Building SWAMPS in Coastal Oregon Communities

A Final Report Submitted to

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EXPANDED EXECUTIVE SUMMARY AND KEY FINDINGS

Oregon's Department of Environmental Quality (DEQ) has listed many coastal OR streams as water quality impaired due to bacteria, habitat and flow modification, dissolved oxygen, and temperature. Further, poor water quality has been charged as one of the primary causes for recent severe low-oxygen ocean conditions off the coast of Oregon (Walker 2006). DEQ has identified urban development and related stormwater runoff as primary factors in poor water quality, and they have identified low impact development (LID) practices as a tool for mitigating these effects. Previous work in Oregon's small coastal communities identified two primary barriers to adopting LID practices: 1) a limited understanding of the relationship between urban development and watershed health, and 2) a lack of capacity for carrying development of a local stormwater management program through to implementation**.**

To address these issues, we developed an open-source StormWater Assessment and Management decision-support Process (SWAMP). This on-line tool assists local governments and developers in streamlining adoption of local stormwater management programs and reduces the implementation costs of these programs. In collaboration with several partners and related programs, SWAMP could be integrated with LID education and training programs to help local jurisdictions assess and design innovative stormwater practices at the parcel and watershed scales.

This on-line tool provides the user with the ability to download local spatial information necessary to analyze stormwater runoff before and after a proposed development. It then helps the user choose a variety of LID practices to reduce the increased runoff and improve water quality. The tool helps the user analyze situations at the site and neighborhood scale. It also provides several types of information necessary to help jurisdictions create their own stormwater management guide; it provides fact sheets on various LID practices, models for sizing these facilities based on local conditions, rainfall maps and an assortment of other related information.

The SWAMP tool and related information is provided in an open source format allowing small jurisdictions to access the resources and not rely solely on hiring consultants to build these resources from scratch. This information is available to all jurisdictions in coastal Oregon watersheds, including the inland portions of the Umpqua and Rogue Rivers. These cities and counties will be able to save money and time in preparing stormwater management materials and programs that support LID. The tool is also available as a teaching tool for educators to help jurisdictions learn these processes and practices.

While the tool is built using spatial information for coastal Oregon, the technology is transferable to other locations. The authors will make the web interface technology available upon request. Many of the processes used in the tool already exist for others to use. For example, we use the Impervious Surface Analysis Tool (ISAT) created by NOAA Coastal Services Center and spatial data from the National Land Cover database. The other information on the website, like LID fact sheets, may be adapted for other locations relatively easily.

All stormwater management guides and decision support tools are written for specific cities, and only the largest cities in Oregon have these materials (e.g. Portland). Furthermore, almost all guides in Oregon, except for the Portland Metro area, do not incorporate LID practices. Other

cities must attempt to modify these documents to fit their own ecosystems and needs which are far different than Portland, or develop these materials on their own by hiring consulting firms.

SWAMP provides a basis to help all jurisdictions in Coastal Oregon assess stormwater runoff and incorporate LID practices into their stormwater management. The information is site specific for their needs and does not need major modifications to be adopted. By providing one open source tool to all of these jurisdictions, the overall cost and barriers for integrating LID practices are lessened.

Due to the complexity of building SWAMP and supporting resources, the current stage of development is as a demonstration project. The development of SWAMP included many focus groups and input by end users to help design the tool and supporting documents. The tool was completed by the end of the grant, but all of the outreach programs were conducted to gather feedback and test the tool as part of the development process.

The intended users include city and county planning and public works department staff, real estate developers and professionals, and consultants that serve coastal communities. In order for these intended users to fully integrate and use SWAMP, there needs to be additional education provided on stormwater assessment, design of LID practices, and basic GIS mapping techniques. City and County planning staff and developers needed to have this education as part of our outreach in order to understand and use SWAMP. This indicates that the SWAMP tool needs to accompany other basic LID education in these coastal communities if we intend to reach the target audience. On the other hand, private consultants and engineers in cities were able to quickly utilize the tool and related resources.

Key Findings

- Applicability to a priority coastal issue – This project addressed a high priority non-point source water quality issue for Coastal Oregon. This is verified by the Oregon Department of Environmental Quality and the Oregon Department of Land Conservation and Development.
- Cost – The development of this tool and related information is cost-effective because the tool provides basic information that is site-specific for all jurisdictions in coastal watersheds. Without this tool, jurisdictions would work independently and have to hire consultants to build this information from scratch. The information would not be built in an open-source format and would have considerable cost for adapting to each local area.
- Maintenance requirements – Maintenance of the final website information and the tool must be completed by the authors of the grant. This is not significant because the tool is part of their regular education programs. We expect to provide updates and maintenance on an as-needed basis.
- Accuracy – Spatial data for land cover and the digital elevation model is the biggest limiting factor. More accurate data is expected to be available to the public within the next 5 years. This would improve the accuracy of the tools. However, the existing runoff and design tools are very accurate at the site scale because they rely on users to enter site-specific information and don't rely on spatial data.
- Speed – Considering the amount of jurisdictions served by this project, the speed of creating this tool and information is much more efficient than the alternative. The amount

of time for each jurisdiction to adopt this tool will depend on the ability for educators to use this as a training tool. Adoption at the local level may take a few more years.

- Ease of use – The use of these tools was found to be more complex for the intended user than we originally assessed. The tools will be easy to use once the jurisdictions have attended some basic training on LID practices and understand how to use basic ArcGIS interfaces. On the other hand, consultants and engineers are excited to use the tool and found it easy to use.
- User capacity requirements (supplies, skills, hardware) – The users need to have a basic understanding of stormwater management, LID practices and ArcGIS mapping tools. The only supplies needed are a computer, internet connection and a printer for printing maps. The web tool provides an ArcGIS user interface that does not require ArcGIS or additional software.

PROJECT DEVELOPMENT

Abstract

Previous work in Oregon's small coastal communities identified two primary barriers to adopting low impact development practices: 1) a limited understanding of the relationship between urban development and watershed health, and 2) a lack of capacity for carrying development of a local stormwater management program through to implementation**.** To address these issues, we developed SWAMP, an on-line StormWater Assessment and Management decision-support Process. This tool will assist local governments and developers in streamlining adoption of local stormwater management programs and reduce the implementation costs of these programs. In collaboration with several partners and related programs, this tool will be integrated with education and training programs in the future to evaluate and design low impact development (LID) practices at the parcel and watershed scales.

This tool will be accessible on-line through Oregon State University's watershed education website (http://extension.oregonstate.edu/watershed/stormwater-solutions). This existing site is being converted to house the tool and supporting documents. This on-line tool provides an ArcGIS user interface that allows the user to define a location of interest using spatial data, gather data relative to that particular site (e.g. soils, precipitation, land cover, etc.), assess the existing and proposed future stormwater runoff from development, and choose various LID practices to decrease and treat this runoff. The user may do this at a site (i.e. lot) or neighborhood scale. The user may also access various LID fact sheets, precipitation data and design tools to help the user develop their own LID designs. This information and tools could also be used by local jurisdictions to create their own stormwater management guide.

This project utilized various end-user focus groups in workshop settings to help design the tools and test the approach. Several focus group meetings were held in the Coastal regions in the first phase to help design the initial tools. The second phase included holding specific workshops in four pilot communities/areas to evaluate the first draft of the tools: Tillamook City/North Coast, Coos Bay and Brookings/South Coast, and Central Point/Rogue River basin. The third phase included finalizing the SWAMP tool and creating supporting fact sheets and other LID related information.

The project development phase was more complex and challenging than originally proposed causing the project to take longer to develop. The final project was complete with a variety of outreach sessions to help design and develop the project; however the final product was not able to be used in additional education programs. The final project is at the demonstration phase: the product has been tested and developed, and it needs to be integrated with other LID related education to meet the full objectives of the project. This is happening now as part of new grants and LID related education programs in Oregon. We also realized some of the initial target audience, such as planners and developers, require more basic education to use the tools most effectively, while consultants and engineers were able to use the tool without much training. Long term impacts of this project will be followed as these tools become integrated into stormwater management programs in cities and counties along the Oregon Coast.

Introduction

Oregon is known across the nation for its high quality salmon habitat, natural resources, and water quality. We are a predominantly rural state and are often called "the state of small cities." Only 10 out of Oregon's 278 cities have populations greater than 50,000 people. Oregon's rural coastline contains a number of small communities with populations all smaller than 50,000 people. Many of these communities experience a high demand on housing and urban development threatens their ability to maintain high quality salmon habitat and water quality.

Oregon's Department of Environmental Quality (DEQ) has listed many coastal OR streams as water quality impaired due to bacteria, habitat and flow modification, dissolved oxygen, and temperature. Further, poor water quality has been charged as one of the primary causes for recent severe low-oxygen ocean conditions off the coast of Oregon (Walker 2006).

In 2003 Oregon Sea Grant and OSU Extension Service began a pilot project entitled Rainstorming, supported with Clean Water Act Section 319 and Coastal Zone Management Act section 6217 funds, to promote local management and regulation of urban stormwater impacts to water quality in small coastal communities. Oregon Sea Grant and OSU Extension have joined the national NEMO network, and with support from NEMO have undertaken an extensive needs assessment in several Western Oregon communities to identify issues that hinder communities' ability to mitigate growth and development impacts. Participating cities also described education and resource assistance programs that would serve to reduce these barriers. The needs assessment highlighted two primary barriers to adoption of low impact development practices in small coastal communities: ***1) a limited understanding of the relationship between urban development and watershed health, and 2) a lack of capacity for carrying development of a local stormwater management program through to implementation.***

The issue of capacity can be broken down into several parts, which include the technical ability of planning departments to develop appropriate stormwater treatment standards; the ability of real estate developers, home builders and other stakeholders to access appropriate low impact development designs; and the availability of staff to create incentive and regulatory programs to ensure implementation of new standards. The workshops also emphasized the vast contrast between progress being made by Portland and Metro, the regional government for the greater metropolitan area, and the lack of progress demonstrated in coastal communities. It became clear

that the knowledge base and experience of Portland and Metro should be leveraged to assist local jurisdictions in other parts of the state.

The intent of this project was to develop and deliver an open-source StormWater Assessment and Management decision-support Process (SWAMP) to streamline adoption of local stormwater management programs and reduce the implementation costs of these programs for both local governments and developers in small coastal communities. Through a partnership with the Department of Land Conservation and Development (DLCD), Oregon Coastal Management Program (OCMP), DEQ, City of Portland, Metro, the South Slough National Estuarine Research Reserve, the OSU College of Forestry, the project supports CICEET's mission by *developing and applying effective, accessible tools that address priority environmental challenges identified by coastal resource managers*.

SWAMP is an open-source, user-friendly tool accessed on the internet through the Oregon State University Extension Service's watershed education website. The data sets needed to run the tools (e.g. rainfall, infiltration rates, and topography) are housed and accessed through Oregon State University's College of Forestry servers. SWAMP simplifies the gathering and analysis of data relevant to the adoption and implementation of local stormwater management programs supporting low impact development (LID) practices. The website also links the user to LID designs and tools to help implement these practices and/or integrate them into a stormwater management guidance document for the local jurisdiction. This innovative approach provides a service to all coastal Oregon communities and could serve as a model for building this on-line support tool in other communities.

Objectives

The overarching goal of this project was to *engage and empower small communities to make informed decisions in managing stormwater runoff and related land use to mitigate the affects of urban growth development on water quality*. To achieve this goal, we sought to utilize innovative technologies and provide outreach education, technical assistance, and financial resources to Oregon's coastal communities to remove barriers and meet the following objectives:

1. **Engage** local decision-makers (planning department staff, planning groups, developers, elected officials, landowners and other stakeholders) by increasing awareness and understanding of the impact development practices have on stormwater and water quality.
2. **Empower** local planning departments, real estate developers and homebuilders to implement low impact development (LID) strategies ranging from site to landscape scale assessment, planning and implementation of LID practices.
3. **Assist** local governments in updating land use plans, creating stormwater plans, and developing incentive and regulatory programs that ensure the implementation of innovative and cost-effective low impact development practices.
4. **Reduce** the implementation costs (time and labor) related to designing new stormwater management practices and reviewing the related development plans.

These four inter-related efforts enhance the effectiveness of land use planning by empowering local communities to make informed decisions in developing and reviewing Stormwater Master Plans, Land Use Plans, Codes and Ordinances to better address stormwater management and related water quality issues. This project sought to create an engaged citizenry who support and

champion efforts in implementing these programs, as well as increase the number of on-the-ground low impact development practices employed by developers.

CICEET funding supported the development and innovative application of SWAMP: an open-source, user-friendly interface for accessing and utilizing analytical tools and data sets. Specifically the funds were used to interview potential end users and partners to help guide the project design, develop SWAMP and related website tools, and test these tools with target audiences in four Coastal Oregon cities. The other outreach efforts complemented this project and were funded by other grants and programs.

Methods

Technical methods

The SWAMP tool includes a variety of products to help the user analyze stormwater runoff at the site/lot and neighborhood scale. The following information is provided on the website to the user: land cover, digital elevation model, aerial photos, precipitation data, soils data, runoff and runoff reduction calculators, LID fact sheets, and LID facility design calculator.

The runoff and runoff reduction calculators are the primary tools for SWAMP and the most complex. An ArcGIS interface was created to allow the user to navigate through the data and conduct. The user locates a particular area of interest using aerial photos and zoom features. The user outlines an area and downloads all of the data for this area (land cover, elevation, etc.). Once this information is gathered, the user can calculate the existing stormwater runoff from the site, and recalculate this runoff based on proposed construction/development. The user can then compare the runoff and choose various LID practices to apply to reduce the increased runoff from the development. The website also provides various LID fact sheets and design calculators to help the user choose and design their project.

The SWAMP tool can be found at this location:
http://meridian.forestry.oregonstate.edu/swampdata/
However, the SWAMP tools and website are being converted to a new location to be integrated into a new education program. The future website will be accessed through http://extension.oregonstate.edu/watershed/stormwater-solutions.

Evaluation methods:

We used focus groups to provide input on the project design and stormwater evaluation processes. We used workshops in four pilot areas to review the first draft of the SWAMP tools. All sessions involved facilitators that recorded input on flip charts and on the computer. No additional formal evaluation methods were used for the SWAMP tools, however the complementary education programs funding by other grants included a variety of evaluations for measuring knowledge gained and behavior changes.

Collaboration methods:

Our internal team consisted of two OSU faculty that helped build the SWAMP tool, a graduate student that helped gather information for the tools and write LID fact sheets, an undergraduate student to help build the design calculators, an Extension faculty member that organized and facilitated the workshops and focus group sessions, and an Extension faculty member that served

as P.I., project manager, educator for the workshops and focus groups, and primary authors for most of the supporting materials.

Our external team consisted primarily of the Oregon Department of Land Conservation and Development (DLCD), Oregon Department of Environmental Quality (DEQ) and a consulting engineer. These partners helped in forming focus groups and providing feedback on project designs throughout the project. The consulting engineer offered assistance on many different aspects of the tools and co-authored the LID fact sheets. The Oregon Environmental Council was another partner that helped deliver many complementary LID education programs with the Extension faculty.

The stakeholders/intended users were identified through our project partners and included planners and engineers with local jurisdictions, consultants and real estate developers.

Knowledge dissemination methods:
Phase 1 – We delivered presentations and held focus group sessions with a variety of potential end-users and project partners to help us design the SWAMP tool and website materials. These included three presentations at coastal planner meetings, two focus group sessions with engineers and consultants from Portland, and numerous meetings with partners.

Phase 2 – We delivered workshops to target end-user groups in pilot areas of Oregon: North Coast, South Coast and Southwestern Oregon. These participants included consultants, city and county planners, city and county public works department staff/engineers and real estate professionals/developers. The purpose of these workshops was to share our draft tools and gain feedback on how we should create the final design.

We also delivered presentations at two national conferences – Coastal Estuarine Research Federation (2009) and the USDA CSREES National Water Quality Conference (2010). These presentations were to our peer professionals and included an overview of our project, descriptions of our technology and an overview of the SWAMP tools.

We are in the process of rebuilding our SWAMP website and incorporating our materials into one large stormwater solutions website. This will be complete in Spring, 2011 and can be found at http://extension.oregonstate.edu/watershed/stormwater-solutions/. Some of our SWAMP tools can also be found at http://meridian.forestry.oregonstate.edu/swampdata/.

Results discussion:
The project activities designed to meet the project objectives (listed above) included four main areas of emphasis: 1) LID outreach education, 2) development and training of Oregon Land Use Explorer created by the OSU library, 3) development of SWAMP tools, and 4) education and outreach on SWAMP tools. This CICEET grant was used to develop SWAMP tools and conduct outreach during the development of the tools. The other complementary efforts were funded by other grants and programs.

1. LID Outreach Education (not funded by CICEET grant) -

A wide variety of LID related outreach education efforts were delivered during the course of this project. All of these were designed to raise awareness of LID practices and increase the capacity of both professionals and the general public to engage in related projects and planning.

A. Stormwater Solutions – A series of LID forums were delivered under the program called "Stormwater Solutions" in partnership with Oregon Environmental Council. These were designed to raise awareness of LID practices for real estate professionals (planners, engineers, developers, landscapers). These were generally a half-day in length and covered various topics such as LID Overview, porous pavements, rain gardens and erosion prevention and control.
B. Rain Gardens – We developed the Oregon Rain Garden Guide (Oregon Sea Grant publication, downloadable at http://extension.oregonstate.edu/watershed/rain-gardens) and delivered a variety of day-long workshops to teach gardeners and landscapers how to build rain gardens.
C. ArcGIS, ISAT and NSPECT - NOAA Coastal Services Center in South Carolina and the National Estuarine Research Reserve in Oregon partnered to deliver three GIS related courses in coastal Oregon. These were designed for the beginning ArcGIS users and covered the basic gathering of data and using some tools related to land use development and LID.

2. Oregon Land Use Explorer project – not CICEET funded

Our project was originally planned to be housed at the OSU library as part of the Oregon Explorer and Land Use Explorer project. Due to a variety of staffing issues at the library and the ability of our project to be most efficient, we created SWAMP to be housed on the College of Forestry's GIS servers. However, the Land Use Explorer project complements our SWAMP project, and the OSU library has provided some outreach education of their related land use tools. Information can be found at this website: http://oregonexplorer.info/.

3. Development of SWAMP tools – CICEET funded

The large majority of this project involved the creation of the SWAMP interface and data analysis tools housed on the following website http://meridian.forestry.oregonstate.edu/swampdata/. SWAMP provides the user with a variety of tools and data to analyze the stormwater runoff at the site and neighborhood scales, choose LID practices to treat the increased runoff and design LID practices. SWAMP and the complementary tools to SWAMP, including LID fact sheets, designs and sizing calculators, will all be housed this Spring on a new website at the stormwater solutions address – http://extension.oregonstate.edu/watershed/stormwater-solutions. This is part of a new LID education project that extends the SWAMP project into the Willamette Watershed.

Our meetings with collaborators, focus groups and workshops with the target audiences helped us develop the SWAMP tools and complementary materials. This demonstration project, even though we were not able to complete all of the outreach efforts originally planned, provides the basis for small jurisdictions to create their own stormwater management guides and incorporate LID practices into their stormwater programs. These impacts are verified by the fact that Oregon Department of Environmental Quality recently granted funding to Extension to extend the SWAMP project to the Willamette Valley and create an extensive complementary LID education effort. Furthermore, our extensive outreach during the project development phase of SWAMP created many contacts and laid the foundation for successful future education efforts.

4. Education and Outreach of SWAMP

As mentioned above, our education and outreach efforts took place throughout the design and development of SWAMP and complementary materials. Due to the complexity of the project, we were not able to develop the tools and provide additional outreach before the project ended. However, the project will continue and an updated website is being created as part of a new grant to extend SWAMP to the Willamette Valley. We also learned through our outreach efforts that some of our target audience, primarily planners and developers, were not able to integrate these LID concepts and tools into their programs without additional education and assistance. On the other hand, consultants and engineering staff were able to learn how to use the tools fairly quickly. Our new grant project to extend SWAMP will help us create an extensive website to house all of the SWAMP tools and related information, and it will help us provide the necessary LID education efforts to help communities adopt these practices.

STATE OF THE TECHNOLOGY

The SWAMP tool has been tested and peer-reviewed for accuracy and acceptance among intended end users. The tool was demonstrated to a wide variety of groups before the final changes were made, but outreach to audiences of the final product has not been completed. As mentioned above, a new grant from Oregon DEQ has been received that will help fund the next phase of this project, extend the area of coverage to parts of the Willamette Valley, and fund an extensive LID education program to ensure its use by small jurisdictions in Western Oregon (coast and inland). The Oregon DEQ expects to utilize SWAMP as the basic framework for small jurisdictions to use in developing their stormwater management guides that support LID practices and address Total Maximum Daily Load regulations.

Application:

Our SWAMP project has been used by our partnering consulting engineer in teaching other real estate professionals about LID. Other end users have tested the tools as part of our outreach towards the end of the project that informed our final changes to the tools. The project has had limited application beyond this because of the current changes to the website that houses SWAMP. However, this tool will be used extensively by users in 2011 – 2012 as part of the new DEQ grant to further develop this tool.

Maria Cahill, GreenGirl Consulting, would be a great contact to provide feedback on this product.
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NEXT STEPS

First, the website that will house SWAMP and all of the supporting materials will be completed in Spring, 2011. Following the completion of the website, we will contact our current partners and all of our past workshop and focus group participants to announce the website.
Second, we will continue to change SWAMP to be more user-friendly for coastal planners to use in creating their stormwater management guides based on these tools.
Third, we will provide more LID related education programs that use SWAMP as a teaching tool and help planners, engineers, consultants and developers learn how to use these tools to incorporate LID projects and planning into their work.

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