Department of Ecology – Water Quality Program
Development of Low Impact Development (LID) Standards for the Municipal Stormwater General Permits

Technical Advisory Committee Meeting #3
January 25, 2010, 10:00am–3:00pm at Federal Way City Hall
MEETING SUMMARY

Goal of the Meeting: The goal of this meeting was to review Ecology's proposed permit framework and SVR/Ecology modeling results, and discuss key questions regarding options for a hydrologic performance standard(s), feasibility, and implementation barriers.

Agenda

Introduction and Agenda Review
Revised Permit Framework
Hydrologic Performance Standards
Feasibility constraints and the permitting process
Implementation barriers (deferred until March 18 meeting)
Next Steps and Prep for Next Meeting
Public input was received after the morning and afternoon discussions

ATTENDEES

A list of attendees is provided at the end of this meeting summary.

TRANSCRIPTION OF FLIP-CHART NOTES

The meeting summary provided here is a transcription of the flip-chart notes taken by Kate Snider during the meeting. This does not provide a full documentation of the dialogue, but provides a record of the primary input received from the attendees.

Ecology presented its thinking based on input to date, including a proposal to require that new development meet a hydrologic performance standard(s), and that redevelopment and small site projects would apply a standardized checklist approach similar to that proposed by Seattle Public Utilities. Based on input from the IAC, Ecology also proposed compliance schedules of 2 years from the permit effective date for Phase I, and 3 years from the effective date for Phase II.

Permit Framework

- As a clarification, the proposed Seattle Public Utilities approach does not have a hydrologic performance standard but is based on what is thought to be achievable in Seattle. We will track for a year and then evaluate. For this reason there is not a focus on site design.
- Concern that preservation of native vegetation is not required – would like to see performance standard be coupled with requirement for preservation or restoration of native vegetation

- How to approach "new development" within city?
- Ecology: We intend to distinguish new 'greenfield' development from ultra-urban new development, where there are different opportunities.
- Is there a threshold of size or cost for urban redevelopment above which the project could meet greenfield standards?
- A threshold related to cost (value of new improvements) should be included.
- What standard should address flow control exempt sites – defer to discussion questions later in this meeting.
- What does "fully protect aquatic resources" mean?
- Ecology's point of view: new development may have fewer or no 'feasibility' off ramps. This is a higher standard because they can design to the site.
- A lot of land in Phase II urbanized areas of Kitsap County are not forested and are already constrained by impacts from adjacent development. Not all land in counties is "greenfield."
- Need to recognize that a new LID performance standard will be more stringent than the existing flow control standard.
- Concern about the last paragraph that "requires" basin level planning. This would be a concern for Phase II jurisdictions.
- Concern about 3rd bullet on last page regarding "off-ramps" for conditions such as high groundwater and steep slopes. It makes sense to protect groundwater from contamination, but ponds are built on steep slopes and there are no off-ramps for the conventional measures. What would be the alternative there?
- We can use rainwater harvest and green roofs to eliminate surface water, so there's no need for off-ramps.

Performance Standard Modeling

The committee referred to the SVR modeling results and the Ecology handout with additional modeling runs for this discussion.

- Clarify interflow assumptions – did not separate surface and interflow. The modeling outputs are the sum of surface runoff & interflow.
- Modeled only new development, not redevelopment.
- Question: Why wasn't a 0.002 inch/hour infiltration rate modeled?
    - Answer: We can interpret from the results of .02 inch/hour model that we would have an even more difficult time meeting the runoff volume or flow rates produced by the historic condition.
- Infiltration rates used are design infiltration rates. Assume appropriate correction factors have been applied.

- Assumes a 2% longitudinal slope across bioretention ponds
- Used precipitation from the Lacey area, which is higher than average for Puget Sound.
- Question regarding infiltration rate for bioretention: The model uses 1.5' per hour, but isn't Seattle using 3' per hour?
    - Answer: 1.5 – assumes all bioretention facilities are serving areas greater than 5,000 sq. ft. pollution generating impervious surface; or 10,000 sq. ft. of impervious, or ¾ acres of lawn/landscape. This is consistent with Seattle's requirement.
- Regarding the assumed 30% void space for aggregate below the pervious pavements: WSU says they find 40% not 30% with commonly used aggregate sizes. That would make a difference by making the pervious pavements more effective in reducing runoff.

Discussion of the table comparing volumes modeled for different scenarios:

- The modeling includes a run of the forested site, and shows acre-feet of water over 45 years of precipitation data.
- For modeling – the consultant scaled everything to a 10 acre development for consistency.
- Could change the corrective factor for native soil infiltration rate.
- Run C with native vegetation shows a dramatic increase in the amount of precipitation that can be addressed on site.
- We did not run an un-mitigated development site.
- Clarify that this did not consider bioretrention designs for a moderate slope (8 – 15%)
- Question: Is it the same size BMPs in all?
    - Answer: Within runs (A, B, C), yes. But not across scenarios. Bioretention widths are same, but lengths change for each scenario.
- For tight soils it's difficult to match forested conditions through infiltration. Must do something with green roof or rainwater harvest. Denser sites require this.
- Assumes all interflow reaches the point of compliance; is this assumption appropriate?
- WWHM and other models will not tell you that the stream has been degraded. The model is not related to a healthy watershed and stream stability. Need real data such as B-IBI.

Discussion of Flow Duration Curve Modeling results:

- On graphs "flow" = surface + interflow
- Assumptions for streamflow erosion – goal is to match forested curve for less frequent flows (1% and less).

- Question: If using Flow Control (pond) requirements for 1% and less, can we match other parts of the curve (10-100% or 1-10%) with LID requirements?

  Answer: Yes. But if we are unable to meet the curve below 1% with LID, then we need a pond.

- Concern regarding the discrepancy for how forested condition is modeled with an infiltration capability assigned to a generic soil type (i.e., till or outwash), but the developed condition is modeled with a site specific infiltration rate.
- For native retention scenarios, we did not disperse water into native vegetation, because we didn't want to assume that would always be possible. Dispersion into the retained native vegetation is an effective strategy and is allowed within the limits specified in the manual. Whatever amount of dispersion into the retained vegetation could be done will reduce predicted runoff amounts lower than shown in our examples.
- Modeling credit for partial dispersion is too low.
- The Ecology handout shows the effect of adding a pond to meet historic flows of 1% or less. The pond releases flows just below the flow associated with the 1% frequency rate. So, it raises the flow duration curve in the 1% and higher frequency range. For the 10 units/acre scenario with low infiltration (0.02 in/hr), it raises the curve so much that Ecology thinks you would need to take water off-site or harvest it in order to meet the flow duration curve in the 1% to 10% range.
- Limits of the model are in the 10%-100% frequency range, because the predicted flows are so low the model does not show them.
- Ecology also ran the EPA standard. This is shown in the Ecology handout as the green line. It is modeled without a pond for a 0.25 inch/hour infiltration rate.
- Ecology stormwater engineer Ed O'Brien's conclusions:
  - The model is a compliance tool for hydrologic performance standard.
  - A volumetric compliance standard is simpler to meet than a flow duration curve.
  - We could use the flow duration curve for the 1-10 percent flow, but it is difficult to use to meet flow and detention requirements for low infiltration rates. It would be hard to use this as a regulatory tool because of the model limitations.
- Question: What is the benefit of reducing the volume? Answer: There is no added water in the surface channel to contribute to erosion.
- Concern that at lower flow rates, the flow to groundwater will actually go as interflow into creek downslope rather than deep groundwater, and thus not have the same effect as modeled.

Discussion Questions:

<u>Question 1:</u> *Do you prefer a volume-based performance standard or a flow duration-based performance standard?*

<u>Question 2:</u> *In light of the computer modeling results, what numeric standard do you prefer?*

Question 3: *Is there a lower limiting site infiltration rate below which achievement of the numeric standard should not apply? For instance, the lower the onsite infiltration rate, the harder it will be to meet a hydrologic performance standard.*

- Clarify that the Ecology flow control standard will continue. This discussion is about an additional standard for LID.
- The PCHB mandates that Ecology require LID where feasible, which means going beyond just building a big pond in outwash soils. They also need to layer on the site design elements.
- Recommend a volume based standard – more straightforward requirement for compliance. The flow duration curve is too hard to model.
- In a graph of "where the water goes," published by Clear Creek Solutions, it shows that just clearing land from forest to pasture, you lose the stream. Recommend using real data from BIBI, May, Booth, and other sources. Preferred method: Regulate the amount of clearing in the watershed and the amount of impervious surface area. Suggest using the 70-10-0 Criteria, which forces development vertically.
    - 70% native vegetation and soil
    - 10% maximum total impervious area
    - 0 effective impervious area
- Roads alone would push it past that requirement. In reply to questions, concern regarding whether the modeling accurately reflects reality. Prefer prescriptive standards based on a percentage of native vegetation and impervious area, but not to 70-10-0. Prescriptive should be something like 35-40% native; limit Effective Impervious Area to 0-5%. If urban – top of building measures required. If that is not an option, then probably a volume based standard is preferred.
- Prefer duration along with a volume standard. Would like to see if model can get better at modeling the lower flows. For greenfield development, must protect high quality streams. Must match forested for all flows, no off-ramps. In modeling we did with CH2M Hill, we also concluded that you will need rooftop harvesting for tight soils. There's a need for assessment of where there are sensitive or high quality water resources – no off-ramps in those locations.
- Prefer flow duration to evaluate effect.
- Concerns regarding liability and O&M associated with green roofs and reuse.
- Concern regarding volume based approach because of problems we can't predict if infiltrating more than would go in naturally. Concern that may not be able to reuse enough to meet the requirement. Flow duration is the better option. Can we determine where the right cutoff is – 2% versus 1-10%?
- Use CC&Rs (covenants) for O&M and reuse.

- Other elements should be brought in to the requirements in addition to the performance standard (minimum native vegetation, minimum Impervious Area, etc). Consider one standard for urban areas and one for counties.
- How would these standards affect locations with very high groundwater? Several jurisdictions in SW Washington are completely surrounded by dikes.
- Could require flow duration and do something else regarding volume reduction – e.g. "reduce developed flow volume by 25% as compared to a volume from a conventional development by using LID."
- That assumes improvement, but is it close enough to the PCHB goal of protecting the resource?
- In forested condition, there is no runoff. The 70-10-0 also addresses bad soils.

Question 4: *Redevelopment Standard: Given the range in opportunities for improvements in stormwater management at a site depending upon the extent of redevelopment, the existing on-site topography, and the surrounding stormwater infrastructure, do you agree that a mandated evaluation process intended to determine the extent to which LID should/can be used in a project is the reasonable approach? Would you prefer a variable hydrologic performance standard that could be tied to one or more of the factors listed above?*

- Redevelopment is constrained by surroundings; checklist makes sense – also for small properties.
- Support this, but also adopt an upper performance goal against which to develop the checklist. SPU maximizes LID techniques where feasible.
- The goal is to improve over time, and need some way to measure performance. Evaluate for the setting (marine versus creek).
- SPU has one to measure against. Currently it's an average for the city.
- Support a checklist, but tie it to improvement in the system. The improvement should be basin specific.
- Support a mandated evaluation process with a prioritized list of BMPs designed to meet a performance goal. Designer must demonstrate why they cannot meet it.
- The prioritization process should be part of the checklist. Unless it's for a large development, which sends it back to performance standard. Need a size threshold.

Question 5: *What would you prefer within non flow-controlled settings (e.g.: drainage areas that discharge directly to marine waters)?*

- Support a mandated evaluation process that has all the site design features, with BMPs focused more on water quality benefit. Not green roofs because of the cost versus the benefit. For these sites, we need to target pollution-generating impervious surfaces with LID techniques, especially LID techniques that have more benefit per $ basis.
- Agree. Focus should be on water quality goals.

- In non-flow control settings water quality is important – but may still need to manage volume to manage pollutant load rather than concentration. Our treatment BMP's don't do a good job with dissolved pollutants. So, by reducing the discharge volume, we can reduce the dissolved pollutants too.
- Prefer either a checklist or a minimum set of prescriptive standards. A checklist would have to also include a prioritization system for the LID techniques. A prescriptive standards approach would have different standards depending on the type of project. Agree regarding prioritized standards.
- Re #5, support water quality based LID BMPs for areas that are flow control exempt,– but not BMP's that just do flow or volume reduction. Near the Columbia River we need to move water quickly. Re #4, Checklists and prioritizations would have to be updated every 2 – 3 years as LID evolves.
- In answer to question #4, prefer a mandated evaluation more than a checklist; a mandated, priorized list of BMP's to achieve a stated goal. If the goal isn't achieved, the proponent has to demonstrate and explain why not.
- Also applicable to small sites in flow controlled watershed – in those settings should also look at flow, in addition to water quality.
- Would like to see additional information on the pros and cons for volume vs. flow duration curve. Re #4 prefer a mandated evaluation process unless it is a large project. At some project size, you should have to meet a performance standard. Re #5, for flow control exempt areas, prefer to stay with the hydrologic performance standard.

Public Input

- Prefer flow duration curve method. It allows for flexibility in matching site-specific conditions. It reflects topography and soils on the site. Concern about the modeling and the fact that the more dispersed, the more goes to interflow versus deep groundwater.
- Perspective from a PE concerned with the health and welfare/safety of public. Concerns re ability to address topography, soils, etc. Poor soils are the norm in Puget Sound. Different conditions need flexibility to address interflow concerns.
    - Concern re volume based – not wanting to experiment.
    - Prefer duration-based modeling and good off-ramps for topography, soils, and groundwater. Till soils can't meet matching a forested condition.
- Another example, on a 10% sloped site, you would need to cut slopes to fit rain gardens. They would be wide and deep swales which have a public safety issue. Crucial to provide off-ramps early in the process. Concern regarding liability for adjacent properties and groundwater impacts. Need to be able to resort to conventional approaches.
- Need to consider the example of a performance standard applied to a school renovation redevelopment. These projects will exceed the 50% value threshold so they could trigger a requirement to match the forested condition. But they are mostly in constrained sites, so they will have a problem with meeting that standard. Why not just 1 standard that combines Flow Control and LID?

- Real concerns about risks of pushing water to interflow.
- Maintenance costs must be factored into decision making of a standard or a checklist. There is a disconnect in that LID decision by developers who consider capital costs to build but don't consider higher maintenance cost for the local government. Not much information on operation and maintenance.
- Homeowners Associations often dissolve and have trouble maintaining facilities. Developer might choose LID BMP but much more problematic for homeowners and municipalities.
- Developers have concerns regarding planning and zoning guidelines. Problem to achieve higher density and maintain native vegetation.
- Concern regarding road widths and code with fire department requirements. No one wants a new road less than 26 feet wide.
- Agree with concerns about off-site impact and Homeowners Associations that dissolve.
- Prefer volume-based approach. Converting evapotranspiration lost to groundwater or harvesting. Need to send to groundwater not to interflow. Need a consistent use for harvesting.
- Consider modeling and design needed to show compliance and issue revised models or framework that works with existing models like WWHM.
- University of Minnesota study on rain garden maintenance in public facilities showed that 4 of 16 were failing. 12 of 16 had infiltration rates that varied by an order of magnitude within facility.

FEASIBILITY

Engineering Feasibility

Question 6: *Review the text from the "Guidance to Help Local Governments Determine When Low Impact Development Practices Should Not Be Required." Do you agree with the criteria presented for which the use of the identified LID technique should not be required?*

- Modification of bioretention language. WSU has some data showing better performance at low infiltration rates – as low as hundredths of an inch per hour. Need to have good site design based on good site analysis and plan the site layout to take advantage of good soils.
- The cost benefit analysis should include maintenance. SPU sets 0.25'/hour as the required infiltration rate. Less than that is harder to maintain because it tends to clog.
- Currently we average the infiltration rate across the site. Instead, we need to make sure it's more specific.
- Question regarding the infiltration rate issue – clarified that recent data is for 'native' measured rates vs. design rates.

- The detail in the SPU checklist was more useful than this document. Tailor it to the jurisdiction.
- Distinguish LID BMP feasibility from the LID concept feasibility. There are no off-ramps for limitations of conventional BMPs. Overall LID concept is applicable everywhere.
- Concern regarding maintenance of vegetated roofs in residential development. Do you allow an argument (from a project proponent) that -- "I can't guarantee maintenance of a green roof, so I didn't include it in my project"? Is this a valid argument? How do you enforce maintenance?
- EPA document regarding the technical feasibility of rainwater harvesting states that non-potable water demand is too low for use in residences. Concern regarding use in single family residence.
- Forcing everyone to have rainwater harvesting may not be appropriate. However, acknowledge WSU local analysis of rainwater harvesting. Use in laundry and low flow toilets makes a dramatic reduction in the total runoff. 10,000 gallons of storage adds $8 per home, with ultraviolet in the cistern. Recommend requiring it in areas of high quality streams or wetlands.
- In area of high quality sensitive resources, require stringent performance standard and require them to look at rainwater harvesting, especially if the site has for tight soils. Look to vegetated roofs to take up additional water.
- Concern regarding developers putting requirement on individual home builder. What is the timeline for compliance? Lots can be left vacant and not completed for 4-5 years.

Question 7*: Using the APWA Matrix, Do you agree with the site conditions under which specific LID techniques should not be required? These are areas identified with shades of red.*

- Dispersion at 15% slope – should this be moved to 20%? There needs to be an upper limit.
- Why is there concern regarding minimum excavation foundations for contaminated soils? Should not excavate at all.
- Porous pavement systems with greater than 5% grade requires special construction.
- Driveways, parking lots, and roads can have roofs. So, vegetated roofs should not be indicated as not applicable for them.
- Clarify that minimum excavation foundations would not necessarily be required.

Competing Needs Feasibility

Question 8: *Do you agree that there are times in which competing needs for space (i.e., not related to stormwater) can make an LID technique or principle not feasible? Examples identified in the APWA text include: pedestrian and vehicle mobility, and housing unit demands. Examples identified by the November edition of the proposed Seattle Public Utilities Director's rule (2009-007) include: historical designation, pedestrian access, usable open space.*

Question 9: *Should the decision about deferring compliance with stormwater LID requirements due to a competing demand be left to the local government on a case-by-case basis? Or, should there be an attempt made to develop more defined guidance for instances where deferring to another demand is acceptable?*

- Yes to both – the council sets zoning requirements. That sets constraints for LID implementation.
- There are endless variations for competing needs. An example is to try to lay out a bike lane. It's very site specific and should be addressed at the local level. It's the hardest. Ecology will not think of every possibility.
- Often comes down to cost. What cost is too high to still develop the site (e.g. to accommodate the cars and still meet forested conditions)? There are endless competing needs. Evaluate with cost thresholds and cost/balance evaluation. Can get very political.
- If this is imposed on places like ports they won't be competitive. Land values are high and they will have to move.
- In addition to a cost formula, we need requirements for aesthetics.
- There were many of the same concerns raised in 2005 with the Ecology manual regarding the pond size, but they did it.
- Would be much better if the decisions were made on a basin scale for competing needs.
- Zoning and Development codes can be changed; shouldn't allow too much flexibility.
- But years and millions of dollars and many considerations went into downtown plans, etc. In downtown areas, change is not easy. These techniques take up space, but ponds can go underground.
- In addition to looking at competing needs, should look at multi-functionality of LID requirements in helping to meet those needs. For instance open space and landscaping requirements. Some open space needs can be met with a native vegetation area. Some subdivisions require usable open space (e.g. for recreation) and we need to be careful about those types of competing needs.

Cost feasibility

10. Relative to new development, do you agree/disagree with the APWA paper that cost is only a factor for vegetated roofs and rainwater collection systems? Why or why not?

11. If you agree with the APWA paper, do you have a suggestion for a cost threshold above which vegetated roofs and rain collection systems would be considered infeasible or unreasonable?

12. Relative to redevelopment: Do you agree that cost should routinely be considered in redevelopment projects on the premise that we want to encourage redevelopment in preference to new development, but we still want to achieve some improvement in stormwater management at these sites?

13. Do you have a suggestion for a generic cost threshold for limiting the application of LID at redevelopment sites? e.g., the cost of implementing LID strategies should not exceed 10% of the total redevelopment project cost.

- Vegetated roofs and rainwater collection are more expensive LID options, but the need to implement them depends upon the sensitivity of the watershed.
- Commercial uses of vegetated roofs can result in savings for energy efficiency.
- Cost is only a concern if requiring that BMP, but not if there is a choice of BMPs.
- Poor soils will require a green roof.
- Needs to be an economic factor, but the benefits are much higher for sensitive resources locations. This should be factored into the cost-benefit evaluation.
- DOT has numbers regarding cost effectiveness of on-site stormwater management. If a cost threshold is exceeded that is the trigger for looking at off-site mitigation.
- For redevelopment define a cost threshold. The standard is based on an evaluation of cost versus protection of environment. The threshold defines at what point this matters to the community.

  SPU caps its projects at a 10% increase in cost for implementing Green Stormwater Infrastructure.

Question # 14: *Should the decision about deferring compliance with stormwater LID requirements due to a cost feasibility be left to the local government on a case-by-case basis? Or, should there be an attempt made to develop more defined state-wide guidance?*

- Don't leave to local government – let the state do it. It is difficult for local officials to be caught between the developers and the protection of natural resources.
- Seattle Public Utilities is applying a method for its own projects where if the capital cost of LID is less than 10% greater than conventional stormwater costs, we go with LID. The recent code adoption in regard to development projects is vague about a maximum cost increase. SPU wants to collect data on project costs and stormwater-related project costs over the near term so that we can re-visit whether we should establish a cost threshold.
- The state should offer guidance or an approved method to do a cost feasibility analysis. But also allow local government to use an alternate but approved method.
- The incentive for redevelopment needs to be maintained, and cost is a factor.

Question #15: *Should any type of feasibility constraints be considered for new greenfields development? Why or why not?*

- There have to be feasibility constraints because of the PCHB ruling, and because many areas have no infiltration whatsoever (D soils). Cannot require compliance of residential projects through green roofs etc. Could do it by basin.

- As an opposing viewpoint, never seen a site where you can't use some form of LID. LID is feasible on all sites. Don't build feasibility into the code. Conventional methods don't have off-ramps.
- LID can be used on every site, but that doesn't mean performance standard is achievable.
- Rather than off-ramps, prefer to reduce the performance standard.
- For greenfield projects big enough to fall under master planning, could look for good soils as long as there are variations in soils. They should have room on-site to achieve a performance standard.
- Depends on what is adjacent to the site.
- There are constraints on individual types of BMP's, and those in total on a project might not get you to the performance standard.

Public Input

- Engineers can design a green roof, but not necessarily model and afford to build it. Checklists take away from flexibility. Designer flexibility is needed – multi function.
- Work towards a water quality standard – incentivize too.
- Roads, parking lots, and utilities are the most significant area to address.
- Certain land uses like "essential public facilities" such as power substations should have off-ramps because of restrictions in interacting with water.
- Regarding competing needs and flexibility, zoning and road widths are not a valid 'competing need'. To meet the Board's direction, need to drive standards to protect resources.
- Where there is an impact, there should be some offsite mitigation.
- On some sites, conventional methods could provide better environmental protection and public health and safety. If roads have more than 10% slope, can't do LID. We had to use concrete walls to make roadside rain gardens work on a 7% slope at Broadview Green Grid.
- Suggest using Ecology minimum requirement #4 – no adverse impact to downstream property.
- Requirement must allow flexibility and evaluate impacts to downstream properties.
- For formulas to assess the ability of soils to receive water, suggest talking to DOH regarding their perc requirements.
- What about a vacant facility with rainwater reuse? People leave for the winter and buildings stand empty in bad economic times.
- Injection wells – would they be considered LID?
- Concern regarding concentrated flow to aquifer – water quality and capacity of aquifer.

- Could do more extensive analysis regarding deep rain gardens. But this is a regulatory dilemma because the permits do not cover Underground Injection Wells.
- Regarding the cost of green roofs and harvesting, that is an AKART decision that Ecology can make. Green roofs are no different from the others except for evapotranspiration. Is the ET value greater than the detention value?
- For harvesting, it crosses line from passive to active, and requires a user. Could regulate as active and passive measures. The benefit is offset by the need to have the control systems.

NEXT MEETING:

Kate or Tina will send out a query on the agenda for the next meeting. Committee members may send suggestions via email in the next several days, as well as written responses to the questions discussed at this meeting.

- Alternatives for performance standards
- Water Quality issues
- Implementation barriers
- More discussion of performance standards
- Will IAC discuss barriers?
- Basin planning

Meeting Attendees

Technical Advisory Committee members

Ed O'Brien, Stormwater Engineer, Department of Ecology
Thomas Holz, P.E>, Consulting Engineer, TWH-LLC
Hans Hunger, Pierce County Public Works
DeeAnn Kirkpatrick, National Marine Fisheries Service
Curtis Hinman, Director LID Research Center, WSU Pierce County Extension
John Palmer, Region 10 U.S. EPA, Office of Water and Watersheds
Alice Lancaster, P.E., Herrera Environmental Consultants
Tracy Tackett, Seattle Public Utilities
Dave Tucker, Kitsap County Public Works
Patrick Harbison, Wallis Engineering
Bruce Wulkan, Puget Sound Partnership
Substitutes for committee members:
Jenny Saltonstall for Curtis Koger, Associated Earth Sciences
Dan Schultz for Ross Dunning, Kennedy Jenks, Consultants

Visiting Implementation Advisory Committee members

Bill Moore, Department of Ecology
Art Castle, Kitsap County Homebuilders Association
Jan Hasselman, EarthJustice

Public

Dawn Anderson, Pierce County
Nancy Winters, HDR, Consultants
Claire Miccio, WSDOT
Jane Zimmerman, City of Everett
Ben Dort, BCRA
Paul Lymberis, Quadrant Homes
Theresa Wagner, City of Seattle
Sean Darcy, Contech
Tom Putnam, Puget Soundkeepers Alliance
Kirk Smith, GHD Inc.
Alex Nguyen, WSDOT
Mark Maurer, WSDOT
Ethan Spoo, City of Oak Harbor
Paul Fendt, CDM
Rick Hand, Sitts and Hill Engineers
Pat Allen, Thurston County
Allison Butcher, Master Builders of King and Snohomish Counties
Jeremy Febus, KPFF
Hollie Shilley, City of Federal Way

Steering Committee and Support

Kate Snider, Floyd/Snider
Tina Gary, Floyd/Snider
Harriet Beale, Department of Ecology
Doug Howie, P.E., Department of Ecology
Kathy Gwilym, P.E., SVR Design Company
Amalia Leighton, P.E., SVR Design Company

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.

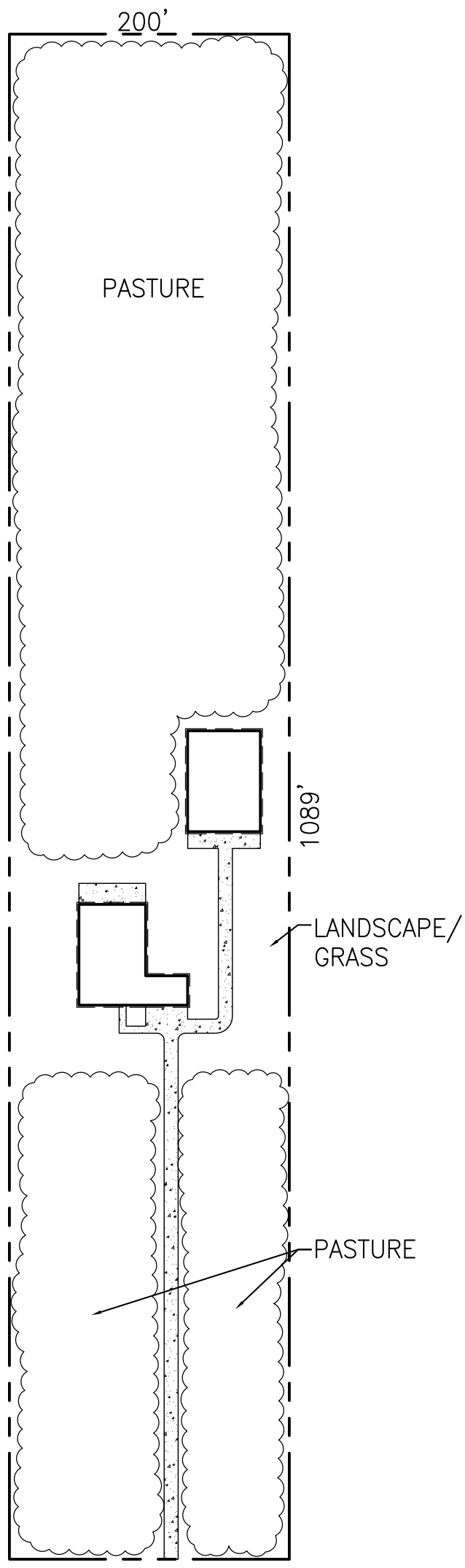
4th Modeling Run D

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.

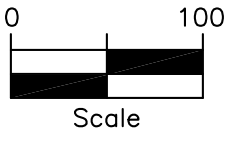
Commercial Site Modeling Runs A and B

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



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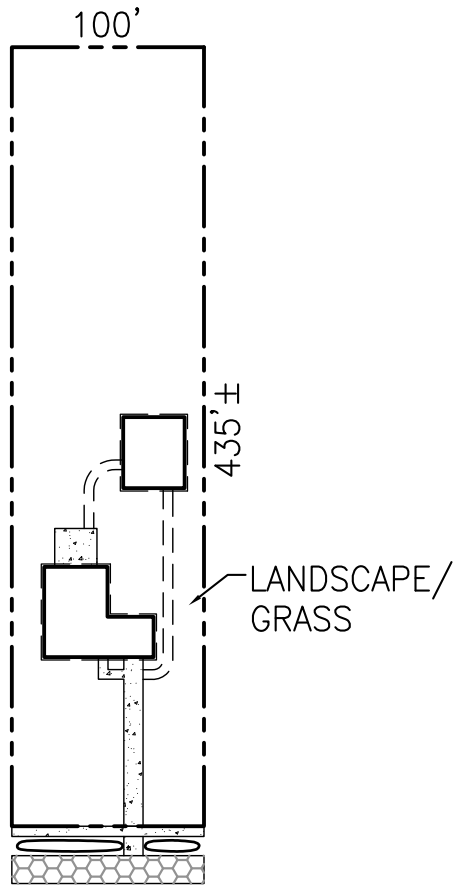
Department of Ecology
LID Technical Committee
Modeling Scenario Sketches

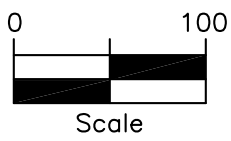
SvR No. 09034

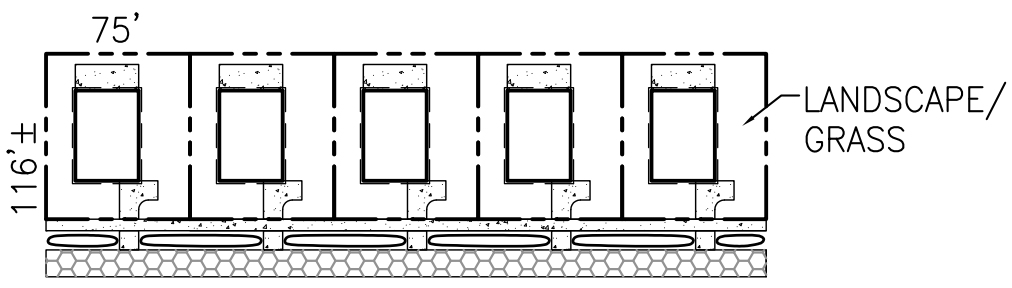
January 19, 2010

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

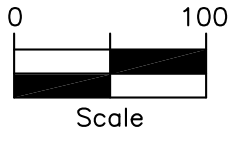


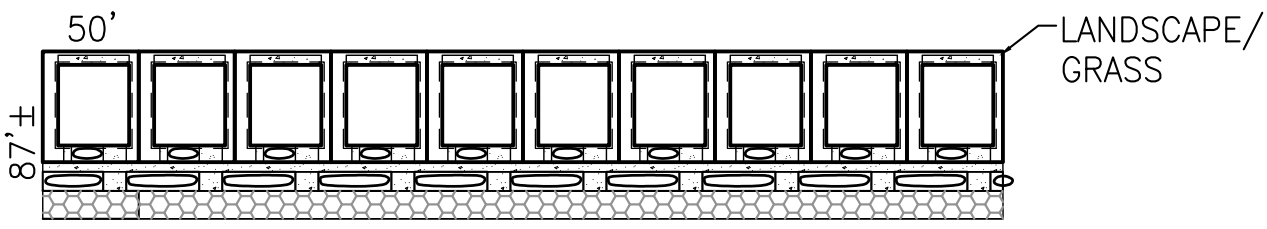
Model Scenario 2: 1 DU/ 1 Acre



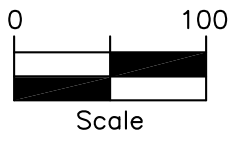


Model Scenario 3: 5 DU/ 1 Acre





Model Scenario 4: 10 DU/ 1 Acre



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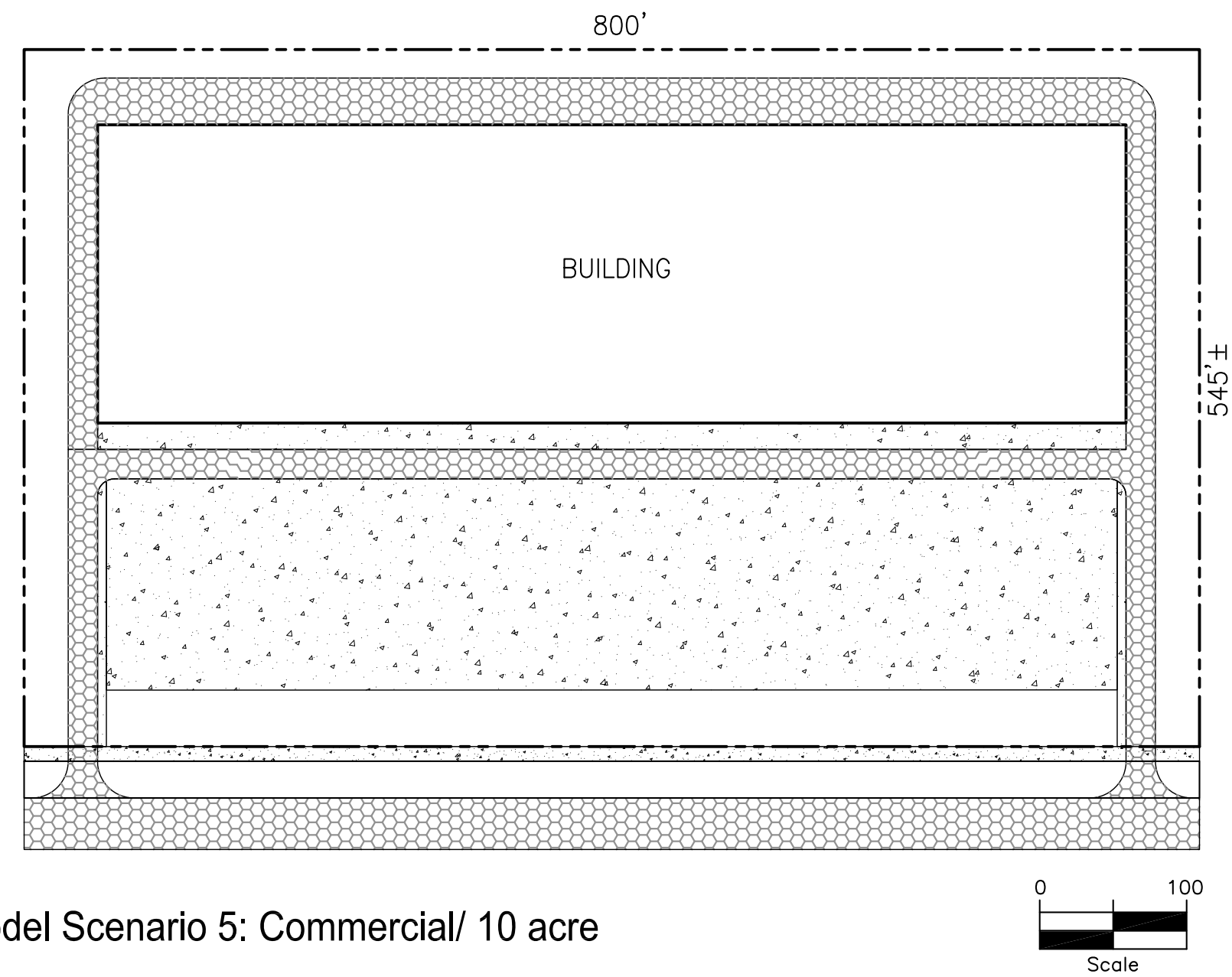
Department of Ecology
LID Technical Committee
Modeling Scenario Sketches

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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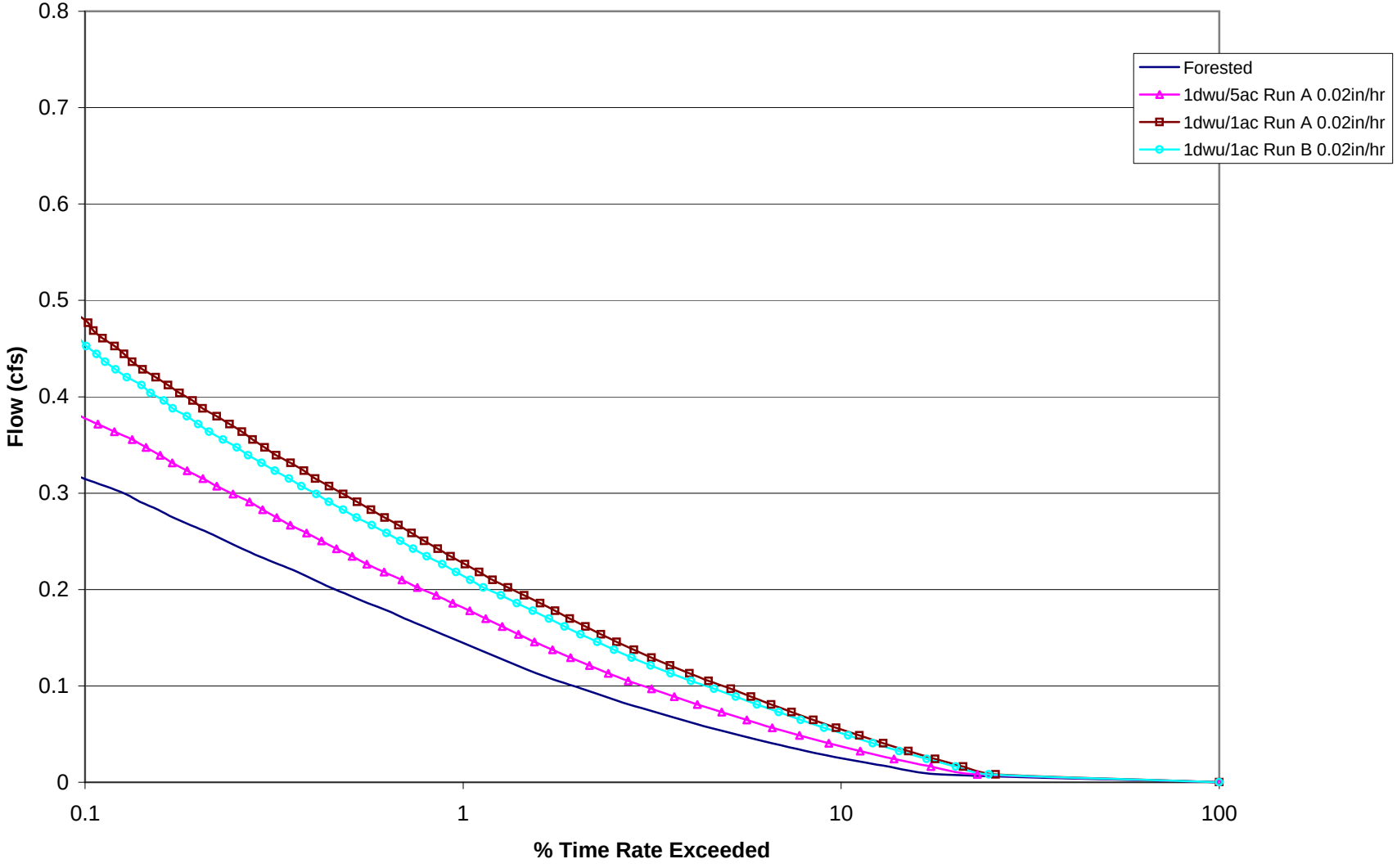
LID Technical Committee
Modeling Scenario Sketches

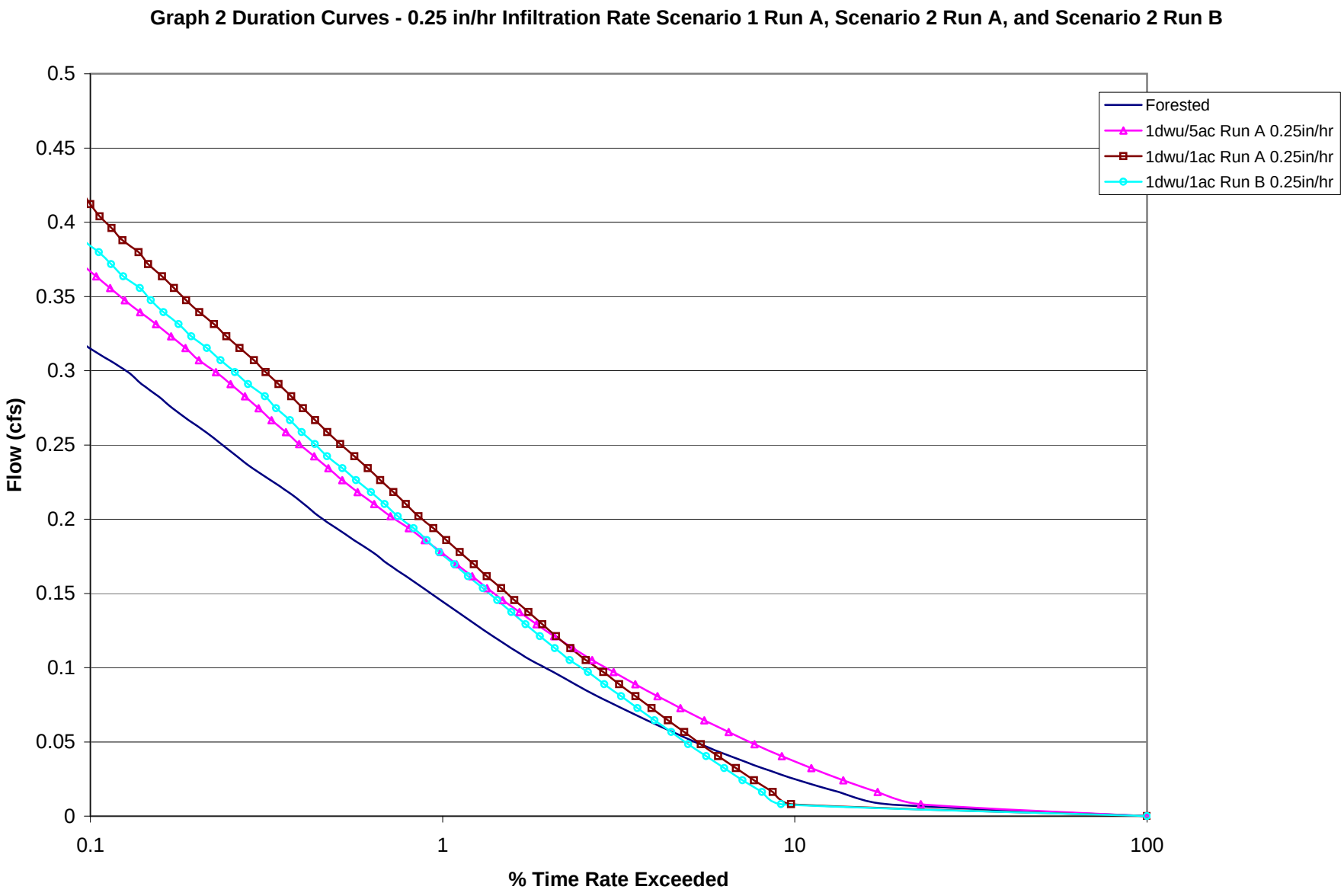
SvR No. 09034

January 19, 2010

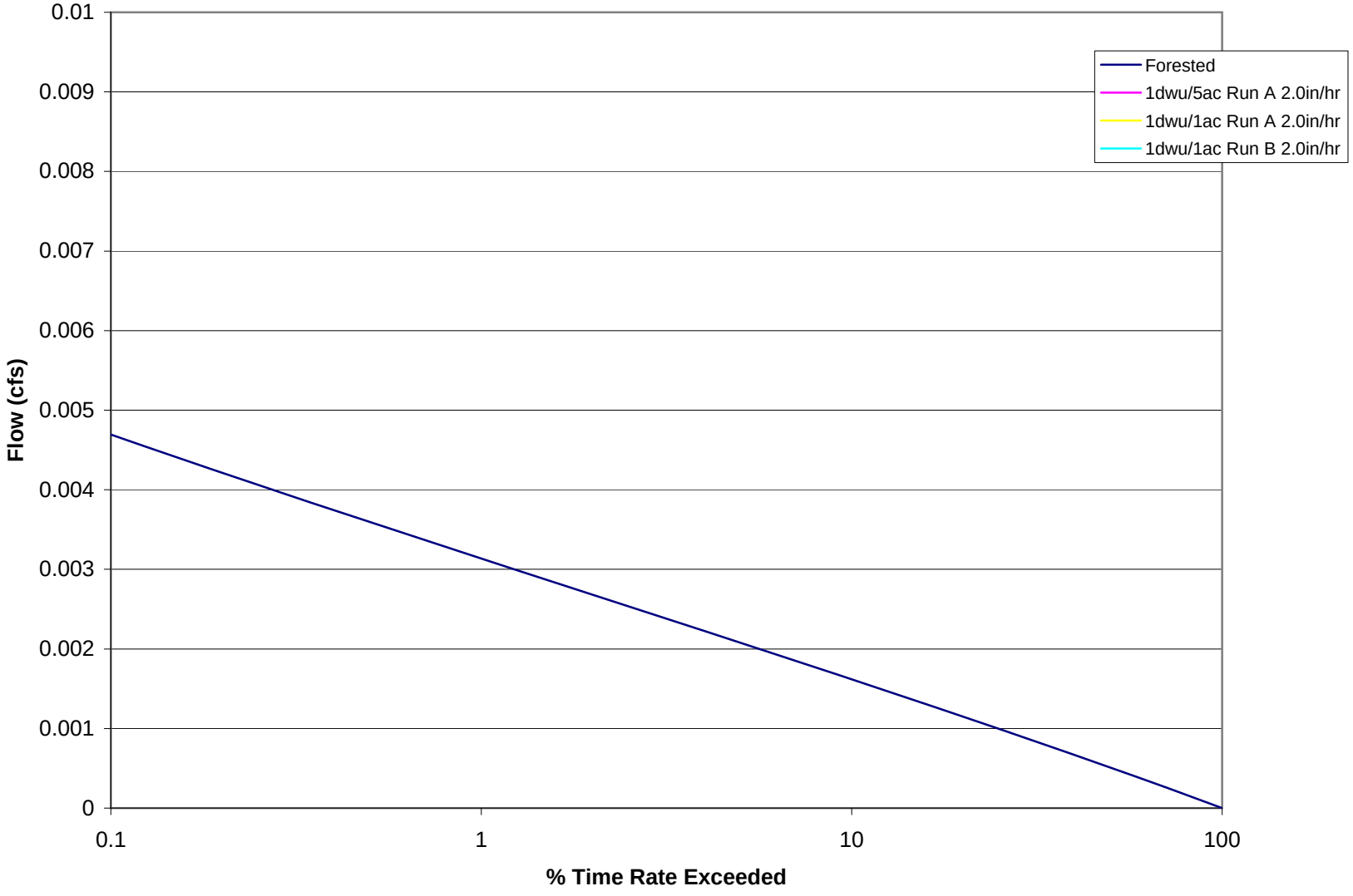
Plotted: Jan 19, 2010 - 3:21:23pm By teresad
File: G:\09c\09034c DOE LID\Current\DOE LID Scenarios.dwg Layout: Scenario 5

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

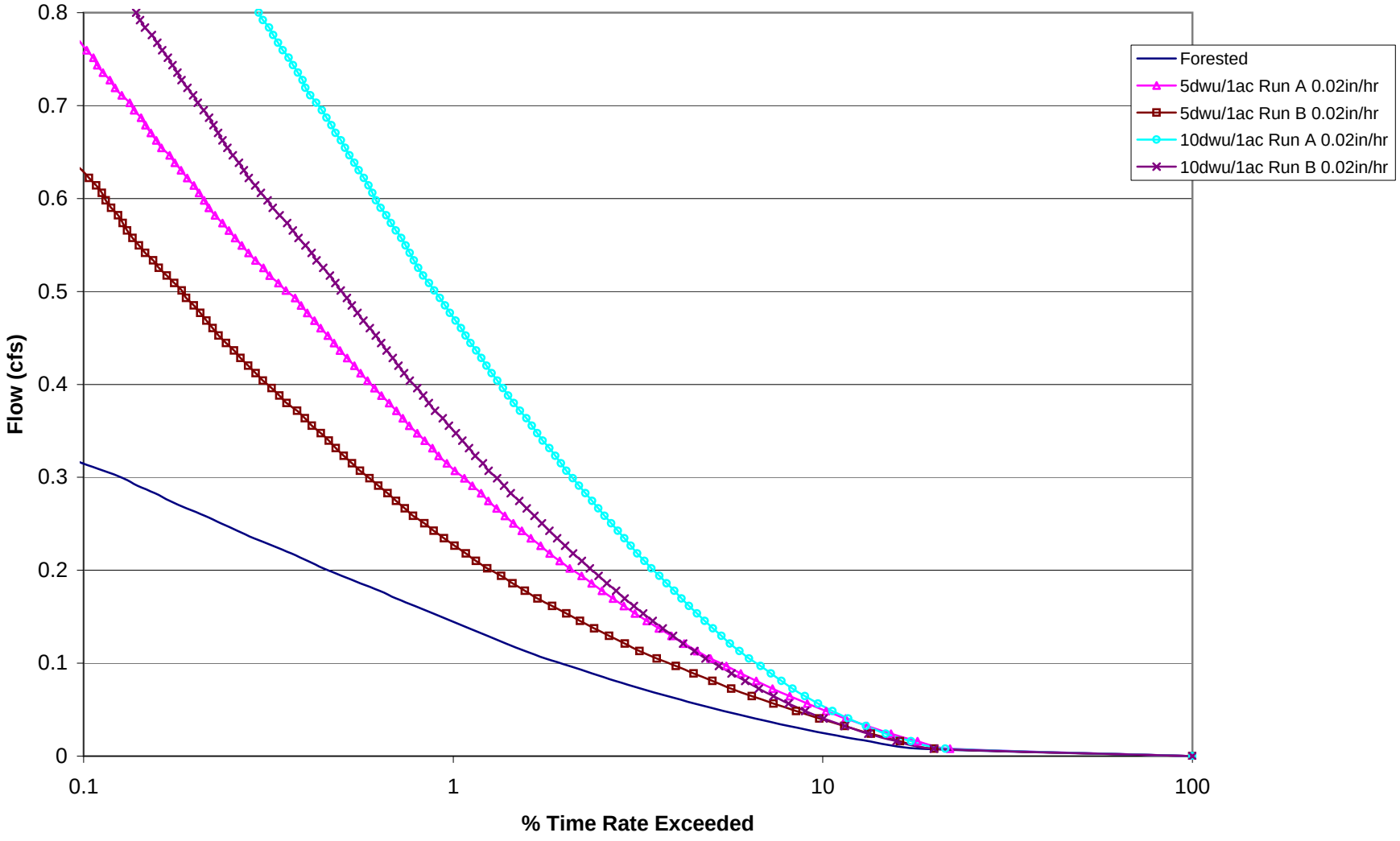



Graph 2 Duration Curves - 0.25 in/hr Infiltration Rate Scenario 1 Run A, Scenario 2 Run A, and Scenario 2 Run B
Flow (cfs)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
1
10
100
% Time Rate Exceeded
Forested
1dwu/5ac Run A 0.25in/hr
1dwu/1ac Run A 0.25in/hr
1dwu/1ac Run B 0.25in/hr

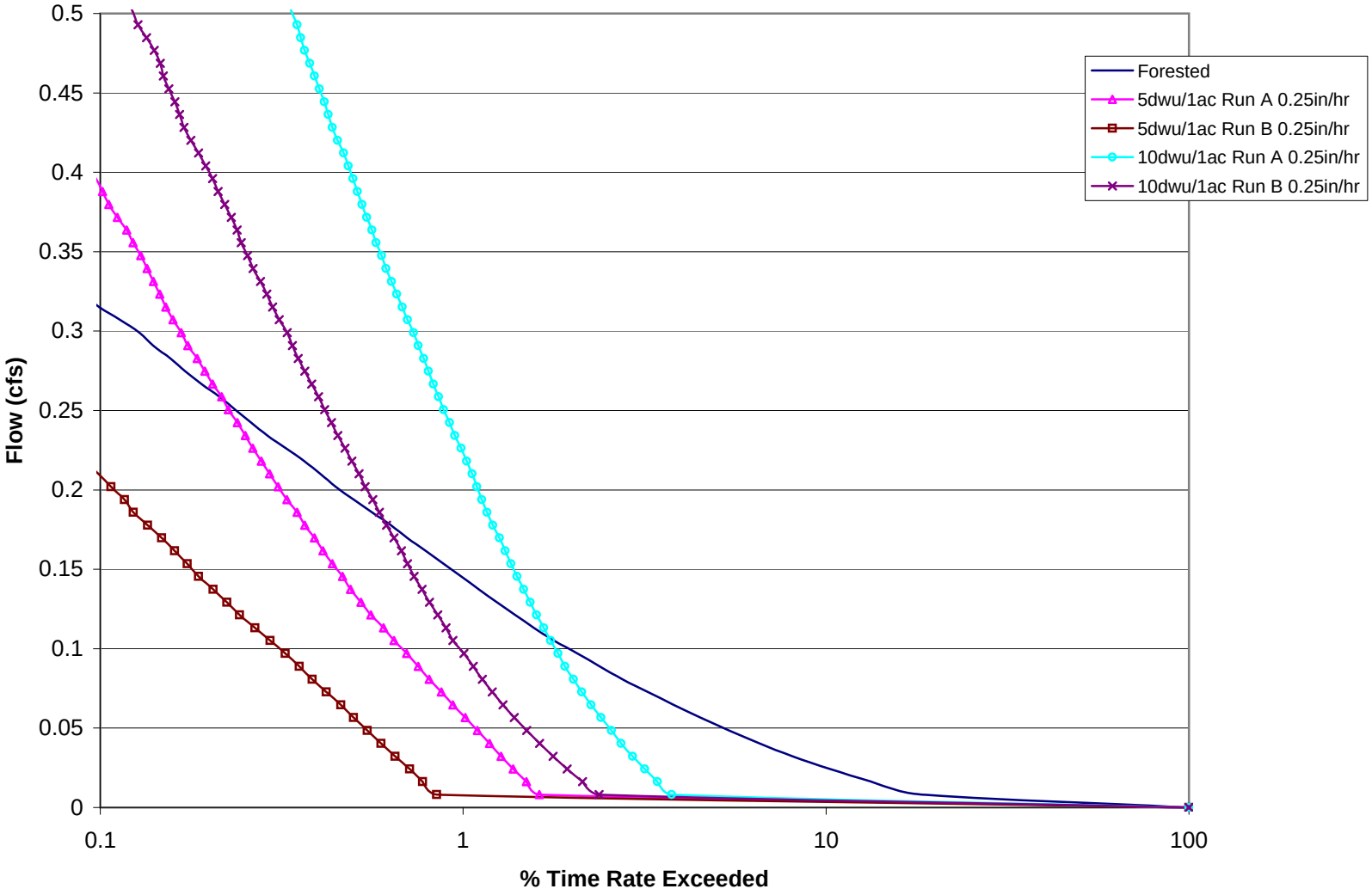
Graph 3 Duration Curves - 2.0 in/hr Infiltration Rate Scenario 1 Run A, Scenario 2 Run A, and Scenario 2 Run B



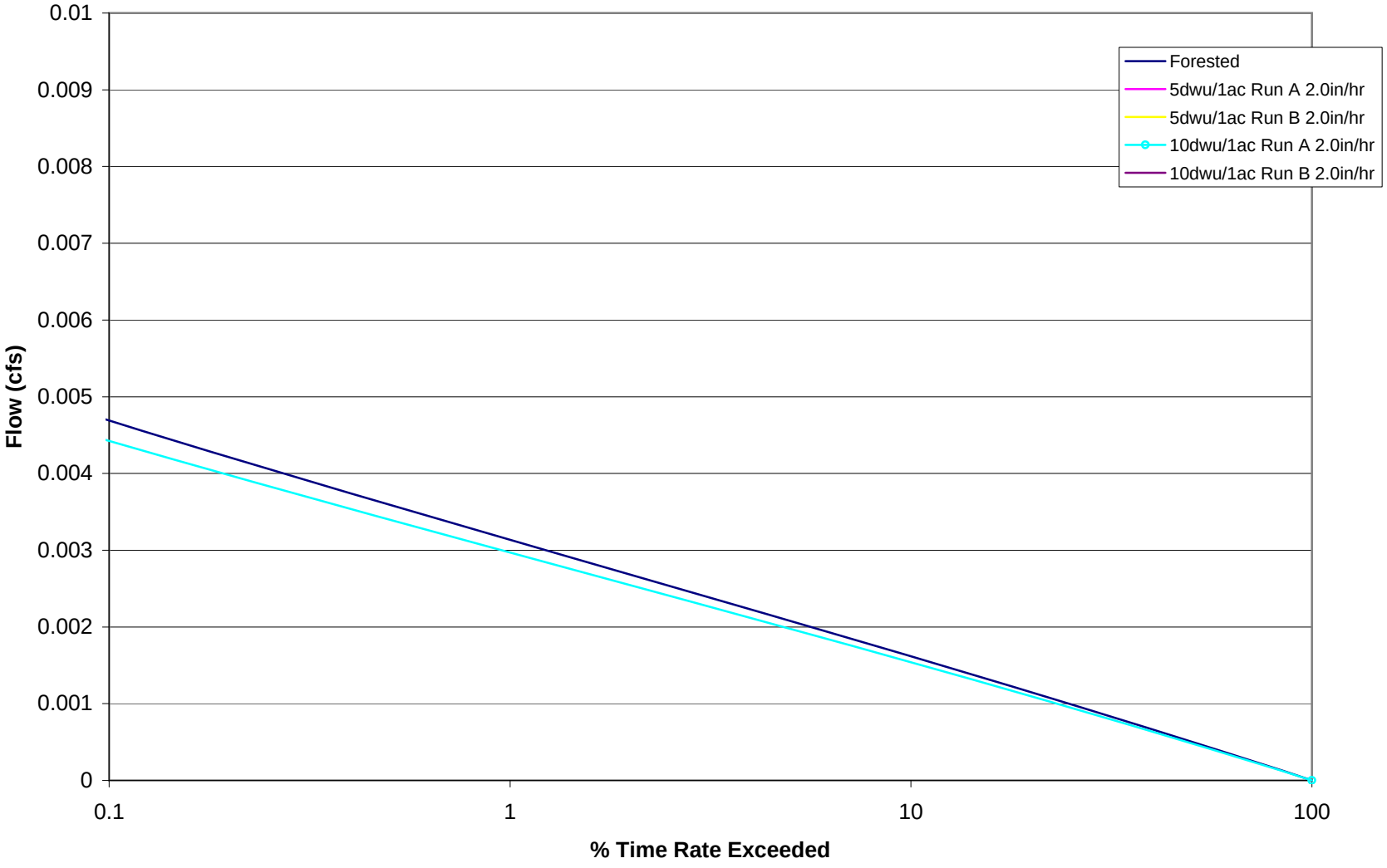
Graph 4 Duration Curves - 0.02 in/hr Infiltration Rate Scenario 3 Run A, Scenario 3 Run B, Scenario 4 Run A, and Scenario 4 Run B



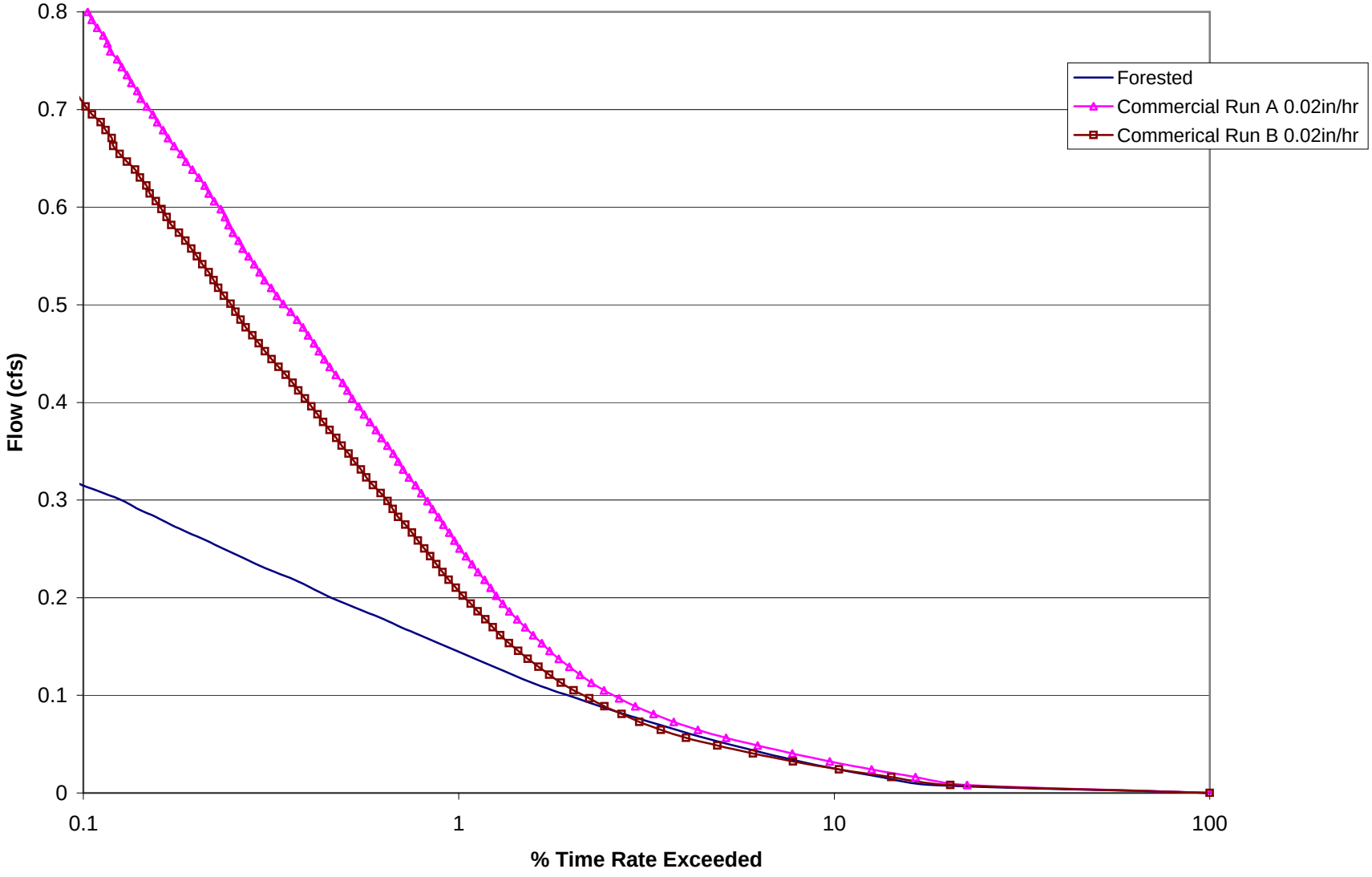
Graph 5 Duration Curves - 0.25 in/hr Infiltration Rate Scenario 3 Run A, Scenario 3 Run B, Scenario 4 Run A, and Scenario 4 Run B

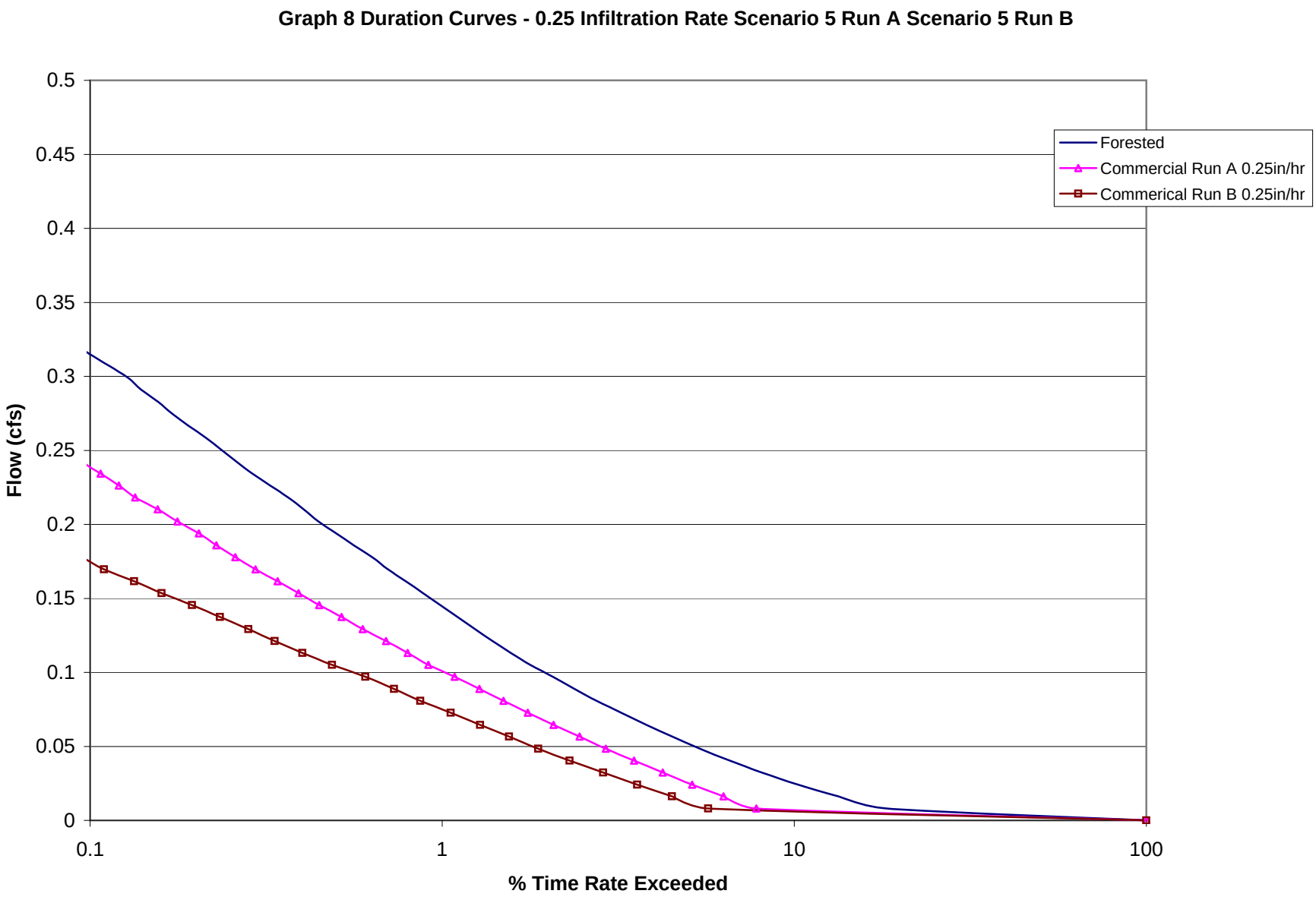


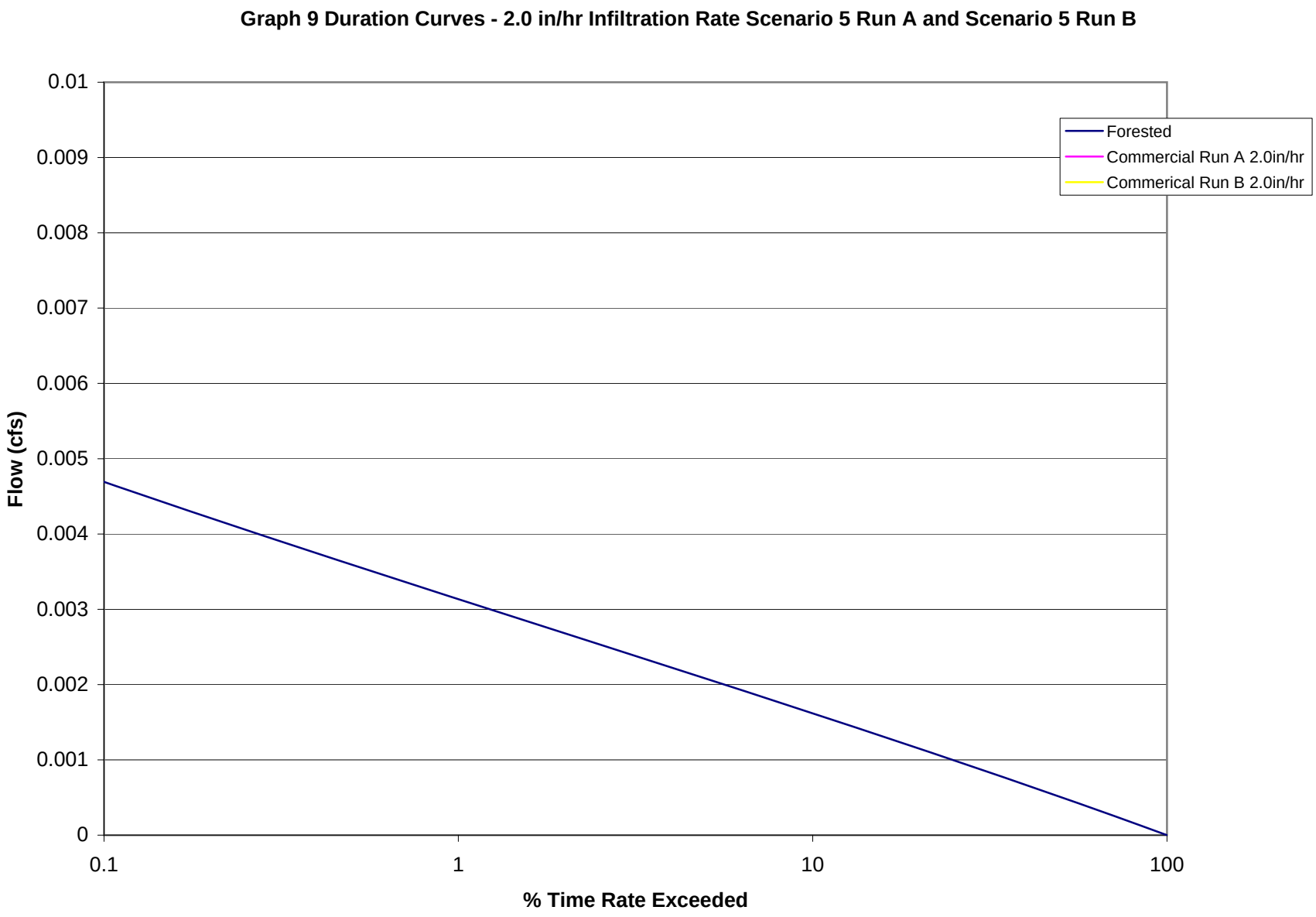
Graph 6 Duration Curves - 2.0 in/hr Infiltration Rate Scenario 3 Run A, Scenario 3 Run B, Scenario 4 Run A, and Scenario 4 Run B



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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DOE LID Technical Committee

Annual Runoff Volume Comparison

SvR #09034 1/19-22/2010

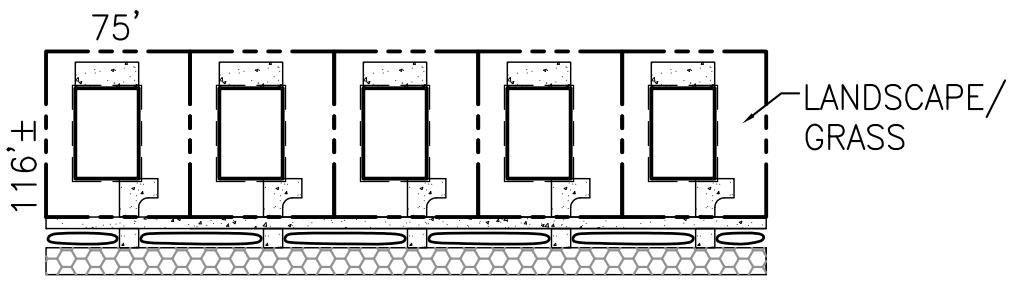
Basin Area = 10 acres for modeling runs

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

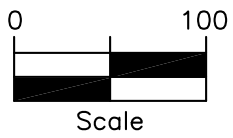
TBD = Run to be completed for 1/25 mtg

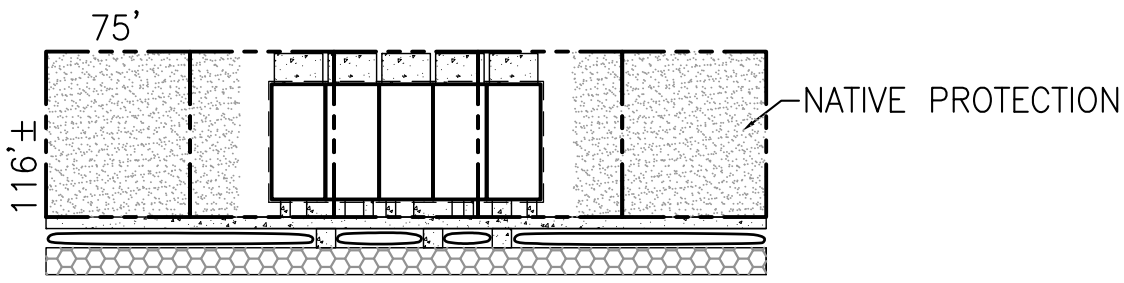
*Volume includes surface and interflow

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

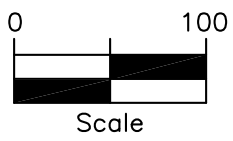


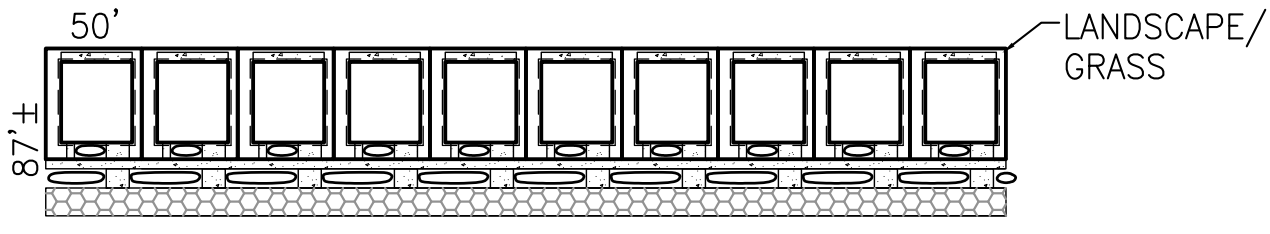
Model Scenario 3: 5 DU/ 1 Acre



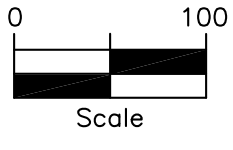


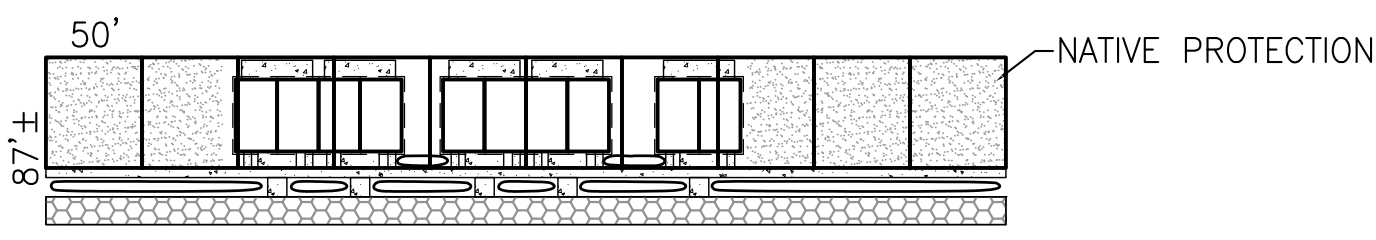
Model Scenario 3: 5 DU/ 1 Acre
with 40% Native Protection



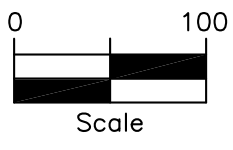


Model Scenario 4: 10 DU/ 1 Acre





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



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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
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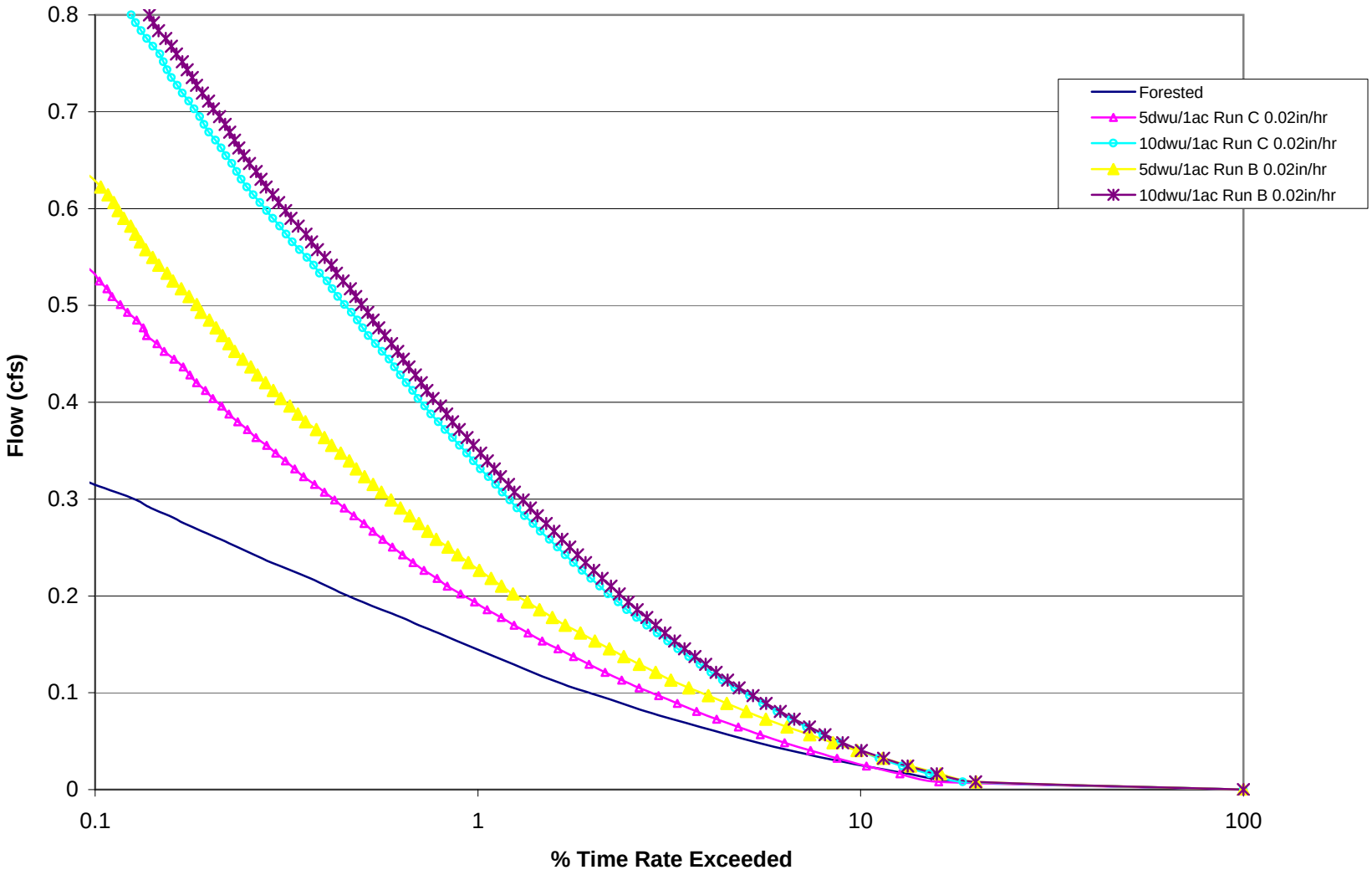
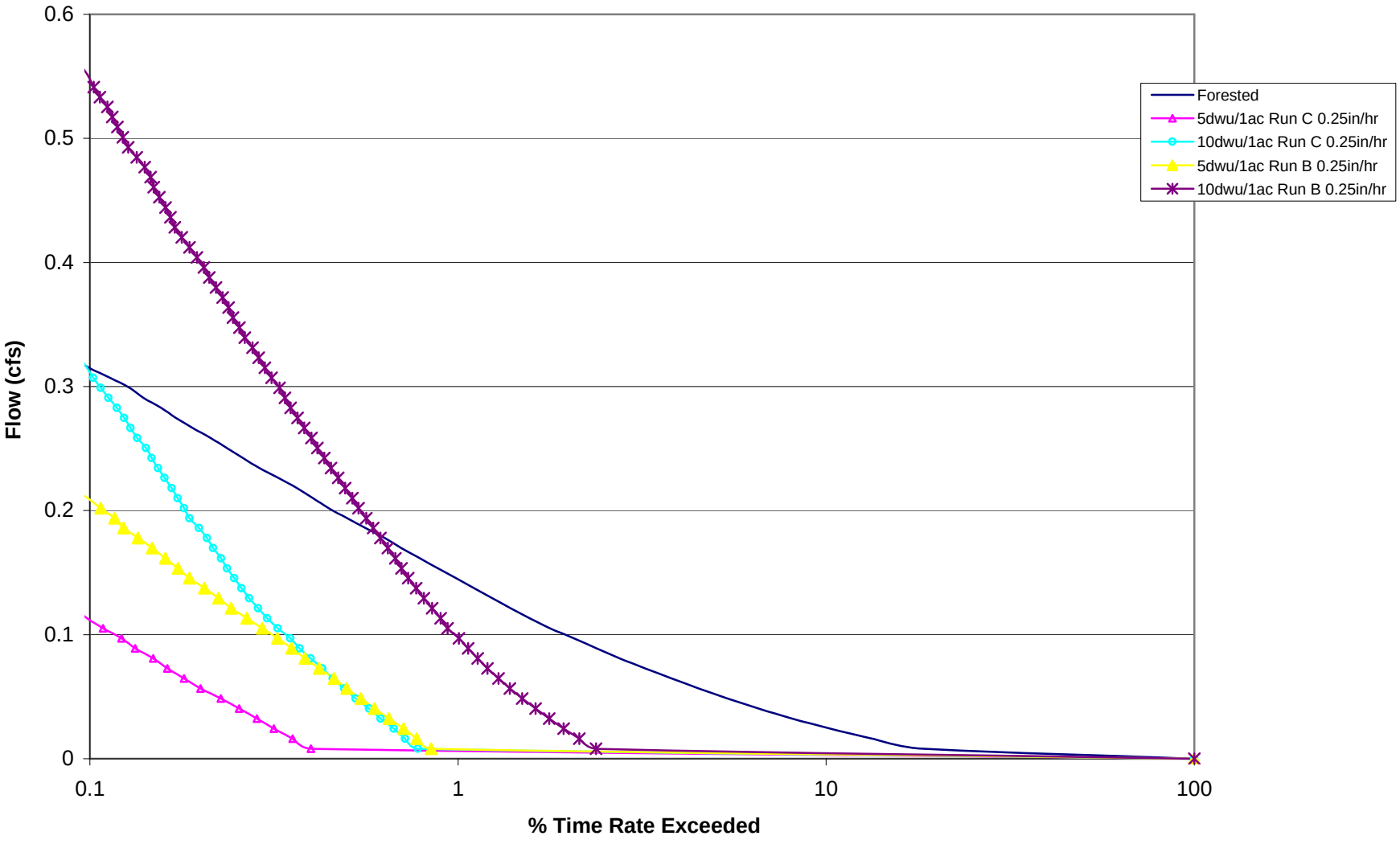
Scenario	4 RUN C WWHM3 Model Assuptions		
Density			Run C
Parcel Area	Native Vegetation		
Development Area	Preservation		
Parcel Frontage			
Development Frontage			
Totals			
	10 du/ac - SF	100 du/ 10 ac - SF	WWHM Entry - Acre
Non-Vegetated Land Cover	43,560	435,600	10.0
Non-Vegetated Land Cover Area	***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***		

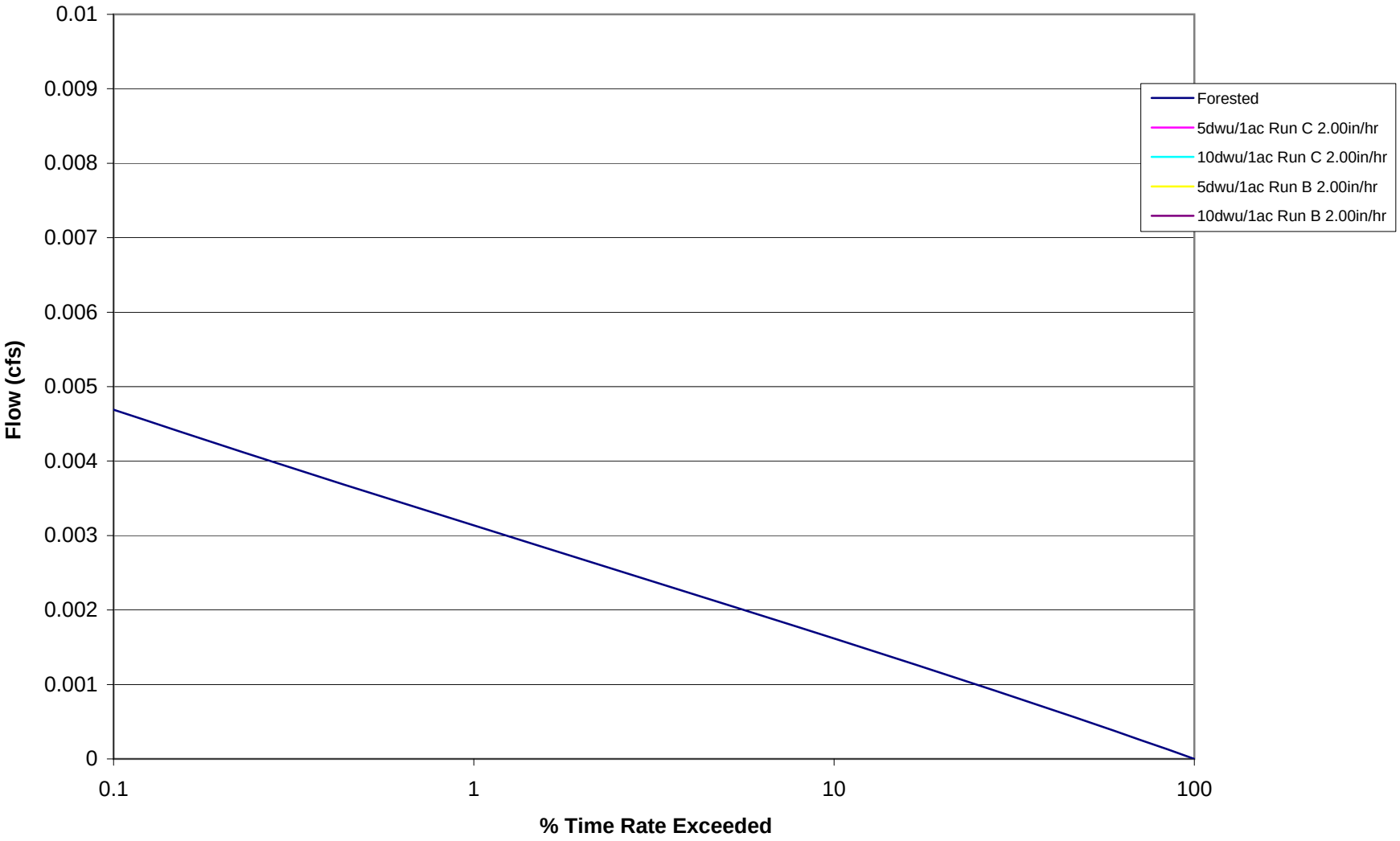
Graph 10 Duration Curves - 0.02 in/hr Infiltration Rate Scenario 3 Run B & C and Scenario 4 Run B & C

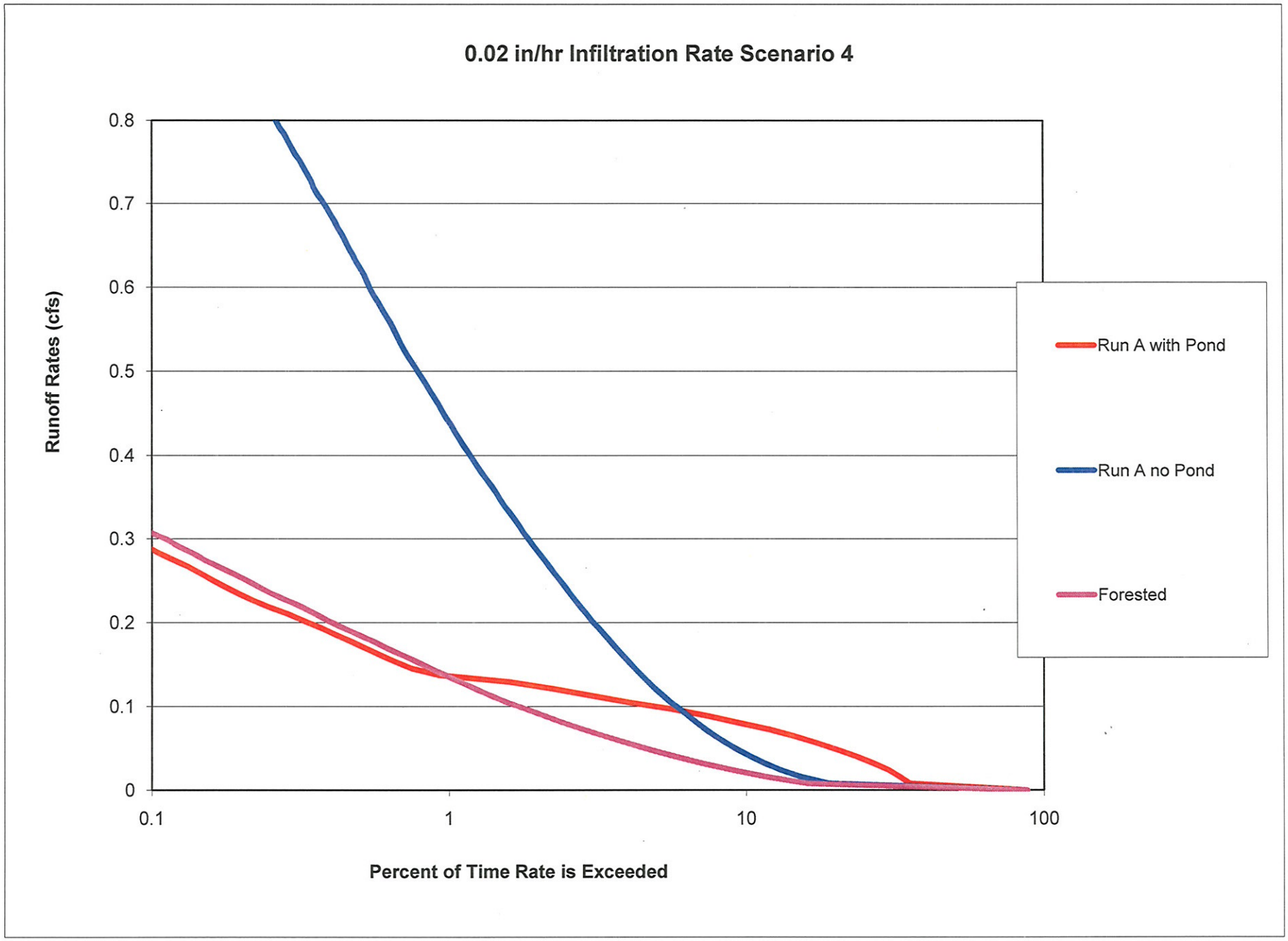


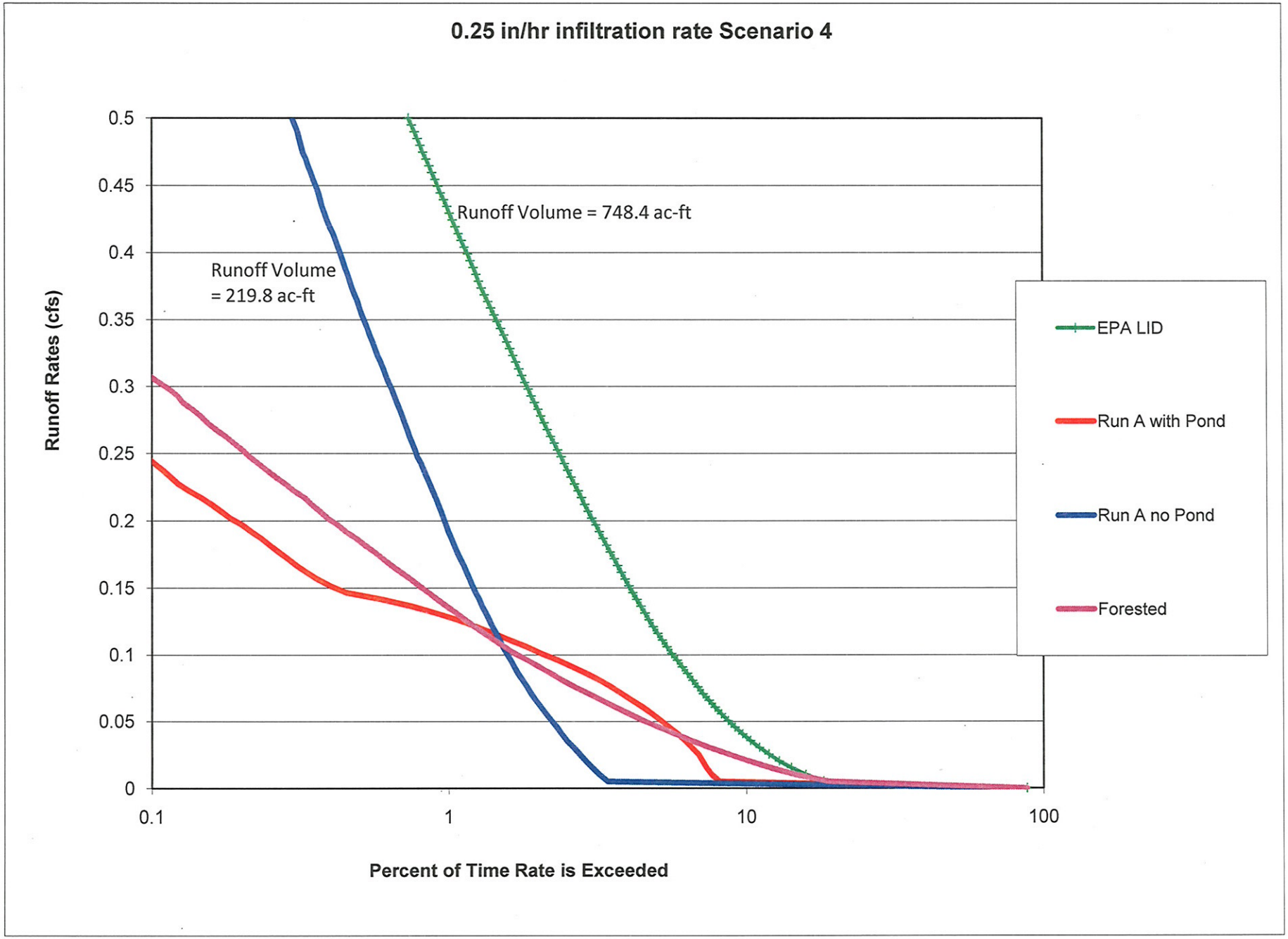
Graph 11 Duration Curves - 0.25 in/hr Infiltration Rate Scenario 3 Run B & C and Scenario 4 Run B & C



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




0.02 in/hr Infiltration Rate Scenario 4
Runoff Rates (cfs)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
1
10
100
Percent of Time Rate is Exceeded
Run A with Pond
Run A no Pond
Forested


0.25 in/hr infiltration rate Scenario 4
Runoff Rates (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
Percent of Time Rate is Exceeded
Runoff Volume = 748.4 ac-ft
Runoff Volume
= 219.8 ac-ft
EPA LID
Run A with Pond
Run A no Pond
Forested