Lessons from Applying Green Community Technologies® to Water Resources in Three West Central Minnesota Communities

Part Two: Issues and Opportunities Affecting Minnesota Communities and Water Resource Management

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Introduction

In 2002, West Central Initiative (WCI) with the assistance of Widseth Smith Nolting and others estimated the cost of meeting current and future needs for water, wastewater and storm sewer repair and replacement for the incorporated cities and one sanitary district within WCI's nine-county service. The estimate showed an immediate need of $472 million and an additional need of $813.5 million over the next 20 years. Total immediate needs statewide were estimated at $6.9 billion. It was assumed this money would be needed to repair and replace existing infrastructure with infrastructure of a similar nature. Given the decreased availability of public funds (federal and state) to support local infrastructure investment and increased concern over environmental impacts in general, WCI recommended, among other things, that alternative strategies be considered for communities of various sizes and that infrastructure planning assistance be provided to communities.

After the WCI report was completed, approximately 25 Minnesota communities invested in "alternative" (soil-based disposal or mound) wastewater treatment systems. Unfortunately, due to a combination of factors that are not well understood in Minnesota, many of these systems did not perform as anticipated, resulting in legal disputes and finger pointing[i].

Despite the unfortunate climate created by this experience with "alternative" wastewater treatment systems, WCI recognized that the underlying issue of how to help small Minnesota communities meet their water-related needs in a cost effective manner while protecting water resource quality had not gone away. WCI contracted with Yellow Wood Associates to apply our systems-based approach to community infrastructure, Green Community Technologies, to the full range of water resource issues in three Minnesota communities: Battle Lake, Ottertail and Brandon. Engineers from Widseth Smith Nolting and Interstate Engineering were engaged throughout the project. The firms were instrumental in identifying communities, making introductions, providing background information, reviewing findings and supporting exploration of alternative approaches. Each community has received a detailed report addressing issues of greatest concern to them.

Battle Lake, Ottertail and Brandon each have distinct relationships to their water resources and different types of infrastructure concerns. Battle Lake has a recently upgraded centralized drinking water system and a centralized wastewater management system that is meeting current needs (with the exception of the north end that is vulnerable and needs a new well and storage facility). Challenges in Battle Lake include planning for future expansion, stormwater management and water conservation. Ottertail has no municipal wastewater management infrastructure and brings its drinking water in from Henning.

Ottertail is also home to many lakes and is expected to grow in population over the next few decades. Brandon has a centralized water system in need of a significant upgrade and an older centralized sewer system as well as challenges and opportunities with respect to stormwater management.

Each community also offers examples of outstanding, innovative approaches to water resource management. Battle Lake has excellent drinking water quality; city-owned land for wastewater irrigation and a voluntary lakescaping project on public land. Brandon has an outstanding example of environmentally sensitive shoreland development on Whiskey Lake, a history of effective actions to reduce inflow and infiltration into sewer pipes, and is introducing water meters. Ottertail is home to a Leadership in Energy and Environmental Design (LEED)-certified building for the County Sheriff's Department that features alternative stormwater management practices, an alternative wastewater treatment through vertical wetlands at Thumper Pond and the Ottertail Water Management District, which is an example of decentralized wastewater management.

The purpose of this report is twofold: 1) to describe the Green Community Technologies approach, including steps communities can take to identify and address water-related issues and opportunities; and 2) to highlight issues and opportunities identified through this work that, if addressed, would benefit many Minnesota communities.

The Green Community Technologies® Approach

Green Community Technologies is a portfolio of services to help communities evaluate the potential for applying sound alternative technologies to municipal infrastructure and related services. In west central Minnesota, we applied the Green Community Technologies approach to water resource infrastructure including drinking water, stormwater and wastewater.

Water is becoming recognized globally, nationally and regionally as an increasingly precious resource. There is room for change in technologies and behaviors to protect, and in some cases, restore local water resources for the benefit of this and future generations. The Green Community Technologies approach to water systems is guided by the following general principles for "green" water systems. We believe that water systems designed to meet human needs should:

- Interfere as little as possible with natural water processes
- Encourage replenishment and maintenance of the water table
- Add as few chemicals/pollutants as possible
- Use conservation and efficiencies to minimize volume
- Be treated only as needed and never over-treated
- Reuse water rather than bring in fresh water whenever possible
- Use natural processes to clean and treat water whenever possible
- Minimize the transport of water from one place to another; keep uses close to sources
- Be energy efficient.

Green Community Technologies' work in water resources is guided by a conceptual understanding of water budgets. A water budget simply states that the rate of change of

water stored in an area, such as a watershed, is balanced by the rate at which water flows into and out of the area. All water on Earth resides in the atmosphere, the land surface and the subsurface. Interactions between water residing in the atmosphere, the land surface and the subsurface vary depending on climate, geology, technology and other factors, and are not completely understood.

Through Green Community Technologies, Yellow Wood has focused on introducing three communities to alternative approaches to stormwater, drinking water and wastewater issues. The response has been quite positive, which indicates that this information has not been readily available or at least not in a form that is customized to the goals and requirements of individual communities. In our experience, manuals, guidebooks and generic training do not result in effective actions on the ground. The Green Community Technologies process, as described above, engages individual communities at the outset in identifying their goals, their issues, and their questions and builds customized responses that fit each community's unique values, conditions and needs.

Issues and Opportunities Affecting Minnesota Communities and Water Resource Management

Green Community Technologies is a service for **communities** because it is in communities that decisions are made (formally and informally) that ultimately impact the quality of life and the quality of natural resources, including water. Communities control natural resource impacts through zoning, infrastructure development, economic development, sponsored activities, education and operations as well as through budgeting, tax incentives and conservation activities. Standards of acceptable behavior with respect to resource conservation and protection are also established and enforced in communities. Many communities are concerned about the implications of sprawl on the cost of future infrastructure and the implications of infrastructure, or the lack thereof, for economic development. Our work in three west central Minnesota communities tells us that residents care deeply about their impact on natural resources and what it means for themselves and for future generations. They desire information that will help them be good stewards within their economic means.

Of course, communities operate within a larger regulatory framework imposed by state and federal governments and are subject to market forces beyond their control. It is beyond the scope of this assignment to review all the regulatory and market issues related to water that impact choices at the local level. Instead, we have focused on three areas, which, if addressed, we believe would improve Minnesota communities' capacities to be better stewards of the water resources they affect.

The issues and opportunities we've identified in the course of this work fall into three major categories:

1. Need for a holistic systems approach to achieve stewardship outcomes
2. Need to improve community access to information on water resources
3. Need to align policies, education, technical assistance and funding to support alternative approaches

1. Need for an integrated systems approach to achieve stewardship outcomes

Water resource issues are significantly impacted at the community level where people live and work. This is where many decisions regarding land use, infrastructure and consumption are made, implemented and enforced. Changing our approach to water, a resource we have taken largely for granted, requires an integrated systems approach that includes understanding the issues themselves, identifying and implementing appropriate technologies, changing behaviors, changing governance and making good use of market forces to reinforce all of the above. This work goes beyond the scope of any single profession. Engineers understand technology and have a crucial role to play in implementation, but they are not necessarily experts in governance and market forces. Planners understand land use, but not necessarily infrastructure. Community economic developers tend to focus more on business development than on governance or infrastructure. So there is no single group that is well equipped to provide the assistance communities really need to solve their infrastructure issues in a timely manner in ways that are cost-effective, environmentally benign and contribute to social goals. We need new forms of genuine teamwork to get the job done in which the focus is on learning together and finding the best solution rather than getting the credit.

In addition, the solutions themselves need rethinking. Conventional solutions tend to be focused at the end of the pipe. What do we do with the wastewater or stormwater now that we have it? How do we get people as much drinking water as they want? Alternative approaches are embedded in systems thinking. How do we reduce stormwater and wastewater at the source so we don't have to treat it? How do we conserve drinking water and make sure it is used appropriately (e.g. not for lawn watering)?

Government programs tend to be categorical, for example, wellhead protection or wetland banking, and do not offer communities the opportunity to think about and address their water resource issues in an integrated systems manner. This is a serious obstacle to change that is hardly unique to Minnesota. Yet the open minds of many Minnesotans and the desire to be good stewards suggest that this could be fertile ground for finding new ways for professionals to interact with communities. Our experience suggests that this process works best when it is community-centric, not expert-centric. It begins by listening carefully to the full range of goals and issues in a community and then drawing the connections between those issues and, in this case, water resources. Through this process, communities can be drawn into learning more about historical and current conditions and cost-effective approaches to improving water stewardship and professionals can learn from one another and from communities and improve the quality of their practice.

2. Need to improve community access to information on water resources

The way communities respond to their water infrastructure needs within the next decade will determine use patterns and environmental impacts far into the future. Many Minnesota communities are already dealing with various types and degrees of impaired water resources as well as failing infrastructure. Based on our experiences in Battle Lake,

Brandon and Ottertail, we believe Minnesota communities want to be effective stewards of their water resources for themselves and for future generations. However, to do so, they need better access to information about their water resources, including groundwater, surface water, wetlands, precipitation, water infrastructure (centralized and individual), watersheds and water quality to be able to make informed decisions and set appropriate priorities. A solid knowledge of local water resources will inform community understanding, allow communities to set meaningful priorities and examine the full range of choices available to them to improve their water stewardship practices, including conventional and alternative approaches and the tradeoffs among them.

A tremendous amount of information has been developed about Minnesota's water resources. Unfortunately, very little of this information has been generated with community use as a priority. Much of it appears to be used by regulators, researchers, nonprofit organizations and others to further the good and important work they do. Many, many different agencies and groups have an interest in and responsibilities toward Minnesota's waters. The result, from the community perspective, is a highly fragmented universe of information that is difficult to identify, find, access, interpret and correlate for any specific community.

For example, watershed information is available from at least four websites, two of which require GIS software and two of which do not. None of the communities we worked with were able to identify the watersheds they impact. We explored all four sites to put together this information on their behalf. None of the sites were set up to automatically produce this information. In addition, we had to overcome issues of inconsistent terminology and definitions of watersheds.

Groundwater information is also widely dispersed. The Minnesota Pollution Control Agency's (MPCA) newly completed (January 2008) Environmental Data Access project (EDA) allows users to search and download data from air and water quality monitoring stations throughout Minnesota. The site offers surface water quality data such as temperature, turbidity, sechi depth, pH, as well as concentrations of minerals and chemicals. Where available, the site also offers ground water quality data from designated water quality monitoring stations. Users can access data via text-based or map-based search tools. The text-based tool allows searches by station ID number, county, water body name, watershed, station type, name of organization that collected the data and project name. The map-based tool uses a searchable interactive map to display various features such as surface water monitoring stations, political boundaries, watershed boundaries, impaired lakes and streams, stream classifications, aquatic life use support, etc. The MPCA intends to incorporate ground-water data from other programs into the EDA where possible, however the site is not comprehensive at this time.

Data not available from the EDA site is listed in a "Ground Water Catalog" which can be accessed via links from the EDA website.[ii] The list of additional sites contained in the catalog is extensive. It would take any single community a great deal of time and effort to assemble all possible information regarding potential contamination in their community. To find out if there is a ground water monitoring station, one must enter the city in the search field and see what it comes up with. All three of the communities we worked with have at least one station, though only Brandon has any data available. The rest say "No

sampling events are available for download at this time. Please visit the Ground Water Catalog to search for off-line records."

Surface water information for lakes is organized by the name of the lake, not the name of the community. Data is not available for every lake. According to Shannon Lotthammer, manager of Water Monitoring Section, Environmental Analysis and Outcomes Division Minnesota Pollution Control Agency, based on 2008 TMDL list and inventory of impaired waters (data collected through 2006) 14 percent of Minnesota stream miles have been assessed for one or more beneficial uses such as healthy fish, aesthetic quality, quality of drinking water and safety for swimming, and 18 percent of Minnesota lakes greater than 10 acres have been assessed for one or more beneficial uses. Additional monitoring is occurring through the Clean Water Legacy Act. The MPCA expects to assess all lakes greater than 500 acres and to "intensively monitor" each of Minnesota's 81 major watersheds over the next 10 years. Through a combination of state, local and volunteer efforts, an additional 30 percent or more of lakes between 100 and 500 acres are expected to be assessed. Communities should know what is not known as well as what is, and when they can expect to have new information.

Any evaluation of localized wetlands begins with the National Wetland Inventory Maps. This resource allows for identification of wetland types, locations and classifications. This information is available nationally through US Fish and Wildlife. Secondly, the soils contiguous to and draining toward the wetlands need to be identified. This can be gathered from the County Soils Classification Maps. The State of Minnesota has an abundance of educational material available identifying the vulnerability of wetlands and emerging issues and initiatives, as evidenced by the Minnesota Wetland Report (published by the Minnesota Board of Water and Soil resources, 2003), as well as the Minnesota Wetlands Protection Report (prepared by the Minnesota Center for Environmental Advocacy, 2006). The Minnesota Wetlands Protection Report explains the reasons for wetland degradation and offers case studies of wetlands lost to development as well as others that have been preserved. A large effort of collaboration by MPCA, MDNR, USDA, MBWSR and USFWS in July 2006 resulted in the Comprehensive Wetland Assessment, Monitoring and Mapping Strategy publication. In addition, MPCA has established impressive monitoring metrics. Citizen groups appear poised and willing to assist in field data acquisition. However, it was very difficult to locate any direct monitoring results from localized wetlands in and around the rural communities of west central Minnesota. With such an extensive monitoring apparatus in place, perhaps the time is nearing when real data will be produced. The ease of distribution of those results to local communities will ultimately determine the value of the wetland monitoring system itself.

Precipitation information for the state of Minnesota can be accessed through the Minnesota Climatology Working Group's website, http://climate.umn.edu, under "Retrieve Historical Data." The Historical Climate Data Retrieval is retrieved by entering the location's coordinates, ZIP code, or by using the interactive map to select the location. Data includes recorded precipitation, temperature and snowfall, and can be presented by day or month back to 1850 – although consistently documented information starts in the late 1880s in most cases. The Minnesota Climatology Working

Group, created by The University of Minnesota in collaboration with state and federal agencies, is made up of three primary units: the Minnesota State Climatology Office (MN_SCO), University of Minnesota Extension Climatology and University of Minnesota St. Paul Campus Climatological Observatory. These units work collaboratively with academic units and atmospheric science agencies, such as the National Weather Service.

Information on infrastructure conditions for centralized infrastructure is typically available from city engineers and city staff. Results of testing required by the state for drinking water and effluent—or waste matter—are also available for centralized systems and for community water systems. However, access to meaningful information on private septic systems is another matter entirely. Exploring the information maze in Minnesota for information ranging from individual sewage treatment system (ISTS) standards to inspection results was daunting to say the least. The information is available through a plethora of sources. Raw data and maps, photos, etc., are available through the State Department of Administration. Here one needs to sort through North Star Mapper and Surface Water Resource Data for Minnesota. Additional GIS data is available from the County Survey websites. General educational information, guidelines for professionals, research, recommendations for homeowners and workshops are found either through MPCA, University of Minnesota Extension office or the College of Natural Resources (U M). These offices and the websites they produce provide exemplary programs such as "A Quick Guide to Small Wastewater Treatment Decisions," as well as Onsite Sewage Treatment Program. The former outlines systems, management and costs. The latter is primarily an educational database, with a section on guidelines and standards. The Metropolitan Council has prepared a very comprehensive document that covers a wide berth of information titled The Local Planning Handbook for Water Resources Management. Information on active management of ISTS was made available by the Otter Tail Water Management District. In short, there is quite a bit of advice and instruction available.

What is lacking is comprehensive information on failed or failing systems that would allow municipalities to understand conditions on the ground and set priorities for management. The County Land and Resource office was cooperative, but in order to actually track inspection results, one has to go to their office and literally wade through paper archives. In addition, with the exception of new system design plans, the county does very few inspections themselves. Municipal inspections are generally limited to new installations.

We offer the following recommendations:

1. In the best of all possible worlds, there should be one place communities can go to find out all that is known about water resources in and around their place (within their municipal boundaries and within the watersheds they affect). One logical organizing framework for this information might be watersheds within or partially within municipal boundaries, but the information itself should be retrievable by the name of the municipality, not the name of the watershed, testing station number or other esoteric identifier.

2. Minnesota should consider making it mandatory to report private and public water testing results directly to the municipality in which the testing occurs. We realize this may be a highly controversial recommendation. There appear to be no such provisions currently. As a result, each community we worked in has test wells whose ownership they do not know any more than they know the results of any testing that may take place. If water is to be considered a public good (a major "if") then it seems to us that water testing results should also be in the public domain.

3. Need to align policies, education, technical assistance and funding to support alternative approaches

Many Minnesota communities have aging infrastructure that was developed using what is now considered conventional approaches (but were, no doubt, state-of-the-art at the time). Alternative approaches are emerging that offer superior results economically, environmentally and socially. In our experience with three Minnesota communities, residents are eager to learn about these alternatives in the context of the issues they face in their own communities.

The conventional approach to stormwater has been based on the assumption that the best thing to do with stormwater is to make it go away as fast as possible. Conventional stormwater management relies on collecting, detaining, channeling and releasing stormwater, often without treatment, or treatment through wastewater facilities. Both of these approaches are increasingly recognized as less than optimal. Treating stormwater through wastewater treatment facilities results in over-treatment and increases costs unnecessarily. Handling stormwater through collecting, detaining, channeling and releasing without treatment pollutes water resources, contributes to erosion and flooding, damages wetlands and costs money.

Alternative approaches seek to reduce stormwater at the source; however where impervious surfaces exist, stormwater is a given. Therefore, the alternatives must also include options for retrofitting and improving stormwater management given existing conditions.

Research has shown that water quality aquatic health is significantly impacted when more than 10 percent of any given watershed is covered with impervious surfaces. Beyond this threshold, the change in the water balance triggers watercourse erosion, which in turn degrades and/or eliminates aquatic habitat.[iii] Alternative approaches to reducing impervious surfaces include stricter overall limits combined with limits adjusted by lot size to equalize buildable capacity between property owners regardless of lot size.

The conventional approach to providing drinking water in small west central Minnesota communities is through a combination of wells and centralized water systems. Centralized systems generally include municipal wells, a water tower, a treatment system and a distribution system. Some communities provide more "treatment" than others. Treatment may include the addition of fluoride, chemical disinfection (usually with chlorine and/or phosphate), water softeners and filtration using mechanical and/or chemical filters. Some communities have water meters for individual users as well as

commercial users; others do not. Most communities use municipal water for fire fighting, and residents use municipal water for watering lawns. In some cases, centralized water has been preferable to individual wells due to water quality issues associated with well water. The conventional approach to sizing drinking water systems is to build to meet the peak capacity demands of the population to be served, taking growth trends into account.

Alternatives approaches to providing drinking water begin with attention to opportunities for water conservation through highly efficient appliances, rainwater and greywater reuse, water-conserving fire-fighting techniques and conservation pricing. Where filtration is desired or required, alternative approaches look to biological treatment over mechanical or chemical treatment wherever feasible. In specifying pumps and motors, alternative approaches look for highly efficient technology and for opportunities to use drinking water infrastructure (e.g. water towers) to produce renewable energy.

The conventional approach to wastewater treatment often involves a combination of centralized collection and treatment systems with land spreading of effluent and field-based sludge disposal and private septic tanks. Conventional treatment processes include **primary treatment,** which removes materials such as fats, oils and greases (FOG), sand and gravels (often referred to as grit), and also larger solids such as human waste, which are allowed to settle. Typically this is a mechanical process. The effluent is then substantially degraded by a **secondary treatment** biological process, removing human waste, soaps and food waste, which cleans the effluent to standards allowing for release into the environment. Some systems include **tertiary treatment** to achieve even higher standards. In smaller communities, conventional approaches to wastewater treatment involve collection and pumping to a series of settlement (stabilization) ponds. In this process, the waste is allowed to settle out over a significant period of time and eventually pumped out for irrigation dispersal. Although a simple process, large amounts of land and settlement time are required.

Alternative approaches to wastewater treatment begin with water conservation and elimination of fats and other difficult-to-treat waste at the source. Greywater reuse is also a consideration. Treatment alternatives may include anaerobic digestion, non-chlorine disinfection, vertical wetlands, constructed wetlands, etc. As learned from Minnesota's earlier experiment with alternative land-based systems, projects must be adequately funded to allow for site specific design and inspection as well as training and ongoing support for systems operators. Soils vary greatly and one size does not fit all.

Decentralized management of wastewater is another alternative approach to centralized systems, and one that greatly reduces the cost associated with collection. Alternative treatment processes in a decentralized setting include shared or cluster systems of various types. Alternatives to land-based sludge disposal include composting and reuse. Even existing centralized systems can benefit from conservation on the front end (low flow appliances, etc).

The conventional approach to municipal budgeting for water and wastewater systems at the municipal level in Minnesota often does not take into consideration replacement

costs. In an environment in which fewer and fewer public dollars are available to support infrastructure replacement, it is only prudent that communities save to cover at least a portion of these costs. Yet Minnesota policies discourage communities from accruing fund balances in excess of current needs.

Conventional municipal pricing appears to be basically uniform and does not address protection for low income residents or conservation pricing that uses market forces to induce conserving behavior while generating revenues for replacement and upgrades. Pricing is one of the most cost-effective means available for inducing behavior change.

Conventional municipal zoning does not incorporate open space or cluster concepts. The communities we worked with have not had the opportunity to learn about and experience the value of these approaches in minimizing environmental impacts and infrastructure costs. Zoning at its best can reflect a vision and plan for a community that goes beyond business as usual.

While we have found some excellent print resources, such as the Minnesota Stormwater Manual, and some excellent technical assistance resources, particularly in the area of lakescaping (for which demand exceeds supply), we have also found some evidence of practices, policies and attitudes that do not contribute to effective community stewardship. For example, the Otter Tail County shoreland management ordinance sets a 25 percent threshold for impervious pavement and does not distinguish between pervious and impervious pavement. This creates a disincentive for the use of pervious pavement, which, if properly prepared and installed, is shown to reduce stormwater runoff and help improve water quality. A second example is the Minnesota education and certification program for stormwater inspectors that is focused exclusively on conventional practices and does not provide education on alternative approaches to stormwater reduction at the source. A third example is the Minnesota Outdoor Recreation Act design specifications for public access sites on lakes that date back to the 1980s and do not incorporate lakescaping practices. There are many existing public access sites on lakes in Minnesota that create runoff from pavement that flows directly into lakes.
Other examples of state policies that do not contribute to effective community stewardship include policies that discourage communities from maintaining account balances for infrastructure replacement costs, and Department of Transportation policies that make it difficult for communities to reduce the width of excessively wide streets and incorporate innovative design features.

Alternative approaches (rain gardens, pervious pavement, biological filtration, etc.) often require greater attention and maintenance on an ongoing basis because they are intentionally sensitive to changes in environmental conditions. Paying attention to performance and consequences is part of learning how to live responsibly and be a good steward. This is a change from the "out of sight, out of mind" mentality of the industrial age. The cost of alternatives is not only in capital and operations, but in maintenance as well. Operation and maintenance costs must be built into the cost of a project at the beginning, for the entire duration or life expectancy of the project. These costs need to be taken into consideration and made eligible for financing along with capital costs. The additional labor associated with maintenance of alternative approaches will be an

increasing part of the green economy, and should be viewed as an opportunity, not only a cost. Grants and loans should be structured to cover maintenance costs over time.

Given Minnesota's longstanding investment in understanding water resources and the recognized importance of these resources to the people of Minnesota, we believe community-focused work that:

- uses an integrated systems approach,
- provides easy community access to all available information, and
- supports alternative approaches to upgrading existing infrastructure and new infrastructure investments where appropriate to meet the goals of communities,

can result in solutions to the infrastructure transition facing many Minnesota communities – solutions that are better economically, environmentally and socially than what they have today.

Every community has its own goals, history of effort, priority issues and underlying resource conditions that shape the types of solutions that will be accepted and supported. Our experience suggests Minnesota communities are open and ready to learn about alternative approaches. However, there is no single approach to any issue that is the right one for all communities. Each community needs the opportunity to learn about customized solutions to their particular circumstances. To enhance adoption of alternative approaches and meet community needs today and in the future, funding and regulatory agencies will need to embrace flexible approaches that emphasize learning from experience and promote peer-to-peer sharing. The three communities of Battle Lake, Brandon and Ottertail provide an opportunity for funding and regulatory agencies to invest in alternative approaches to a wide range of infrastructure affecting water resources on a pilot demonstration basis in communities that are already interested in these approaches and have supportive professionals to assist them with implementation. Funding and regulatory agencies can use a pilot with three prepared communities to work together to discover how best to align policies, funding, education, and technical assistance to achieve results at the local level.

[i] Small Community Wastewater Systems Minnesota ACED Perspective of Problems, 3./1/06.

[ii] http://www.pca.state.mn.us/data/eda/index.cfm

[iii] British Columbia Ministry of Water, Land and Air Protection. Stormwater Planning: A Guidebook for British Columbia. May 2002.