Center for Environmental Excellence by AASHTO
Stormwater Management Community of Practice (CoP)

STATE-OF-THE-PRACTICE REPORT:
EPA Post-Construction Stormwater Control Rulemaking

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DISCLAIMER

This State-of-the-Practice Report summarizes the discussions of Stormwater Management Community of Practice members who spoke as individual members of the community and did not necessarily represent their agency's views or positions. In addition, the contents of the report do not necessarily represent the views or positions of AASHTO or the Center for Environmental Excellence.

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EXECUTIVE SUMMARY

The United States Environmental Protection Agency (U.S. EPA) is in the process of a national rulemaking to strengthen post-construction stormwater rules with the objective of improving surface water quality. The proposed rulemaking will have a significant impact on state Department of Transportation (DOT) stormwater programs, in that the rules will change the way DOTs must manage stormwater from new highways, as well as on existing highways and other facilities on land owned by DOTs.

The proposed rulemaking will result in changes that will be incorporated into stormwater National Pollutant Discharge Elimination System (NPDES) permits issued by the EPA and the states. DOTs hold both Phase I and Phase II stormwater NPDES permits. The EPA is proposing to make changes in the following areas for post-construction stormwater management:

- Expand the area subject to federal stormwater regulations.
- Establish specific requirements to control stormwater discharges from new development and redevelopment.
- Develop a single set of consistent stormwater requirements for all Municipal Separate Storm Sewer Systems (MS4s).
- Require MS4s to address stormwater discharges in areas of existing development through retrofitting the storm drain system or drainage area with improved stormwater control measures.
- Explore specific stormwater provisions to protect sensitive areas, including Chesapeake Bay.

The regulations will likely require DOTs to implement low impact development (LID) stormwater measures, control runoff volume, provide mitigation for hydromodification impacts, and address retrofitting of existing infrastructure.

LID implementation for highways is a relatively recent initiative, and measures that reduce runoff volume and mitigate for hydromodification require additional research to improve their applicability for DOTs. Retrofit of stormwater management measures in existing infrastructure will be costly and must be assessed relative to benefit and maintenance requirements. The expansion of the coverage area of regulations outside of existing Phase I and Phase II areas will have considerable cost with a potentially low benefit. DOT facilities in rural areas traditionally incorporate passive stormwater management measures, such as sheet flow off the roadway, vegetated shoulders, swales for drainage conveyance, and natural dispersion and infiltration.

This Community of Practice (CoP) report includes an overview of the State-of-the-Practice for LID implementation, runoff volume control, hydromodification mitigation and retrofitting by DOTs, and investigates the research needs to eliminate data gaps and refine current approaches to support their application in a highway environment. Specific research proposals that are needed to support the implementation of the anticipated EPA rulemaking are provided by the CoP participants. A list of resources of current research in highway stormwater management is also provided.

INTRODUCTION*

The Center for Environmental Excellence by AASHTO has established a Stormwater Management Community of Practice (CoP). The purpose of the Stormwater Management CoP is to create a forum where State Department of Transportation (DOT) practitioners can engage in facilitated discussions on emerging issues, research data needs, and innovative stormwater quality compliance solutions. The CoP has two primary goals, the first of which is to extend each state DOT's network and contacts, enabling them to share experiences and engage in technology transfer. The second goal is to develop a State-of-the-Practice Report (this document) on a selected focus topic. The Stormwater Management CoP consists of representatives from 16 state DOTs, the Federal Highway Administration (FHWA), and the Federal Transit Administration (FTA). The Stormwater Management CoP members agreed that the proposed United States Environmental Protection Agency (U.S. EPA) Rulemaking for post construction stormwater control (stormwater rulemaking) should be the top priority for this phase of the CoP.

This State-of-the-Practice Report discusses the proposed EPA stormwater rulemaking and tools that DOTs will need to comply with the rulemaking including implementation of low impact development (LID), runoff volume reduction, hydromodification mitigation, and retrofitting. This report also discusses research needs to develop tools for DOTs to comply with the anticipated regulations.

BACKGROUND

EPA Proposed National Rulemaking to Strengthen the National Stormwater Program

The EPA Office of Water asked the National Research Council (NRC) in 2006 to review the national stormwater program and recommend ways to strengthen it. The current stormwater program regulations were promulgated in 1990 (Phase I) and 1999 (Phase II) and have remained largely unchanged since that time. In October 2008, the NRC published a report, "Urban Stormwater Management in the United States," which summarized the findings of the Committee on Reducing Stormwater Discharge Contributions to Water Pollution. The report found that stormwater programs are hampered by regulations that focus on specific pollutants and ignore the volume of discharge. The NRC report also concluded that the regulations provide broad discretion to the discharger in how compliance is achieved and monitored. Four overarching conclusions and recommendations were provided by the study authors:

1. The EPA's current approach to regulating stormwater is not likely to produce an accurate or complete picture of the extent of the problem, nor is it likely to adequately control the contribution of stormwater to water body impairment.
2. Flow and related parameters like impervious cover should be considered for use as proxies for stormwater pollutant loading.

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3. The EPA should engage in much more vigilant regulatory oversight in the national licensing of products that contribute significantly to stormwater pollution.
4. The federal government should provide more financial support to state and local efforts to regulate stormwater.

In response to the NRC report, the EPA initiated a rulemaking (2009) to strengthen the stormwater program by establishing specific requirements for the management of post-construction stormwater discharges. The rulemaking will expand the scope of municipal National Pollutant Discharge Elimination System (NPDES) permits and provide consistency in NPDES program implementation nationally. The main considerations of this rulemaking include:

1. Establishing post construction standards for stormwater discharges from newly developed and redeveloped sites.
2. Expanding the scope of the existing municipal regulations to include additional municipal dischargers.
3. Establishing specific requirements for transportation-related Municipal Separate Storm Sewer Systems (MS4s).
4. Establishing a single set of minimum measures for all other non-transportation MS4s.
5. Addressing stormwater discharges from existing development through retrofitting.
6. Including specific provisions for the Chesapeake Bay watershed and other sensitive areas.

As a first step in the rulemaking, EPA issued questionnaires to stakeholders in the following groups: owners, operators, developers, and contractors of developed sites, and owners or operators of MS4s and states and territories. Most DOTs received a questionnaire as a part of the information collection request (ICR) process. The list of recipients is included as Appendix A. Appendix B contains the schedule for the ICR process, which was generally:

- October 2009 – Federal Register (FR) notice was published, announcing the EPA's intent to enter into ICR process.
- December 2009 – EPA distributed draft questionnaires for comment.
- January 2010 through June 2010 – EPA held listening sessions.
- August 2010 – DOTs received the ICR questionnaire.
- October 2010 – EPA hosted a question-and-answer webinar on the ICR with the DOTs.
- October/November 2010 – DOTs submitted their completed questionnaires to EPA.

EPA expects to report to Congress in the summer of 2011, publish a draft rule in the FR for public comment in late 2011, and release an updated version of the rule in September 2011. The EPA expects to take final action on the rule (promulgation) in November 2012. Once promulgated, the rule would have to be incorporated into NPDES permits to become effective. This will occur as permits in each state expire and as they are renewed.

The rule will have a substantial effect on DOT stormwater programs once it is implemented. The focus of this CoP report is to explore the likely changes to the stormwater program from the rulemaking, assess the impacts on DOT stormwater programs, and provide recommendations for suggested research to prepare for the anticipated changes.

DISCUSSION

DOT stormwater programs are unique compared to those for traditional MS4s. DOTs primarily operate facilities (highways, rail, and airports) that focus on providing a platform to allow for the efficient movement of people and goods. Municipalities have authority over the people who are using transportation infrastructure in the municipality and have the authority to control how those people conduct themselves through use and enforcement of regulation and ordinance. By comparison, DOT facilities are passive and uniform, diffuse (covering a wide geographic area), and include safety as a primary objective. DOTs primarily operate single-purpose facilities (roads and highways), which can allow for a permit with more focused objectives as compared to a traditional MS4 permit that addresses multiple land uses. A significant portion of pollution sources (i.e., atmospheric deposition and release from vehicles) is outside of the DOT's control. Accordingly, some of the requirements in a traditional MS4 permit will not result in significant or timely gains in water quality when applied to a DOT; however, they will reduce the resources available to support more beneficial program elements. DOTs are often issued (or are co-permittees on) multiple NPDES permits, resulting in varied program requirements throughout the state. DOT agencies cross many city and county jurisdictional boundaries and typically occupy a very small land area in any watershed, with limited right-of-way for improvements. Finally, DOTs are unique in that the safety of both the public and DOT personnel dominates the design of the infrastructure and constrains activities that can occur in the right-of-way.

Water quality stressors can be unique both locally and regionally, and therefore, flexibility is needed for stormwater program implementation. A prescriptive set of national requirements would not be the most effective approach to improve water quality from the DOT right-of-way. In this respect, the applicability of the maximum extent practicable (MEP) standard for DOTs may differ from traditional MS4s.

DOTs must also emphasize source control as one of the most effective measures available. DOT facilities are passive and uniform, and the elimination of a constituent of concern (for example, in product manufacture) is by far superior to end of pipe treatment. An obvious example is the elimination of lead in gasoline in the 1970s. Had the EPA not taken this step, DOTs would be struggling with lead exceedances and lead TMDLs today. Consistent with the recommendation in the NRC report, EPA assistance in the implementation of national source control measures would be highly beneficial to improving DOT stormwater quality.

The Phase I and Phase II stormwater regulatory programs were developed primarily for municipalities and applied to linear infrastructure with little modification. The authority for the NPDES permitting system in most states has been delegated to the individual state by the EPA. The state entity administering the NPDES program has the latitude to impose permit requirements that are more protective of water quality than the EPA's Phase I and Phase II rules, but the state's rules cannot be less protective. Under this system, it is possible that state regulators can feel constrained, with little discretion to modify the basic EPA permit framework for DOTs. The water quality benefit of some permit elements is subjective and difficult to assess quantitatively. NPDES permit programs are based on the MEP standard. Establishing permit requirements for a DOT that differ from an MS4, may alter the MEP for the DOT as compared to the MS4. Absent national guidance for a DOT specific permit framework, states do not have a basis to refocus DOT NPDES permits.

An important outcome of the rulemaking for DOTs would be for the EPA to acknowledge the fundamental differences between DOT and MS4 stormwater programs and accommodate those differences through a modified or model permit framework.

All aspects of the rulemaking will likely have important impacts to DOT stormwater programs. Combining Phase I and Phase II programs would bring significant changes to DOTs currently operating under Phase II permits, and some DOTs could see a geographic expansion of their permit coverage area. The EPA may be specifying the types of post-construction best management practices (BMPs) for new and redevelopment under this rulemaking. This is a critical issue for DOTs that have unique physical and safety constraints, in addition to unique constituents of concern. There are four primary areas associated with the rulemaking that may place technical challenges on DOTs, which are the focus of this Report:

1. Implementation of LID;
2. Hydromodification mitigation;
3. Runoff volume reduction; and
4. Retrofit of existing highway infrastructure with stormwater treatment/volume reduction features.

Some states currently have requirements to address one or more of these items as a part of the MS4 stormwater program, or as a part of the §401 certification or Section 7 Endangered Species Act (ESA) consultation. New Hampshire, New York, Delaware, Maryland, Washington, Oregon, and California are examples with existing requirements. Massachusetts recently released its Phase II MS4 permit[1] for select watersheds and has requirements for BMP retrofits, runoff retention, and recharge.

Low Impact Development

LID features are being incorporated into highway systems in parts of the country, particularly on the east and west coasts. There is good guidance available for LID design, particularly focusing on green streets, that is less applicable to highway environments. There is not universal agreement on the definition of LID for highways or on the types of practices that constitute conformance with LID principles, since various definitions and approaches are used at the local, state, and federal level. However, the definition of LID put forth by the U.S. EPA[2] provides one standard:

> "A comprehensive stormwater management and site-design technique. Within the LID framework, the goal of any construction project is to design a hydrologically functional site that mimics predevelopment conditions. This is achieved by using design techniques that infiltrate, filter, evaporate, and store runoff close to its source."

The CoP has summarized current highway LID approaches in Table 1 based on experience of the members. Not all of the practices listed are being implemented by all DOTs, but each has general acceptance for use and meets basic safety, operation, maintenance, and performance metrics. The approaches listed in Table 1 were selected based on their use of LID principles (infiltration, evapotranspiration, volume reduction) or their sustainability, as in source control and pollution avoidance.

[1] http://www.epa.gov/ne/npdes/stormwater/mimsc_sms4.html
[2] http://cfpub1.epa.gov/npdes/greeninfrastructure/information.cfm#glossary

Table 1: LID Approaches in the Highway Environment

Current	Emerging	Limited or No Applicability
• Vegetated Swales • Vegetated Strips • Infiltration • Bioretention • Flow Dispersion • Media Filter Drains • Compost Amended Soils/Bioslopes	• Permeable Shoulders • Permeable Pavement (non-highway) • Source Control of Pollutants within the Right-of-Way	• Reduced Lane Widths

Design resources for highway LID approaches listed in Table 1 include the Washington State Department of Transportation Highway Runoff Manual (2010a) and NCHRP Report 565, "Evaluation of Best Management Practices for Highway Runoff Control" (2006), including Volume III, "Low Impact Development Design Manual for Highway Runoff Control." Permeable friction course research is discussed by Eck, et al. (2010). Source control is discussed in a Domestic Scan report on highway stormwater programs (see Reference 7).

Nevertheless, one of the challenges for DOTs is the lack of effective and tested LID options for the highway environment. DOTs have the responsibility to verify performance, reliability, maintenance requirements, cost, compatibility with the roadway structural section and safety of a BMP prior to widespread implementation. Additional research is needed to expand the LID BMP toolbox for DOTs while also identifying what is not applicable in the highway environment and quantifying the environmental benefit with respect to stream geomorphology, water quality and volume reduction.

Hydromodification

Hydromodification is the alteration of the natural hydrologic regime in a stream course due to changes (increase or decrease) in discharge volume, peak flow, and duration. Hydromodification is normally the result of the addition of impervious surface, and the improvement of overland flow conveyances (ditches, channels, pipes) that reduce the time of concentration, also resulting in an increase in the peak discharge.

The implementation of volume reduction BMPs can reduce, or in some cases eliminate, the effects of hydromodification. Currently, most DOTs use detention basins to mitigate for hydromodification. Few locations in the country require matching of the pre-project flow duration curve, but this requirement is becoming more common. The flow duration curve is a flow history of the cumulative period for each discrete discharge value over a period of rainfall record. For hydromodification control, a range of flows, classified by return period, are usually mitigated.

The use of detention by DOTs is problematic from a safety standpoint (necessitating the use of guardrail at a minimum) and requires a significant amount of right-of-way. Conditions that require hydromodification mitigation for highway improvements are variable. Local area rainfall, antecedent moisture, additional impervious area, changes in the time of concentration, receiving stream bed material, in-stream vegetation, and the size of the local drainage area versus the entire watershed of the receiving stream all influence hydromodification impacts. More research is

needed to understand when flow control (or flow duration control), versus in-stream BMPs are appropriate, and when highways have a de minimis contribution to hydromodification.

Washington State DOT has completed some research into conditions whereby they are exempt from hydromodification control based on receiving water conditions. The procedure is valid for 5th order streams or greater. Appendix C contains a presentation describing the procedure. NCHRP Report 521 (2004) discusses the need for research related to hydromodification and discusses a candidate research project entitled, "Assessment of the Effects of Hydromodification, Sedimentation and Turbidity," with an estimate research budget of from $125,000 to $175,000.

In New York State, the hydromodification requirement is to retain the runoff from the 1-year, 24-hour storm, and attenuate runoff from the 10-year and 100-year, 24-hour events. Exceptions are granted for discharges to a 5th order stream, or if a downstream analysis shows that flow attenuation (based on receiving stream conditions) is not required.

Volume Reduction

The NRC report notes that, "A primary goal of stormwater management is to reduce the volume of runoff from impervious surfaces." Highway BMPs can accomplish volume reduction through infiltration and evapotranspiration. Volume reduction is a key component of LID practices.

Runoff volume reduction is difficult for DOTs because there often are technical barriers to infiltration within the highway right-of-way. The roadway structural section is constructed at 90% relative compaction, which for most materials results in relatively low soil permeability. Saturation of the subgrade should also be avoided since some materials can shrink, swell, and loose bearing capacity. BMPs that can be used in the highway right-of-way for volume reduction are generally LID approaches: vegetated swales, vegetated strips, infiltration, bioretention, flow dispersion, and compost-amended soils. NCHRP Report 565 (2006) briefly discusses volume reduction approaches for highway environments.

Volume reduction can also be achieved through design practices, such as the judicious selection of highway alignments through relatively less permeable soils, minimizing grading, preserving existing vegetation, and providing buffer areas for riparian resources. Runoff volume can also be reduced by eliminating curbed shoulders and longitudinal drainage systems in favor of flow dispersion and vegetated swale conveyances. Full depth porous pavements hold great potential for volume reduction, but they are not in use by DOTs since significant technical barriers (pavement design life and operation in cold climates) remain.

In New York State, there are requirements to demonstrate the volume reductions that are achieved with the design practices used on the project through a "Specific Reduction Factor." These requirements are described in the New York State Stormwater Management Design Manual, which applies to NYSDOT[3].

Retrofit

A significant amount of the highway system in the U.S. occupies rural areas and incorporate sheet flow through vegetative conveyances (natural and engineered flow dispersion), as well as vegetated buffer areas. These systems provide disconnected impervious areas, as well as opportunity for precipitation interception that mitigate stormwater discharges. Urban highway

[3] http://www.dec.ny.gov/docs/water_pdf/swdm2010entire.pdf

systems, on the other hand, present significant technical challenges with insufficient space to construct LID BMPs and insufficient access for maintenance. NCHRP Report 565 (2006) notes that about 14% of the 750,000 highway miles in the U.S. are in urban areas.

Retrofit of highways for storm water quality mitigation has traditionally been limited to BMPs installed at the end-of-pipe; however, changes in maintenance practices, pavement systems and source control BMPs within the right-of-way will most likely emerge as the preferred retrofit approach from both cost and effectiveness perspectives.

Safety is a concern for any retrofit approach used for highways. Stormwater BMPs cannot have vertical obstructions in the clear recovery zone, or create ponding areas that could be a safety hazard for an overturned vehicle unless protected by a guardrail. The safety of maintenance workers is also a key factor, locations where stormwater BMPs must be maintained need a maintenance pullout for vehicles.

Maintenance requirements of stormwater BMPs are also a consideration in a retrofit program. Treatment BMPs must operate passively, not cause flooding, and not require maintenance during storm events. DOTs must choose retrofit BMPs with maintenance requirements that are compatible with other routine maintenance practices, such as mowing and the clearing of open-channel conveyances.

The CoP has summarized highway retrofit practices currently in use in Table 2. Not all of the practices listed are being implemented by all DOTs, but each has general acceptance for use and meets basic safety, operation, maintenance, and performance metrics.

Table 2: Retrofit BMP Applications in a Highway Environment

Current	Emerging
• Vegetated Swales • Vegetated Strips • Bioretention • Proprietary Media Filters • Media Filter Drains	• Permeable Friction Course Overlays • Flow Dispersion • Permeable Shoulders • Permeable Pavement (non-highway) • Source Control of Pollutants within the Right-of-Way • Floating Wetland Islands • Stormwater Harvesting/use

Currently, highway retrofits can be required as a part of the NPDES permit, as is the case for North Carolina and Washington State DOTs, but are primarily driven by TMDLs. For example, the EPA has placed numeric criteria for nutrients (total nitrogen and phosphorus) on Florida DOT, and Caltrans has recently completed a retrofit program for trash BMPs in a Southern California District. Retrofits have been required in New York State since 2008 in some watersheds with TMDLs. The New York State Department of Environmental Conservation develops TMDL implementation plans (particularly for phosphorus) that specify pollutant load reductions, necessitating retrofit of existing highway infrastructure for compliance. NYSDOT is evaluating converting existing ditch conveyances into dry vegetated swales to reduce runoff volume and total phosphorus through sedimentation and filtration.

Proprietary BMPs are difficult for DOTs to specify in construction documents (must be an “or equal” alternative available) and may require specialized maintenance practices or equipment.

However, some DOTs, such as Oregon and Washington, have requirements to reduce dissolved metals (principally resulting from Section 7 ESA consultations) that may require proprietary BMP use. Their small footprint and targeted constituent application can make them technically more suitable than non-proprietary BMPs for some applications.

Design resources for highway retrofit approaches listed in Table 2 include the Washington State Department of Transportation Highway Runoff Manual (2010a) and NCHRP Report 565, "Evaluation of Best Management Practices for Highway Runoff Control" (2006), including Volume III, "Low Impact Development Design Manual for Highway Runoff Control." Retrofit of BMPs in highway infrastructure is discussed in detail by Caltrans (2004). The use of permeable friction course as a retrofit is discussed by Eck, et al. (2010); other references are included in the Resources section of this report.

BARRIERS TO IMPLEMENTATION OF STORMWATER MANAGEMENT FOR DOTs

Capital and operation and maintenance (O&M) costs remain one of the primary barriers to implementation of stormwater BMPs in the highway system. DOTs purchase the minimum amount of right-of-way necessary to construct the highway, which has the lowest facility lifecycle cost. Integrating stormwater BMPs into highway designs may increase the right-of-way requirements (requiring purchase or condemnation of additional right-of-way), increasing the project design, construction, and O&M costs.

DOT funding for owner/operator retrofit-only or stand-alone stormwater quality improvement projects is typically limited by restrictions on funding sources. DOTs may not have the ability to use resources designated for capital improvement projects (highway capacity increasing) on these projects. DOTs can program transportation enhancement (TE) projects, but the project must generally be eligible for Federal TE funding. In general, stormwater quality enhancements may be funded more easily as part of a capital project. DOTs do not have the flexibility to levy or collect user fees, and must fund transportation projects within the confines of state and federal regulations.

A problem remains for funding the maintenance of treatment BMPs for DOTs. As treatment BMPs are constructed for TMDL compliance, as stand-alone retrofits or with new or rehabilitation projects, the number of sites requiring maintenance will expand over time, with a resulting increase in required maintenance resources. The procedure for DOTs to acquire additional maintenance resources through the state budget process is not aligned with the time frame within the project delivery process where the final inventory is known, unless a life cycle cost analysis is performed for each project.

Other barriers to implementation of the requirements anticipated in the rulemaking can be grouped into four categories.

1. **Safety**
   Safety is the most important criteria in highway design. The preservation of trees, vegetation, and the use of temporary ponding of stormwater in LID BMPs can impact highway safety. However, many of the practices listed in Table 1 are compatible with highway safety design criteria and may be incorporated into the clear recovery zone with

little modification. Traditional non-proprietary BMPs that pond water or have vertical obstructions are generally not compatible or require additional expense for highway applications (such as the use of guardrail). The safety of highway maintenance workers is also a key concern. Highway BMPs must operate passively, not require maintenance during rain events, and not cause flooding if they were to malfunction.

2. **Maintenance**
   The highway system is distributed over a large area, making maintenance of BMPs labor and time intensive. In addition, many regulatory agencies require tabulation, tracking and reporting of post-construction BMP installations. The current trend is for DOTs to reduce landscape maintenance along the highway with most funding targeted for roadway repair, resurfacing, and snow removal.

3. **Vector Control**
   Vector control (mosquitoes) can be a problem for LID BMPs that have not been properly designed or are in need of maintenance. Deferred maintenance on BMPs may be a reality for DOTs but is problematic if public health is threatened. Vector control must be considered a barrier for any BMP that ponds or that may pond water if maintenance is deferred.

4. **Technical Design Problems and Physical Limitations**
   Roadway pavement systems are constructed on compacted engineered fill or a certified excavation section. Once constructed, the subgrade soil modulus (stiffness) is reduced with increasing moisture content. Pavement damage results when the subgrade soil modulus is reduced compared to the design condition. As indicated previously, compacted soils have relatively poor infiltration rates and, in most cases, they will not support infiltration of stormwater. Compaction may be avoided outside of the structural section, but infiltration of runoff in this area may not be practical, depending on the soil lithology, relative grade difference to the pavement system, and available infiltration area.

Soil properties vary widely in the U.S., so it is not possible to characterize infiltration suitability for DOTs on a general basis. However, in many areas, particularly in the Midwest, soils are not suitable for infiltration. Studies in Southern California show retrofit of infiltration BMPs at DOT facilities to be viable at less than 30% of the sites (pre-screened specifically for infiltration feasibility) due primarily to poor infiltration of site soils (Caltrans, 2003).

Washington State Department of Transportation (WSDOT) published a report entitled, "Barriers to Implementing Low Impact Development Approaches in Washington State Roadways and Highways" (2010b). This publication also identifies several institutional barriers to LID implementation:

- Risk aversion
- Stormwater as an afterthought in design
- Lack of incentives
- Lack of management support
- Lack of education and training
- Competing agency missions
- Lack of a flexible and comprehensive toolbox

DOTs are being named as stakeholders in TMDLs, because they cross nearly every watershed in a state, and they own and operate a significant and visible portion of public infrastructure. As TMDL implementation schedules are developed, DOTs are faced with the complex task of anticipating future TMDL compliance requirements when implementing post-construction programs and satisfying existing TMDL load allocations. Regulatory agencies must begin to integrate TMDL requirements by watershed to assist TMDL stakeholders in expending resources efficiently.

OPPORTUNITIES FOR IMPLEMENTATION OF STORMWATER MANAGEMENT FOR DOTs

The EPA rulemaking will require changes in how highway stormwater is managed and will necessitate an increase in the performance (and the diversity of methods) of management practices used by DOTs. Opportunities for implementation of stormwater management practices will require new research, will entail increased costs, and will range from technical to programmatic.

Use Existing Infrastructure

It will be imperative to use the existing highway and drainage infrastructure in stormwater management solutions to meet the rulemaking requirements. Implementation of retrofit approaches that require significant structural changes to the roadway system and/or appurtenances are unaffordable and inconsistent with sustainable infrastructure practices.

Texas DOT has pioneered research that is consistent with the philosophy of incorporating existing infrastructure into improved highway stormwater management. Permeable friction course (PFC) overlays are in routine use throughout most of the southern states to reduce pavement noise and hydroplaning potential. Texas Department of Transportation (TxDOT) research shows that PFC has a substantial benefit for highway runoff water quality. A second example also under study by TxDOT is batch detention, which can be easily and inexpensively retrofit to existing dry detention and flood control basins. Impounding runoff without discharge for a pre-determined period prior to release, results in significant improvement in effluent quality compared to dry detention. While neither of these technologies reduces runoff volume, they exemplify the characteristics of approaches that maximize the use of existing highway infrastructure. Links to more information on these projects is provided in the References and Resources sections of this report.

Investigate Credit Trading

The highway right-of-way has significant constraints, notably an emphasis on public and DOT personnel safety and limited space, which increase the cost of stormwater management. Highway systems typically represent about 2 to 3% of the impervious area in most watersheds, and they may not be the primary contributor to a receiving water impairment. Urban development areas served by highway infrastructure may be a better location to mitigate for highway stormwater impacts for both performance and economy. Land costs are generally higher for DOTs, and the ability to avoid ecologically sensitive areas is greater outside of the highway right-of-way. Urban areas also have more diverse sources of stormwater pollution than highways, which may present better opportunities to improve receiving water quality.

For example, a study was completed in Atlantic Beach, Florida on the cost of meeting a TMDL for nutrients. The study noted that the cost of removing nitrogen in wastewater varied from $31 to $52/kg at the city's two wastewater treatment plants. The cost for removing nitrogen from stormwater using wet detention ponds ranged from $12,000 to $16,500/kg. DOTs may have far more leverage spending mitigation resources to fund projects of acute need in the local community (such as an upgrade to a wastewater treatment plant), than through the installation of BMPs within the highway right-of-way. This type of approach to mitigation, a form of credit trading, should be explored by DOTs as a potentially more cost-effective option.

It will be important for DOTs to work with regulatory agencies to develop plans to determine where mitigation resources should be expended for the greatest environmental benefit. Highly degraded streams in urban areas may not be a priority for mitigation compared to a stream that is of higher quality but showing signs of stress from urbanization. DOTs that have existing credit trading programs, or are investigating their use include Delaware, Maryland, and Florida. Programs must be flexible to meet DOT constraints; for example, DOTs cannot generally pay for mitigation in advance of project construction.

Emerging BMPs

Emerging BMPs are those BMPs that are under development, experimental, or being implemented on a pilot basis by DOTs. Emerging BMPs must focus on source control as the most effective method of pollution reduction for DOTs. The NRC report notes in its summary section that,

> "Products that contribute pollutants through stormwater—like de-icing materials, fertilizers, and vehicular exhaust—would be regulated at a national level to ensure that the most environmentally benign materials are used."

There have been some significant advances in source control to the benefit of DOT stormwater programs and the environment, including banning of lead in gasoline, the reduction of copper in vehicle brake pads (Washington and California), and EPA banning the private use of pesticides such as diazinon and chlorpyrifos. Future source control practices for DOTs may focus on reducing zinc in the right-of-way (highway appurtenances) and in vehicles (tires and tire weights).

Similarly, there remains substantial potential to improve BMPs focused on DOT maintenance practices. The use of coal tar pavement sealants has been banned by most DOTs due to high levels of polycyclic aromatic hydrocarbons (PAHs). Other potential targets include release agents (surfactants) used in paving operations, paint stripe removal practices, chemical use in vector and weed control, and maintenance of sheet flow from the edge of pavement to reduce shoulder erosion.

Funding

Stormwater programs are chronically underfunded, since they are a relatively new addition to agency budgets and the requirements change with each NPDES permit cycle. The NRC report supports this conclusion, stating that:

> "The federal government should provide more financial support to state and local efforts to regulate stormwater. State and local governments do not have adequate financial support to implement the stormwater program in a rigorous way."

The rulemaking may be an unfunded mandate, but given the discussion in the NRC report, DOTs may want to take the opportunity to secure increased dedicated funding for stormwater programs, since program requirements will become more prescriptive and more costly.

DOT stormwater activities are eligible for federal aid. While there is no federal money set aside specifically for stormwater, it is up to the state to determine how to spend federal highway trust fund resources. Stand-alone stormwater quality improvement projects (retrofitting) can receive federal funding; however, projects must be consistent with state transportation plans and be included in applicable municipal planning organization plans and the state transportation improvement plan. Federal funding is also provided under the Transportation Enhancements Program (TEP), which includes a provision for "mitigation of highway runoff." The TEP is funded through the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU) through the Surface Transportation Program (STP).

SUGGESTED RESEARCH AND DATA NEEDS

The CoP developed research and data needs specifically focused on preparation for the anticipated requirements from the rulemaking. These research topics should be forwarded through AASHTO for consideration for funding through the National Cooperative Highway Research Program (NCHRP). Only the suggested research topics/titles are presented here, additional details of selected research topics are contained in Appendix D.

A. Research Title:
"Low Impact Development Practices to Mitigate the Impacts of Nutrients and Pathogen Contributions from Highway Rights-of-Way"

B. Research Title:
"Permeable Shoulders"

C. Research Title:
"Stormwater Storage"

D. Research Title:
"Use of Compost and Compost Amended Vegetated Filter Strips for Hydrologic Mitigation: Effectiveness and Design Guidance"

E. Research Title:

"Hydromodification: Parameters for Mitigation Requirements"

ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in this report:

AASHTO	American Association of Highway and Transportation Officials
ALDOT	Alabama Department of Transportation
BMP	Best Management Practice
Caltrans	California Department of Transportation
CDOT	Colorado Department of Transportation
CoP	Community of Practice
DelDOT	Delaware Department of Transportation
DOT	Department of Transportation
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FLDOT	Florida Department of Transportation
FR	Federal Register
FTA	Federal Transit Administration
ICR	Information Collection Request
ILDOT	Illinois Department of Transportation
MEP	Maximum Extent Practicable
MIDOT	Michigan Department of Transportation
MS4	Municipal Separate Storm Sewer System
NCDOT	North Carolina Department of Transportation
NHDOT	New Hampshire Department of Transportation
NRC	National Research Council
NPDES	National Pollutant Discharge Elimination System
NYSDOT	New York State Department of Transportation
O&M	Operation and Maintenance
ODOT	Oregon Department of Transportation
PAH	Polycyclic Aromatic Hydrocarbon
PFC	Permeable Friction Course
TMDL	Total Maximum Daily Load
TRB	Transportation Research Board
TXDOT	Texas Department of Transportation
VDOT	Virginia Department of Transportation
WISDOT	Wisconsin Department of Transportation
WSDOT	Washington State Department of Transportation

RESOURCES

1. Center for Environmental Excellence by AASHTO, http://environment.transportation.org

2. Practitioner's Handbooks Webinar: 13. Developing and Implementing a Stormwater Management Program in a Transportation Agency, available at http://environment.transportation.org/center/products_programs/webinar_handbook_13.aspx
   Description: Assists transportation agencies in developing and/or implementing a storm water management program that satisfies the requirements of the Clean Water Act

3. Low Impact Development Training Program for Linear Transportation Projects, available at http://www.lowimpactdevelopment.org/epa03_transportation.htm
   Description: Presentation developed as an interactive training program for federal, state, and local transportation agencies; slides include basic materials for each module and instructor notes; manual was developed in National Highway Institute format to be consistent with other transportation programs

4. Managing Stormwater with Low Impact Development Practices: Addressing Barriers to LID, available at http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/AddressingBarrier2LID.pdf
   Description: EPA Fact sheet discussing barriers and solutions to LID implementation in urban infrastructure

5. Pilot Projects for LID Urban Retrofit Program in the Anacostia River Watershed, available at http://www.co.pg.md.us/Government/AgencyIndex/DER/ESG/pdf/Final%20Technical%20Report_Phase%20III.pdf
   Description: Technical report on LID retrofits in highways in the Anacostia river watershed, specifically to implement LID demonstration projects on U.S. Route 1, MD Route 201, and Interstate 95

6. Water Quality Management of Highway Runoff, available at http://www.nhi.fhwa.dot.gov/training/list_catalog.aspx?cat=&key=&num=142047&loc=&sta=%25&tit=&typ=&lev=&ava=&str=&end=&drl= Description: Course for management of water quality from highways developed by the National Highway Institute (fee)

7. Scan 08-03: Best Practices In Addressing NPDES And Other Water Quality Issues In Highway System Management, available at http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-68A_08-03.pdf
   Description: Final Scan Team Report on implementation of stormwater programs for a DOT

8. Revisions to November 22, 2002 EPA Memorandum “Establishing Total Maximum Daily Load (TMDL) Waste Load Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs,” November 12, 2010

9. Stormwater Quality Benefits of a Permeable Friction Course, available at http://www.crwr.utexas.edu/reports/pdf/2008/rpt08-03.pdf

10. Center for Research in Water Resources Online Report 10-01: Hydraulic Conductivity Measurement of Permeable Friction Course Experiencing Two-Dimensional Nonlinear Flow Effects, available at http://www.crwr.utexas.edu/reports/pdf/2010/rpt10-01.pdf

11. Drainage Hydraulics of Porous Pavement: Coupling Surface and Subsurface Flow, available at www.crwr.utexas.edu/reports/2010/rpt10-2.shtml

12. Underground Stormwater Quality Detention BMP for Sediment Trapping in Ultra-Urban Environments: Final Results and Design Guidelines, available at http://tti.tamu.edu/publications/catalog/record_detail.htm?id=30975

13. Water Retention Techniques for Vegetation Establishment in TxDOT West Texas Districts, available at http://tti.tamu.edu/publications/catalog/record_detail.htm?id=32490

14. Water Retention Techniques for Vegetation Establishment in TxDOT West Texas Regions, available at http://tti.tamu.edu/publications/catalog/record_detail.htm?id=32491

15. Bioretention for Stormwater Quality Improvement in Texas: Pilot Experiments, available at http://tti.tamu.edu/publications/catalog/record_detail.htm?id=32500

16. Florida Roadway Design Office, State Drainage Office, Drainage Research Projects, available at http://www.dot.state.fl.us/rddesign/dr/Research-projects.shtm
Description: Research on pervious pavement and stormwater re-use is available under the Stormwater Academy section

    University of Central Florida (UCF) Stormwater Management Academy (http://stormwater.ucf.edu) contains two reports and a program for analyzing pervious pavement/ballast storage systems:
    - Feasibility of Waste Tire Used in Pollution Control, available at http://stormwater.ucf.edu/research/FILES/FinalReportSeptember2008.pdf
    - Alternative Stormwater Sorption Media for the Control of Nutrients, available at http://stormwater.ucf.edu/research/Final%20Report%20Sept%2026.pdf
    - Pervious Pavement Water Management Analysis Model, available at http://www.stormwater.ucf.edu/previous_concrete_pavement_research_files/designaid.xls

    Information on FDOT exfiltration trenches (also called French drains) is available at
    - http://www.dot.state.fl.us/rddesign/rd/rtds/10/285.pdf
    - ftp://ftp.dot.state.fl.us/LTS/CO/Specifications/SpecBook/2010Book/443.pdf

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Caltrans, "Infiltration Basin Site Selection Study," Volumes 1–3, Report: CTSW-RT-03-025 Caltrans Division of Environmental Analysis, Sacramento, CA (2003), available at http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/_pdfs/new_technology/CTSW-RT-03-025/IFB_Final_Report.pdf

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Washington State Department of Transportation, "Highway Runoff Manual," Environmental and Engineering Programs Design Office, Olympia, WA (2010a), available at http://www.wsdot.wa.gov/Environment/WaterQuality/Runoff/HighwayRunoffManual.htm

Washington State Department of Transportation, "Barriers to Implementing Low Impact Development Approaches in Washington State Roadways and Highways," Office of Research and Library Services, Olympia, WA (2010b), available at http://www.wsdot.wa.gov/research/reports/fullreports/756.1.pdf

APPENDIX A:

List of DOT ICR Recipients

STATE	MS4 NAME	MS4 TYPE	Contact
AK	Alaska Dept of Transportation & Public Facilities-Central Region	DOT_State	Randy Vanderwood
AK	Alaska Dept of Transportation & Public Facilities-Northern Region	DOT_State	Brett Nelson
AL	Alabama Department of Transportation	DOT_State	Don W. Vaughn
AR	Arkansas State Highway & Transportation Department	DOT_State	Gary Williamson
AZ	Arizona DOT	DOT_State	Todd G. Willilams
CA	CALTRANS Divison of Environmental Analysis	DOT_State	Scott McGowen
CO	Colorado DOT Ind MS4	DOT_State	Rick Willard
DC	DC DOT	DOT_State	
DE	Delaware Department of Transportation	DOT_State	Randy Cole
FL	Florida DOT District 2	DOT_State	Alan Obaigbena
FL	Florida DOT District 5	DOT_State	Michael H. Hill, PE
FL	Florida DOT District 6	DOT_State	Jaime Barrera
FL	Florida DOT District 7	DOT_State	Susan C. Moore
HI	Hawaii DOT	DOT_State	Robert Shin
ID	Idaho Transportation Dept District #6	DOT_State	Karen Hiatt
ID	Canyon Highway District No.4	DOT_Local	Tim Richards
ID	Ada County Highway District	DOT_Local	Erica Anderson Maguire
ID	Lakes Highway District	DOT_Local	Eric Shanley
IL	Palos Road District	DOT_Local	
IL	Illinois DOT	DOT_State	Thomas Ripka, P.E.
IN	Indiana DOT	DOT_State	
KS	Kansas Department of Transportation	DOT_State	Scott Vogel
KY	Kentucky Transportation Cabinet	DOT_State	
LA	Louisiana Department of Transportation and Development	DOT_State	William Temple
MA	Massachusetts Highway Department	DOT_State	Henry Barbaro
MD	Maryland State Highway Administration	DOT_State	Sonal Sanghavi
MD	Maryland Transit Administration	DOT_State	Diane Ratcliff
MD	Maryland Transportation Authority	DOT_State	Douglas Novocin
ME	Maine DOT	DOT_State	
MI	Michigan DOT-Statewide MS4	DOT_State	
MI	Bay CRC MS4-Bay	DOT_Local	Julie Bowker
MI	Allegan CRC MS4	DOT_Local	
MI	Muskegon CRC MS4	DOT_Local	Paul R. Bouman
MN	Minnesota DOT Metro District MS4	DOT_State	Beth Neuendorf
MN	Minnesota DOT Outstate District MS4	DOT_State	Nicklas Tiedeken
MO	Missouri Dept of Transportation.	DOT_State	William B. Carter (Brad)
MS	Mississippi Department of Transportation	DOT_State	John Taylor
MT	Montana DOT	DOT_State	Stefan Streeter
MT	Montana DOT Great Falls	DOT_State	Michael P. Johnson
MT	Montana DOT Butte	DOT_State	Jeff Ebert
MT	Montana DOT Missoula	DOT_State	Daniel Ham
NC	North Carolina DOT	DOT_State	Matt Lauffer
ND	North Dakota DOT	DOT_State	Mark Gaydos
ND	Cass County	DOT_Local	Tim Solberg
ND	Grand Forks County	DOT_Local	Carole McMahon
ND	Morton County	DOT_Local	Chuck Morman
NE	Nebraska Department of Roads	DOT_State	Cindy Veys
NH	New Hampshire Department of Transportation	DOT_State	Mark Hemmerlein
NJ	Essex County	DOT_Local	Joseph Divencenzo Jr.
NJ	Bergen County Department of Public Works	DOT_Local	Bergen County
NJ	New Jersey DOT Region South	DOT_State	Jeffrey Callahan

STATE	MS4 NAME	MS4 TYPE	Contact
NJ	Delaware River Port Authority of Pennsylvania and New Jersey	DOT_Local	John J. Matheussen
NJ	Burlington County Bridge Commission	DOT_Local	Sasaha J. Harding
NJ	Mercery County	DOT_Local	David W. Stem
NM	New Mexico Department of Transportation, District 3	DOT_State	Katherine Trujillo
NM	New Mexico Department of Tansportation, Disctrict 5	DOT_State	John E. McElroy
NM	New Mexico Department of Transportation, District 1	DOT_State	Paul Little
NV	Nevada Department of Transportation	DOT_State	James Murphy
NY	New York State DOT	DOT_State	Dave Graves
NY	County of Rockland County Roads	DOT_Local	Andrew Connors
NY	County of Wayne Highway Department	DOT_Local	Kevin Rooney
NY	Chemung County Highway Department	DOT_Local	Andrew P Avery
OH	Ohio DOT	DOT_State	Robert Lang
OK	Oklahoma DOT	DOT_State	Michele Dolan
OR	Oregon DOT	DOT_State	Jeff Moore
PA	Pennsylvania DOT	DOT_State	
RI	Rhode Island DOT	DOT_State	Allison LeBlanc
SC	South Carolina DOT	DOT_State	Ramond H. Vaughan
SD	South Dakota DOT	DOT_State	Joan Bortnem Clarke
TN	Tennessee Department of Transportation (TDOT) - Statewide MS4	DOT_State	John Hewitt
TX	Texas DOT Central Office	DOT_State	Duncan Stewart, P.E.
TX	Texas DOT at Wichita Falls	DOT_State	Jill Holmes
TX	Texas DOT at Yoakum District	DOT_State	Bryan Ellis
TX	Texas DOT at El Paso District	DOT_State	James Stevenson, P.E.
TX	Texas DOT - Houston District (Pasadena)	DOT_State	Gary Trietsch, P.E.
TX	Texas DOT Dallas	DOT_State	William Hale
TX	Texas DOT at Beaumont Distict	DOT_State	Lisa Collins
UT	Utah DOT	DOT_State	Jerry Chaney
VA	Virginia Department of Transportation	DOT_State	Roy Mills
VT	Vermont Agency of Transportation	DOT_State	Craig Digiammarino
WA	Washington State DOT	DOT_State	Larry Schaffner
WV	West Virginia - Department of Transportation - Division of Highways	DOT_State	Laura A. Conley - Rinehart
WY	Wyoming Department of Transportation - District 1	DOT_State	Tim McGary
WY	Wyoming Department of Transportation - District 2	DOT_State	Lowell Fleenor

APPENDIX B:

U.S. EPA Slides from DOT Information Session, October 5, 2010

Stormwater Rulemaking Information Collection Request Webcast

October 5, 2010

US Environmental Protection Agency

Stormwater Challenges

- Stormwater remains a leading cause of water quality impairment
  - According to the 2004 Water Quality Inventory, urban stormwater discharge is the source of problems in:
    - 22,559 miles, or 9.2% of all impaired rivers and streams
    - 701,024 acres, or 6.7% of all impaired lakes
    - 867 square miles, or 11.3% of all impaired estuaries
- Many developed and rapidly developing areas are excluded from regulation
- Current program inadequate at controlling post construction stormwater discharges
- In 2006 EPA commissioned the National Resource Council (NRC) to do a study on EPA's stormwater program
- In October 2008 NRC released *Urban Stormwater Management in the United States*, available at: www.epa.gov/npdes/stormwater

Considerations for Rulemaking

- On December 28, 2009, EPA published a Federal Register Notice announcing the initiation of rulemaking to strengthen its stormwater program and to further reduce the impact of post construction discharges from developed sites to our Nation's waters

  (FR 74 FR 68617-68622)

- The main considerations of this rulemaking include:
  - Establishing post construction standard for stormwater discharges from newly developed and redeveloped sites
  - Expanding the scope of the existing municipal regulations to include additional municipal dischargers
  - Establishing specific requirements for transportation-related MS4s
  - Establishing a single set of minimum measures for all other non-transportation MS4s
  - Addressing stormwater discharges from existing development through retrofitting
  - Including specific provisions for the Chesapeake Bay watershed

Stormwater Rulemaking Schedule

- Data Collection
  - Information Collection Request
  - Site Visits
- SBREFA* Panel this Fall – impacts on small businesses and small communities
- Report to Congress in Summer 2011
- Proposal in September 2011
- Final Action in November 2012

*SBREFA=Small Business Regulatory Enforcement Fairness Act of 1996

Information Collection Request (ICR)

- Six surveys have been approved by OMB
- MS4 and permitting authority survey sent, recipients have 60 days to complete
- Owner of developed sites survey will be sent this week
- Copies of surveys on the website
- States were provided with the list of MS4s that received the survey in their state

	Estimated Total Number	**Survey Sample**
NPDES permitting authorities	Authorized states (46), Non-authorized states, EPA is authority (DC, ID, MA, NH, NM)	All
Regulated Phase I and II MS4s	Phase I - 750 Phase II - 5891	Phase I - 266 Phase II - 342
Regulated Transportation MS4s- State or County DOTs	149	84
Unregulated cities, towns, townships, villages, counties	16,335	932
Owners of developed sites (long/short version)	739,547	2,985

How were Regulated MS4s questionnaire recipients selected?

- EPA worked with States to develop a database of all currently regulated Phase I and II MS4s

- EPA sampled the State DOT's central office from each state (if applicable) with certainty and randomly sampled up to four additional state divisional offices and/or local/county DOTs depending on the number of DOTs in each state.

Purpose of MS4 Questionnaires

- To collect baseline information to inform EPA's rulemaking considerations
  - Assess existing local stormwater programs to establish a baseline
  - Estimate the current capacity and budgets of localities for their existing programs, including retrofit programs as applicable
- EPA will use this information to evaluate the incremental costs and impacts on MS4s and local jurisdictions and benefits that may result from additional requirements

Transportation-Related MS4 Questionnaire
PART A – Technical Information

Questions A-1:A-11

- The type of MS4
- Number of MS4 permits, co-permittees, permit term, types of roads that the DOT owns, operates, and/or maintains
- Administrative approach to stormwater management
- Types of activities/locations covered under the MS4 permit

Questions A-12:A-18

- Extent of MS4 coverage

Questions A-19:A-32

- Specific stormwater program components:
  - six minimum measures
  - source control measures
  - Industrial
  - GIS data)

Transportation-Related MS4 Questionnaire PART A – Technical Information (Cont'd)

Questions A-33:A-36

- Implementation of post construction program:
  - post-construction activities within the stormwater program
  - mechanisms to ensure continued operation and maintenance of post-construction stormwater controls
  - site plan reviews
  - stormwater controls on variety of types of property

Questions A-37:A-39

- Classification of activities considered new development, redevelopment, or maintenance
- Application of post-construction stormwater management requirements to areas subject to and not subject to MS4 permits

Questions A-40:A-43

- Performance standards or design criteria for post construction stormwater discharge from new and redevelopment projects
- Alternative programs for complying with any standards

Questions A-44:A-45

- Specific information regarding performance standards/design criteria for new development

Transportation-Related MS4 Questionnaire PART A – Technical Information (Cont'd)

Questions A-46:A-48

- Specific information regarding performance standards/design criteria for redevelopment

Questions A-49:A-55

- Retrofit practices and programs
- Funding mechanisms for retrofit programs

Questions A-56:A-65

- Specific stormwater controls installed, maintained
- Data on cost and/or performance
- Local or state regulations that conflict, encourage, or incentivize stormwater retention practices
- Addressing lack of capticity in stormwater conveyence system

Questions A-66:A-69

- Monitoring data
- Additional comments

Transportation-Related MS4 Questionnaire
PART B – Financial Information

Questions B-1:B-3

- Total operating budget and stormwater related budget
- Activities included in the stormwater budget

Questions B-4:B-6

- Number of full time equivalents associated with your stormwater staff and non-stormwater staff
- Funding sources for implementing the stormwater program

Questions B-7:B-9

- Off-site mitigation and payment-in-lieu
- Authority related to adjacent properties

Questions B-10:B-11

- Stormwater fee questions

Questions B-12:B-20

- Capital improvement projects and/or requirements (including retrofit of existing property)
- Goals and budget of stream restoration projects

Transportation-Related MS4 Questionnaire
PART C – Contact Information

Question C-1

- Identify the person who can answer follow-up questions EPA may have regarding any answers provided in the questionnaire.

Website

www.epa.gov/npdes/stormwater/rulemaking

- Questions & Answers to Frequently Asked Questions
- List of Survey Recipients
- Updated Rulemaking Information and Announcements

Follow-up Questions

If you have survey questions following this teleconference contact us via one of the following ways:

- Phone
  - 703-633-1639 or
  - Toll-free: 1-877-797-5643
- E-mail:
  - TransMS4help@erg.com for Transportation-Related MS4 Questionnaire

EPA Contacts

- Questions related to Part A:
  - Rachel Herbert, herbert.rachel@epa.gov
  - Jesse Pritts, pritts.jesse@epa.gov
- Questions related to Part B:
  - Todd Doley, doley.todd@epa.gov

Submitting the Questionnaire

- Can the online questionnaire be entered repeatedly?
  - Yes, the online questionnaire can be accessed an unlimited number of times. You can download the questionnaire and related files from the website. Once you download the questionnaire, it is on your computer. You can open it and save it as many times as you want - just like any other file on their computer.
- Is a signature required? If so, how is it entered?
  - Yes, as described in the certification section, the certification statement must be signed by "the individual responsible for directing or supervising the preparation of the questionnaire. The certifying official must be an official duly authorized DOT representative. "
- Some text boxes are too small for the amount of text entered. Will all text entered into text boxes be visible to EPA?
  - If you run out of space in a particular text box then use the additional space in Question A-69. EPA will not be able to view information provided in a text box if it is beyond the character limit.

Submitting the Questionnaire (Cont'd)

- Is the questionnaire only being submitted online?
  - There are two options for submitting your questionniare and other documents that were outlined in the final instructions:
    - Email: As an alternative to mailing a CD/DVD to the specified address, you may e-mail your signed certification statement, completed questionnaire, and supporting documents to Surveysubmit@erg.com.
    - Mail a CD/DVD: Once the questionnaire is complete, save the file as a Microsoft® Excel workbook to a CD or DVD depending on the size required to hold your completed questionnaire and any additional supporting documents. EPA prefers that diagrams and reports or documents submitted with the questionnaire also be saved and submitted on the CD/DVD, if possible. Please save a pdf version of the signed certification statement, also available from http://app6.erg.com/stormwatersurvey/ to the CD/DVD or return a hardcopy of the signed certification statement. The certification statement, questionnaire response, and supporting documents must be mailed:

      U.S. Environmental Protection Agency
      Stormwater Management Questionnaire
      Transportation–Related MS4
      c/o Eastern Research Group, Inc.
      14555 Avion Parkway, Suite 200
      Chantilly, VA 20151-1102

APPENDIX C:

WSDOT Hydromodification Assessment

Stormwater Quantity Control for Highways in Western Washington

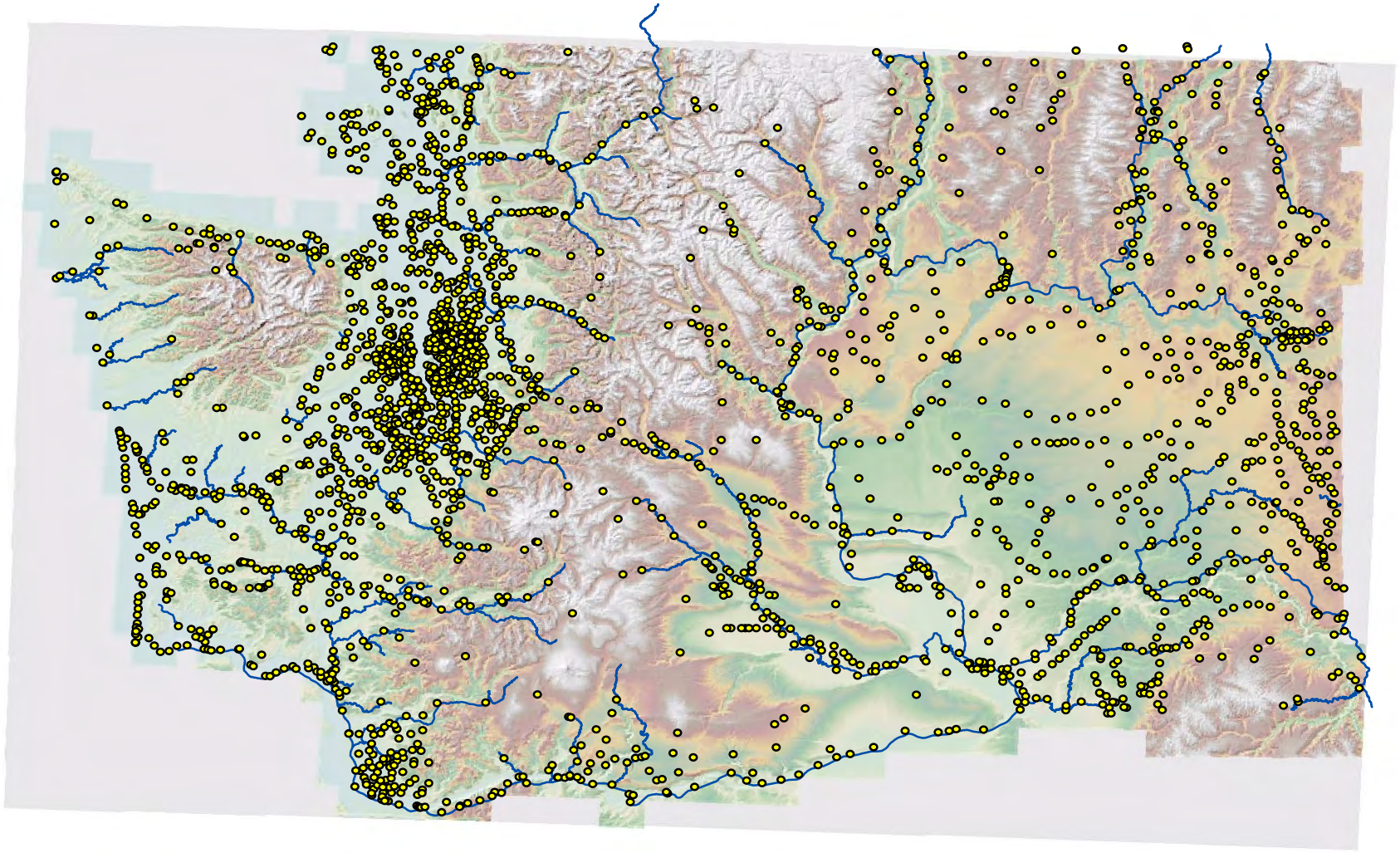
The Case for Exempting Projects Discharging to Rivers

David Hartley, Ph.D., P.E.
Principal Hydrologist
nhc northwest hydraulic consultants

Kenneth M. Stone
Environmental Manager
Washington State Department of Transportation

National Hydraulic Engineering Conference
Portland, Maine
August 26, 2008

Washington State Population Distribution



Features

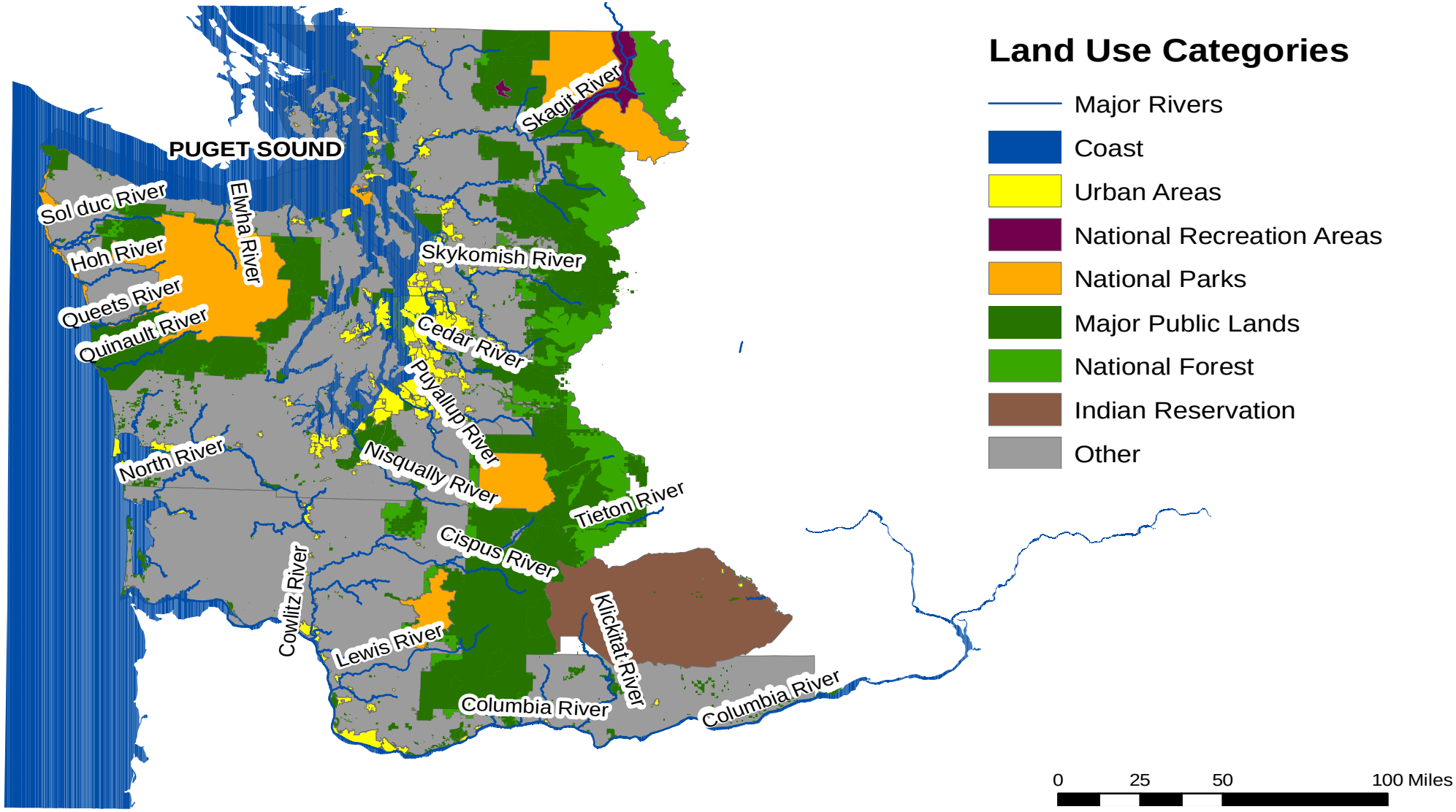
- City
- River

0 25 50 100 Mile

Flow Control – Regulatory Context

- WA State regulates stormwater discharge quantity (flow control) to prevent increases in the stream channel erosion rates that are characteristic of natural conditions (i.e., prior to disturbance by European settlement)
- The flow control standard intends to maintain the volume, velocity, and peak flow rate of pre-project stormwater runoff
- Intent is to maintain channel stability and protect fish habitat and production. 1999 ESA listing of Puget Sound Chinook Salmon and Bull Trout – NOAA & USFWS concerns, need for “B.A.S.”
- In the hydrologic analysis, pre-project land cover condition is presumed to be the historic condition (usually forested in western Washington)
- Results in significantly larger detention facilities, and the possibility of additional right of way = higher cost; and marginal eco-benefits
- Exacerbates challenge of managing stormwater in urban areas

Land Use and Water Resources of Western Washington



Flow Control – Regulatory Context

- Washington is a delegated state for purposes of implementing the Clean Water Act
- Stormwater management minimum requirements are found in WA Department of Ecology stormwater manuals
- NPDES permitees can either adopt the WA Department of Ecology stormwater manual, or an equivalent manual
- Flow control standard becomes a requirement in Clean Water Act §401 and 402 (NPDES) permits issued by the state
- 2001: Ecology publishes their *Stormwater Management Manual for Western Washington*, includes current version of the Flow Control Standard (updated 1992 manual)
- The 2001 manual allows for an exemption to the standard for projects or areas based upon a hydrologic analysis that demonstrates that exempted area runoff will not increase erosion forces on the stream channel

Charge to the Consultant Team

- Phase I-
  - Review Literature on Environmental Thresholds
  - Conceptualize Exemption Approach(es)
- Phase II- (assuming success with Phase I)
  - Pilot method to identify qualifying stream reaches
  - Demonstrate Method to Sponsors and Cooperators
- Phase III- (assuming success with Phase II)
  - Apply Method to All Streams in Western Washington
  - Determine Criteria for Eligible Land Areas
- Phase IV- Present to NOAA, USFWS, WDFW, EPA

Stormwater Flow Control in Western Washington

- **Goal**
  - **prevent downstream erosion from all development projects**
  - **control peaks and durations of discharges ranging between half the 2-yr flow to the 50-year peak to pre-developed conditions.**

- **Typical Detention Storage Required:**
  - **Over 5 inches of rain equivalent or 32,000 cubic feet per mile for each new highway lane.**
  - **Up to 0.30 acres of land for an open water pond or concrete vaults in the right-of-way.**

Alternative Criteria for Flow-Control-Exempt Receiving Streams

- Minimum Stream order (“Big River”)
- Minimum Residual Forest Cover
- % Impervious Area Limit
- River Gradient
- Tidal Dominance

Minimal Available Literature

- **Eastern Washington Interim**

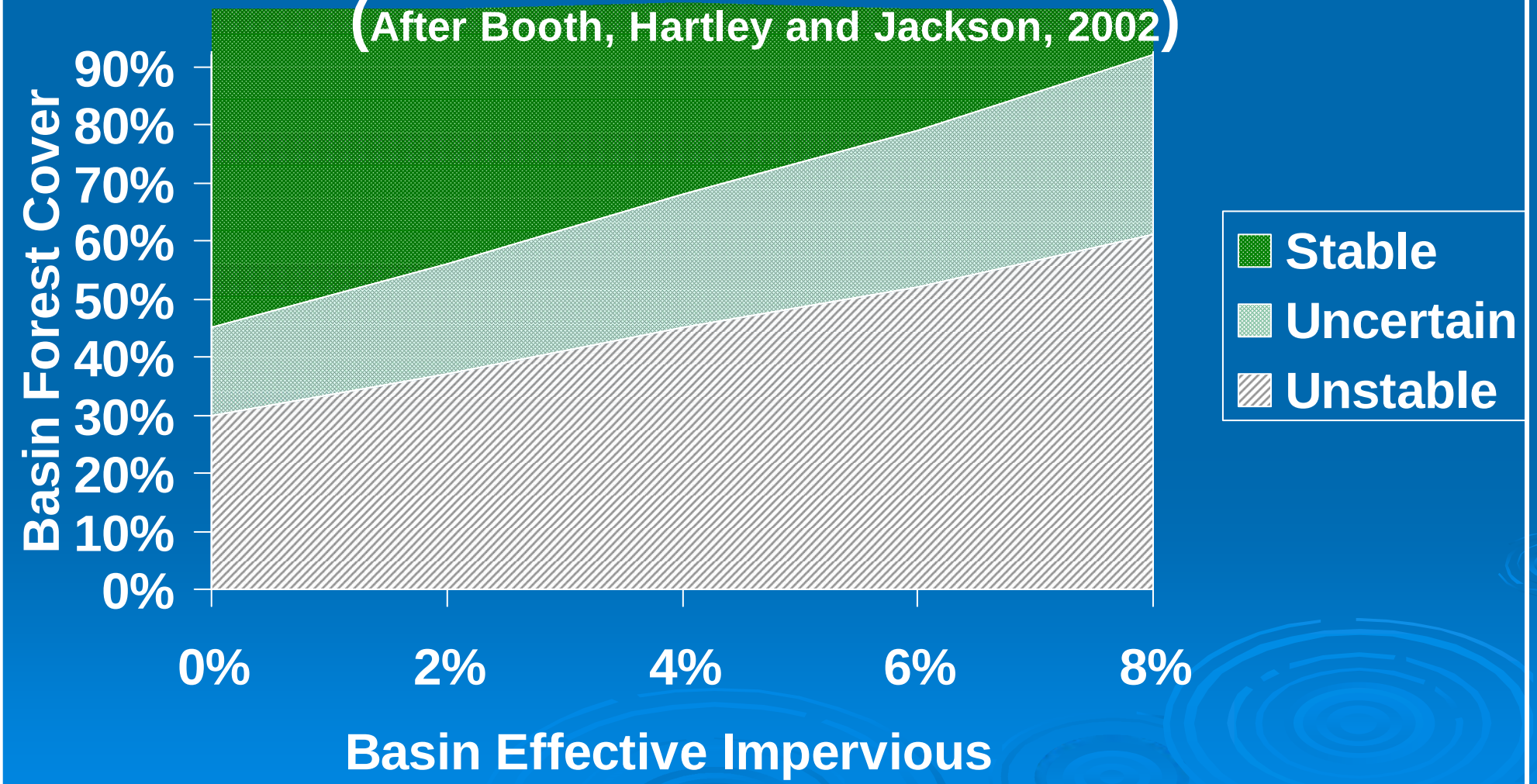
  <5% TIA, >5th Order, east coast studies, (Interfluve, 2003)

- **Maximum EIA-Minimum Native Cover Combinations**

  stability criteria for 3rd Order Puget Lowland streams, (Booth, Hartley, Jackson, 2002)

Channel Stability and Basin Cover- without Detention

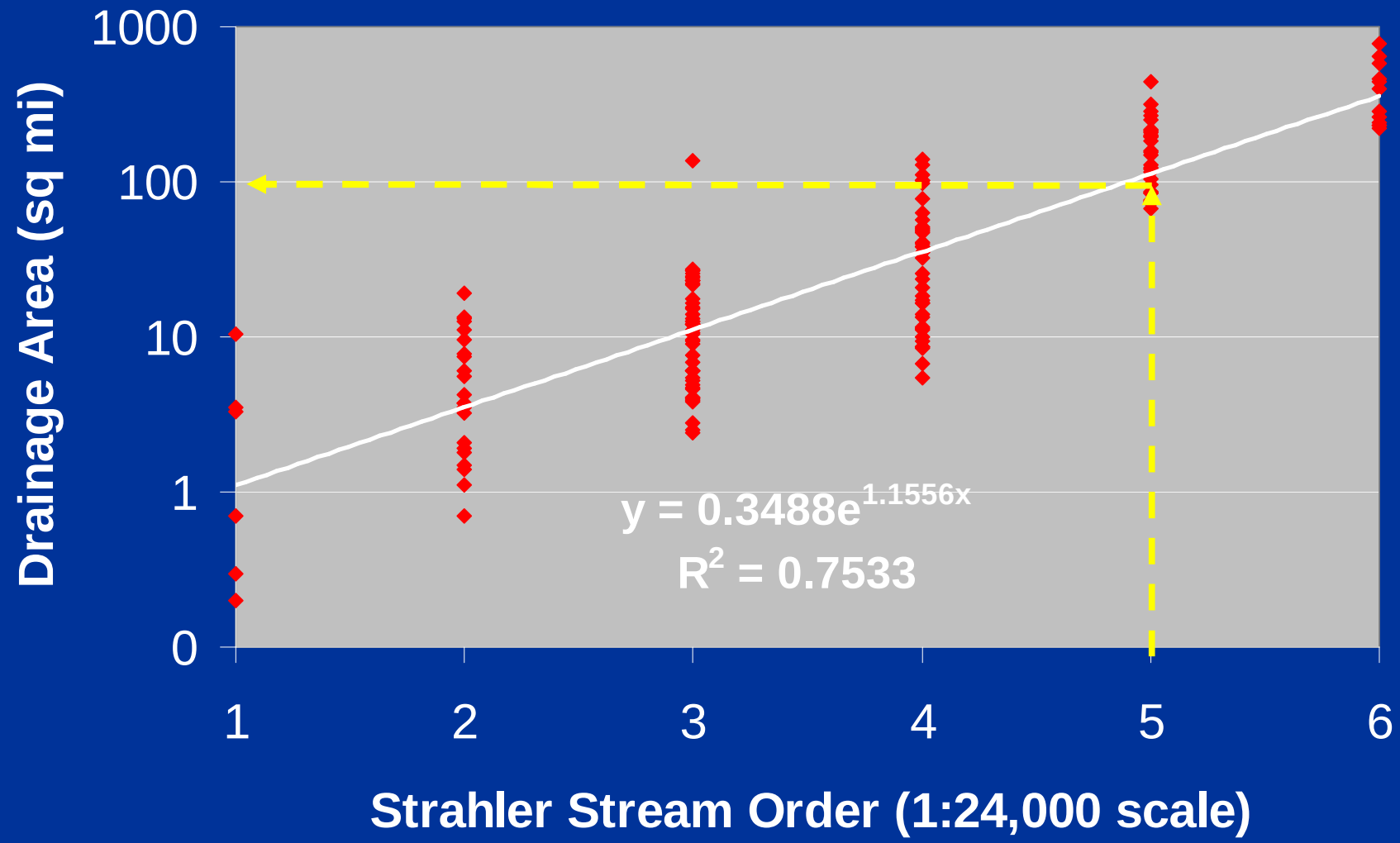
(After Booth, Hartley and Jackson, 2002)



Conservative Approach to Weak Science and Uncertainty

- Require higher forest retention and lower effective impervious indicated by uncertainty envelope (Booth, Hartley, and Jackson (2002)
- Assume Future Build-Out Conditions (using GMA planning areas)
- Only allow direct discharge to streams that are typically 2 orders larger than those predicted to be stable
- Require continuous compliance with criteria from mouth to upstream limits

Drainage vs. Stream Order
USGS Stream Gages, Western Washington



Land Cover Criteria (LCC) in Equation Form

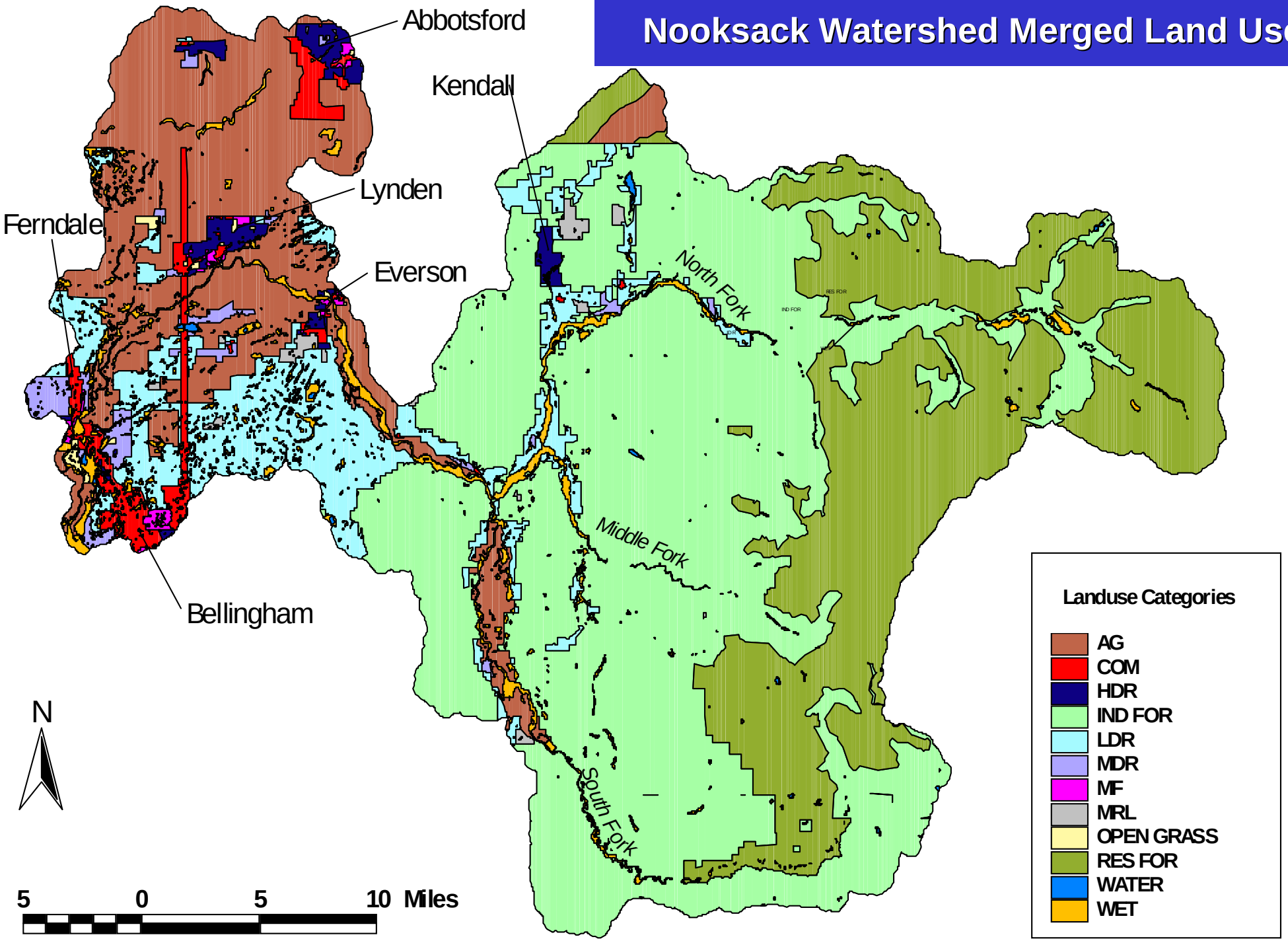
LCC = %Grass + 0.50 %AG + 5.75 * %EIA < 55.4%

In which: Grass = all urban pervious surface

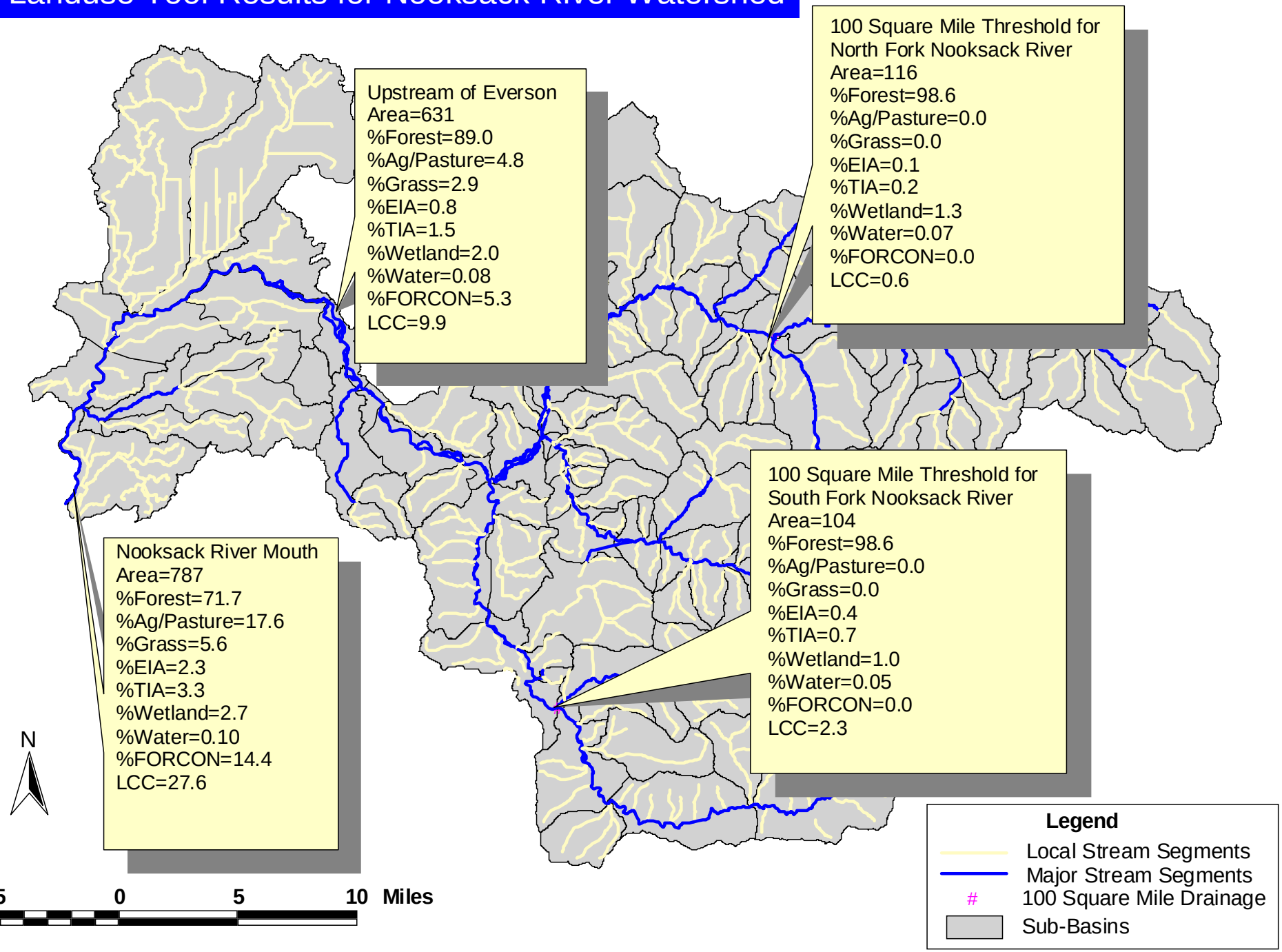
AG = Agricultural Land

EIA = "effective" or directly connected impervious

Nooksack Watershed Merged Land Use



Cumulative Landuse Tool Results for Nooksack River Watershed



Results of GIS Analysis

Large Streams that Fail the LCC Criterion:

- Only 8 Streams with Greater than 100 sq mi exceeded the criteria and could not be exempted.
- Failed Streams typically were in lower basins that included heavier urbanization
- All other streams with greater 100 sq mi of drainage passed number several dozens.
- Exempted streams benefit from the preservation of State and Federal forest lands in the foothills and on the western slope of the Cascades as well as rural zoning.

What Land Areas are Eligible for Direct Discharge?

- Exempt Areas drain directly, no intervening:
  - perennial stream
  - Class I, II, III Wetlands
- Protect non-perennial streams & Class IV Wetlands
  - Flow splitters & BMPs for erosion and hydro-period.
- Properly convey quality-treated flow
  - Man-made, non-eroding water course
  - Conveyance capacity for buildout
  - Non-eroding outfall

Flow Control Standard Exemption

Peer Review and Adoption Process

- During NHC's investigation a series of workshops were held
- Participants included representatives from federal, state and local governments, and consulting firms
- Adoption was part of review and comment period for Ecology 2005 revisions to their western WA stormwater manual
- After Ecology's approval of the exemption, it became part of 2005 Ecology manual, then included in WSDOT's revised 2006 Highway Runoff Manual
- Flow Control exemption includes a list of water bodies exempt from flow control (runoff treatment still required)
- 130 water bodies listed statewide: lakes, marine waters, rivers and river reaches

Flow Control Standard Exemption

Legal Challenges & Avoided Costs

- NPDES Phase I/II permits issued by Ecology in January 2007, included by reference the 2005 western WA manual and its flow control exemption
- Permits appealed by both permittees and environmental advocacy groups (WSDOT intervened)
- Flow control exemption appealed by environmental groups, but the appeal on this issue was withdrawn
- Negative comments on flow control exemption still being received in the context of WSDOT's draft NPDES municipal permit, and project-level environmental documents
- So…universal acceptance of exemption not achieved yet
- However, WSDOT estimates savings from the exemption in the hundreds of millions of dollars

Acknowledgments

Sponsors: Washington Department of Transportation, Larry Schaffner and Rich Hovde, Co-project managers

Washington Department of Ecology, Ed O'Brien, project manager

Consultant Team: Northwest Hydraulic Consultants
Herrera Environmental

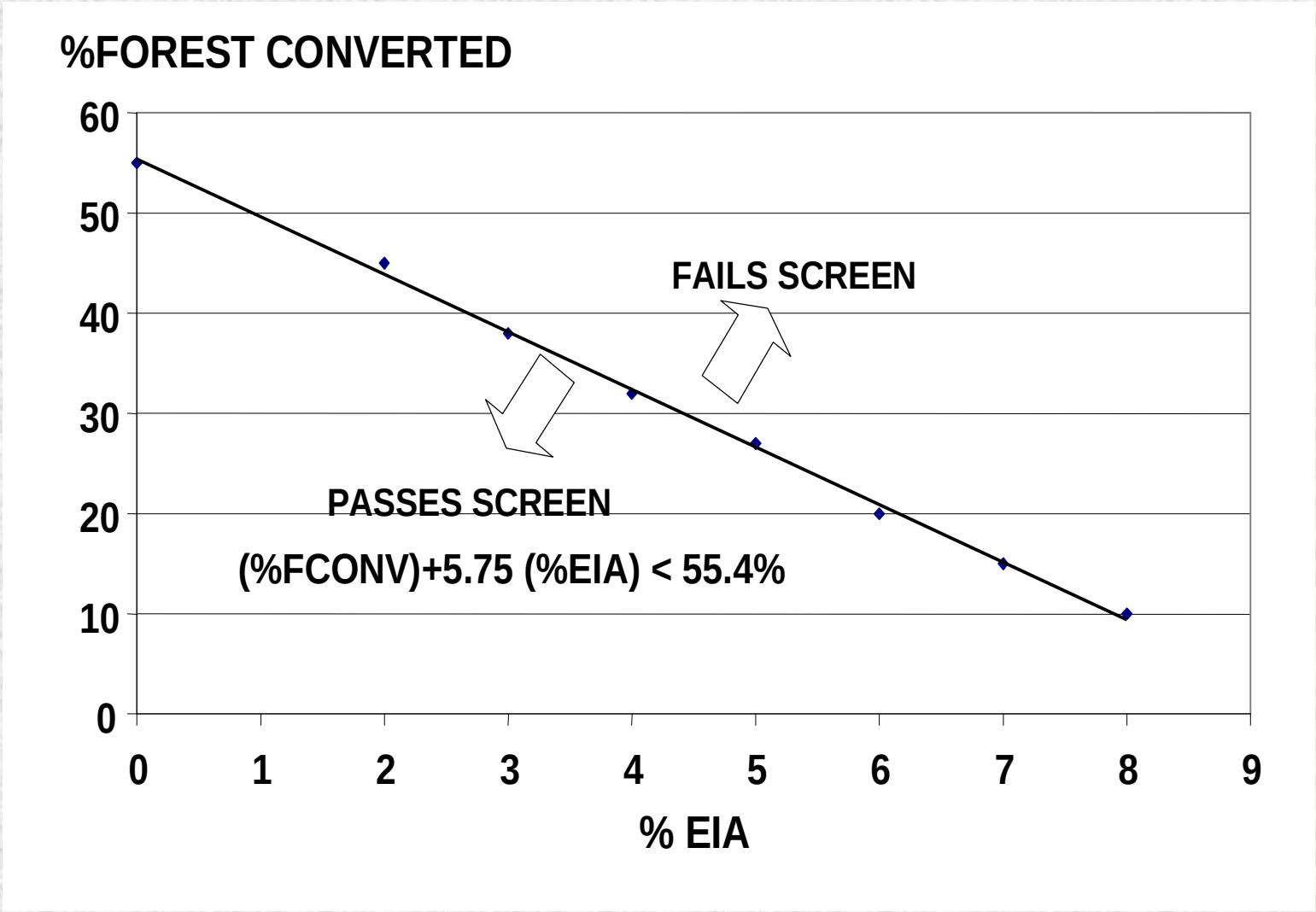
Cooperation: Western Washington Municipal Stormwater Managers

Questions?

Aggregated Future Landuse Categories and Associated Land Cover Percentages

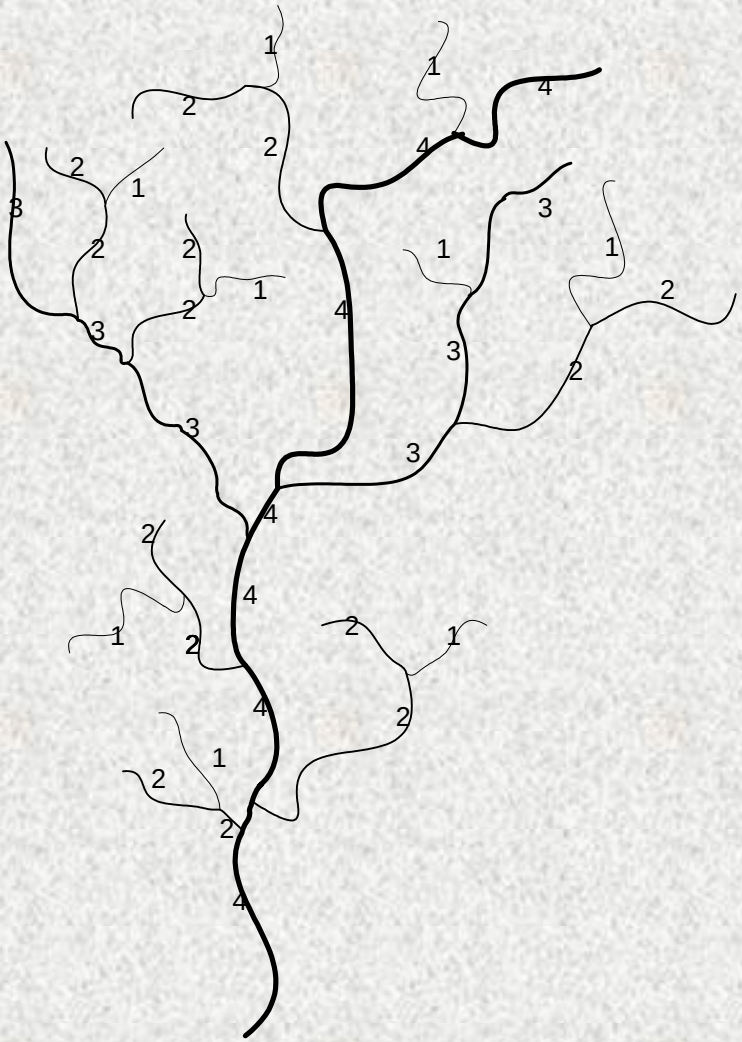
Aggregated Future Landuse Category	Land Cover Percentages of Aggregated Landuse Categories						
	Forest	Pasture	Grass	EIA	TIA	Wetland	Open Water
Open Water							100
Wetland						100	
Roadless forest	100						
Roaded forest	99.5			0.5	1		
Parks and recreational space			100				
Quarries and mining			50	50	50		
Agricultural		99		1	1.3		
Low Density Residential		48	48	4	10		
Medium Density Residential			90	10	20		
High Density Residential			75	25	38		
Multi-Family Residential			52	48	60		
Commercial			14	86	90		

Cover Criteria for 2nd – 3rd Order Stream Stability

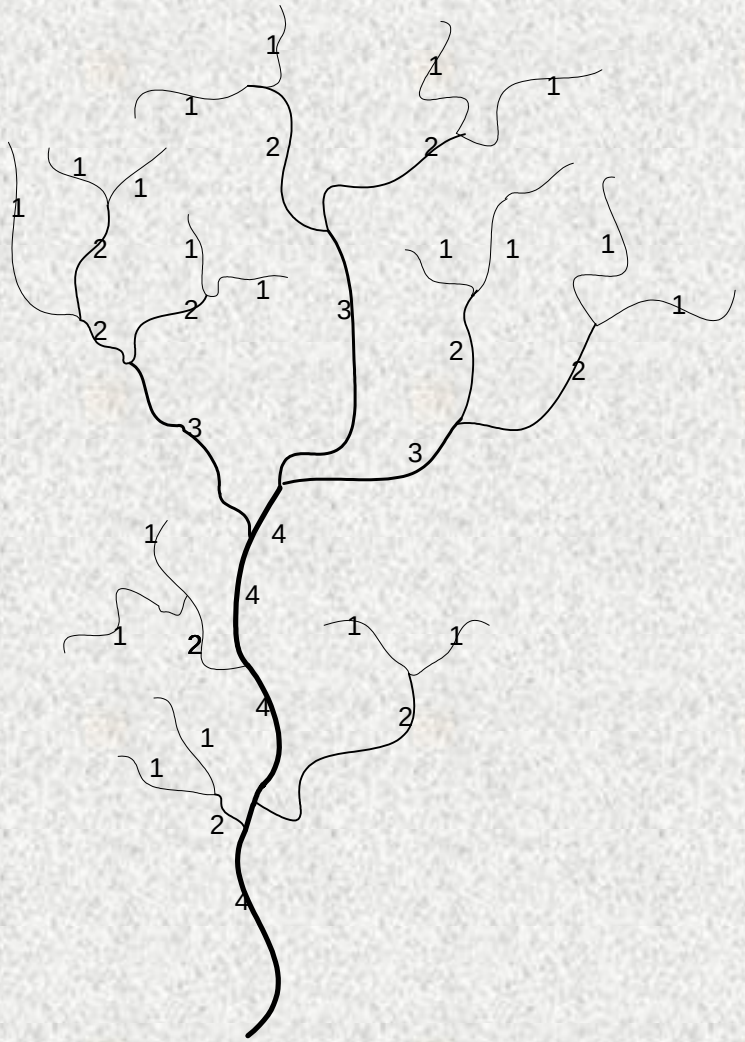


Phase II- Discharge of Stormwater to 5th Order Streams: Determining Exempt Reaches, (Y-8314 TAD AN)

Stream Ordering Schemes- we applied Horton-Strahler



Horton Method

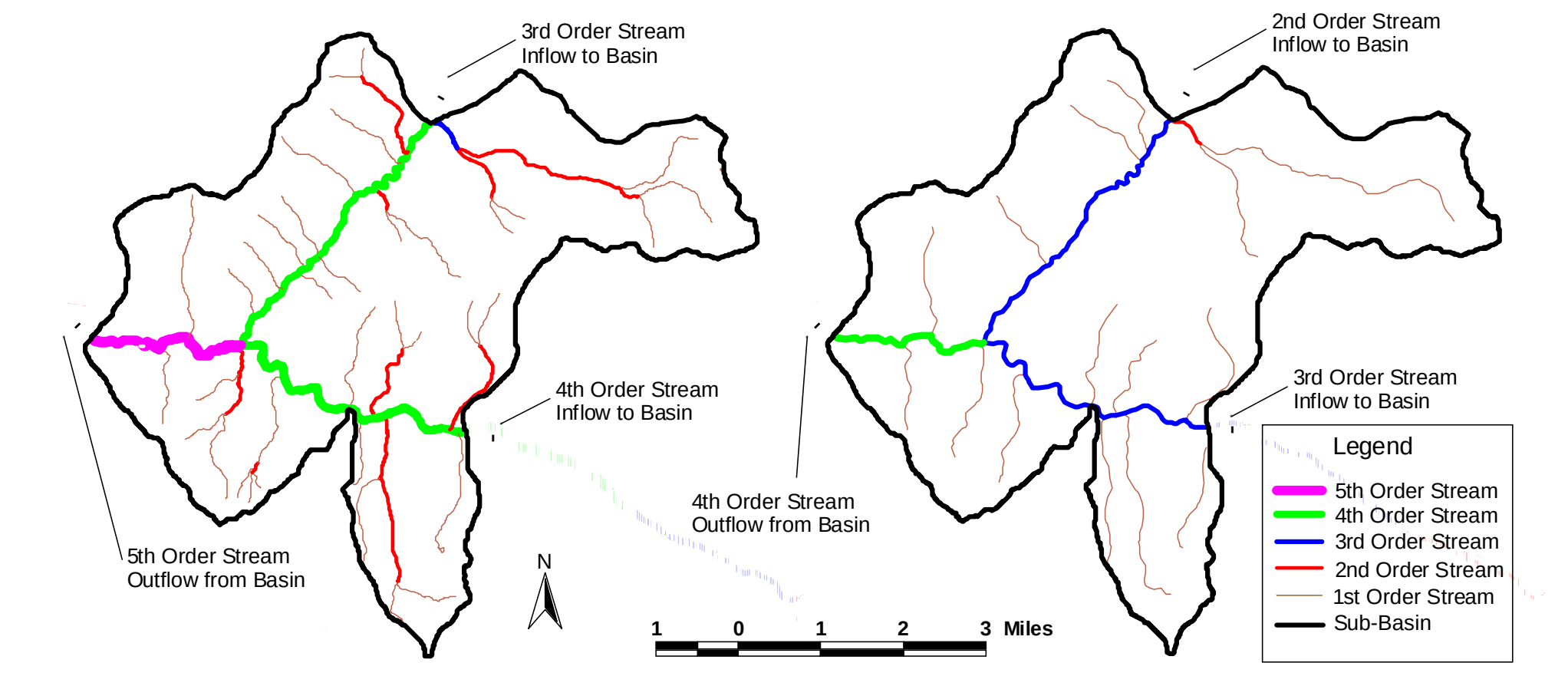


Horton-Strahler Method

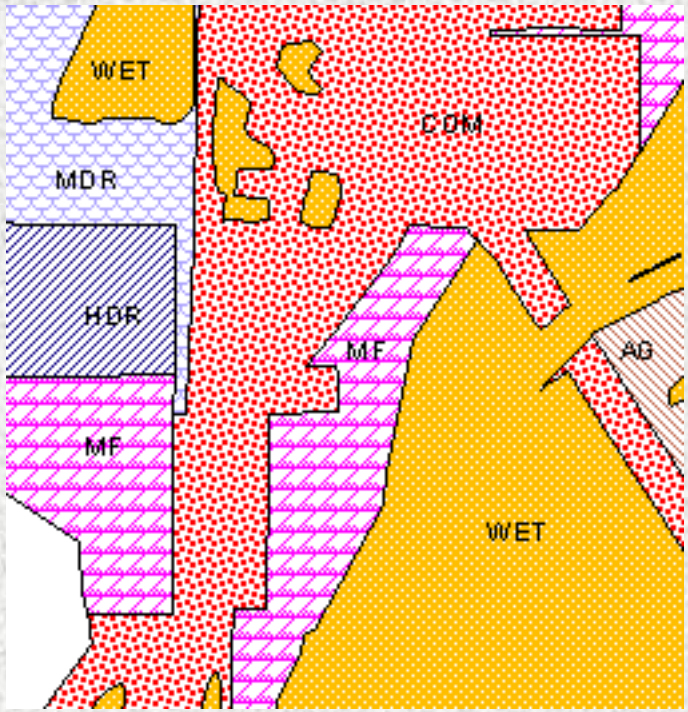
Phase II- Discharge of Stormwater to 5th Order Streams: Determining Exempt Reaches, (Y-8314 TAD AN)

Ambiguity of Stream Order as Measure of Stream Size

- 1:24,000 vs. 1:100,000 Scale Comparison



Data Sets for Determination of Future Impervious and Forest Loss Percentages



- **Assess Data Quality/Availability for Buildout Assessment of Watershed Cover**
  - **County and City Zoning and Comprehensive Plan Data**
  - **USFS SDA/IRAs and National Parks Planning Data**
  - **National Wetlands Inventory Dataset**
  - **Washington State Dept. of Ecology Lakes Dataset**

Peer Review Process

- Workshop for State & Local Jurisdiction
  - (Dept of Ecology, King County, Cities)
- Workshop and Document Review by Services
  - (NOAA-Fish, USFWS, US-EPA, WDFW)
- Publication of project memos and report on WSDOT web site

Background on Cover and Stream Size-Based Exemption Criteria

- **Phase I established a viable threshold for exemption combining stream size and land cover at buildout:**
  - ✓ **Stream Size (5th or higher order)**
  - ✓ **Weighted values for impervious & urban pervious area**
- **Criteria applies conservatism to address uncertainty:**
  - ✓ **Based on model parameter values that produce most impact in response to land cover change (Booth, Hartley, Jackson. 2002)**
  - ✓ **Assuming No Flow Mitigation basin-wide**
  - ✓ **Apply cover threshold based on small stream data only to larger (more robust) streams**

Replacement of Stream Order with Drainage Area

- **Concluded Stream Order Should be Replaced**
  - **Order Depends on Map Scale**
  - **Order Has Poor Repeatability Unless Canonical Maps Are Established**
  - **Drainage Area Easily Generated with Existing GIS Data**
  - **Highly repeatable compared to stream order**
  - **100 square miles correlates with 5TH order at 1:24,000 scale**

Phase II

- Define Stream Orders
- Determine methods for determining % impervious and change in vegetative land cover
- Apply method to pilot watershed
- Model effectiveness of flow control for large rivers
- Assess effect of channel gradient in large rivers
- Develop guidelines for tidally influenced streams
- Workshop with Ecology

Phase III and IV

- Define Exempt Stream Reaches
- Define conditions for direct discharge

Aggregated Future Landuse Categories and Associated Land Cover Percentages

Aggregated Future Landuse Category	Land Cover Percentages of Aggregated Landuse Categories						
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Medium Density Residential			90	10	20		
High Density Residential			75	25	38		
Multi-Family Residential			52	48	60		
Commercial			14	86	90		

Genesis of the WSDOT Method

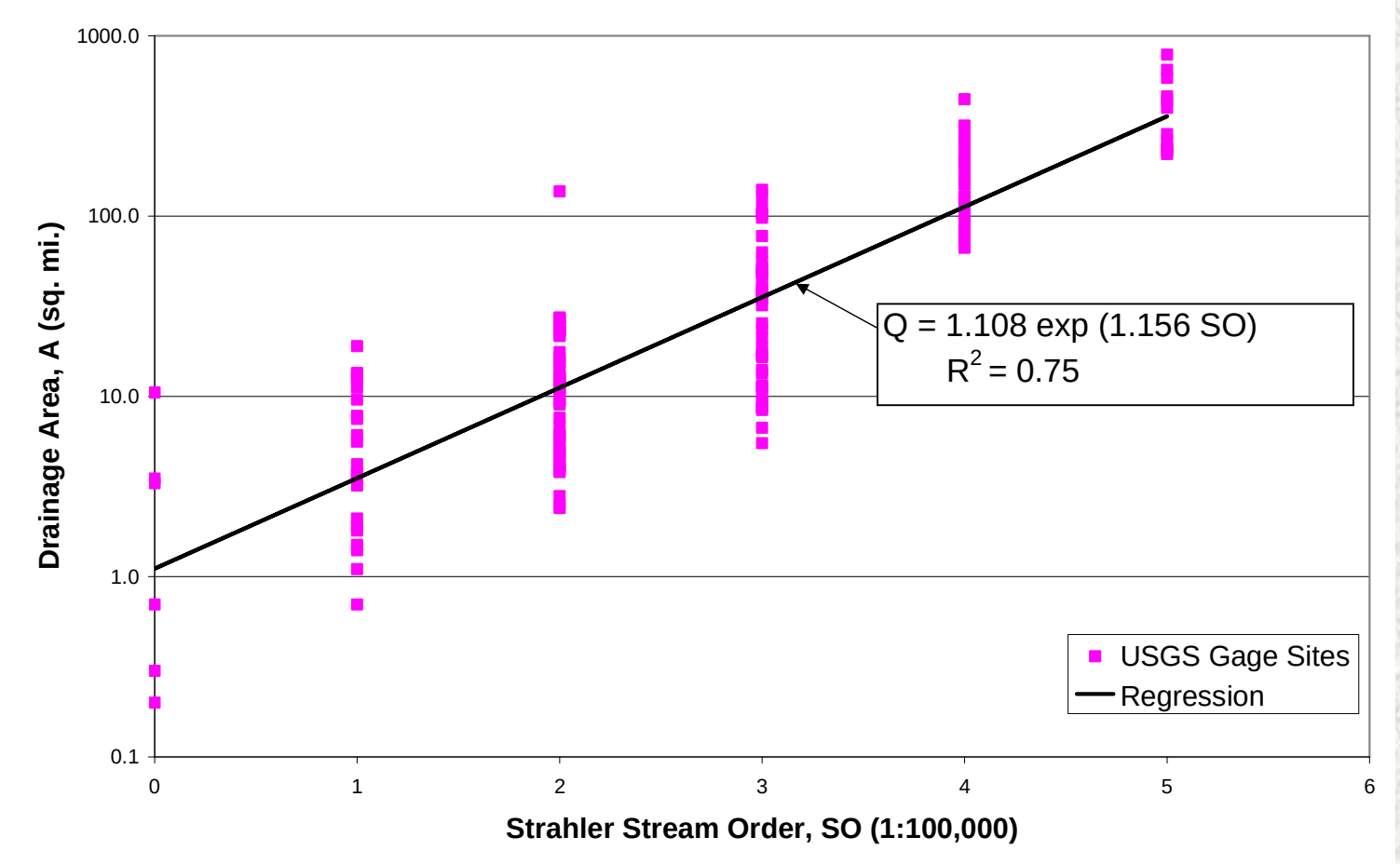
- Booth and Jackson (1997) documented field-based studies establishing $Q2/Q_f10>1$ as a stream stability threshold for small basins
- Booth, Hartley, and Jackson (2002) applied the threshold with HSPF modeling to defined stable, unstable, and uncertain stream stability regions within the forest retention-EIA continuum.
- WSDOT project applied multiple conservative assumptions and interpretation of earlier work to account for uncertainty

Evaluation of Land-Cover Criteria using GIS Tool

- LCC = %Forest Converted + 5.75 * %EIA
  - ✓ Where '%Forest Converted' = %Grass + 0.5 * %AG
- To pass the Criteria a site must have
  - ✓ LCC < 55.4%
  - ✓ Greater than 100 Square Miles Contributing Area

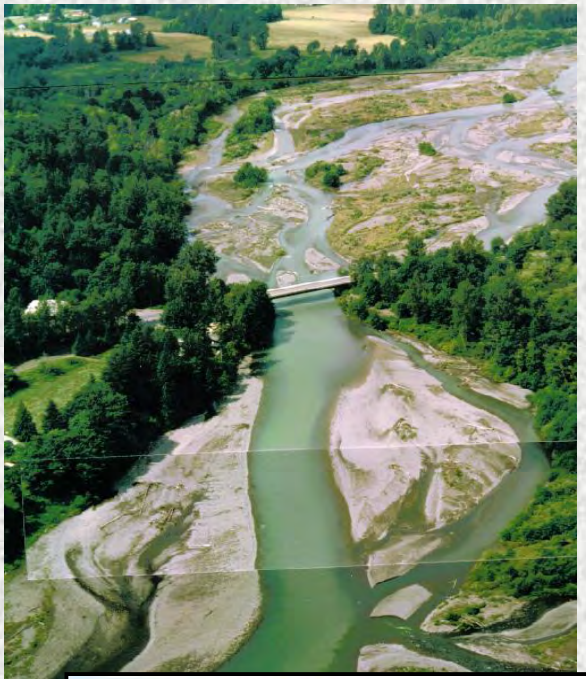
An Improved "Large Stream" Criterion

- **Strahler Stream Order (1:100,000) vs. Drainage Area**



Phase II- Discharge of Stormwater to 5th Order Streams: Determining Exempt Reaches, (Y-8314 TAD AN)

Nooksack Watershed Pilot Application



- Nooksack Watershed Dataset Collection
- GIS Processing of Data
- Application of AVENUE Script
- Identification of Exempt Reaches
- Discussion of Proximity Requirements

Results from the Nooksack Watershed

Location	Area (miles^2)	Percent Land-Cover							%Forest Converted	LCC
		Forest	Ag. or Pasture	Grass	EIA	TIA	Wetland	Water		
South Fork	104	98.6	0.0	0.0	0.4	0.7	1.0	0.05	0	2.3
North Fork	116	98.6	0.0	0.0	0.1	0.2	1.3	0.07	0	0.6
Upstream of Everson	631	89.0	4.8	2.9	0.8	1.5	2.0	0.08	5.3	9.9
Mouth	787	71.7	17.6	5.6	2.3	3.3	2.7	0.10	14.4	27.6

Nooksack Watershed Recommendations

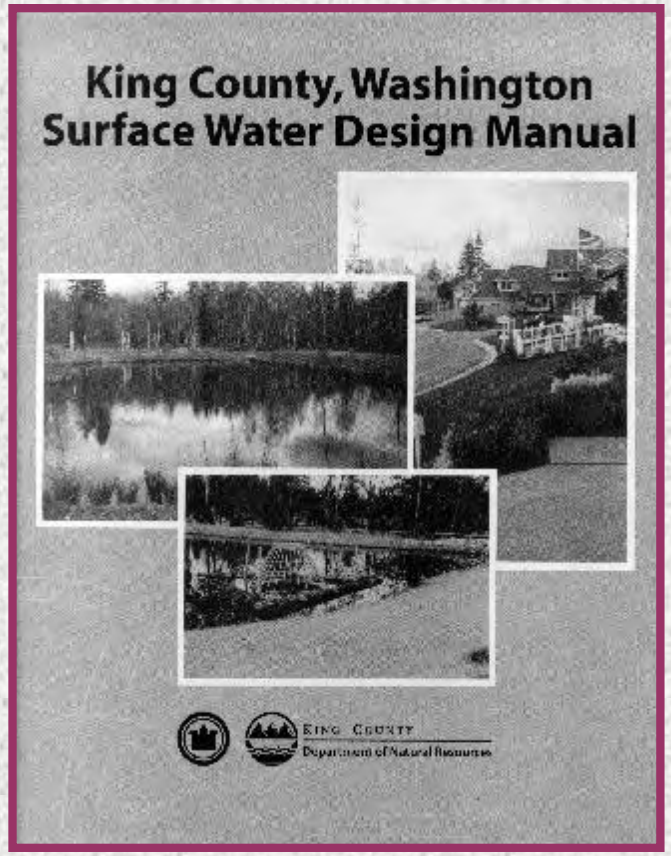
- **Exempt Direct Drainage Areas adjacent to:**
  - ✓ North Fork Nooksack downstream from Glacier Ck
  - ✓ South Fork Nooksack downstream from Skookum Creek
  - ✓ Nooksack downstream from the confluence of the North and South Forks to the mouth of the river

Phase II Recommendations

Recommendations

- **Given that data are available to apply a basin size and future cover criteria:**
  - **GIS analysis piloted for Nooksack should be replicated throughout western Washington**
- **For river basins in which LCC>55.4:**
  - **Consider establishing a higher LCC threshold (141?) within PDDAs, or**
  - **Apply a gradient or tidal criteria for exemption**

Additional Recommendations Associated with Qualifying Exempted Areas



- Manmade conveyance to river/lake OHW line
- Public ROW or easement for conveyance system
- Conveyance capacity handles buildout conditions
- Conveyance is non-erodible at capacity
- No significant disruption of wetland or stream flow regime- drainage proximity required
- No discharge to floodplain side channels, springs, or wetland habitats that provide salmonid habitat

Phase III and IV Results

- GIS Coverage of All Stream Locations that Drain 100 square miles
- Computed LCC values for all reaches downstream of 100 square mile points
- List of “Passed” and “Failed” Streams

Results- Specifics, continued

- Large Streams that Pass LCC Criterion:
  - All others in Western Washington
- Under Additional Study for Exemption Based on Different Criteria
  - *Sammamish River*

Stormwater Quantity Control for Highways in Western Washington- The Case for Exempting Projects Discharging to Rivers

Presented by

David Hartley, Northwest Hydraulic Consultants, Inc.

Ken Stone, Washington DOT

Washington State Department of Transportation

Discussion of Proximity Requirements- What is the Allowable "Sending" Area?

- Purpose of Proximity Requirements
  - ✓ Limit watershed area that qualifies as a DDA
  - ✓ Avoid excessive interference with natural flow patterns
- King County SWDM (1998) Approach
  - ✓ ¼ mile maximum distance between project outlet and 100-yr floodplain boundary
  - ✓ Total DDA uncertain. Depends on spatial array of projects
- Alternative Approach in this Study
  - ✓ Specify maximum distance from OHW line for DDA
  - ✓ 0.5 miles maximum applied in this study
  - ✓ Total DDA predictable from river length

Development and Evaluation of Stream Order as an Exemption Criterion

- **Stream Order Layer Developed for Western Washington**
  - **Searched for existing GIS stream coverage with flow direction**
  - **Based on WDFW 1:100,000 stream layer**
  - **Used GIS Script to assign order to WDFW stream segments**

Cumulative Future Imperviousness and Forest Cover Loss

- Assess Data Quality/Availability for Buildout Assessment of Watershed Cover
- Develop Methods for Western Washington Watersheds
- Develop GIS-based, Cumulative Land Cover Tool

Phase II- Discharge of Stormwater to 5th Order Streams: Determining Exempt Reaches, (Y-8314 TAD AN)

Develop Methods for Western Washington Watersheds

- Aggregated Future Landuse Categories and associated Land Cover Percentages
- Develop Sub-Basin Delineation
- Perform Subbasin and Landuse Intersection

Develop GIS-based, Cumulative Landcover Tool

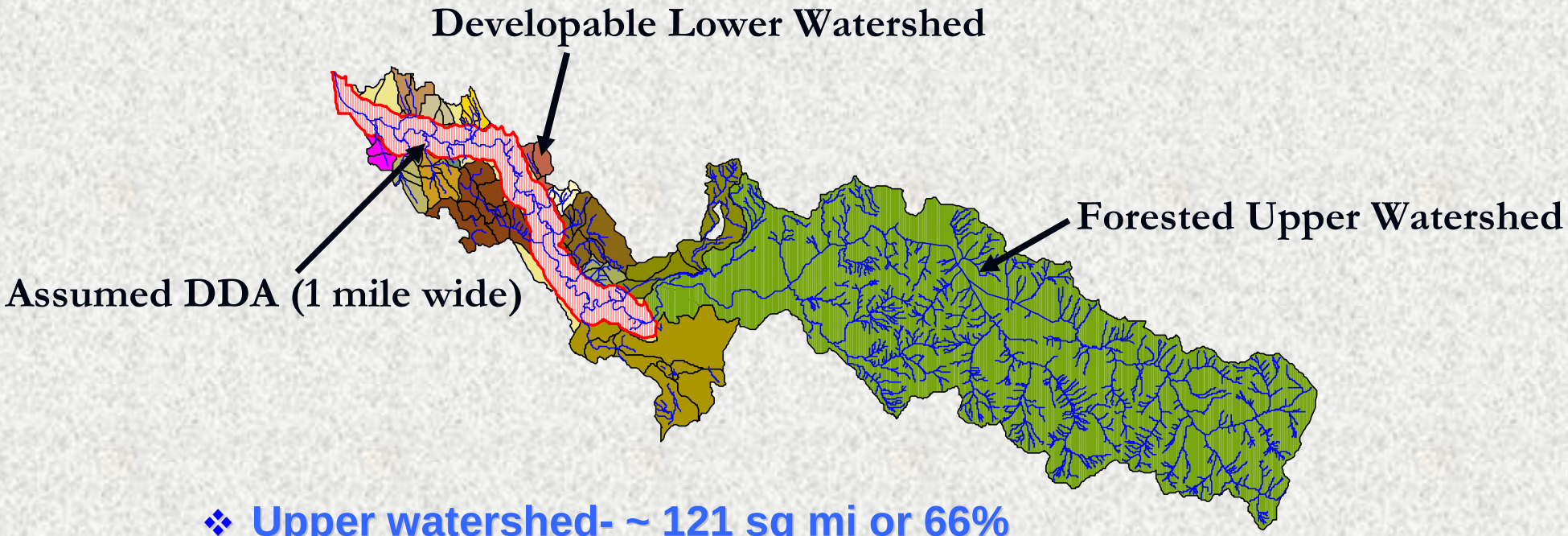
- **Purpose: To summarize cumulative landcover and basin area upstream of any stream segment in a watershed.**
  - **AVENUE script (ArcView 3.X)**
  - **What the script does:**
    1. **Calculates landcover for every sub-basin in a watershed given a subbasin-landuse overlay and landuse-landcover lookup table**
    2. **Determines Sub-Basin topology from an existing stream segment GIS coverage**
    3. **Summarizes the contributing landcover and total basin area for each stream segment in a watershed.**

GIS Processing of Data

1. Transformation to common coordinate system
2. Application of aggregated landuse categories to each dataset
3. Merging of landuse datasets to generate a watershed wide landuse coverage
4. Partitioning of WAU based subbasin boundaries
5. Application of Cumulative Landcover GIS-Tool
6. Identification of Exempt Reaches

Comparative Analysis of Detention Pond Benefits-
Case Study of a Small Stream and Mainstem River

Cedar River Watershed



- Upper watershed- ~ 121 sq mi or 66%
- Lower watershed tribs- 44 sq mi or 24%
- PDDAs- 17.5 sq mi or 10%

Phase II- Discharge of Stormwater to 5th Order Streams: Determining Exempt Reaches, (Y-8314 TAD AN)

Comparative Analysis of Detention Pond Benefits

- Detention Ponds in PDDAs provide:
  - 1%-4% reductions geomorphically significant flow durations
  - Have ~1/200 the potential protective power as DPs in tributary subbasins
  - Are ineffective primarily because of limited size of PDDAs
- Most river segments with DA>100, will have LCC<55.4

Phase III Activity

- Currently Working on all Watersheds West of the Cascades
- Expected Completion: End of August, 2004

Context of Project

- Past Exemptions for Rivers based on “B.P.D”
- 1999 ESA listing of Puget Sound Chinook and Bull Trout- NOAA-USFWS concerns, need for “B.A.S.”
- WSDOT Nickel Projects, HRM and DOE Manual Updates
- Justify Exemptions or Build Expensive Flow Control Facilities with Marginal Eco-benefits

APPENDIX D:

Selected Research Statements

A. Research Title:

Low-Impact Development Practices to Mitigate the Impacts of Nutrients and Pathogen Contributions from Highway Rights-of-Way

Need for the Research
Stormwater runoff from transportation Rights-of-Way (ROW) may contain nutrients (particularly phosphorus and nitrogen) and may contain pathogens (though it is unclear if DOTs are a source that would "contribute" to a receiving water violation for sanitary quality), which can have adverse environmental impacts on receiving waterbodies. Accordingly, DOTs are being named or have been named in Total Maximum Daily Loads (TMDLs) for nutrients and pathogens across the country. There is a need to determine if roadways and roadside areas are a significant source of pollution as a result of discharging these constituents/indicators. There is a need to identify what Best Management Practices (BMPs) are effective and appropriate at treating these pollutants. There is also a movement to require the use of Low-Impact Development (LID) practices to treat stormwater runoff. This research would identify which LID practices are effective and appropriate at treating nutrients and pathogens within the transportation ROW setting. Research would also determine if LID is not appropriate (on a cost-benefit basis) and recommend other approaches (such as source control) that should be pursued if appropriate.

Scope of Research
The scope of this research is to determine which LID practices are appropriate from a cost and effectiveness standpoint to remove nutrients and pathogens that originate on highways and roadside areas, including an assessment as to which practices are appropriate within narrow ROW.

An important aspect of the research is to evaluate the significance of the contributions of these pollutants from road surfaces and roadside areas relative to other land uses and to provide a cost/benefit analysis (i.e., analysis of the cost to implement LID practices vs. the environmental benefit). The research will determine if the discharge of these constituents/indicators is significant and if treatment BMPs are necessary to meet the MEP standard.

This research would involve a synthesis of: 1) prior studies done to characterize the stormwater runoff from the ROW (with special focus on nutrients and pathogens) and 2) prior studies that have findings about the effectiveness of LID practices to treat nutrients and pathogens. The research would result in a) a determination of whether DOTs need to remove nutrients and pathogens from runoff to meet the MEP standard, b) if it is appropriate to include DOTs as a stakeholder in TMDLs for these constituents/indicators, and c) a list of LID practices that are appropriate for use within a transportation ROW, as well as a list of LID practices that are inappropriate for such use. Recommendations would be made as to the most effective and least costly options for DOTs to control these constituents/indicators.

Benefits
DOTs are being named or have been named in TMDLs for nutrients and pathogens across the country. LID approaches to stormwater management are being required in NPDES permits. This research would benefit DOTs by a) providing research indicating whether DOTs are a significant

source of pollution for these constituents/indicators and under what conditions this is true, b) demonstrating the types of LID measures that are effective in the removal of nutrients and pathogens, and c) providing DOTs with effective and quantitative tools for compliance with existing TMDLs.

Urgency
DOTs are facing compliance schedules for nutrient and pathogen TMDLs that require quantitative load reductions on a defined schedule. This research is needed to assist DOTs in meeting the requirements of TMDL implementation plans, while at the same time implementing the new LID requirements. Research is also needed to inform the regulatory community if discharge from the ROW is a significant source of these constituents/indicators, and under what conditions it would be appropriate to require treatment BMPs.

B. Research Title:

Permeable Shoulders

Scope of Research
This project would look at the use of permeable pavements along shoulders. It would primarily look at the suitability of such pavements from a design, constructability, maintenance, and longevity standpoint. However, it would also look at the flow spreading, energy dissipation, and treatment benefits with respect to managing highway stormwater runoff. Representative spot samples of the water quality benefits from pervious pavement will be taken. That in combination with results from the primary flow control study of this research will be used to direct future research.

Benefits
The benefits resulting from this research include:

- Revealing the challenges of constructing permeable pavements in a highway setting;
- Identifying the maintenance necessary to keep the material functioning properly;
- Determining life expectancy of pervious pavement in typical highway shoulder applications;
- Developing design criteria for pervious pavement shoulder applications; and
- Identifying in-situ flow spreading, energy dissipation, and treatment performance in Washington State.

Urgency
The proposed U.S. EPA rulemaking will most likely require volume reduction from highways. Permeable pavements in shoulder areas would be one way for DOTs to reduce the volume of runoff from highways. The research should be started now to coincide with the release of the final EPA rule in 2012.

C. Research Title:

Stormwater Storage

Scope of Research

New construction and replaced impervious surfaces will trigger the new LID standard in the future. In implementing the new LID standard, DOTs need a factual basis to assess the feasibility of applying these standards to the states' transportation networks. The proposed research is to conduct a literature search to determine to what extent, if any, highway runoff can be redistributing below impervious pavement, allowing the subgrade to be used for stormwater storage and infiltration, without presenting significant risk to the integrity of the highway infrastructure.

Benefits

This project would benefit the DOTs by defining feasibility and establishing guidelines for redistributing highway runoff below impervious pavement (i.e., subgrades) in preparation of impending stormwater-related LID regulatory requirements.

Urgency

The proposed U.S. EPA rulemaking will most likely require volume reduction from highways. Storage of runoff under pavements would be one way for DOTs to reduce the volume of runoff from highways. The research should be started now to coincide with the release of the final EPA rule in 2012.

D. Research Title:

Use of Compost and Compost Amended Vegetated Filter Strips for Hydrologic Mitigation: Effectiveness and Design Guidance

Need for the Research

Highways can contribute to hydrologic changes with subsequent degradation of streams. Permits and regulations are beginning to require management of stormwater to minimize adverse hydromodification. Traditional methods of stormwater control emphasis detention, which requires considerable land. Many urban LID practices, such as bioretention cells, are not applicable in the highway environment. There is a need for hydrologic mitigation techniques that are effective in linear right-of-ways. Filter strips have been used for treatment of highway runoff, but their effectiveness in hydromodification has received less attention. Washington State DOT (WSDOT) has conducted research on quantifying infiltration in road shoulders and adjacent rights of way in semi-arid eastern Washington, but this has not been extended to other regions. Other studies by WSDOT show that vegetated filter strips (VFS), vegetated filter strips enhanced by compost amended soil (CAVFS) and compost blankets, used for water quality purposes have hydrologic benefits. However, design criteria and methods for quantifying the hydrologic benefit are not well established.

Scope of the Research
This project will examine how the volume and flow rate of highway runoff is modified by flowing through vegetated filter strips and compost amended filter strips.

Research would consist of a review of relevant existing research and literature, followed by controlled field experimentation. Variables included in the testing include vegetation type and density, soil characteristics, compost characteristics, rainfall intensity, duration and frequency, and roadside slope. The study would look at the modification of the runoff hydrograph, specifically the size and timing of the peak flow rate, duration of runoff, and the total volume of runoff. The results would be analyzed to develop quantitative guidance that can be used by engineers to design and size drainage and secondary stormwater flow control measures (SCMs).

Benefits
The proposed U.S. EPA stormwater rulemaking will likely require state DOTs to mitigate for hydromodification impacts. Roadside filter strips used by DOTs may provide partial or complete hydromodification mitigation. The proposed research would quantify this benefit and give DOTs a tool for hydromodification mitigation compliance. This research could lead to flow control "credits" for SCMs primarily intended for water quality treatment. On the project level the result would be reduced size of detention facilities (with savings in construction and right-of-way costs), or elimination of the need for additional flow control SCMs altogether.

Urgency
The proposed U.S. EPA rulemaking will most likely require hydromodification mitigation for highways. In addition, runoff volume reduction is being considered as a surrogate measure for quantitative pollution reduction requirements in NPDES permits. Tools are needed by DOTs to comply with the likely rules. The research should be started now to coincide with the release of the final EPA rule in 2012.

E. Research Title:

Hydromodification: Parameters for Mitigation Requirements

Need for the Research
Highways can contribute to hydrologic changes with subsequent degradation of streams. Permits and regulations are beginning to require management of stormwater to minimize adverse hydromodification, but there are no consistent standards for determining when a water body needs hydrologic protection or setting a range of flows that should be managed.

Scope or Research
The research would focus on two aspects of hydromodification mitigation. The first goal is to develop criteria for differentiating between water bodies that are vulnerable to hydrologic changes caused by added impervious surfaces, and those that are not. The second goal is to determine the range of flows that need to be controlled to protect stream processes.

While most would agree that large rivers such as the Mississippi, the Columbia and the Willamette are not affected hydrologically by development, the low end of the range of river

flows is not established. The State of Washington has developed detailed criteria, but that is an exception. Those criteria still need to be evaluated for general applicability across different regions. The research would consist of a) gathering criteria that may be in place in the various states and their rationales, b) conducting a critical review of hydrologic and geomorphic literature pertinent to this issue, and c) developing criteria and guidance based on the first two steps.

There are no consistent criteria established for the range of flows that need to be controlled to protect stream integrity. Oregon and Washington, for example, have different endpoints for flow control, despite having similar climates. Oregon's criteria are based on informed geomorphic opinion, but the state has not undergone rigorous review for general applicability. The research would consist of a) a review of existing criteria and their rationales, b) critical review of hydrologic, geomorphic and biologic literature pertinent to this issue, particularly concerning validity of concepts used to identify endpoints and regional applicability, and c) development of guidance for criteria based on the first two steps.

Benefits
The proposed U.S. EPA stormwater rulemaking will likely require DOTs to mitigate for hydromodification impacts. By providing consistent, scientifically supportable criteria for when hydrologic mitigation is appropriate and for the range of flows that should be controlled, rational rulemaking would be supported, and the rules would provide protection to vulnerable water bodies while avoiding requirements that expend resources for no discernable benefit.

Urgency
The proposed U.S. EPA rulemaking will most likely require hydromodification mitigation for highways. The research should be started now to coincide with the release of the final EPA rule in 2012.