way width of 60. For scenario 1, assume no frontage improvements for rural condition. For Scenario 5, assume commercial is adjacent to arterial with multiple lanes. For 5, it was assumed the frontage would relate to 36 feet of road width 10-foot planter and 10-foot sidewalk.
20.	For sites with 2 in/hr infiltration rate, it is assumed that the residential roof is infiltrated into infiltration trenches so the area of the roof is not inputted into the model for scenario 1 and 2. Infiltration trenches need to be minimum 15 feet from building and so this would not be applicable with scenarios 3 and 4.

DESCRIPTION OF MODELING RUNS FOR THE SCENARIOS

Scenario 1 = 1 dwu/5ac
Scenario 2 = 1 dwu/1ac
Scenario 3 = 5 dwu/1 ac
Scenario 4 = 10 dwu/1ac
Scenario 5 = Commercial development

1st Modeling Run A

Assume that the private walks and drives are pervious and drain to gravel infiltration trench that is the same size of area as the walk/driveway and this overflows to bioretention facility. The public walks are pervious and drain to gravel infiltration trench that overflows to bioretention. Public road is non-pervious and drains to public bioretention. Roof dispersion is applied just to scenario 1 and 2.

2nd Modeling Run B

Same assumptions as 1st modeling run except the public road is pervious. Pervious road is modeled as gravel infiltration trench that overflows to public bioretention.

3rd Modeling Run C

3rd modeling run is to modify site plans of scenarios 3 and 4 from 2nd modeling run to preserve a portion of native vegetation. For Scenario 3 it is assumed there is 40% Native Protection Area within the 1 acre. For Scenario 4 it is assumed there is 30% Native Protection Area within the 1 acre.

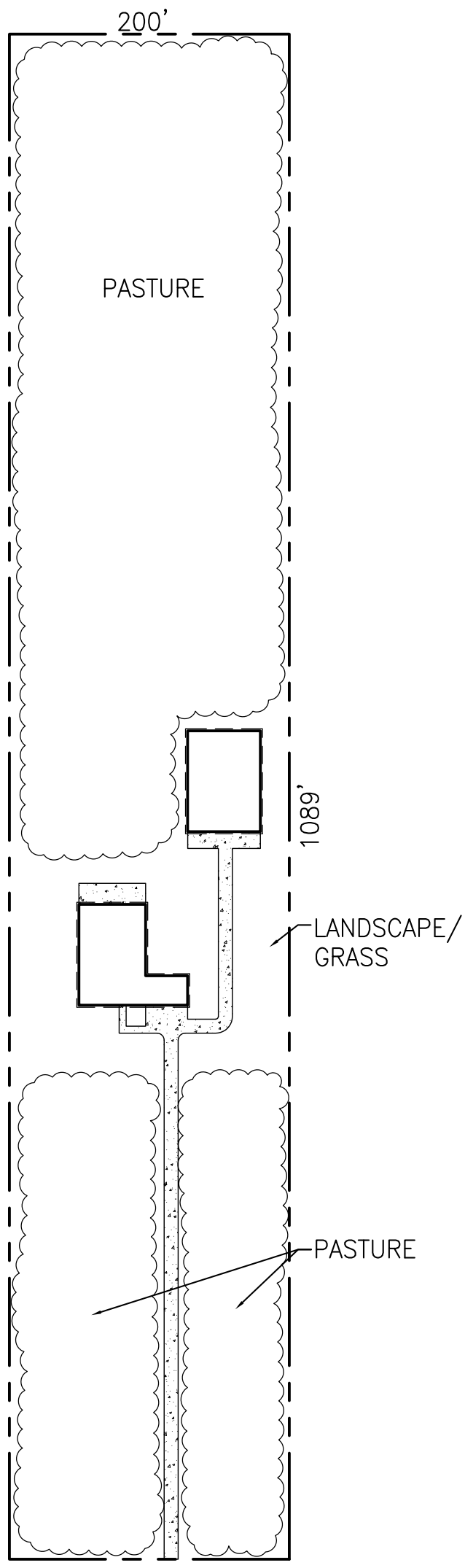
4th Modeling Run D

4th modeling run is to run each scenario with USEPA standard. Assumption for modeling to be determined by DOE. This analysis will not be included in time for the meeting on 1/25/10.

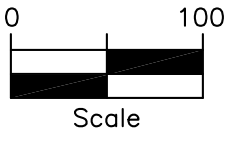
Commercial Site Modeling Runs A and B

Additionally, for scenario 5, 1st modeling run (run A), we assume that the commercial delivery trucking route is impervious draining to private bioretention, the parking area is pervious draining to a gravel infiltration trench then overflow to bioretention facility. Impervious areas drain to bioretention facility.

For scenario 5, 2nd modeling run (run B), assume same approach as 1st modeling run, except assume the commercial delivery trucking route is pervious draining to gravel infiltration trench that overflows to bioretention facility. It is assumed that all the pervious areas are under 2-percent, so that the ponding depth matches the subbase depth.



Model Scenario 1: 1 DU/ 5 Acre



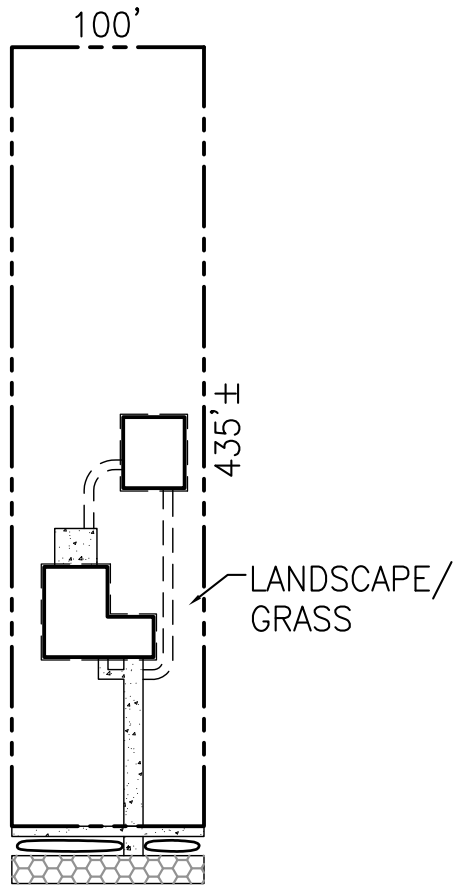
DRAFT

Department of Ecology
LID Technical Committee
Modeling Scenario Sketches

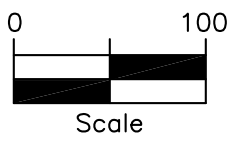
SvR No. 09034

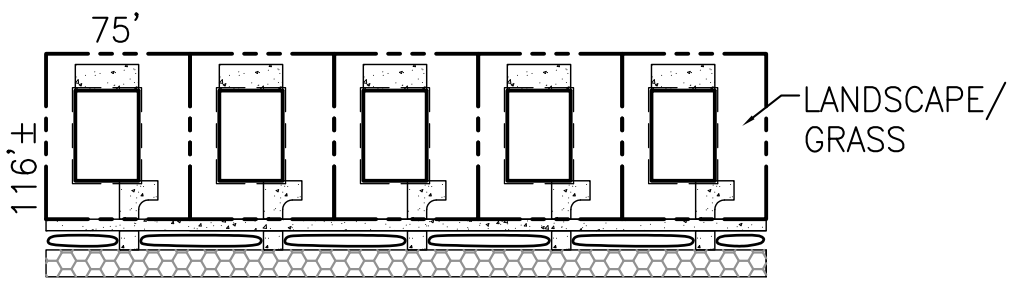
January 19, 2010

Plotted: Jan 19, 2010 - 3:21:44pm By teresad
File: G:\09c\09034c DOE LID\Current\DOE LID Scenarios.dwg Layout: Scenario 1

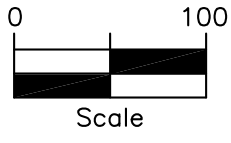


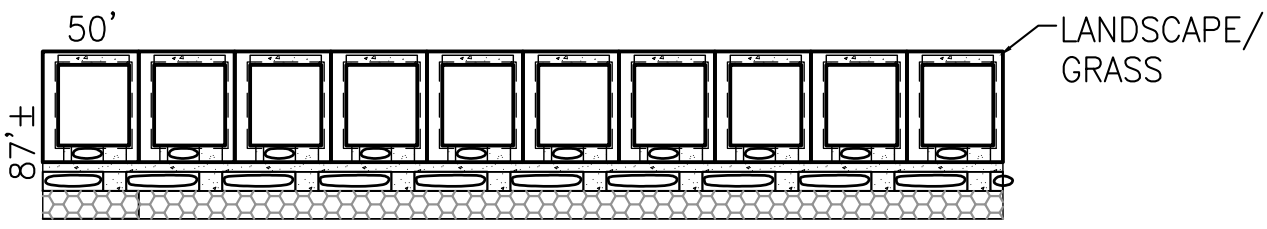
Model Scenario 2: 1 DU/ 1 Acre



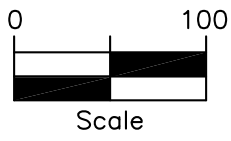


Model Scenario 3: 5 DU/ 1 Acre





Model Scenario 4: 10 DU/ 1 Acre



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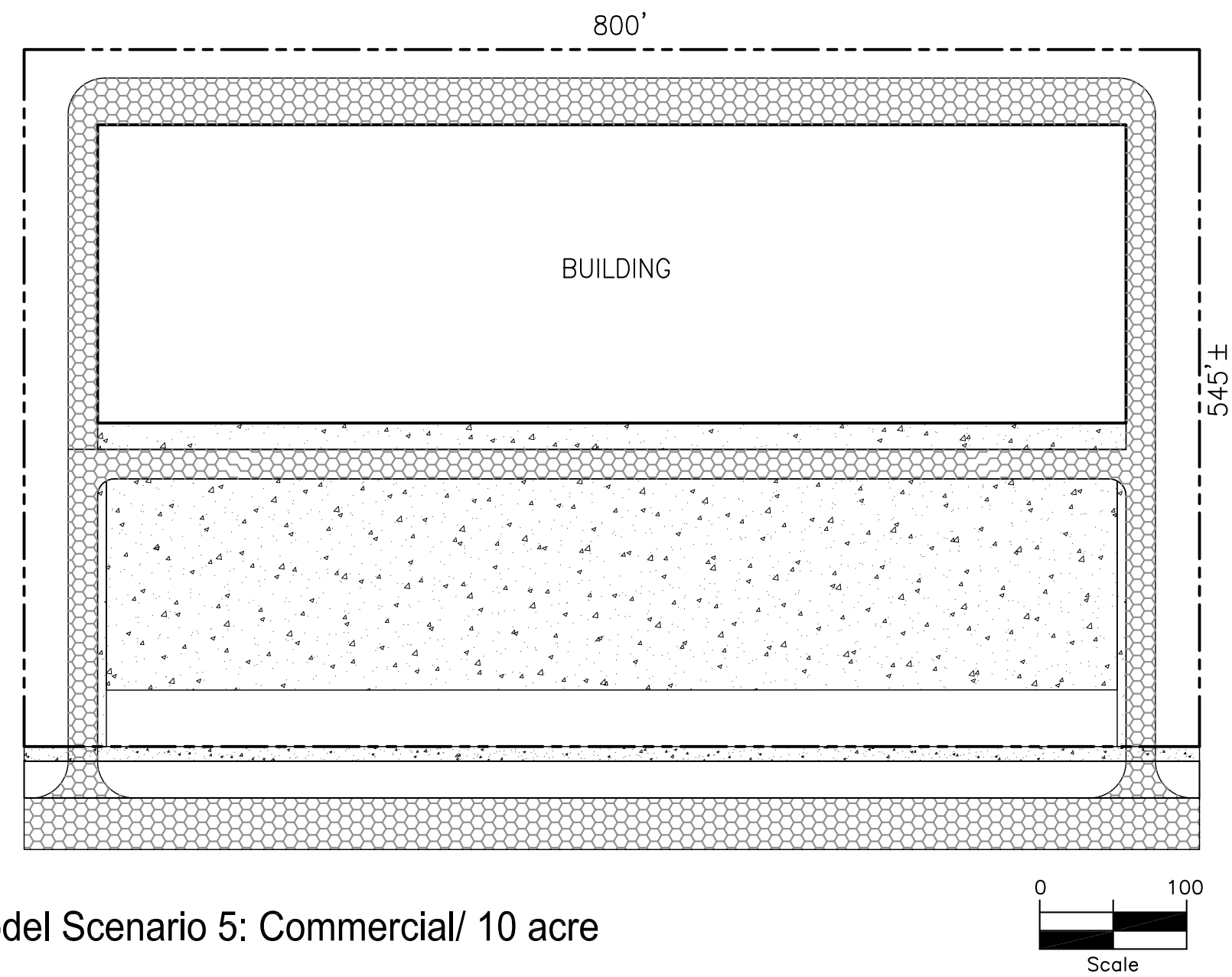
LID Technical Committee
Modeling Scenario Sketches

SvR No. 09034

January 19, 2010

Plotted: Jan 19, 2010 - 3:20:28pm By teresad
File: G:\09c\09034c DOE LID\Current\DOE LID Scenarios.dwg Layout: Scenario 2_3_4



Model Scenario 5: Commercial/ 10 acre

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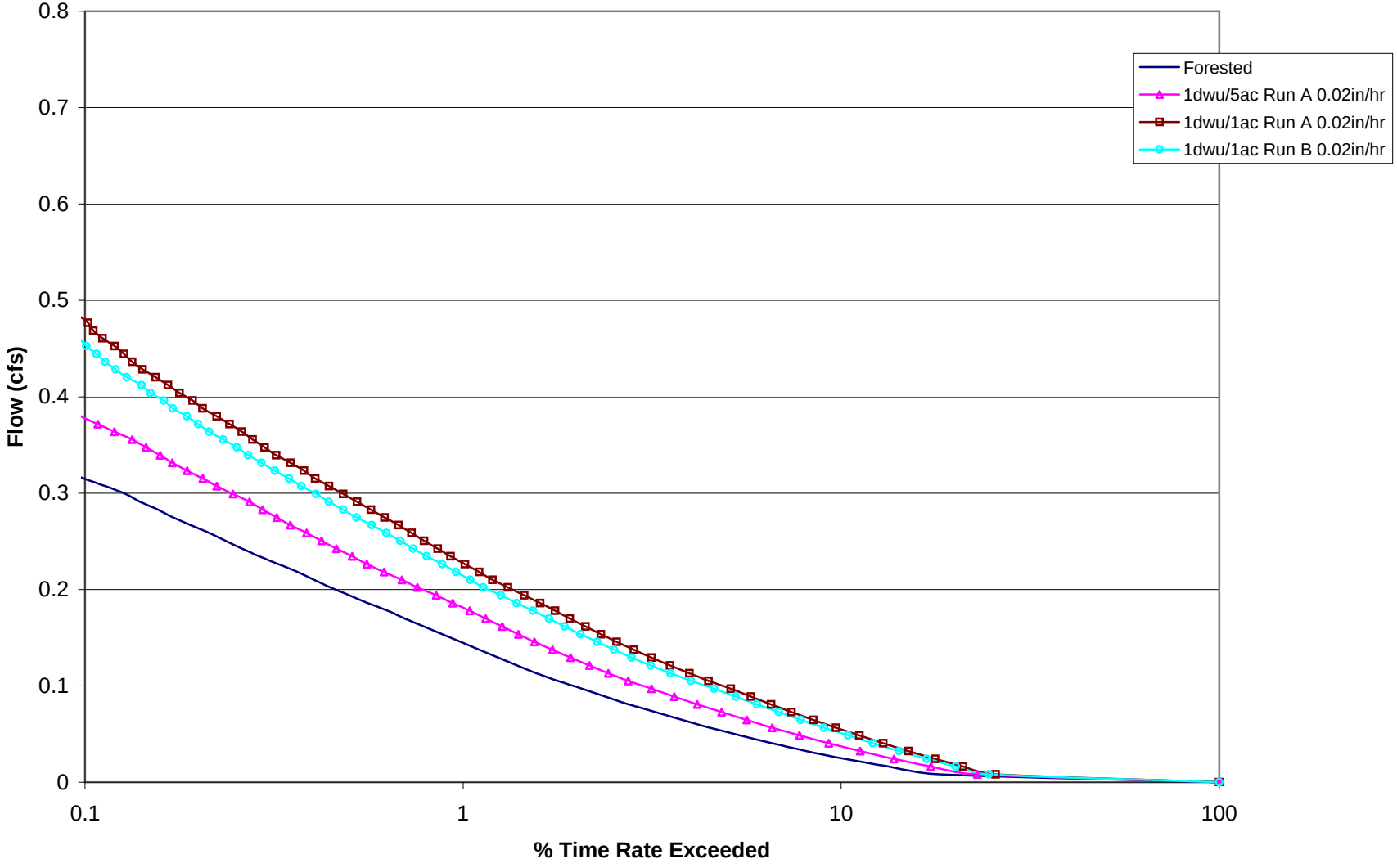
Department of Ecology
LID Technical Committee
Modeling Scenario Sketches

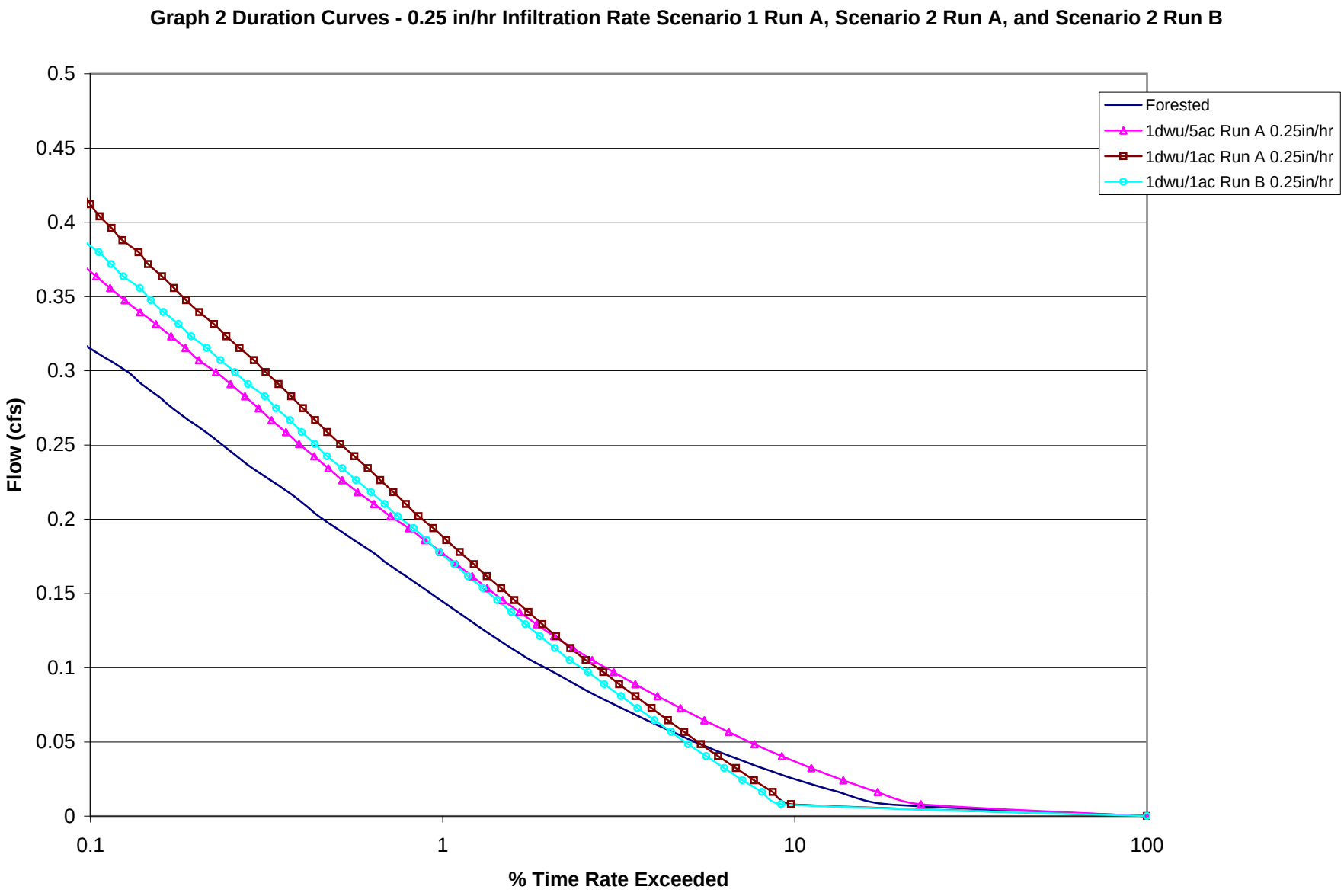
SvR No. 09034

January 19, 2010

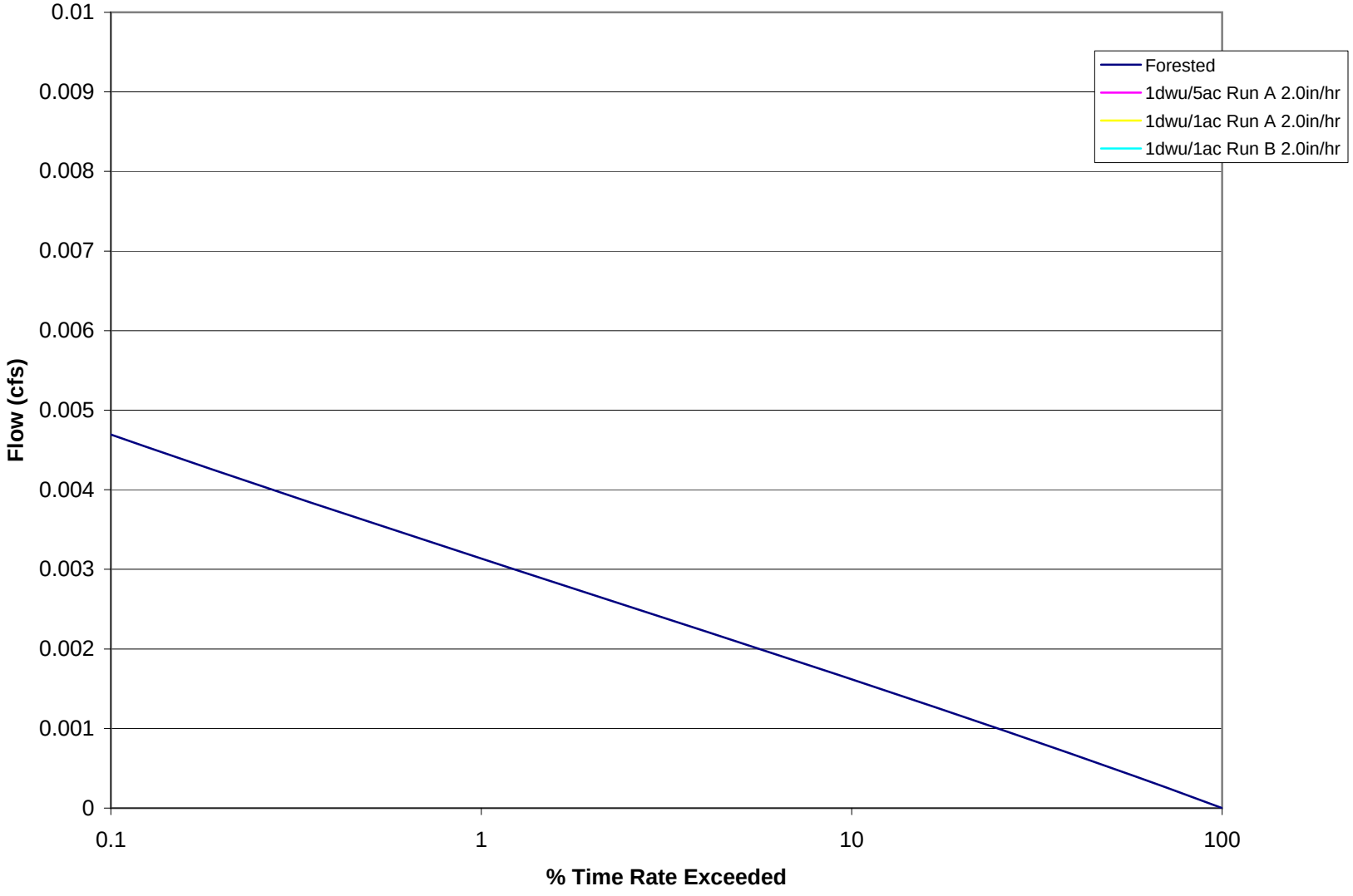
Plotted: Jan 19, 2010 - 3:21:23pm By teresad
File: G:\09c\09034c DOE LID\Current\DOE LID Scenarios.dwg Layout: Scenario 5

Graph 1 - Duration Curves - 0.02 in/hr Infiltration Rate Scenario 1 Run A, Scenario 2 Run A, and Scenario 2 Run B

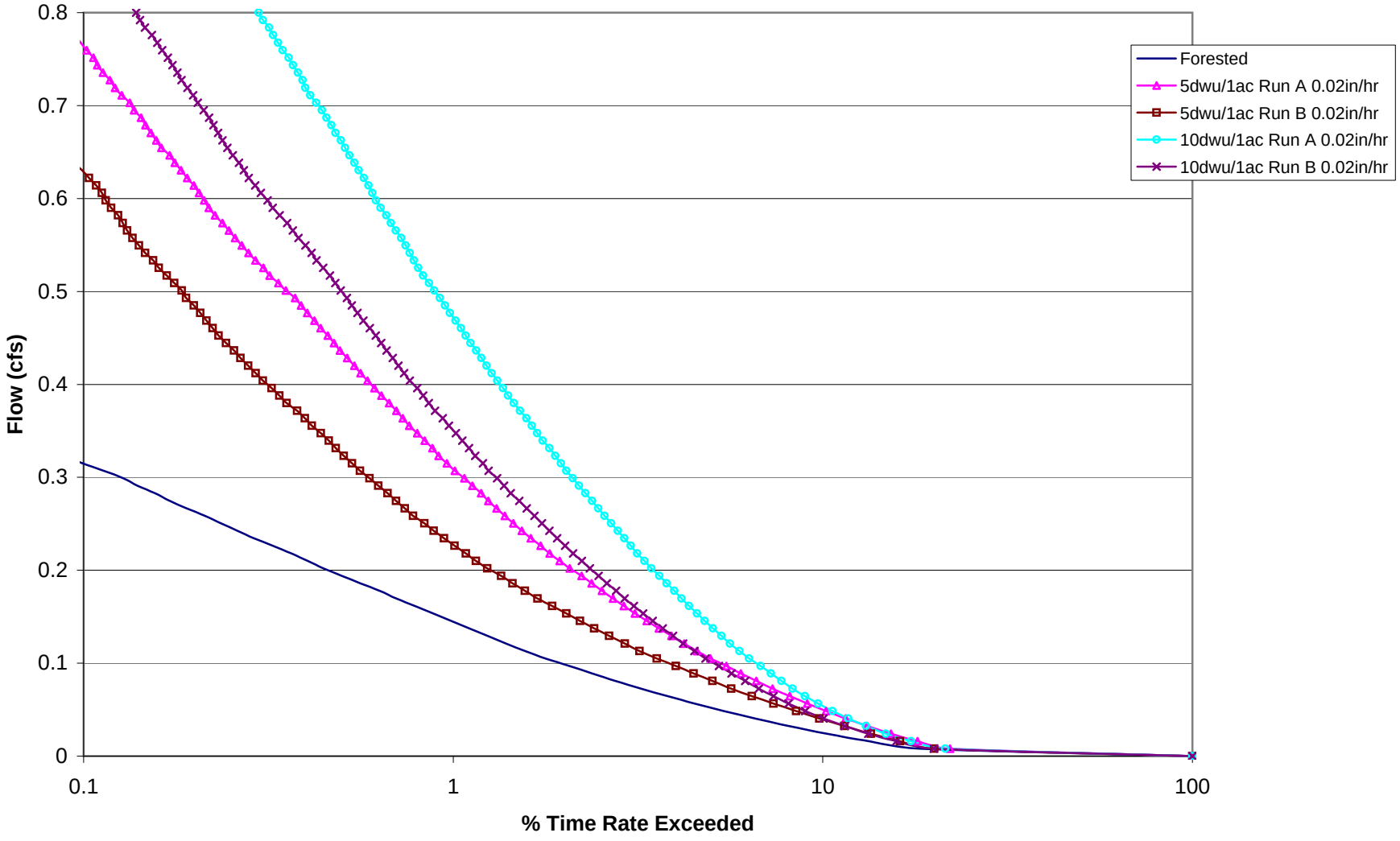



Graph 2 Duration Curves - 0.25 in/hr Infiltration Rate Scenario 1 Run A, Scenario 2 Run A, and Scenario 2 Run B
Flow (cfs)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
1
10
100
% Time Rate Exceeded
Forested
1dwu/5ac Run A 0.25in/hr
1dwu/1ac Run A 0.25in/hr
1dwu/1ac Run B 0.25in/hr

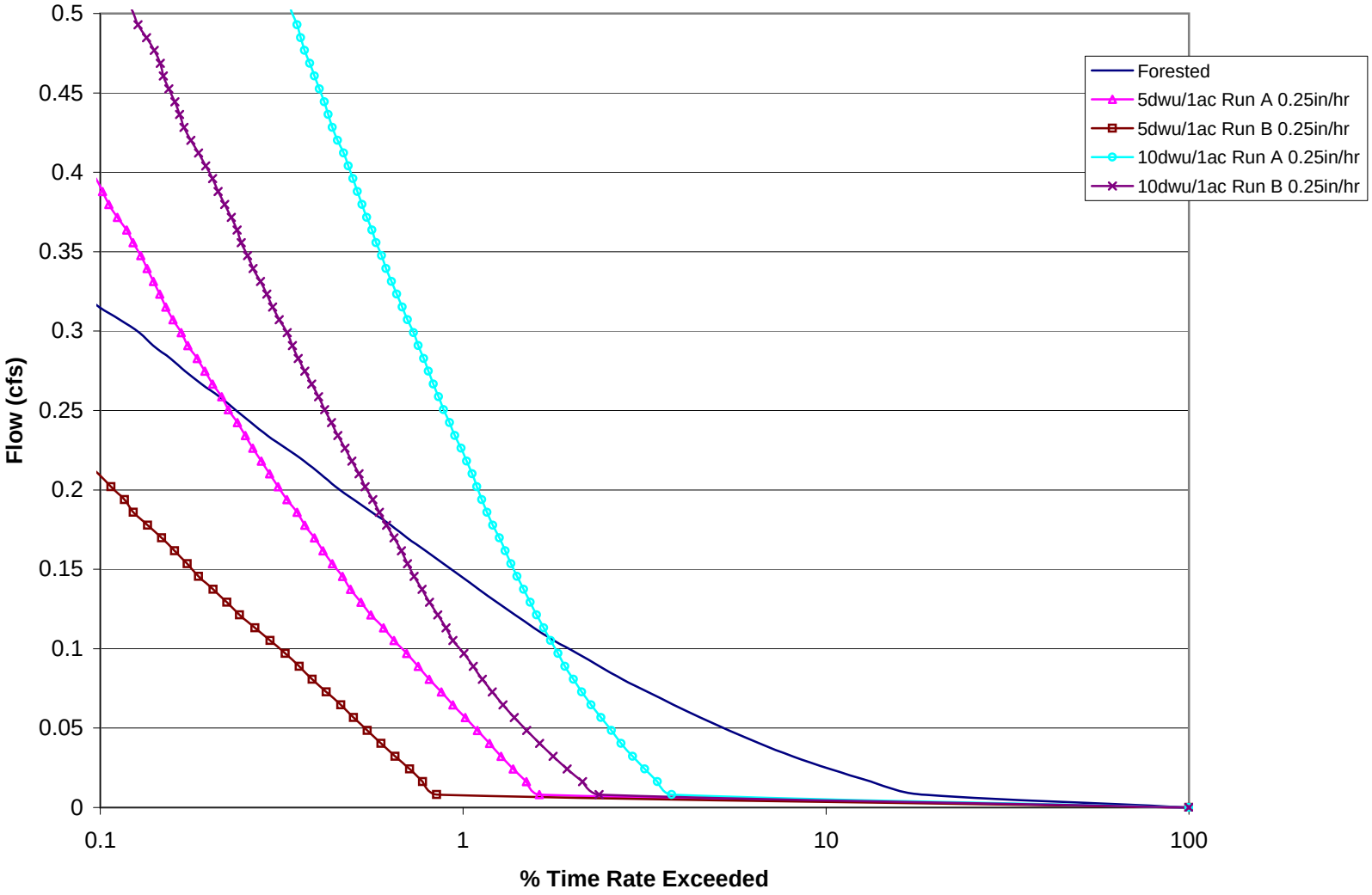
Graph 3 Duration Curves - 2.0 in/hr Infiltration Rate Scenario 1 Run A, Scenario 2 Run A, and Scenario 2 Run B



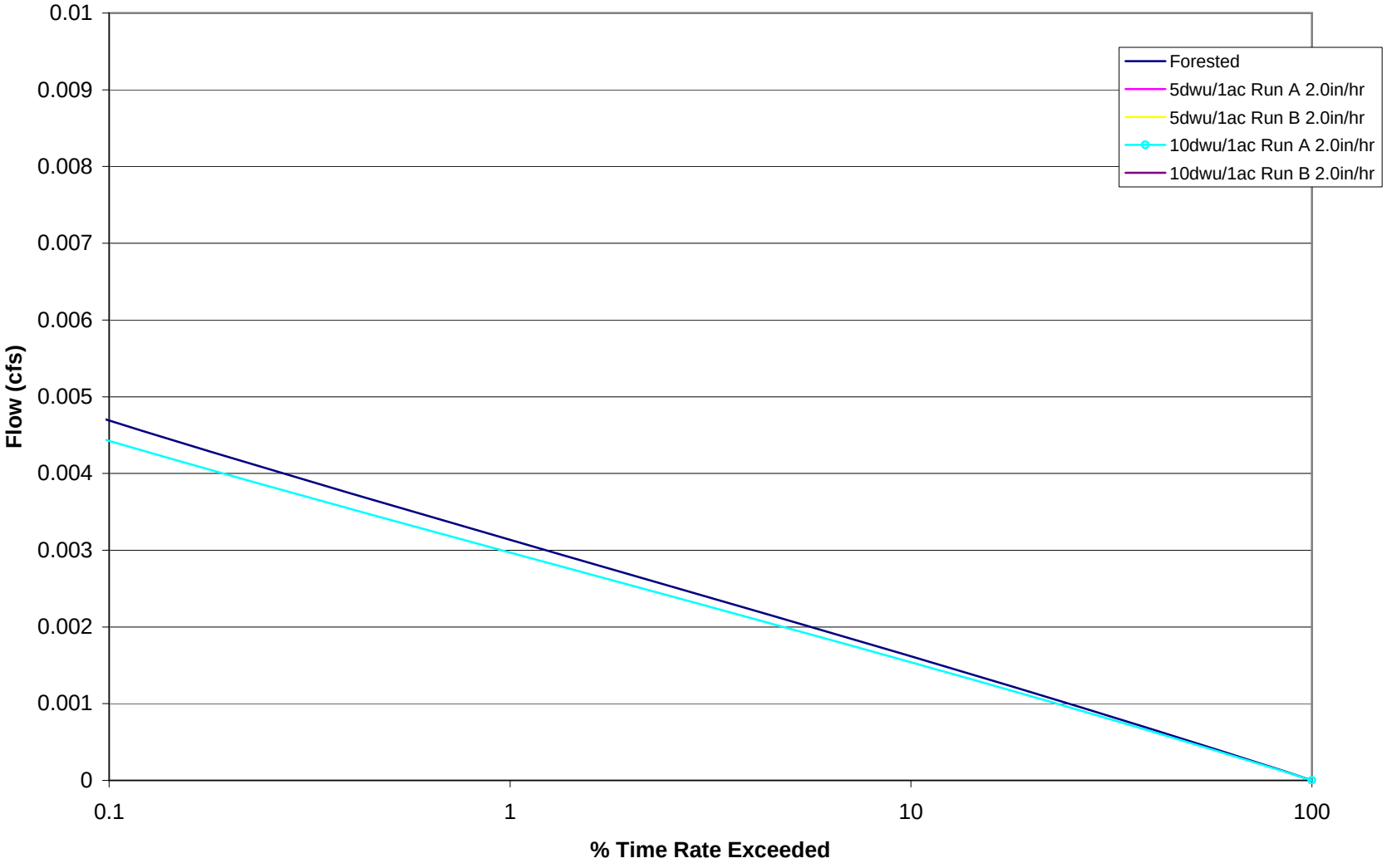
Graph 4 Duration Curves - 0.02 in/hr Infiltration Rate Scenario 3 Run A, Scenario 3 Run B, Scenario 4 Run A, and Scenario 4 Run B



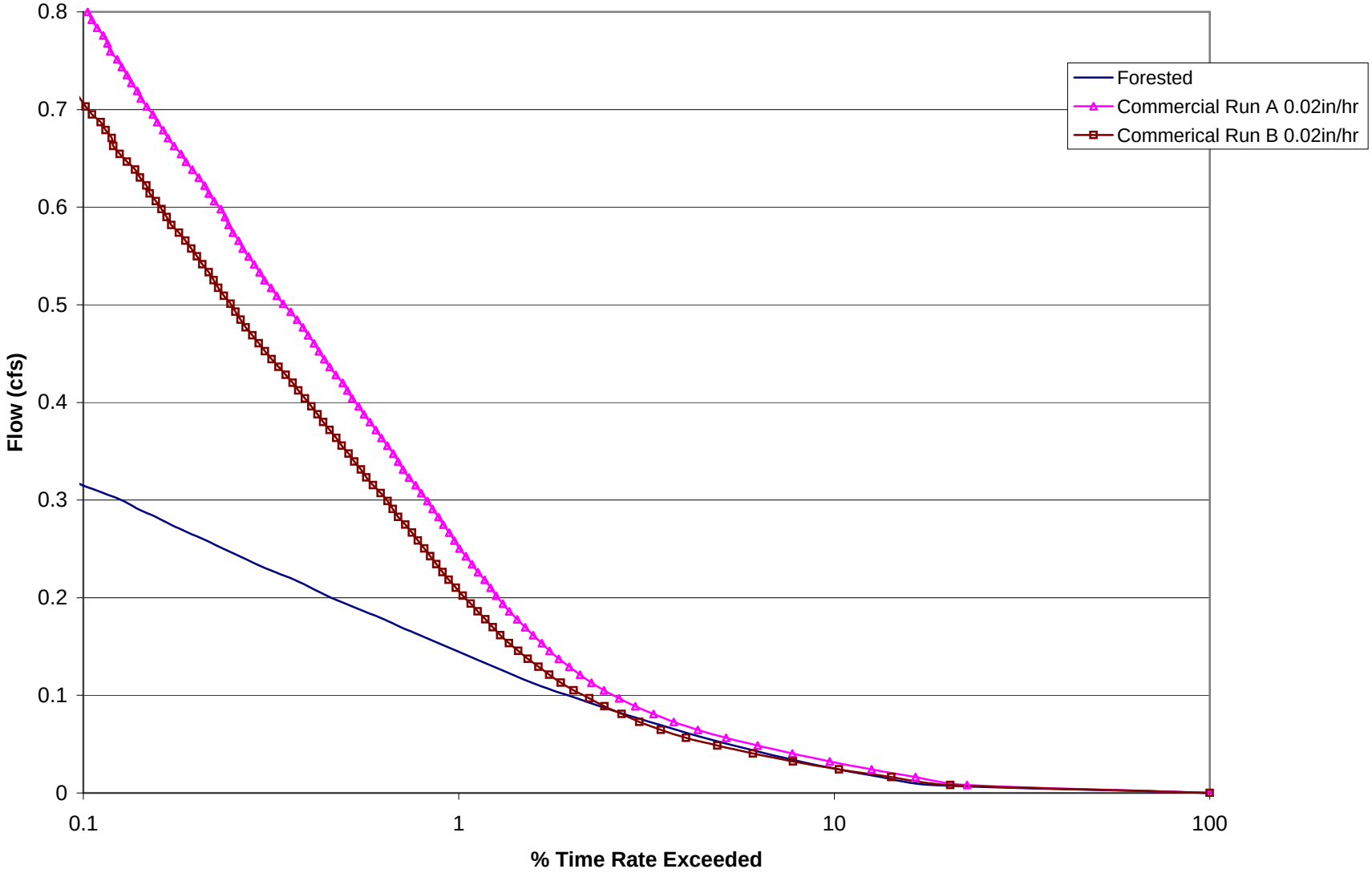
Graph 5 Duration Curves - 0.25 in/hr Infiltration Rate Scenario 3 Run A, Scenario 3 Run B, Scenario 4 Run A, and Scenario 4 Run B

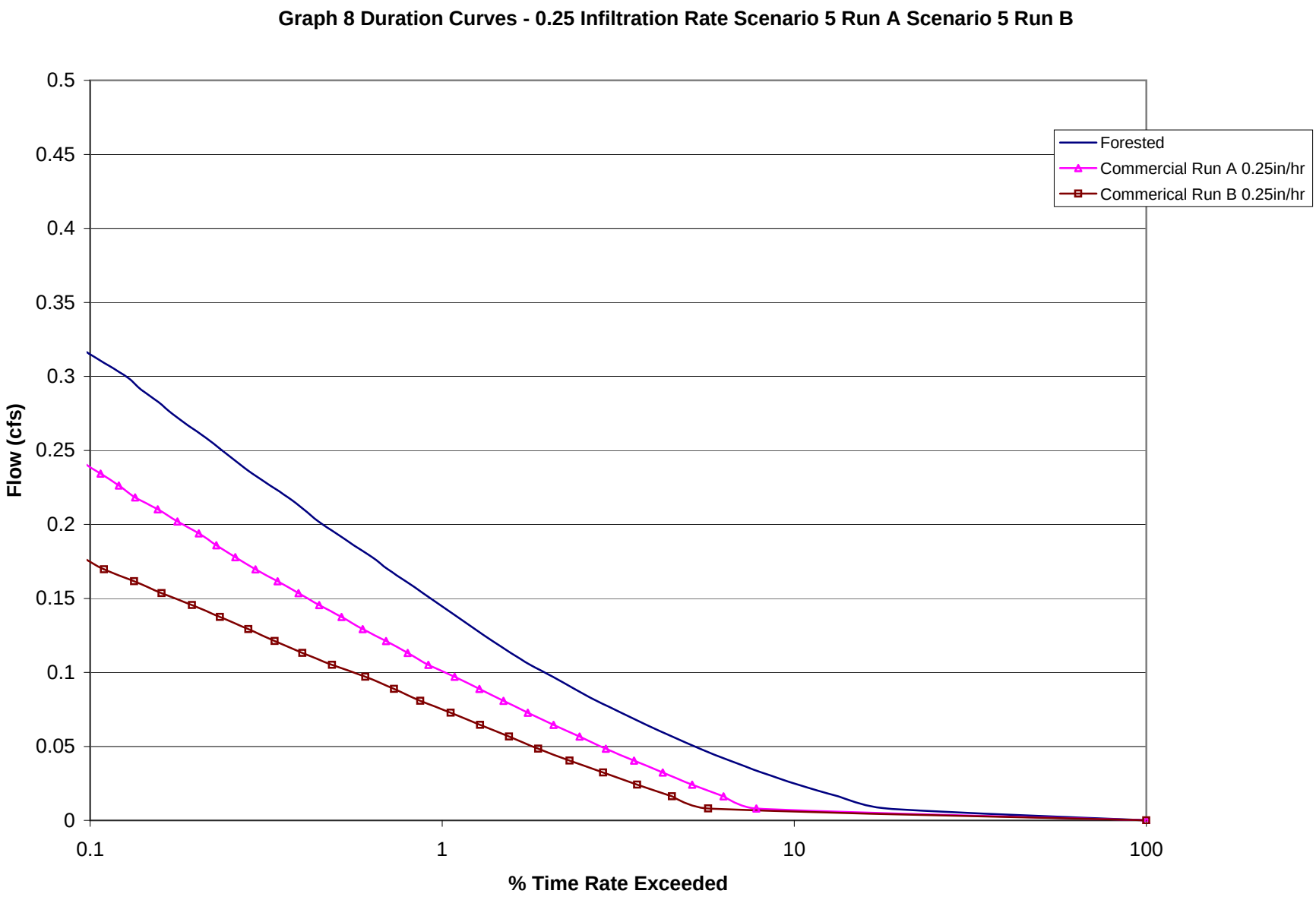


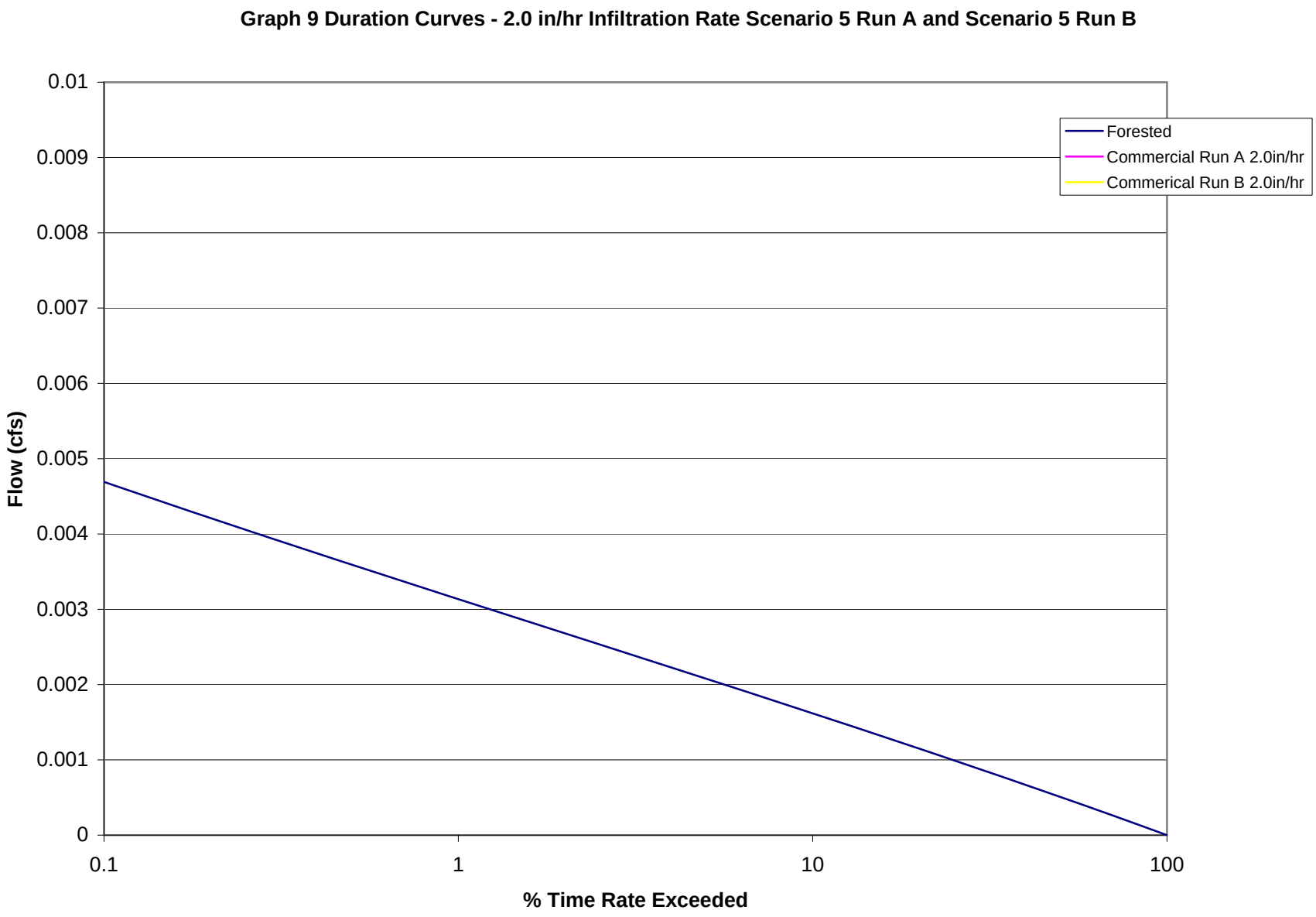
Graph 6 Duration Curves - 2.0 in/hr Infiltration Rate Scenario 3 Run A, Scenario 3 Run B, Scenario 4 Run A, and Scenario 4 Run B



Graph 7 Duration Curves - 0.02 in/hr Infiltration Rate Scenario 5 Run A and Scenario 5 Run B




Graph 8 Duration Curves - 0.25 Infiltration Rate Scenario 5 Run A Scenario 5 Run B
Flow (cfs)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
1
10
100
% Time Rate Exceeded
Forested
Commercial Run A 0.25in/hr
Commerical Run B 0.25in/hr


Graph 9 Duration Curves - 2.0 in/hr Infiltration Rate Scenario 5 Run A and Scenario 5 Run B
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Flow (cfs)
0.1
1
10
100
% Time Rate Exceeded
Forested
Commercial Run A 2.0in/hr
Commerical Run B 2.0in/hr

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Annual Runoff Volume Comparison

SvR #09034 1/19-22/2010

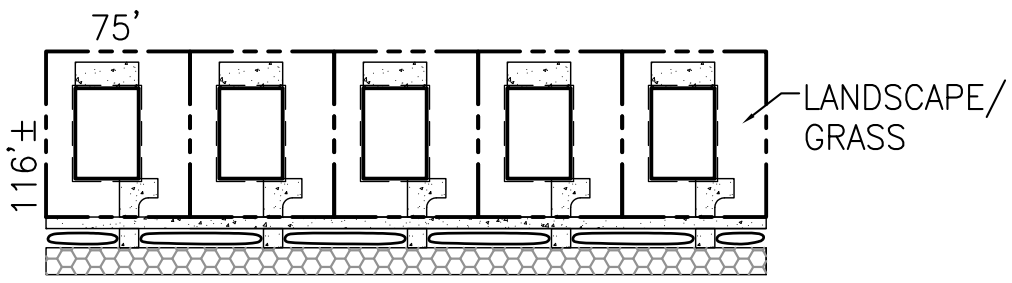
Basin Area = 10 acres for modeling runs

Scenario # (dwu/ac)	Run #	Infiltration Rate 0.02 in/hr		Infiltration Rate 0.25 in/hr		Infiltration Rate 2.0 in/hr	
		Forested Runoff Vol* (ac-ft)	Post LID Runoff Vol* (ac-ft) At Downstream POC LID Facility	Forested Runoff Vol* (ac-ft)	Post LID Runoff Vol* (ac-ft) At Downstream POC LID Facility	Forested Runoff Vol* (ac-ft)	Post LID Runoff Vol* (ac-ft) At Downstream POC LID Facility
1 (1/5)	A	287	396.846	287	353.686	0.54	0
2 (1/1)	A	287	542.837	287	263.917	0.54	0
2 (1/1)	B	287	503.055	287	239.271	0.54	0
3 (5/1)	A	287	539.555	287	66.846	0.54	0
3 (5/1)	B	287	453.243	287	28.016	0.54	0
3 (5/1)	C	287	341.094	287	11.08	0.54	0
4 (10/1)	A	287	795.274	287	219.839	0.54	0.29
4 (10/1)	B	287	596.085	287	108.518	0.54	0
4 (10/1)	C	287	565.237	287	36.763	0.54	0
5 (commercial)	A	287	442.141	287	133.77	0.54	0
5 (commercial)	B	287	365.261	287	85.58	0.54	0

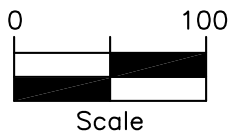
TBD = Run to be completed for 1/25 mtg

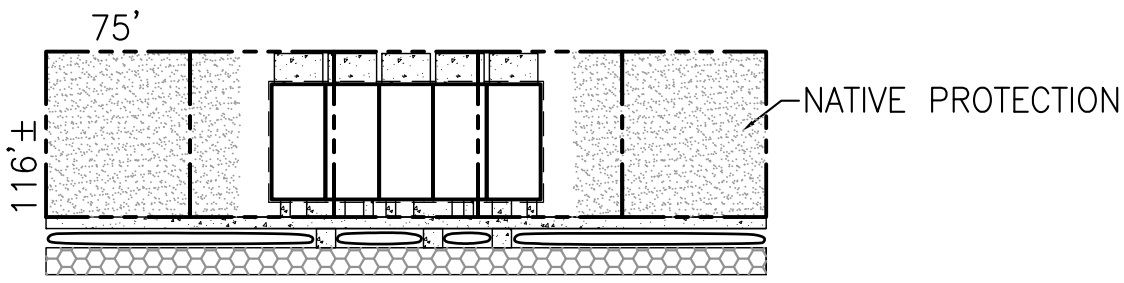
*Volume includes surface and interflow

See Modeling Assumptions Description for information re. each scenario and modeling run.

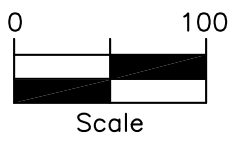


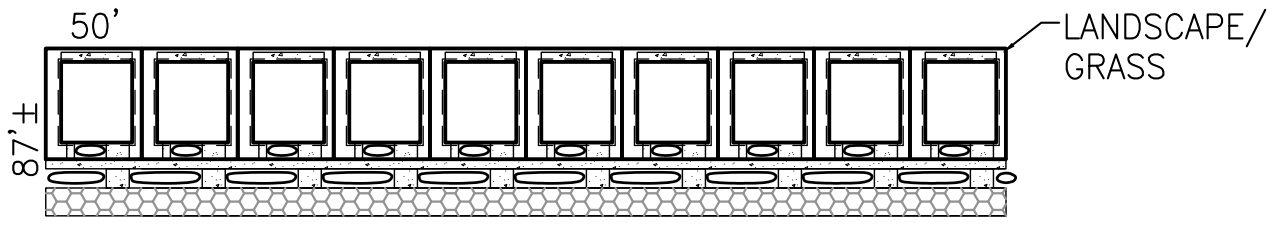
Model Scenario 3: 5 DU/ 1 Acre



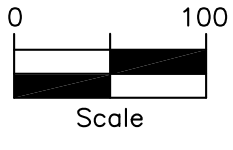


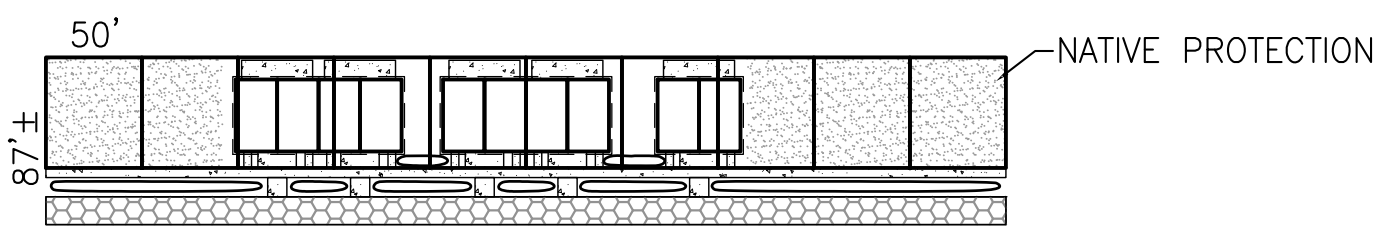
Model Scenario 3: 5 DU/ 1 Acre
with 40% Native Protection



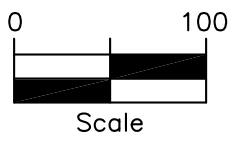


Model Scenario 4: 10 DU/ 1 Acre





Model Scenario 4: 10 DU/ 1 Acre
with 30% Native Protection



DRAFT

Department of Ecology
LID Technical Committee
Modeling Scenario Sketches

SvR No. 09034

January 19, 2010

Plotted: Jan 20, 2010 - 8:10:00am By teresad
File: G:\09c\09034c DOE LID\Current\DOE LID Scenarios.dwg Layout: Scenario 3 w Native

SvR DESIGN COMPANY

Model Scenario 3 RUN C NATIVE PRESERVATION

Department of Ecology - Stormwater Management with Low Impact Development Techniques
SvR # 09034
January 22, 2010

Prepared By:
Kathy Gwilym, PE
Amalia Leighton, PE
Lolly Kunkler, PE
QA/QC - Tom von Schrader, PE

Scenario	3 RUN C WWHM3 Model Assuptions		
Density			Run C
Parcel Area	Native Vegetation		
Development Area	Preservation		
Parcel Frontage			
Development Frontage			
Totals			
	5 du/ac - SF	5 du/ 10 ac - SF	WWHM Entry - Acre
Non-Vegetated Land Cover	43,560	435,600	10.0
Non-Vegetated Land Cover Area	***19,260***	***192,600***	***4.42***
House and Accessory Buildings	9,000	90,000	2.07
Patio/ Walks	2,000	20,000	0.46
Driveway/ Parking	760	7,600	0.17
ROW - Walks	2,250	22,500	0.52
ROW - Roads	5,250	52,500	1.21
Vegetated Land Cover			
Vegetated Subtotal	***24,300***	***243,000***	***5.58***
Preserved Native Vegetation Forest	17,400	174,000	3.99
Landscape/ Grass	3,500	35,000	0.80
ROW - Landscape	3,400	34,000	0.78

Design Assumptions:	***Parcel***	***10 Acre Development***	
Bioretention Length for Private	***30 lf***	***1,500 lf***	
Bioretention Length for Public ROW	***65 lf***	***3,250 lf***	*(10 ft subtracted from frontage for driveway entrance)*
Roof Dispersion/Infiltration Credit	***No***		

SvR DESIGN COMPANY

Model Scenario 4 RUN C NATIVE PRESERVATION

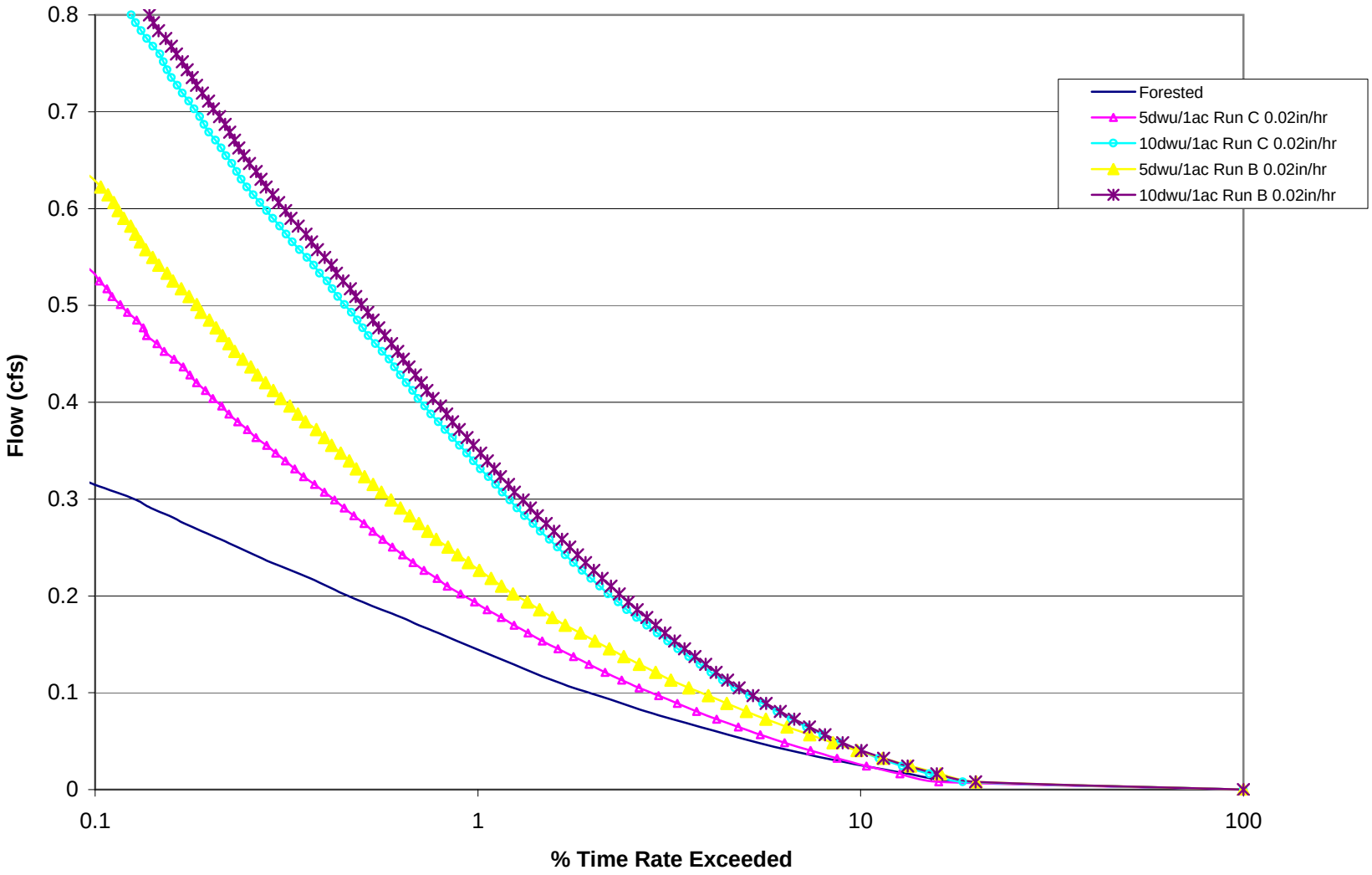
Department of Ecology - Stormwater Management with Low Impact Development Techniques
SvR # 09034
January 22, 2010

Prepared By:
Kathy Gwilym, PE
Amalia Leighton, PE
Lolly Kunkler, PE
QA/QC - Tom von Schrader, PE

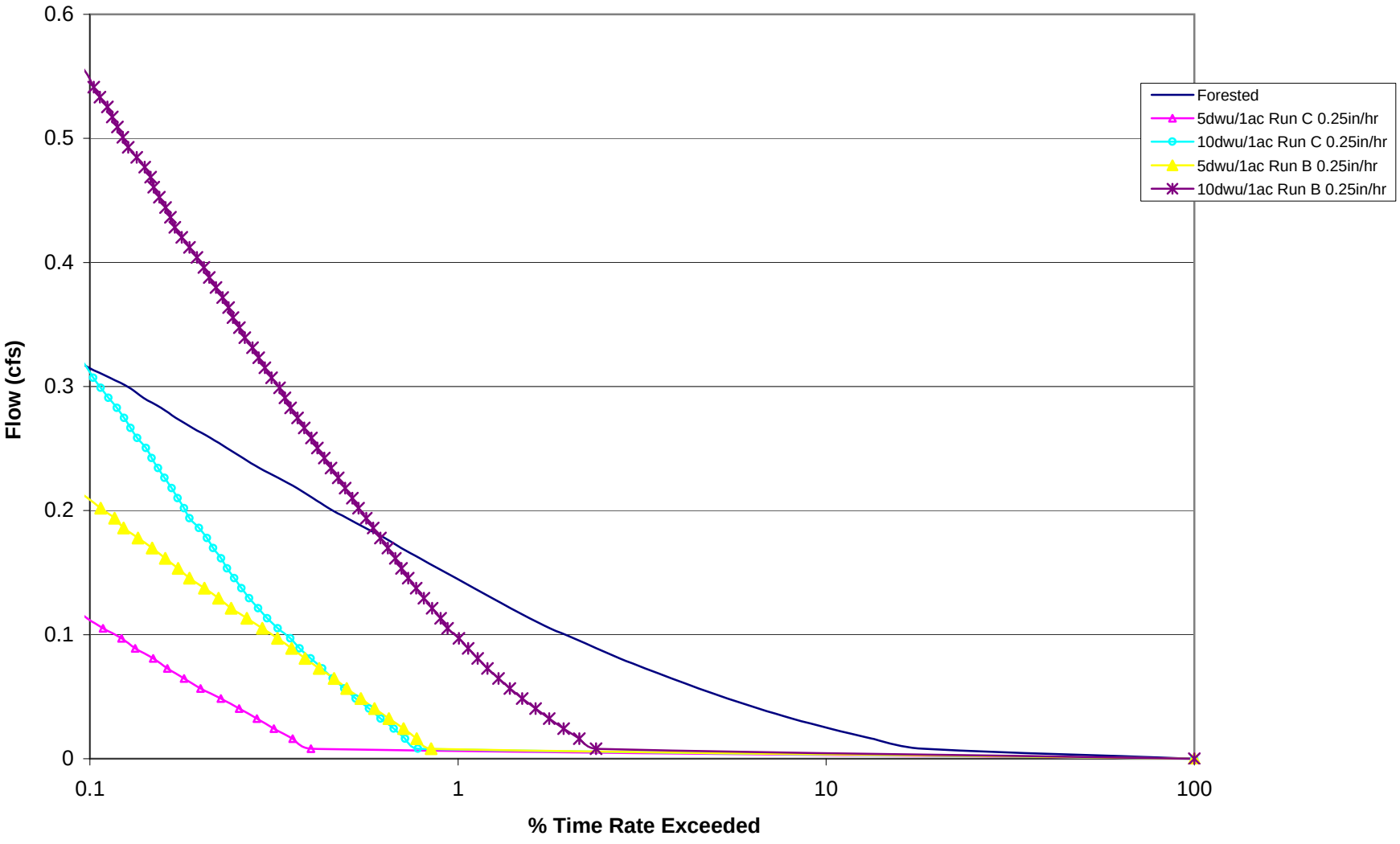
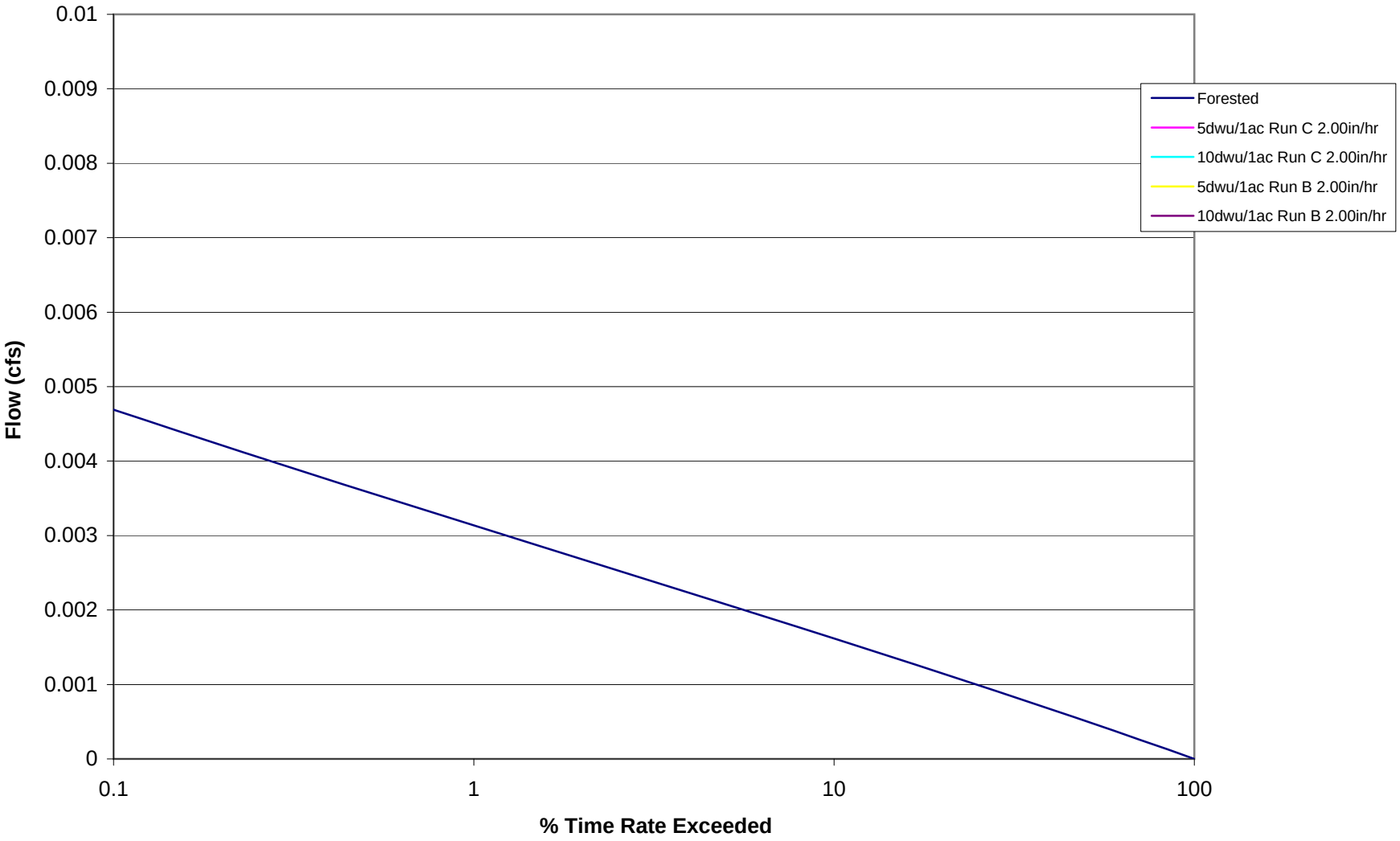
Scenario	4 RUN C WWHM3 Model Assuptions		
Density			Run C
Parcel Area	Native Vegetation		
Development Area	Preservation		
Parcel Frontage			
Development Frontage			
Totals			
	10 du/ac - SF	100 du/ 10 ac - SF	WWHM Entry - Acre
Non-Vegetated Land Cover	43,560	435,600	10.0
Non-Vegetated Land Cover Area	***22,060***	***220,600***	***5.06***
House and Accessory Buildings	9,000	90,000	2.07
Patio/ Walks	2,000	20,000	0.46
Driveway/ Parking	1,300	13,000	0.30
ROW - Walks	2,500	25,000	0.57
ROW - Roads	7,260	72,600	1.67
Vegetated Land Cover			
Vegetated Subtotal	***21,500***	***215,000***	***4.94***
Preserved Native Vegetation Forest	13,000	130,000	2.98
Landscape/ Grass	4,000	40,000	0.92
ROW - Landscape	4,500	45,000	1.03

Design Assumptions:	***Parcel***	***10 Acre Development***	
Bioretention Length for Private	***15 lf***	***1,500 lf***	
Bioretention Length for Public ROW	***40 lf***	***4,000 lf***	*(10 ft subtracted from frontage for driveway entrance)*
Roof Dispersion/Infiltration Credit	***No***		

Graph 10 Duration Curves - 0.02 in/hr Infiltration Rate Scenario 3 Run B & C and Scenario 4 Run B & C



Graph 11 Duration Curves - 0.25 in/hr Infiltration Rate Scenario 3 Run B & C and Scenario 4 Run B & C



Graph 12 Duration Curves - 2.00 in/hr Infiltration Rate Scenario 3 Run B & C and Scenario 4 Run B & C