

WATER QUALITY FACILITY INVESTIGATION

Summary Report

SPR 335

by

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16. Abstract The genesis for this research project was a desire to comply with the National Pollutant Discharge Elimination System (NPDES) as cost effectively as possible. The construction of stormwater handling and treatment facilities is costly because of the labor, materials and land required. After these facilities have been built, they then present an ongoing maintenance liability. In addition, the provisions of NPDES call for monitoring that presents another ongoing cost. Research in all these areas could lead to improved water quality, reduced costs, or accomplishing both simultaneously. This project evaluated the state of practice and available data regarding stormwater Best Management Practices (BMPs) and monitoring, devised a streamlined and simplified approach to try and satisfy monitoring requirements, and then attempted to use that approach to evaluate both traditional and innovative stormwater BMPs. These attempts identified obstacles to systematically and cost effectively monitoring stormwater BMPs and possible remedies to these obstacles. The key outcomes of the project were the validation of a novel BMP, the identification of obstacles to monitoring, and a template for developing BMP monitoring plans.					
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				APPROXIMATE CONVERSIONS FROM SI UNITS			
Symbol	When You Know	Multiply By	To Find	Symbol	When You Know	Multiply By	To Find
<u>LENGTH</u>							
in	inches	25.4	millimeters	mm	millimeters	0.039	inches
ft	feet	0.305	meters	m	meters	3.28	feet
yd	yards	0.914	meters	m	meters	1.09	yards
mi	miles	1.61	kilometers	km	kilometers	0.621	miles
<u>AREA</u>							
in ²	square inches	645.2	millimeters squared	mm ²	millimeters squared	0.0016	square inches
ft ²	square feet	0.093	meters squared	m ²	meters squared	10.764	square feet
yd ²	square yards	0.836	meters squared	m ²	meters squared	1.196	square yards
ac	acres	0.405	hectares	ha	hectares	2.47	acres
mi ²	square miles	2.59	kilometers squared	km ²	kilometers squared	0.386	square miles
<u>VOLUME</u>							
fl oz	fluid ounces	29.57	milliliters	ml	milliliters	0.034	fluid ounces
gal	gallons	3.785	liters	L	liters	0.264	gallons
ft ³	cubic feet	0.028	meters cubed	m ³	meters cubed	35.315	cubic feet
yd ³	cubic yards	0.765	meters cubed	m ³	meters cubed	1.308	cubic yards
NOTE: Volumes greater than 1000 L shall be shown in m ³ .							
<u>MASS</u>							
oz	ounces	28.35	grams	g	grams	0.035	ounces
lb	pounds	0.454	kilograms	kg	kilograms	2.205	pounds
T	short tons (2000 lb)	0.907	megagrams	Mg	megagrams	1.102	short tons (2000 lb)
<u>TEMPERATURE (exact)</u>							
°F	Fahrenheit	(F-32)/1.8	Celsius	°C	Celsius	1.8C+32	Fahrenheit
<u>TEMPERATURE (exact)</u>							

*SI is the symbol for the International System of Measurement

ACKNOWLEDGEMENTS

The results of this research are directly attributable to the efforts of the members of the Technical Advisory Committee (TAC) for the project:

Ranei Nomura, Oregon DEQ
Jeff Moore, ODOT Office of Maintenance
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William Fletcher, ODOT Geo-Environmental
Frank Wildensee, City of Portland
Lee Walker, Clean Water Services (formerly Unified Sewerage Agency)
Tom Szymoniak, ODOT Region 4
Elton Chang, FHWA
Jim McNamee, ODOT Maintenance
Ron Reisdorf, ODOT Geo-Environmental

It is hoped that the results of this research project will bear fruit that will reward them for their efforts.

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WATER QUALITY FACILITY INVESTIGATION

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1.0 INTRODUCTION

The National Pollutant Discharge Elimination System (NPDES) is a collection of regulations and procedures, and subsequent amendments, which arose from the federal legislation that has come to be known as the Clean Water Act. The essence of NPDES is that any discharge to “waters of the U.S.” needs a permit. The State Highway system in Oregon includes a multitude of such discharges.

The genesis for this research project was a desire to comply with the NPDES as cost effectively as possible. The construction of stormwater handling and treatment facilities is costly because of the labor, materials and land required. After these facilities have been built, they then present an ongoing maintenance liability. In addition, the provisions of NPDES call for monitoring, which presents another ongoing cost. Research in all these areas could lead to improved water quality, reduced costs, or both.

Several strategies influenced the course of the research project. One line of inquiry that was considered was to compare the various established best management practices (BMPs) being used to treat highway runoff in terms of both performance and cost over time. Evaluating innovative, simple, but unproven BMPs’ effectiveness was another concept. Another suggested line of inquiry was to establish the performance of common BMPs well enough to minimize or eliminate the need for ongoing monitoring. Related questions then arose regarding the composition of runoff and levels of natural contaminants. Schemes to simplify the sampling and lab analysis required for monitoring were also contemplated.

The final scope and approach of this research project was to evaluate the state of practice, devise a streamlined and simplified approach to satisfying monitoring requirements, and then use that approach to evaluate both traditional and innovative BMPs. This report summarizes the findings of the research and describes the research products contained on the accompanying CD.

2.0 LIST OF PRODUCTS

This research project produced eight separate reports, each of which contributed to an understanding of the problem of monitoring BMPs and how to improve the process. The eight reports, in the order they were completed, are as follows:

1. Bibliography (Annotated with database)
2. Information Analysis and Needs Assessment
3. Monitoring Plan Template
4. Monitoring Plan for Highway 26 Check Dams
5. Monitoring Plan for Highway 20 at Pilot Butte
6. Report on Monitoring at Highway 26
7. Report on Monitoring at Highway 20
8. Summary and Evaluation of Implementation

These reports are included as PDF files on the CD accompanying this document. This summary report briefly describes and summarizes each of these reports, providing a road map of sorts to guide the reader through the large body of work produced by this project.

The reports were each based upon their respective predecessors. The Bibliography and the Monitoring Plan Template were the two key products of the research project. The other reports are supporting materials that document the lessons learned and some of the issues that affect the challenges facing an agency seeking to monitor the performance of stormwater handling facilities. Because this project evolved while it was being carried out, the problem statements and work plans are also included in the appendix to help the reader understand this evolution.

3.0 SUMMARY OF EACH PRODUCT

3.1 BIBLIOGRAPHY

Product 1 is an annotated bibliography compiled by Geosyntec Consultants¹ and Oregon State University (OSU), consisting of a total of 59 entries. These are divided up into three categories:

- High Usefulness Potential References (12 entries)
- Medium Usefulness Potential References (27 entries)
- Additional non-annotated References (20 entries)

A very short list of four extremely useful publications could be derived from these, based on how often the various entries are referenced in the subsequent reports for this research project. These four are as follows:

- Shoemaker, Leslie, Mohammed Lahlou, Amy Doll, Patricia Cazenias (2000). “Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring” *FHWA Office of Natural Environment*. FHWA-EP-00-002
- Strecker, Eric, Lynn Mayo, Marcus Quigley, and Jim Howell (2001). “Guidance Manual for Monitoring Highway Runoff Water Quality.” *U.S. Department of Transportation Federal Highway Administration* FHWA-EP-01-022
- Strecker, Eric, Marcus Quigley, Ben Urbonas, Jim Howell, and Todd Hesse (2002). “Urban Stormwater BMP Performance Monitoring: A guidance manual for meeting the National Stormwater BMP Database Requirements.” *ASCE/EPA* [Online Available, May 2002] <http://www.bmpdatabase.org>
- Zeigler, Eric, Brian Laurenson, Armand Ruby, and Jon Ingersoll (2000). “Caltrans Guidance Manual: Stormwater Monitoring Protocols (2nd Edition).” *California Department of Transportation*

The database developed for the project contains 15 additional entries that were not included in the bibliography.

3.2 INFORMATION ANALYSIS AND NEEDS ASSESSMENT

Product 2 is a report that summarizes what was learned both through applying the bibliography and through consultation with the Technical Advisory Committee. It was clear that a published inventory of BMPs currently deployed over Oregon’s state highway system was so limited as to raise questions about how representative it might be of all the BMPs in the overall system. The data sets available regarding the effectiveness or performance of those same BMPs was even less extensive.

¹ Portland, OR

Key conclusions included the following:

- ODOT should pursue a less ambitious approach to the development of monitoring plans. This conclusion was based on the amount of information available and the financial and personnel resources available for the task.
- Monitoring guidance of a less technical nature than existing documents is needed because the existing national level documents are written for a specialized, research audience. This limits the user-friendliness of the documents for the types of personnel likely to apply the results of this research project.

The report notes that, with the collection of guidance documents and BMP monitoring case studies, there is an adequate amount of information available to develop a stormwater quality facilities monitoring protocol for this purpose. This protocol would eventually take the form of a monitoring plan template. The use of this template could, over time, extend the available data on the performance of BMPs with the information needed to alleviate the shortcomings noted in the available data sets.

3.3 MONITORING PLAN TEMPLATE

Product 3 is a monitoring plan template. The objective of developing a monitoring plan template was to make it easier to develop and implement monitoring plans for ODOT facilities in order to comply with regulatory requirements. Geosyntec and OSU produced a Microsoft Word template that consisted of the fundamental structure for a stormwater monitoring plan. Standard headings and text were included in black with notations in red indicating where facility-specific details needed to be inserted. The notations gave guidance, with varying degrees of specificity, as to the nature of the material that needed to be added.

Two facilities were selected to serve as a test for using the monitoring plan template:

- A simple type of facility – a series of check dams on U.S. Highway 26; and
- A complex type of facility – a stormwater handling and treatment facility on U.S. Highway 20.

The intention was to then use the two monitoring plans to monitor these two sites.

3.4 MONITORING PLAN FOR HIGHWAY 26 CHECK DAMS

Product 4 presents the first monitoring plan developed using the template. This monitoring plan was for a series of check dams on U.S. Route 26 west of Government Camp, Oregon. The monitoring plan was developed by Geosyntec and OSU. The check dams were constructed out of rubble rock in the ditch alongside the highway. The purpose of the check dams was to remove suspended sediment from the highway runoff before it entered the nearby natural stream. The check dams are shown in Figure 3.1.



Figure 3.1: View of check dams along U.S. Route 26 at milepoint 49.

3.5 MONITORING PLAN FOR HIGHWAY 20 AT PILOT BUTTE

Product 5 is the second use of the monitoring plan template. This monitoring plan was for a diverse set of stormwater facilities on U.S. Route 20 in Bend, Oregon. The monitoring plan was developed by Geosyntec and OSU. The site is adjacent to Pilot Butte. The facility included culverts, sediment manholes, oil-water separators, swales, detention ponds and dry wells in a variety of combinations. The facilities at this site had a much broader purpose of managing the stormwater, treating it to remove a broad range of highway contaminants and disposing of the water through infiltration and evaporation. Figure 3.2 shows the location of these facilities.



Figure 3.2: View from Pilot Butte of a portion of the U.S. Route 20 project for which a monitoring plan was developed. Stormwater detention basins appear in the center left of the photo.

3.6 IMPLEMENTING MONITORING AT THE HIGHWAY 26 SITE

Product 6 is a report ODOT produced, documenting the results and experience of applying the monitoring plan for the U.S. Route 26 check dams. The plan was followed as closely as circumstances allowed. The plan called for collecting and analyzing the grain size and concentrations of four representative heavy metals in the sediments accumulated behind the check dams. This was to be done at the end of the dry and wet seasons. It also called for collecting water samples to be analyzed for total suspended sediment. These samples were to be collected from water pooled behind the check dams during several major precipitation events.

The check dams proved to be very effective at removing suspended sediment. The average total suspended sediment for all the samples collected was less than 10 mg/liter. The heavy metals present in the sediments were within the range of values naturally occurring in the rocks of Mt. Hood.

Both mistakes and shortcomings of the plan, and by extension the template, were uncovered in this exercise. For example, it was discovered that a table listed reporting limits for aqueous

samples instead of the sediment samples that were the intended application. A shortcoming that was discovered was that for a good portion of the wet season the precipitation was coming as snow, not rain, and the plan made no mention of how snow should be treated.

3.7 IMPLEMENTING MONITORING AT THE HIGHWAY 20 SITE

Product 7 is a report ODOT produced documenting the experience with the monitoring plan for the Highway 20 site at Pilot Butte. Unfortunately no actual monitoring took place, but the attempt was very instructive as to the obstacles that a monitoring effort faces. The key obstacles were as follows:

- The need for traffic control;
- The number of staff needed to conduct monitoring;
- The travel time and distance from Salem;
- The reliability of forecasts for events of sufficient duration and intensity; and
- The lack of Bend ODOT personnel available to perform the monitoring.

Changes in ODOT business practices could be used to eliminate or minimize these obstacles for future monitoring projects. Examples of such changes would be a) the hiring of staff for, or assigning of staff to, monitoring duties; and b) the design of manholes and outfalls in locations that are easily accessible without traffic control.

3.8 SUMMARY AND EVALUATION OF IMPLEMENTATION

Product 8 is a report Geosyntec and OSU produced to summarize the highlights of each step in the project and assess them in retrospect. It does not attempt to repeat or encapsulate all the information in the preceding reports.

4.0 CONCLUSION

Taken together, this series of research products and reports documents the issues and processes involved with monitoring highway stormwater facilities. The key publications relating to this topic are identified in an annotated bibliography. The needs of ODOT are assessed based on published information from the perspective of a private, third party. A template for monitoring stormwater was put together to help address these needs. The template was used to actually create two stormwater monitoring plans for two sites on ODOT's system. Implementation of these plans was then attempted. A number of lessons were learned from each of the attempts, even though one attempt was nominally successful while the other attempt failed. From inception to completion, the perceived needs of ODOT regarding stormwater monitoring evolved. This evolution was very important to the nature of the completed project as well as the lessons learned.

The monitoring plan template should make the development of ODOT's stormwater monitoring plans more uniform and less laborious. The final template is better for having been actually used to write plans and conduct monitoring. The implementation efforts also are instructive about operational realities that should be kept in mind as plans are written with the template. The research project also identified a number of obstacles to efficient monitoring that ODOT has the ability to control.

APPENDICES

APPENDIX A – STAGE 1 PROBLEM STATEMENT



FY 01 RESEARCH PROBLEM STATEMENT

Research Unit
200 Hawthorne SE, Suite B-240
Salem, OR 97301-5192

Office Phone: (503) 986-2700
FAX Phone: (503) 986-2844

TITLE

47-Water Quality Facility Investigation

PROBLEM (Description of need)

In order to comply with environmental water quality regulations and Governor Kitzhaber's directive "The overall objective for state agencies under the Oregon Plan and this Executive Order is to protect and restore salmonids and to improve water quality" ODOT has now constructed a number of stormwater treatment facilities. These facilities have been designed and installed with the intent of capturing pollutants associated with highway stormwater runoff. These facilities are part of a new engineering science and it is not clear how efficient or how effective their operation will be over time. As ODOT considers installing more and more of these water quality facilities it would be beneficial to compare just how effective and cost efficient they are, both with respect to each other and with respect to other ODOT water quality Best Management Practices (BMPs).

PROPOSED RESEARCH, DEVELOPMENT OR TECHNOLOGY TRANSFER ACTIVITY

This project would compare various water quality facilities for cost effectiveness and efficiency for stormwater pollutant removal. Stormwater would be monitored for reduction in pollutant levels as it moved through various treatment facilities (such as swales, ponds, etc). Sediment and pollutant loads captured by various facilities would be analyzed and recorded. Construction costs of these facilities would be researched. Long term maintenance costs and costs for disposal of polluted sediments would be estimated.

BENEFITS

Once this data was collected, the various stormwater facilities could be rated for efficiency and effectiveness. ODOT could better determine the benefits of one type of facility over another or when and where the installation of a facility might be most appropriate as a water quality BMP. This information would be helpful to all agencies that are working to develop cost effective methods to meet stormwater requirements

CONTACT PERSON:

Name, address and phone number

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STATE
OTHER

Submittal of this form via E-mail is preferred: barnie.p.jones@odot.state.or.us

APPENDIX B – STAGE 2 PROBLEM STATEMENT



SPR RESEARCH PROGRAM SECOND-STAGE PROBLEM STATEMENT FY01

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I. PROBLEM NUMBER

01RD06

II. PROBLEM TITLE

Water Quality Facility Investigation

III. RESEARCH PROBLEM STATEMENT

ODOT installs water quality treatment facilities to capture pollutants associated with highway storm water runoff and to improve the quality of water carried in ODOT storm drain systems. Installation of these facilities is a relatively new practice and it is not clear how effectively many of these facilities operate over time. Very little data has been collected that documents specific improvements these facilities have made to the quality of water flowing in ODOT storm drain systems. As more and more water quality treatment facilities are installed, ODOT needs to know how efficient and cost effective these facilities are in protecting water quality, how they compare with one another, and how they compare with other water quality Best Management Practices (BMPs).

State and Federal environmental regulatory agencies now require pollutant management for many of the urban public storm water systems in Oregon. Storm drain discharges are regulated to protect the quality of both surface waters and underground aquifers. Protection of aquatic habitat from storm water pollutants is also regulated. Water quality facilities may be required to treat storm system water in order to protect endangered salmon or other endangered aquatic species. Because of this, ODOT and other public agencies that own and operate storm water systems throughout Oregon are installing water quality treatment facilities to capture pollutants and to comply with environmental regulations that protect water resources and fish habitat.

As more of these facilities are required and installed there is a need to develop consistent and systematic data that measures their efficiency and effectiveness. Monitoring pollutant levels can be very expensive and interpreting data can be difficult due to the number environmental variables encountered in the field. Current data available on treatment facilities tends to be from laboratory bench tests or geographic regions outside of Oregon. Much of this data has been developed using varying procedures or inconsistent water quality baselines, making comparisons difficult. The efficiency and effectiveness of these facilities can fluctuate widely depending on environmental factors. There is a need to develop an assessment process for water quality facilities that is specific to Oregon. This assessment process needs to take into account Oregon's unique storm water pollution issues and the State's unique regional environments.

IV. RESEARCH OBJECTIVES

The objective of this project is to develop monitoring methods that will assess the efficiency of water quality treatment facilities for a variety of constituents. ODOT has installed many different types of water quality facilities to remove pollutants from the water that flows through its storm systems. These vary from very simple settling ponds, weirs, and swales in open ditch drainage systems, to facilities specifically designed to filter storm water carried in enclosed piped systems. Designed facilities might include concrete catch basins or settling ponds or commercial vaults and manhole inserts such as compost filters, or "stormceptor" treatment vaults. This project will define parameters such as cost, pollutant removal rates, maintenance, appropriate applications, etc. by which these facilities can be compared or assessed. Tasks that will need to be accomplished in order to develop this assessment include the following:

1) Literature Search

There is existing information and data related to the efficiency and pollutant removal effectiveness of water quality facilities. While most storm facility literature reflects water treatment in laboratory settings or geographic settings outside of Oregon, some is directly applicable to ODOT and Oregon storm systems. A few Oregon agencies have begun to monitor the efficiencies and pollutant removal rates of the facilities they have installed. The literature search would concentrate on researching what information and data has been generated that is directly applicable to Oregon storm systems. It would also focus on local data that has already been collected, how it could be standardized, or how data collection might be modified so that agencies that are currently collecting data can better share and utilize this information.

2) Information Analysis

Analyzing information compiled from the Literature Search in Task 1 will likely require communication with other Oregon agencies concerned with storm water management. There are a number of Oregon agencies that have already expressed an interest in compiling local data and information that is related to water quality treatment facilities and analyzing it for trends, efficiencies, or appropriate monitoring parameters. The information analysis would concentrate on identifying what local information is currently available, how it might be expanded, and how it could be used to assess the efficiency of various water quality treatment facilities.

3) Assess Needs

After known information and data is compiled and analyzed, further information that is needed to assess the efficiency of treatment facilities can be identified. This will entail identifying measurable parameters or data that can be collected and analyzed for specific types of treatment facilities. Measurable parameters might include water quality data collected before and after facility treatment, measured amounts of pollutants captured by facilities, facility costs, or facility maintenance costs that are accrued over time. One type of facility might be recommended over another for treatment of specific pollutants or in specific environmental situations. It is likely this type of information will need to be considered when assessing treatment facility efficiencies.

4) Develop Pilot Project

After assessment parameters are defined, a pilot project can be developed. For the pilot project, different types of water quality facilities will be selected for evaluation. The pilot project will collect information that can be used to assess specific parameters for specific types of water quality facilities. Priority water quality issues will be considered in the development of the pilot project. Facilities under investigation may be prioritized for their efficiency in removing a specific pollutant such as lead or hydrocarbon. Cost effectiveness might be prioritized with low cost, low tech. treatment facilities investigated for their pollutant removal capabilities. The pilot project will be developed to test not only an evaluation process but to investigate specific questions regarding the efficiency of specific types of water quality facilities.

5) Collect Data

Appropriate data and information will be collected as defined in the Pilot Assessment Project. It is likely that this would include pollutant sampling and analysis as well as tracking and estimating facility costs over time. Because facility efficiency may vary over time, it is expected the research project may develop some recommendations for future long term monitoring or investigations.

6) Evaluate Project

The pilot assessment project will be evaluated for its usefulness and effectiveness in assessing water quality treatment facilities. This evaluation will also address how well the pilot project answered specific questions regarding treatment facility operations that it was trying to answer. Finally the entire research project will be evaluated for how the information it has collected can best be shared and utilized both by ODOT and other agencies involved with storm water management.

7) Final Report

The final report will summarize the project and evaluation information for distribution within ODOT and to the Oregon storm water management community. The report will be organized in such a way as to make research findings easily accessible and useful to those who develop and install storm water treatment facilities.

V. WORK TASKS, COST ESTIMATE AND DURATION

WORK TASK	COST ESTIMATE	DURATION
1) Literature Search	\$10,000	3 months
2) Information Analysis	\$10,000	3 months
3) Assess Needs	\$ 5,000	3 months
4) Develop Pilot Project	\$10,000	3 months
5) Collect Data	\$50,000	12 months
6) Evaluate Project	\$ 5,000	3 months
7) Final Report	\$ 5,000	3 months
8) Research Administration	\$20,000	

Total Time and Budget: 30 months and \$115,000
(Because there is interest in this project from outside agencies concerned with storm water management, there may be an opportunity to receive additional outside funding. It may be appropriate to adjust work tasks accordingly.)

VI. IMPLEMENTATION PLAN

The findings of this research would offer guidance to Oregon storm water management agencies to help select appropriate water treatment facilities for their storm systems. Research project findings could also include recommendations for monitoring guidelines that would help management agencies better share the data they collect and assess the efficiency of their storm water treatment facilities in the future. Findings of this research and final reports could be distributed through outreach organizations and agencies that focus on storm water management issues such as Oregon Association of Clean Water Agencies (ACWA) or Oregon Department of Environmental Quality.

VII. POTENTIAL BENEFITS

This research project will help ODOT and other storm water management agencies manage storm systems more cost effectively and reduce storm water pollutant loads in Oregon. Ultimately this will help protect Oregon’s water resources and fish habitat. The project will also help ODOT meet various Federal and State environmental permit and program requirements tied to clean water issues.

VIII. PROBABILITY OF SUCCESSFUL OUTCOME

HIGH MEDIUM OR LOW (CIRCLE ONE)

IX. SUBMITTED BY

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APPENDIX C – ORIGINAL WORK PLAN

Research Project Study Proposal
For
WATER QUALITY FACILITY INVESTIGATION

State Planning and Research Project

Submitted by

Wayne C. Huber, Ph.D., P.E.
Professor, Civil, Construction, and Environmental Engineering

of

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for

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January 2002

Contents

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11. Work Time Schedule
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13. Résumés

**Research Project Study Proposal
For
WATER QUALITY FACILITY INVESTIGATION**

1.0 Identification

1.1 Organizations Sponsoring Research:

Oregon Department of Transportation (ODOT)
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Paul R. Wirfs, ODOT GeoHydro
William Fletcher, ODOT Environmental

Frank Wildensee, City of Portland
Lee Walker, Clean Water Services (formerly Unified Sewerage Agency)
Tom Szymoniak, ODOT Region 4
Elton Chang, FHWA
Brett Sposito, ODOT Research
Jim McNamee, ODOT Maintenance

1.4 Friends of the Committee

Janet Gillaspie, Oregon Association of Clean Water Agencies (ACWA) (503) 236-6722
Chauncy Anderson, United States Geological Survey (USGS) (503) 251-3206
Doug Pierce, WSDOT (360) 705-7812
Art Martin, National Marine Fisheries Service (NMFS)

1.5 Project Champion

Ron Reisdorf, ODOT Geo/Hydro

2.0 Problem Statement

ODOT installs various types of water quality treatment facilities to capture pollutants associated with highway storm water runoff and to improve the quality of water carried in ODOT storm drain systems. Installation of these facilities is a relatively new practice and it is not clear how effectively many of these facilities operate over time. While a limited amount of stormwater runoff treatment data have been collected in Oregon and the Pacific Northwest, there is almost no documented specific improvements that these facilities have made to the quality of water flowing in ODOT storm drain systems. As more and more water quality treatment facilities are installed, ODOT needs to know how well these facilities perform and how cost-effective these facilities are in protecting water quality, how they compare with one another, and how they compare with other water quality Best Management Practices (BMPs) not currently being employed by ODOT. Some lower cost/lower tech options have been installed by ODOT, and particularly for these systems, almost no data exist on effectiveness of removing pollutants such that they can be compared with other typically more expensive options.

As more highway stormwater facilities are required and installed there is a need to develop consistent and systematic data that characterize their efficiency and effectiveness. Monitoring pollutant levels can be very expensive, and interpreting data can be difficult due to the number of environmental variables encountered in the field. Current data available on treatment facilities tend to be from laboratory bench tests or geographic regions outside of Oregon or the Pacific Northwest. Much of these data have been developed using varying procedures or inconsistent water quality baselines, making comparisons difficult. The efficiency and effectiveness of these facilities can fluctuate widely depending on environmental factors. There is a need to develop an assessment process for water quality facilities that is specific to Oregon. This assessment process

needs to take into account Oregon's unique storm water pollution issues and the State's unique regional environments.

There have been a number of efforts to develop protocols for monitoring and reporting on the effectiveness of stormwater BMPs. One of the most prominent of these has been the US EPA's and American Society of Civil Engineers BMP Database Project (ASCE/EPA BMP Database). This effort has included the development of a peer-reviewed set of monitoring and reporting data, suggested procedures for analyses of performance data, and more recently the development of a more detailed guidance document on BMP monitoring (www.bmpdatabase.org, Strecker, et al., 2001¹). Recently, the City of Portland has developed guidance for commercial BMPs on required performance data. The State of Washington Department of Ecology is also developing protocols for BMP testing², but this draft document is more of a guide for potential control device vendors than for a DOT, although it contains much valuable information. EPA also provides guidance on monitoring protocols³. Finally, another prominent transportation agency that has been conducting significant levels of BMP testing is the California Department of Transportation (CalTrans). Although most of the testing work has been in Southern California, the protocols that they have been employing should be reviewed as well.

ODOT potentially has a variety of BMP monitoring needs. These could range from more simple confirmatory type testing to actually evaluating how to improve the design of BMPs to improve performance. What would be useful to ODOT is to develop a suite of testing protocols for various types of data needs.

3.0 Objectives of the Study

The objective of this project is to develop water quality monitoring methods or testing protocols that can be used to assess the effectiveness of water quality treatment facilities for a variety of constituents. This would likely include the development of several levels (in terms of effort) of protocols to meet different effectiveness information goals.

ODOT has installed many different types of water quality facilities to remove pollutants from the waters that flow through its storm systems. These vary from very simple settling ponds, weirs, and swales in open ditch drainage systems, to underground facilities designed to filter storm water carried in enclosed piped systems. These underground facilities have included concrete catch basins, settling ponds, commercial vaults, manhole inserts such as compost filters, and treatment vaults. This project will define methods to evaluate parameters such as cost, amount of runoff treated, amount of

¹ Strecker, E.W., M.M. Quigley, B.R. Urbonas, J.E. Jones, and J.K. Clary. 2001. "Determining Urban Storm Water BMP Effectiveness," ASCE Journal of Water Resources Planning and Management, Vol. 125 NO. 3, pp. 144-149, May/June.

² Washington State Department of Ecology. 2001. Guidance for Evaluating the Performance of Stormwater Pollutant Removal Technologies (including the test protocol) November 30, 2001 (draft)

³ U.S. EPA, September 1997. Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls, EPA 841-B-96-004, U. S. Environmental Protection Agency, Nonpoint Source Control Branch, Washington, DC.

runoff infiltrated or evapotranspired, pollutant removal rates or effluent quality achieved, maintenance, appropriate applications, etc. by which these facilities can be compared or assessed. Specific objectives include:

- Conduct a review of available literature and reports on BMP monitoring protocols
- Obtain information on BMP testing occurring in Oregon and Pacific Northwest
- Develop potential needs for BMP assessment data and potential strategies to meet these needs.
- Develop protocols for BMP testing for ODOT
- Develop a testing plan for future testing of BMPs by ODOT and its Partners

4.0 Background and Significance of Work

State and Federal environmental regulatory agencies now require pollutant management for many of the urban public storm water systems in Oregon. In addition, many non-urban requirements could occur due to increasing number of total maximum daily loads (TMDLs) set for water bodies located in rural areas as well as from increasing requirements to address endangered species and other environmental issues related to road surface runoff. Storm drain discharges are regulated to protect the quality of both surface waters and underground aquifers. Protection of aquatic habitat from storm water pollutants is also regulated. Water quality facilities may be required to treat storm system water in order to protect endangered salmon or other endangered aquatic species. Because of this, ODOT and other public agencies that own and operate storm water systems throughout Oregon are installing water quality treatment facilities to capture pollutants and to comply with environmental regulations that protect water resources and fish habitat. ODOT and other agencies need to determine how effective BMP facilities are for purposes of improving implementation of BMPs as well as to improve decision-making in overall environmental programs (such as TMDL setting and implementation plans).

5.0 Benefits

This research project will help ODOT and other storm water management agencies manage storm systems more cost effectively and reduce storm water pollutant loads in Oregon. Ultimately this will help protect Oregon's water resources and fish habitat. The project will also help ODOT meet various Federal and State environmental permit and program requirements tied to clean water issues that have requirements for assessing the effectiveness of implemented stormwater BMPs.

6.0 Implementation

The findings of this research would offer guidance to Oregon storm water management agencies to help evaluate and select appropriate water treatment facilities for their storm systems. Research project findings would provide recommendations for monitoring guidelines that would help management agencies better share the data they collect and assess the efficiency of their storm water treatment facilities in the future. Findings of this research and final reports would be distributed through outreach organizations and agencies that focus on storm water management issues, such as Oregon Association of Clean Water Agencies (ACWA) and Oregon Department of Environmental Quality. Many of these agencies are represented on the Technical Advisory Committee.

7.0 Work Plan

Division of Work into Three Phases

The research will be conducted in three phases, with only the first two phases included in the budget (and schedule) in this proposal. The third phase is dependant on the results of the first two phases. This work plan shows all three phases for purposes of defining the ultimate goals and objectives of the project. The phases consist of:

Phase 1: SUMMARY OF EXISTING INFORMATION AND NEEDS ASSESSMENT

Phase 1 consists of conducting tasks 1 to 3. At the end of this phase, which would include the literature review, analysis of the information collected and an assessment of ODOT's needs for BMP performance information, the project team would then be prepared to develop more detailed BMP monitoring and performance protocols and to develop a plan for BMP testing.

Phase 2: DEVELOP TESTING PROTOCOLS AND MONITORING PLAN

Phase 2 consists of conducting Tasks 4 to 6, which include the development of detailed monitoring protocols and a plan for the testing of BMPs for assessing their performance. At the end of this task, the project team would be prepared to implement or assist others in implementation of the testing program. A final report on Phases 1 and 2 would be completed as well.

Phase 3: FACILITY TESTING AND REPORTING

Phase 3 would consist of tasks 7 through 9 and would include conducting the tests, evaluating test results, and preparing a final project report that would summarize testing results and implications for ODOT and other stormwater management agencies. Tasks that will need to be accomplished in order to develop this assessment include the following:

7.1 Phase 1: SUMMARY OF EXISTING INFORMATION AND NEEDS ASSESSMENT

Task 1- Literature Search:

Some information and data related to the performance and pollutant removal effectiveness of water quality facilities are available. While most storm facility literature reflects water treatment in laboratory settings or geographic settings outside of Oregon, some is directly applicable to ODOT and Oregon storm systems. A few Oregon agencies have begun to monitor the performance and pollutant removal rates of the facilities they have installed. The literature search would concentrate on researching what information and data have been generated that are directly applicable to Oregon storm systems. It would also focus on local data that have already been collected, how they could be standardized, or how data collection might be modified so that agencies that are currently collecting data can better share and utilize this information. Data sources will include the Oregon Department of Transportation, ASCE/EPA BMP Database, the Oregon Association of Clean Water Agencies, Oregon Department of Environmental Quality, Washington American Public Works Association Stormwater Managers group (most of the stormwater agencies in Washington participate in this group), California Department of Transportation, and other agencies or organizations that appear to have relevant data and/or protocols. The product of this task would include an annotated bibliography that summarizes each of the reports or other types of documents obtained.

Task 2- Information Analysis

Analyzing information compiled from the Literature Search in Task 1 will likely require communication with other Oregon agencies concerned with storm water management. A number of Oregon agencies have already expressed an interest in compiling local data and information that are related to water quality treatment facilities and analyzing them for trends, performance, and/or other appropriate monitoring parameters. The information analysis would concentrate on identifying what local information is currently available, how it might be expanded, and how it could be used to assess the efficiency or effectiveness of various water quality treatment facilities. The product of this task would be a short report that summarizes what data are available and how they could be expanded to address data needs. This “expansion” would also include an assessment of how other data from outside Oregon may be employed.

Task 3- Assess Needs

After known information and data are compiled and analyzed, further information that is potentially needed to assess the effectiveness of treatment facilities can be identified. The project team will develop a menu of potential strategies for assessing the effectiveness of BMPs based upon potential goals. These strategies could include:

- Monitoring for the purpose of verification of effectiveness
- Monitoring for assessment of BMP design and how to improve designs
- Monitoring to establish that with the BMP, desired effluent quality is being achieved.

Each of these types of goals could potentially result in different monitoring programs. For example, if one were interested in merely establishing that overall ODOT stormwater runoff water quality downstream of a BMP was adequate to protect beneficial uses, then the monitoring program might focus on effluent quality from the BMP and perhaps an assessment of how much runoff was bypassed or not. Upstream BMPs (such as source controls) would not be accounted for in this approach. If one were interested in establishing that the BMP itself was effective, then input/output BMP monitoring along with bypass amounts would be needed. Finally, an even higher level of monitoring would be warranted if one wanted to assess the design of the BMP to improve performance. The project team will convene a meeting with the TAC to identify potential strategies and approaches.

Once the types of monitoring strategies are identified then the work will entail identifying measurable parameters or data that can be collected and analyzed for specific types of treatment facilities. Measurable parameters might include water quality data collected before and after facility treatment, measured amounts of pollutants captured by facilities, facility costs, or facility maintenance costs that are accrued over time. One type of facility might be recommended over another for treatment of specific pollutants or in specific environmental situations. It is likely this type of information will need to be considered when assessing treatment facility efficiencies. The ASCE/EPA BMP database provides a foundation for the consideration of what types of parameters to consider for ODOT. The product of this task would be a short report that describes the selected strategies for assessing BMP performance for ODOT. It would also include a listing of monitoring parameters and approaches that would then be used to develop protocols.

One of the decisions that ODOT will need assistance with is to decide what constitutes “good” BMP performance. In the past and currently, many researchers and others focus on percent removal of pollutants as the measure of effectiveness. The ASCE/EPA database team has reached the conclusion that percent removal is an inappropriate measure of performance. It appears from the analysis of the ASCE/EPA database that BMPs are somewhat effluent quality limited or at least described better in terms of the effluent quality that can be achieved (Strecker et al., 2001¹). Percent removals are problematic in that if influent concentrations are low (sometimes due to good source controls) then the BMP may be mis-characterized as a poor performer. Likewise, if sources are very high, even if the effluent quality is relatively poor, a BMP could be mis-characterized as a “good” performer.

One option that this research team would suggest to ODOT is that BMP performance measures include the following elements as appropriate:

- How much runoff is prevented (hydrological source control such as infiltration, etc.)
- How much runoff is treated by the BMP and discharged.
- What are the treated runoff water quality characteristics? (effluent quality)

- How much runoff is not treated (bypassed, etc.)?

This would allow determinations of not only concentration effects, but also pollutant loading considerations. Among the important considerations would be to develop performance descriptors would be how they can be used for not only demonstrating reductions in pollution to the “maximum extent practicable”, but also how they can be utilized logically within the TMDL context of load reductions and benefit impairment frequency reductions.

7.2 Phase 2: DEVELOP TESTING PROTOCOLS AND MONITORING PLAN

Task 4- Development of BMP Monitoring Protocols

Based upon the above approaches for protocols, a more detailed listing and discussion of BMP monitoring protocols for ODOT would be developed. If one or more of the above identified sources of BMP monitoring protocols are found to be satisfactory, then they would be adapted and incorporated into the protocols. The protocols would clearly identify the intended purpose of the BMP performance information desired and then would spell out the monitoring protocols and approaches to be implemented. This would be prepared for different BMP categories. The project team would likely require one to two meetings with the TAC to discuss possible options for the protocols. The product of this task will be a short report and tables of protocols.

Task 5- Field Testing Monitoring Plan

A field testing monitoring plan that identifies potential BMP monitoring sites and programs would be developed. The plan would include:

- Specific objectives of monitoring
- Potential BMP types and monitoring sites
- Sampling strategies (grabs vs. composites, etc.)
- Sampling equipment
- Sampling procedures and protocols
- Number of sampling events (storms and dry weather if appropriate)
- Health and safety issues
- Quality assurance/quality control
- Monitoring database and reporting details

After the protocols and assessment parameters are defined, existing low-cost, low-tech. water quality facilities will be considered and selected for evaluation. Other types of BMPs will also be considered. The different types of water quality facilities will be assessed for specific parameters according to the protocols developed above. Priority water quality issues for ODOT will be considered in the selection of existing facilities. These issues will likely include ESA issues, TMDLs, and other ODOT water quality issues. Facilities under investigation may be prioritized for their efficiency in removing a

specific pollutant such as lead or hydrocarbon. Cost effectiveness might be prioritized with pollutant removal capabilities. Not only will the evaluation process be assessed, but also specific questions regarding the effectiveness and performance of specific types of water quality facilities will be investigated.

Task 6- Final Phase I and II Report

The final report will summarize the project and evaluation information for distribution within ODOT and to the Oregon storm water management community. It will summarize the results and recommendations arrived at during the first two phases of the project and included the recommended plan for Phase 3. The report will be organized in such a way as to make research findings easily accessible and useful to those who develop and install storm water treatment facilities, as well as to those who are considering monitoring studies to assess the effectiveness of roadway and other stormwater BMPs in Oregon.

7.3 PHASE 3: FACILITY TESTING AND REPORTING (Not included in the budget)

Task 7- Collect Data

Appropriate data and information will be collected as defined in task 5. It is likely that this would include pollutant sampling and analysis as well as tracking and estimating facility costs over time. Because facility efficiency may vary over time, it is expected the research project may develop some recommendations for future long term monitoring or investigations. Data evaluation reports would be prepared following the protocols developed under Task 4. As the scope of this program cannot be defined until Phases I and II are complete, this task has not been included in the current budget. In addition, it is possible that additional OSU environmental engineering personnel (and laboratories) and/or ODOT and/or other members of the TAC or others may be best suited to carry out some or all of the monitoring efforts.

Task 8- Evaluate Monitoring Data and BMP Effectiveness

The evaluation project for low cost, low tech. or other water quality facilities will be assessed for its usefulness and effectiveness in assessing water quality treatment facilities. This evaluation will also address how well the project answered the specific questions regarding treatment facility operations that it was trying to answer. Finally the entire research project will be evaluated for how the information it has collected can best be shared and utilized both by ODOT and other agencies involved with storm water management. BMP performance methods from Phase 1 and 2 will be utilized to prepare the assessment of BMP effectiveness.

Task 9- Final Report, Phase 3

After completion of Phase 3, a final report would summarize the project and evaluation information for distribution within ODOT and to the Oregon stormwater management community. The report will be organized in such a way as to make research findings

easily accessible and useful to those who develop and install storm water treatment facilities.

7.4 Schedule and Deliverables

The proposed project work schedule to accomplish the tasks for Phases 1 and 2 is shown in Table 1. The tasks would be completed within 12 months.

Quarterly reports of progress will be provided. The first quarterly report will describe the literature review results as well as the status of the information analyses. The second quarterly report will summarize the completion of the First Phase of the project. The third quarterly report will summarize the development of the protocols and monitoring plan. The fourth and final quarterly report will summarize the completion of the project.

The PIs will present the task summary reports to the TAC after each phase. These meetings will provide more opportunity for technical exchange and for the evaluation and redirection of project emphasis and direction. In addition, the PIs will meet with the TAC as needed for the development of the protocols.

8.0 Budget Estimate

The detailed budget estimate is included in Table 2. It includes supplemental formats to meet ODOT project planning and management requirements. Fiscal year allocations are based on a starting date of approximately March 1, 2002. Summary budgets for Phases 1 and 2 by fiscal year are provided in Tables 3 and 4. The proposers can only estimate how ODOT will actually allocate its \$20,000 research administration fee.

9.0 Project Team

The project team consists of personnel from the Department of Civil, Construction, and Environmental Engineering at Oregon State University and from GeoSyntec Consultants. Co-principal investigators are Dr. Wayne C. Huber, P.E. at OSU and Mr. Eric W. Strecker, P.E. at GeoSyntec (Portland office). The overall project manager will be Wayne Huber. Their qualifications are described briefly below, and résumés of the two PIs are appended to the proposal. At OSU Dr. Huber will be the primary project staffer, with possible help from students. At GeoSyntec, Mr. Strecker will provide the primary effort but will also supervise other company staff familiar with the project theme, as needed.

Please note that by submission of this proposal, Oregon State University affirms that it has received a written commitment from GeoSyntec to participate in the project as indicated in this proposal and for the proposed budget.

Dr. Huber has participated in and led many projects related to urban stormwater management and modeling, for EPA and other agencies, as documented in his attached résumé. He is the principal author and manager of the EPA Storm Water Management

Model (SWMM) for the Environmental Protection Agency. He has over 33 year's experience as a teacher and researcher at the University of Florida and Oregon State University and recently was co-PI of NCHRP Project 25-9 related to water quality impacts of highway construction and repair materials. He also participated as a team member in preparation of highway runoff quality evaluation procedures for the Federal Highway Administration.

Mr. Strecker has over 16 years of experience in stormwater management, especially in the design, monitoring, and evaluation of the effectiveness of BMPs and integrated stormwater master and site planning. He is by training a water resources engineer and fisheries biologist. He has assisted federal, state, and local government clients in conducting stormwater research and monitoring projects and developing and implementing stormwater management plans. He has assisted the EPA and FHWA in conducting national research programs, including developing a comprehensive approach to assessing the design and performance of urban stormwater management practices for the EPA (ASCE/EPA National BMP Database), the development of a national database on highway runoff water quality, and preparation of a guidance document on highway runoff water quantity and quality monitoring for the Federal Highway Administration.

10.0 Facilities Available

The ODOT Research Group will fund the research entirely. OSU and GeoSyntec Consultants will provide office and laboratory facilities. Experiments would be conducted in the field in Phase 3. If this third phase were funded by ODOT, the OSU environmental engineering laboratories would be available for chemical and biological analyses.

11.0 Work Time Schedule

The project is scheduled to begin in March 2002 and be completed by February 2003. (although the exact starting and ending dates are flexible). Table 1 shows the overall work and time schedule, by phase and task. Phase 3 could begin in the fall/winter of 2002/2003 as dictated by the plan and ODOT's preferences. However, a water quality sampling effort in Oregon should begin as early in the wet season (beginning fall) as possible.

12.0 Reports

The Research Reports will provide descriptions of the research approaches, analysis of the data, discussion of results, and conclusions as appropriate. All reports will be produced in the standard ODOT Research Group report format unless some other format is deemed to be more appropriate as a supplement to the ODOT format. The project team will provide and edited and revised Final Report following ODOT review.

Table 1. Schedule of project tasks and deliverables.

Phase and Task	2002			2002			2002			2003		
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
1-1												
1-2												
1-3												
2-4												
2-5												
2-6												
Rev. Final Rpt.												
Deliverables			X		X	X		X	X	X		X

Table 2. Budget, by phase, task, and fiscal year.

Task Phase 1	OSU	GeoSyntec	Team	ODOT	Totals
1-1 Literature Search - FY2002	2,500	10,500	13,000		\$13,000
1-1 Literature Search - FY2003	0	0	0		\$0
1-1 Literature Search - Subtotal	2,500	10,500	13,000		\$13,000
1-2 Information Analysis - FY2002	2,200	6,000	8,200		\$8,200
1-2 Information Analysis - FY2003	1,672	3,000	4,672		\$4,672
1-2 Information Analysis - Subtotal	3,872	9,000	12,872		\$12,872
1-3 Assess Needs - FY 2002	0	0	0		\$0
1-3 Assess Needs - FY2003	2,000	8,000	10,000		\$10,000
1-3 Assess Needs - Subtotal	2,000	8,000	10,000		\$10,000
Phase 1 - FY2002	4,700	16,500	21,200		\$21,200
Phase 1 - FY 2003	3,672	11,000	14,672		\$14,672
Phase 1 - Subtotal	8,372	27,500	35,872		\$35,872
Phase 2					
2-4 Development of BMP Monitoring Protocols - FY2002	0	\$0	0		\$0
2-4 Development of BMP Monitoring Protocols - FY2003	7,959	19,000	26,959		\$26,959
2-4 Development of BMP Monitoring Protocols - Subtotal	7,959	19,000	26,959		\$26,959
2-5 Field Testing Monitoring Plan - FY2002	0	0	0		\$0
2-5 Field Testing Monitoring Plan - FY2003	5,000	12,500	17,500		\$17,500
2-5 Field Testing Monitoring Plan - Subtotal	5,000	12,500	17,500		\$17,500
2-6 Final Phase I and II Report - FY2002	0	0	0		\$0
2-6 Final Phase I and II Report - FY2003	3,000	2,000	5,000		\$5,000
2-6 Final Phase I and II Report- Subtotal	3,000	2,000	5,000		\$5,000
Phase 2 - FY2002	0	0	0		\$0
Phase 2 - FY2003	15,959	33,500	49,459		\$49,459
Phase 2 - Subtotal	15,959	33,500	49,459		\$49,459
Project Subtotals	24,331	61,000	85,331		\$85,331
OSU Indirect Costs on Subcontract - FY2002	6,336		6,336		\$6,336
OSU Indirect Costs on Subcontract - FY2003	3,264		3,264		\$3,264
OSU Indirect Costs on Subcontract - Subtotal	9,600		9,600		\$9,600
ODOT Research Administration - FY2002				5,000	\$5,000
ODOT Research Administration - FY2003				15,000	\$15,000
ODOT Research Administration - Subtotal				20,000	\$20,000
Grand Total - FY2002	11,036	16,500	27,536	5,000	\$32,536
Grand Total - FY2003	22,895	44,500	67,395	15,000	\$82,395
Grand Total	33,931	61,000	94,931	20,000	\$114,931

Table 3. Phase 1 summary budget table, including OSU indirect costs on subcontract.

Phase 1	OSU	GeoSyntec	Team	ODOT	Totals
FY2002	11,036	16,500	27,536	3,000	\$30,536
FY2003	6,936	11,000	17,936	2,000	\$19,936
Total	17,972	27,500	45,472	5,000	\$50,472

Table 4. Phase 2 summary budget table, including OSU indirect costs on subcontract.

Phase 2	OSU	GeoSyntec	Team	ODOT	Totals
FY2002	0	0	0	0	\$0
FY2003	15,959	33,500	49,459	15,000	\$64,459
Total	15,959	33,500	49,459	15,000	\$64,459

WAYNE C. HUBER, PROFESSOR

Department of Civil, Construction, and Environmental Engineering
Oregon State University
Corvallis, Oregon 97331-2302

EDUCATION

BS (Engineering) California Institute of Technology, 1963
MS (Civil Engineering) Massachusetts Institute of Technology, 1965
PhD (Civil Engineering) Massachusetts Institute of Technology, 1968

PROFESSIONAL EXPERIENCE

1968-79 Assistant and Associate Professor of Environmental Engineering Sciences,
University of Florida
1979-91 Professor of Environmental Engineering Sciences, University of Florida
1991- Professor, Department of Civil, Construction, and Environmental Engineering,
Oregon State University, Department Head, 1991-2000

PROFESSIONAL SOCIETIES AND ORGANIZATIONS

Member, American Society of Civil Engineers
Member, ASCE Environmental and Water Resources Institute
Chair, ASCE EWRI Watershed Council, 1999-2000
Member, American Geophysical Union
Member, International Association for Hydraulic Research
Member, American Water Resources Association
Member and Past Chair, ASCE Urban Water Resources Research Council

REGISTRATION

Registered Civil Engineer, Florida

PARTIAL LISTING OF RESEARCH CONTRACTS AND GRANTS

1. Storm Water Management Model, Co-I, FWQA, 1969-1970 (\$125,000)
2. Decision Model for Stormwater Management, Co-PI, EPA, 1971-1973 (\$105,000)
3. Data Collection Strategy for Water-Quality Studies, Co-PI, NSF, 1972-1974 (\$45,000/yr)
4. Nationwide Characterization of Stormwater Discharges (with American Public Works Association), Co-PI, EPA, 1973-1976 (\$100,000)
5. Impact on the Great Lakes of Wet Weather Flows from Urban Areas in Canada, Co-PI, Environment Canada, 1974-1975 (\$25,000)
6. Urban Stormwater Management Model, Co-PI, EPA, 1975-1977 (\$120,000) and Urban Runoff Analysis Methodology, 1976 (\$25,000)
7. Multipurpose Stormwater Management, Co-PI, EPA, 1977 (\$59,000)
8. Urban Rainfall-Runoff-Quality Data Base, Co-PI, EPA, 1978-1979 (\$51,000)
9. General Methodology for Evaluating Urban Stormwater Quality Management Alternatives, Co-PI, EPA 1978-1980 (\$73,000)
10. Assessment of Receiving Water Impacts from Urban Stormwater Pollution, EPA, Co-I, 1978-1979 (\$79,000)
11. Receiving Water Quality Data Base and Model Review, PI, EPA, 1980-1983 (\$94,000)
12. Impacts of Development on the Water Resources of Cypress Creek North of Tampa, Co-PI, SW Florida Water Management District, 1984-1986 (\$113,000)
13. Formulation of New Hydrologic Methodologies, PI, Florida DOT, 1988-1991 (\$150,000)
14. Tualatin River Basin Study, Oregon Dept. of Environmental Quality, Co-I, 1992-1993 (\$204,000)

15. SWMM - ARC/INFO AML Development, Delaware Dept. of Natural Resources and Environmental Quality, PI, 1993-1994 (\$100,000)
16. Environmental Impact of Construction and Repair Materials on Surface and Ground Waters, National Cooperative Highway Research Program, Co-PI, 1994-2000 (\$1,400,000)
17. Evaluate/Improve SWMM Modeling Techniques for Stormwater, Sanitary Sewer Overflow, and Combined Sewer Overflow Mgmt., EPA, PI, 1997-2001 (\$49,000)
18. Using GIS Databases to Estimate Stormwater Runoff, US Geological Survey, Oregon Water Resources Research Institute, Co-I, 2000-2001 (\$6,615)
19. SWMM Water Quality Enhancement for Coastal Areas, University of New Orleans from EPA Star project, 2000-2001 (\$76,000)
20. Optimization of Urban Sewer Systems During Wet Weather Periods, Co-PI, Environmental Protection Agency through subcontract to University of Colorado, 2001-2003 (\$54,793)
21. Sustaining Multiple Functions for Urban Wetlands, Co-I, National Science Foundation, 2001-2002 (\$70,000)

SELECTED PUBLICATIONS

1. Huber, W.C., Nelson, P.O., Eldin, N.N., Williamson, K.J., and J.R. Lundy, "Environmental Impact of Runoff from Highway Construction and Repair Materials: Project Overview," *Transportation Research Record 1743*, National Academy Press, Washington, DC, 2001, pp. 1-9.
2. Nelson, P.O., Williamson, K.J., Azizian, M.F., Thayumanavan, P., Huber, W.C., and Eldin, N.N., "Environmental Impact of Runoff from Highway Construction and Repair Materials: Screening and Evaluation Methodology," *Transportation Research Record 1743*, National Academy Press, Washington, DC, 2001, pp. 16 – 24.
3. Nelson, P.O., Huber, W.C., Eldin, N.N., Williamson, K.J., Azizian, M.F., Thayumanavan, P., Quigley, M.M., Hesse, E.T., Lundy, J.R., Frey, K.M. and R.B. Leahy, Environmental Impact of Construction and Repair Materials on Surface and Ground Waters, Volume I: Summary of Methodology, Laboratory Results, Model Development, National Cooperative Highway Research Program, Report 448, Transportation Research Board, National Research Council, National Academy Press, Washington, DC, 2001, 128 pp.
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5. O'Loughlin, G., Huber, W.C. and B. Chocat, "Rainfall-Runoff Processes and Modelling," *Journal of Hydraulic Research*, Vol. 34, No. 6, 1996, pp. 733-751.
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REGISTRATIONS

Registered Civil Engineer: California, 1987
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PROFESSIONAL HISTORY

GeoSyntec Consultants, Associate, 2000-Present
URS Greiner Woodward Clyde, Regional Manager-Water Quality Practice, 1985 - 2000
University of Washington, College of Engineering, Lecturer, 1985
California Department of Fish and Game, Fisheries Seasonal Aide, 1983
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American Society of Civil Engineers, Urban Water Resources Research Council
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Oregon Association of Clean Water Agencies, Stormwater Committee
Water Environment Federation, Watershed Management Committee

SELECTED PUBLICATIONS

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Strecker, E.W., G. Boyd, and P. Mangarella, "Targeting and Selection Methodology for Urban Best Management Practices," presented at the National Conference on Urban Runoff Management, Chicago, Illinois, April 1993.

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APPENDIX D – AMENDED WORK PLAN

Exhibit A-1: Revised scope, budget, and timeline for ODOT Project SPR 335 Water Quality Facility Investigation, OSU Project K5085A.

The original budget for this project included two phases, Phase 1: Summary of Existing Information and Needs Assessment and Phase 2: Develop Testing Protocols and Monitoring Plan. A third phase, Phase 3: Facility Testing and Reporting, was included in the Work Plan, but funding for this phase had not been allocated as part of the current budget. Phase 1 has been completed to the satisfaction of the TAC. Phase 2 has been modified and parts of Phase 3 have been incorporated into the new Scope with the remaining budget. The proposed changes to the Work Plan are described in the Table 1 below.

Table 1. Proposed Changes to the Water Quality Facilities Investigation Work Plan.

Original Tasks	New Tasks	Brief Description
Phase 2	Phase 2	
Task 4 – Development of BMP Monitoring Protocols	Task 4 – Development of BMP Monitoring Plan Template	Instead of developing a general BMP monitoring protocol, a BMP monitoring plan template will be developed. This template will be used to develop the site-specific monitoring plans in the next task. The template will include references to the four primary monitoring protocols identified in Phase 1 for ease in developing a site-specific monitoring plan.
Task 5 – Field Testing Monitoring Plan	Becomes Task 5 – Development of Field Testing Monitoring Plans	Original description unchanged. However, will include 2 or 3 monitoring plans (instead of 1) depending on the available funds. Since the original Task 4 has been significantly reduced, some of those funds will be used for this expanded Task 5.
Task 6 – Final Phase I & II Report	Eliminated. Becomes part of new Task 8	A Final Phase 1 and 2 report will not be prepared. The Phase 3 Final Report will include information, recommendations, and conclusions found in all three phases.
Phase 3	Phase 3	
Task 7 – Collect Data	Becomes Task 6 – Collect Data	Original description unchanged. ODOT personnel will carry out all monitoring and submit the data to the Project Team in a pre-specified format (i.e., electronic data files). As mentioned above, 2 or 3 BMPs will be selected for monitoring. Monitoring will continue for 1 year.
Task 8 – Evaluate Monitoring Data and BMP Effectiveness	Becomes Task 7 – Evaluate Monitoring Data and BMP Effectiveness	Original description unchanged.
Task 9 – Final Report	Becomes Task 8 – Final Report	Original description unchanged.
Additional Task not in original plan	Task 9 – Development of BMP Monitoring Guidance Document.	A concise guidance document (~4-5 pages) geared toward field technicians. It will be completed after monitoring and data analysis, and included as an attachment to the Final Report (Task 8). The document will reflect lessons learned in implementing the monitoring plans developed in Phase 2.

Based on the changes to the Scope of Work shown in the above table, the new project tasks are:

- Task 4 – Development of BMP Monitoring Plan Template
- Task 5 – Development of Field Testing Monitoring Plans
- Task 6 – Collect Data (performed by ODOT)
- Task 7 – Evaluate Monitoring Data and BMP Effectiveness
- Task 8 – Final Report
- Task 9 – Development of BMP Monitoring Guidance Document

The timeline for completion of the above tasks is included in Table 2.

Table 2. Proposed Timeline for Completion of Revised Work Plan.

Phase & Task	FY 2003								FY 2004												FY 2005		
	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
2-4	█	█																					
2-5			█	█	█																		
3-6						█	█	█	█	█	█	█	█	█	█	█	█						
3-7																	█	█	█				
3-8																			█	█	█		
3-9																					█	█	

To date GeoSyntec Consultants has charged \$31,000 to the project. OSU has charged approximately \$24,750, including indirect costs on the GeoSyntec subcontract. Phase 1 funds are completely exhausted. The remaining Phase 2 funds allocated to GeoSyntec are approximately \$30,000. OSU funds are less than in the original budget because project expenditures have been spent early in the academic year. However, the OSU contribution will still occur as planned. The projected costs of each of the revised tasks are shown in Table 3. The projected total of \$32,800 may be as much as \$6,000 less than the total remaining funds because of the normal accounting delays at OSU. Any residual will be used to bolster the GeoSyntec and OSU budgets for Phases 2 and 3.

The new contract end date is 9/30/04.

The overall budget reallocation due to the change of the contract end date is as follows:

FY02(Spent): \$20,053 FY03: \$50,000 FY04: \$19,878 FY05: \$5,000

Total: \$94,931

Table 3. Revised Budget by Phase and Task.

	OSU	GeoSyntec	Team
Phase 2			
Task 4 – Development of BMP Monitoring Plan Template	\$300	\$ 5,000	\$5,300
Task 5 – Development of Field Testing Monitoring Plans	\$500	\$ 8,000	\$8,500
Phase 2 Totals	\$800	\$ 13,000	\$13,800
Phase 3			
Task 6 – Collect Data	\$0	\$0	\$0
Task 7 – Evaluate Monitoring Data and BMP Effectiveness	\$500	\$ 8,000	\$8,500
Task 8 – Final Report	\$600	\$ 4,000	\$4,600
Task 9 – Development of BMP Monitoring Guidance Document	\$900	\$ 5,000	\$5,900
Phase 3 Totals	\$2,000	\$ 17,000	\$19,000
Grand Total	\$2,800	\$30,000	\$32,800
Possible additional residual to be applied to GeoSyntec and OSU if available.			approx. \$6,000

