Roger C. Sutherland, PE

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Professional Summary

Mr. Sutherland is a principal water resources engineer with over 52 years of professional engineering experience in watershed/stormwater management planning, water quality planning and BMP design, urban hydrology, stormwater pollutant load estimation and BMP modeling, riverine hydraulics, and floodplain mapping.

He applies hydrologic, hydraulic, and water quality models to solve surface water problems. Those projects include the explicit modeling of continuous urban runoff flows, pollutant loadings and concentrations, and pollutant removals associated with water quality control measures such as street and catch basin cleaning, infiltration practices, grassy swales, regional detention facilities, and the use of patented stormwater treatment technologies.

Mr. Sutherland is a recognized international expert in urban stormwater load modeling and using street sweeping and catchbasin cleaning practices to remove pollutants from urban runoff. He is also the principal author of a state-of-the-art urban stormwater quality modeling package called SIMPTM, which has been used on numerous projects. In the 1990s, the USGS recognized the model as the best stormwater quality modeling package in the country.

Mr. Sutherland is the author of over fifty publications, primarily on stormwater quality modeling and the pollutant reduction benefits of cleaning practices. Many of these publications can be found at WorldSweeper.com, and a selection of the best and most impactful publications can be found at ResearchGate.com.

Mr. Sutherland's experience in urban stormwater quality modeling dates to 1973, when he began his master's research at the University of Maryland. He participated in numerous Nonpoint Source studies mandated by Section 208 of the Clean Water Act in the 1970s. He also was a consultant to the Nationwide Urban Runoff Program (NURP) projects in Bellevue, Washington, and Champaign, Illinois, which both studied the water quality impacts of street sweeping practices. Mr. Sutherland was the co-editor of the Stormwater Treatment Northwest Newsletter from 1997 until its discontinuation in 2009. He has also participated several times in a University of Washington-sponsored short course in the early 2000s that focused on various patented stormwater treatment technologies, where he lectured on the water quality benefits associated with high-efficiency street cleaning.

Mr Sutherland has either presented and/or taught at conferences and short courses on the topics of urban hydrology, hydraulics, and water quality well over one hundred times since 1975. Mr. Sutherland has lectured seventeen times from 1990 through 2003 as a faculty member for the "Designing Best Management Practices for Stormwater Quality Improvement" short course sponsored by the University of Wisconsin. Most of these courses were held in Madison, Wisconsin, but approximately six were scattered throughout the country from Portland, Maine, to Portland, Oregon. Mr. Sutherland was a member of the opening general session panel at STORMCON 2011 in Anaheim, CA, where the topic was MS4 preparations for the likelihood of numeric limitations in stormwater discharges. His teaching and expertise have increased the knowledge and skills of several hundreds of professionals and have promoted the use of state-of-the-art practices throughout the United States.

Mr. Sutherland has presented two webinars through Forester University. The first, presented in May 2013, was titled “Clean Streets Mean Clean Streams,” which explored the science behind the relationship between an effective street-sweeping program and its ability to reduce pollutants found in stormwater significantly. He reviewed the essential elements of a street sweeping program needed to maximize effectiveness, outlined the appropriate way to manage these elements, and identified the associated water quality benefits that would result.

The second, presented in November 2013, was titled “Street Dirt: A Better Way of Measuring BMP Effectiveness,” which focused on the chemistry of street dirt to document the effectiveness of various difficult-to-measure MS4 program elements like public education. It described the processes and equipment needed for street dirt monitoring, sampling, and analysis and identified the MS4 programs that are best candidates for progress monitoring via street dirt monitoring.

Most recently, Mr. Sutherland and Mr. Ranger Kidwell-Ross presented two workshops at California’s Stormwater Awareness Week, a free Continuing Education event held annually during the last week of September. The 2023 workshop was titled “Street Sweeping: America’s First Line of Defense for Stormwater Pollution Runoff Abatement.” The 2024 workshop was titled “Enhanced Street Sweeping Guidelines: How to Develop a Maximum Value Sweeping Program.”

Professional Qualifications/Registration(s)
Professional Engineer, Oregon, No. 12015, 1983

Education
M.S., Water Resources Engineering, University of Maryland, 1975
B.S., Civil Engineering, University of Maryland, 1972

Memberships/Affiliations
American Water Resources Association (retired)
American Public Works Association (retired)

Employment History
Cascade Water Resources, LLC, Principal Engineer and Sole Owner 2017 to present
AMEC Earth & Environmental, Inc., Principal Engineer, Portland, Oregon, 1998 to 2020
Kurahashi & Associates (KAI), Vice President, Tigard, Oregon, 1993 to 1998
OTAK, Water Resources Engineer, Lake Oswego, Oregon, 1986 to 1993
Self Employed, Senior Water Resources Engineer, Aloha, Oregon, 1984 to 1986
CH2M HILL, Water Resources Engineer, Portland, Oregon, 1977 to 1984
Harza Engineering, Water Resources EIT, Chicago, Illinois, 1975 to 1977
University of Maryland, Research Associate, College Park, Maryland, 1973 to 1975
Greiner Environmental Systems, Civil Engineer, Baltimore, Maryland, 1973

Representative Projects

Street Cleaning Evaluations and Related Modeling

Clean Streets, Clean Seas: Innovating Public Works to Intercept Microplastics in Urban Runoff for NOAA Sea Grant Program being led by the City of Santa Barbara, California
Microplastic pollution is a quickly escalating threat to marine ecosystems, and recent studies show that stormwater runoff transports the bulk of terrestrial microplastic to the sea. Solving this environmental crisis through upstream source control and green infrastructure will take decades; thus, immediate interception technologies are desperately needed. This pioneering project pushes the boundaries of ongoing Public Works department activities and technologies

initially designed to capture sediment and larger marine debris and conducts the first-of-its-kind research to investigate and demonstrate whether these activities can efficiently also capture microplastics and how to innovate to improve the capture of microplastics from stormwater runoff. The Public Works approaches to be investigated are the only existing methods that can be immediately deployed at scale to intercept microplastic before reaching the ocean and other tributary waterways: street sweeping, use of full capture trash devices, and catch basin cleaning, which are conducted by >30,000 Public Works departments across the country. Collaborating with the foremost experts in microplastic research, municipal end-users, and street-sweeping industry experts will address these critical data gaps to capture microplastics on a large scale.

Mr. Sutherland, along with Mr. Ranger Kidwell-Ross of WorldSweeper.com, are acting as Co-Principal Investigators and leading the research efforts into the effectiveness of enhanced street sweeping practices to remove microplastics before they are transported to receiving waters via stormwater runoff. As part of their efforts, they will be conducting state-of-the-art, real-world controlled street sweeper pick-up performance tests designed to address the project's research questions and serve as a form of Consumer Reports for understanding the relative effectiveness of various street sweeping models in effectively removing microplastics and multiple ranges of particle sizes of silica material from 1 to 6370 microns that mimic the overall particle size distributions of observed street dirt. Street dirt is the primary source of urban stormwater contamination. Pollutant concentrations vary widely by particle size, with the higher concentrations showing an affinity for the smaller particle sizes that have traditionally been shown to be the most difficult to remove.

Street Dirt Collection and Analysis for San Juan County, Washington, Cascade Water Resources, LLC.

Mr. Sutherland was contracted to conduct a comprehensive street dirt collection and analysis for San Juan County, Washington. The focus of the study was the streets and parking lots associated with the Ferry docking and departure facilities on each of the three main islands comprising San Juan County. The results of the physical (i.e., sieving) and chemical analyses conducted on the collected street dirt led to the realization that stormwater pollution discharges from these facilities were significant. It also led to the County’s purchase of its first street sweeper, a regenerative air machine used to periodically sweep the streets and parking lots associated with these vial transportation facilities.

Street Sweeping Program Review for Metropolitan Government Nashville and Davidson County, Metro Water Services, Stormwater Division, Wood (formerly AMEC Foster Wheeler).

Mr. Sutherland was the Principal Investigator of this Street Sweeping Program Review, which was mandated by Metro Nashville’s municipal separate storm sewer system (MS4) stormwater permit with the Tennessee Department of Environment and Conservation. The permit requires Metro Nashville to operate a street sweeping program on an ongoing basis to effectively sweep streets to remove as much material as possible from entering the stormwater inlets. In addition to increased stormwater system efficiency and improved water quality, the street sweeping program provides various benefits to Metro Nashville and its citizens, including enhanced community aesthetics, public and vehicle safety, and pavement preservation. Mr. Sutherland conducted an overview of the program. He identified several concerns related to the guidelines he had previously established for what an enhanced street-sweeping program needed to do to maximize pollutant removal from stormwater runoff. Mr. Sutherland contracted Ranger Kidwell-Ross of WorldSweeper.com to survey other street-sweeping programs for similar-sized cities nationwide comprehensively. The final report, published in July 2019, identified a range of potential program improvements and various cost estimates needed to implement those improvements.

Los Penasquitos Lagoon Sediment TMDL Development for the City of San Diego, California, AMEC Foster Wheeler.

As part of this TMDL development process, Mr. Sutherland conducted a detailed review of City reports that documented several street sweeping studies to identify where additional information could add value towards ensuring that existing and potential future sediment and pollutant reduction benefits from street sweeping are considered as part of the Los Peñasquitos TMDL project. The previous studies evaluated the pollutant reduction benefits of implementing an Aggressive Street Sweeping program of weekly or twice weekly sweeping throughout the City. Three documents and seven appendices, all published in the last two years, were reviewed, totalling over 500 pages. Mr. Sutherland then wrote a 13-page memorandum summarizing the review results and recommended additional steps to evaluate the sweeping program further and apply it to the Los Penasquitos Lagoon watershed.

Implement the Enhanced Street Sweeping Pilot Program for Burbank and Glendale, California, Larry Walker & Associates, Inc.

As part of the TMDL Implementation Plan, Mr. Sutherland participated in the design and implementation of an enhanced street sweeping pilot program needed to help the Cities of Burbank and Glendale, CA, evaluate the program potential in achieving compliance with their allocations from the LA River Metals TMDL. The goal of the Pilot Program was to identify and evaluate the specific actions needed to improve the existing sweeping programs within each of the cities so that they either attain or support the attainment of the waste load allocation requirements of the TMDL. If successful, the implementation of costly structural control measures like LID retrofit will be minimized. The Pilot Program evaluated potential actions that the sweeping programs would control, like the type of sweeper used, sweeping speed, sweeping frequency, and the ticketing and enforcement of curb blockages from parked car interference.

For the data collection component, street sediment, referred to as “street dirt,” was collected over four months by the prime consultant LWA using the procedures documented by Mr. Sutherland. The goal of data collection was to develop the information needed to establish a baseline of the current effectiveness of street sweeping pickup and to evaluate potential enhancements. Mr. Sutherland conducted controlled street sweeper pick-up performance tests of the sweepers currently owned by the Cities. He was the Principal Investigator who evaluated the collected data, arrived at various conclusions, and developed promising recommendations, which have now been documented in a draft report currently under review by the cities.

The next logical step for a future project is to use the collected street dirt data to calibrate the SIMPTM model and conduct a detailed evaluation of the reductions in stormwater metal concentrations that would be realized throughout each of these cities if the recommended enhancements were implemented. This next step will be a critical one if the cities plan on eventually presenting to the State Water Quality Board an enhancement street sweeping program as the mechanism, they will use to achieve TMDL compliance.

Street Cleaner Pick-Up Performance Testing for Elgin Sweeper Company

Mr. Sutherland was the Project Manager and Principal Investigator who designed and implemented a series of controlled pick-up performance tests for four different Elgin sweeper models. These tests aimed to measure the street dirt pick-up efficiency of several Elgin models under operating conditions typically found throughout the country. As part of the testing protocol, Mr. Sutherland had to create a street dirt simulant that closely mimicked the observed size distribution of particulates found in street dirt. He was given complete control of the testing protocol and its execution.

After sweeping, Mr. Sutherland maintained the chain of custody for the remaining material collected from the test rack. A soil lab was used to weigh and sieve the remaining material and

certify its results. Since initial loadings were known, Mr. Sutherland could compute the overall pick-up efficiencies and efficiencies for each of the eight particle size categories. Overall pick-up efficiencies ranged from 81.0% to 97.5% for a forward sweeping speed of 5 miles per hour. One of the machines was tested with and without water to suppress dust. The result was a 20% reduction in particulate pick-up efficiency while using water, documenting what had been expected that the use of water to control fugitive dust while sweeping reduces pick-up performance.

Street Sweeping Program Evaluation Study, District of Columbia (DC) Public Works
As a sub-consultant to Malcolm Pirnie, Inc. (MPI) located in Arlington, Virginia, Mr. Sutherland was the Project Manager and Principal Investigator for a comprehensive street sweeping program evaluation effort for the DC Department of Public Works. The client was faced with deciding what specific street sweeper model they should purchase in the future. Mr. Sutherland designed and implemented controlled street sweeping pick-up performance testing of two models of the three-wheeled mechanical street sweepers they own. He was the primary author of two technical memorandums. One memorandum documented the procedures needed to conduct the tests, and the other reported the results of the tests.

Street Sweeping Program Pilot Study; City of Seattle Public Utilities (SPU)
Mr. Sutherland worked directly with SPU in the development and implementation of their year-long street-sweeping pilot study that swept the pilot test areas every two weeks. He was involved in selecting the specific street dirt collection and pilot sweeping areas throughout residential and industrial neighborhoods. Mr. Sutherland was responsible for documenting the procedures needed to collect street dirt data and training the Seattle area consultant staff to implement the data collection program. Previous work for SPU included the pick-up performance testing of nine candidate street cleaners. The results of these tests helped SPU decide which street cleaner model to purchase for use in the pilot study.

WisDOT Street Sweeper Evaluation, Wisconsin Department of Transportation
Mr. Sutherland consulted Wisconsin DOT in cooperation with Wisconsin DNR and the USGS on a state-of-the-art street sweeper evaluation project. The project determined the water quality benefits of high-efficiency (i.e., Schwarze EV series) street cleaning of ultra-urban Wisconsin highways. Runoff from two small, almost identical drainage areas comprised entirely of I-894 pavements in Milwaukee was sampled (by automatic samplers) for 18 months. During this period, one of the highway shoulders within one of the drainage areas was swept weekly, whereas the other shoulder remained unswept. Rainfall and discharge were measured, and the pollutant loads were analyzed. Mr. Sutherland reviewed the monitoring plan and conducted a three-day workshop for WisDOT staff on using the SIMPTM program.

Water Quality-Related Benefits of Portland's Street Cleaning Program, City of Portland, Oregon
Mr. Sutherland acted as project manager and principal investigator on a project designed to estimate the pollutant reduction benefits of the city's existing street sweeping program. The project concluded that the sweepers of the era (i.e., mid-1980) were not very effective in picking up fine sediments. As a result, a SIMPTM simulation showed little area-wide pollutant reduction benefits associated with the sweeping program that existed at the time.

Stormwater Pollutant Loading and Transport Modeling

Thea Foss Watershed Urban Pollutant Load Generation and Street Cleaning Effectiveness Evaluation for the City of Tacoma, Washington, AnchorQEA, LLC
Mr. Sutherland was the Project Manager and Principal Investigator for AMEC's portion of this project. Previous source monitoring by AnchorQEA, LLC (who also designed and oversaw the capping and remediation of contaminated sediments in the Thea Foss Waterway as part of a 110 million dollar Superfund effort) has determined that pollutants being transported by untreated stormwater draining some 5700 acres of residential, commercial and industrial lands

threatens to undermine the previous remediation with the further deposition of sediments, mercury, PAH's, phthalates, pesticides and PCB's. The city asked AnchorQEA to identify, evaluate, and recommend the appropriate BMPs to be deployed in the watershed to prevent recontamination of the cap sediments in Thea Foss Waterway. Mr. Sutherland assisted Anchor QEA using its proven pollutant loading model called SIMPTM. The Simplified Particulate Transport Model (SIMPTM) was used to estimate pollutant loadings from the upland urbanized watershed areas whose upland areas drain via four different types of streets - low, medium, and high-use city streets, and the I-5 freeway. Mr. Sutherland directed the SIMPTM modeling, which was also used to evaluate the pollutant reduction benefits associated with alternative street sweeping practices.

Cross Israel Highway Stormwater Quality Study (CIHSWQS), CIH Ltd, Tel Aviv, Israel, Pacific Water Resources, Inc.

Mr. Sutherland was the project manager and principal investigator for a comprehensive study of a 2.4 km portion of the Cross Israel Highway (CIH) near Tel Aviv, Israel, which started in 2002 and continued for two years. The study characterized the quality of the stormwater discharges expected to occur from the CIH once it reached its projected ultimate traffic volumes of well over 100,000 vehicles per day. It also evaluated the effectiveness of periodic high-efficiency cleaning in reducing pollutant loadings to the Yarkon River. The Yarkon River flows next to the Hayarkon Springs well field, which provides over half of the drinking water supply for Tel Aviv. Environmental groups that demanded the study were concerned that runoff from the CIH would negatively impact this vital water supply. The 2001 Israeli Supreme Court ruled that a comprehensive study must be undertaken.

The study that AMEC (formerly Pacific Water Resources) was selected to undertake involved monitoring CIH stormwater quality during a wet weather season (i.e., mid-October through mid-April) when the existing traffic volume was only about 10,000 vehicles per day. Both dry and wet season road dirt accumulations were also monitored on both the CIH and several other heavily travelled highways that had traffic volumes projected in the future on the CIH. The stormwater quality model SIMPTM was initially calibrated to simulate the stormwater quality and road dirt accumulations observed on the CIH accurately during the initial low traffic volume. Then, using an algorithm developed from an analysis of data obtained on the higher road dirt accumulations observed on other Tel Aviv area roadways, SIMPTM was used to project pollutant loadings for these future traffic conditions expected on the CIH. The results of these model projections for much higher future traffic loadings led to the final decision by the CIH stakeholders' group to continue moving forward with the construction of the remaining unbuilt portions of the CIH.

Verification of the Modeling Results from Cross Israel Highway Stormwater Quality Study (CIHSWQS), CIH Ltd, Tel Aviv, Israel, AMEC Earth & Environmental, Inc.

Mr. Sutherland was the Project Manager and Principal Investigator for the 2011 verification of the 2004 CIHSWQS) modeling results and conclusions that allowed the construction of the controversial 300 km long Cross Israel Highway to continue. The 2001 Israeli Supreme Court ruling that mandated the 2004 AMEC (formerly PWR) modeling study (described above) also designated a group of decision-makers referred to as the Accompanying Team (AT). The AT was instructed to work closely with CIH, Ltd and oversee the environmental aspects of the CIH, including the risks of water contamination. Following the completion of the CIHSWQS, the AT agreed to accept the AMEC's recommendations that there would be no significant environmental impact on the drinking water supplies.

Another key recommendation was to conduct further monitoring once the CIH reached the projected traffic volume of at least 100,000 vehicles daily. The monitoring would then verify the results of the 2003-2004 SIMPTM modeling efforts. By August 2009, the highway traffic volume reached over 140,000 vehicles per day, and CIH Ltd contracted with AMEC (formerly PWR) to

develop an additional data monitoring plan. The monitoring began in October 2009. The collected model verification data focused on monitoring the road dirt's magnitude and physical and chemical characteristics that the previous 2004 modeling efforts had projected. Since the additional data collection was to occur throughout the entire 2009-2010 wet season (i.e., October through April), it would represent an excellent verification data set since runoff from rainfall events would reduce these accumulations, and the verification model would have to demonstrate its ability to match the observed accumulations. The modeling results were documented in the December 2010 Phase VI CHISWQS Report and presented at STORMCON 2011. They illustrate that the multi-million-dollar decade-long CIHSWS provides indisputable proof that the SIMPTM model projects exceptionally accurate estimates of continuous long-term stormwater pollutant loadings and concentrations for highways at least. This realization holds significant implications for other clients facing similar needs, such as TMDL implementation planning, where the accurate projection of pollutant loadings from urban highways and other urbanized landscapes is of vital interest.

Quantifying the Impact of Catch Basin Cleaning and Street Sweeping on Stormwater Quality, City of Livonia, Michigan, Hubbell, Roth, and Clark

As a sub-consultant to Hubbell, Roth, and Clark (HRC), Mr. Sutherland was the Project Manager and Principal Investigator for a comprehensive stormwater quality evaluation effort of Livonia's current and future practices regarding catchbasin and street cleaning. The objective was to estimate the area-wide pollutant reduction benefits that could be realized from improvements to cleaning practices throughout the City of Livonia. The pollutants of interest were TSS, COD, TP, TCu, and TZn.

Mr. Sutherland designed the modeling study, developed the monitoring plan, trained HRC staff in the data collection procedures, reviewed the monitoring data, participated in the modeling itself, and was the primary author of the Technical Report submitted to HRC. Over six months, the project monitored the accumulation of street dirt and catchbasin sediments for four representative pilot study areas in the Tarabusi Creek sub-watershed of the Rouge River Basin. The street dirt data, along with the hourly precipitation depths for the 50+ rainfall events that occurred between street dirt samplings, were used to calibrate the SIMPTM model, which in turn was used to simulate over 50 years of TSS and associated pollutant loadings and concentrations.

The model was also used to determine the most cost-effective and optimal pollution reduction cleaning program. The conclusion that optimal street sweeping every two weeks during the non-frozen period of the year using regenerative air sweepers along with annual catchbasin cleaning would result in a 75+% reduction in annual TSS stormwater washoffs compared to no cleanings was later viewed by other stormwater professionals as unrealistic. Mr. Sutherland has since concluded that the TSS reductions projected in Livonia and Jackson (see project description below) were a direct result of the fact that, unlike any other loading model, the SIMPTM model uses sediment transport equations to simulate all of the various sediments particles being transported by urban runoff and not just the less than 100 micron or so particles that are usually captured by automatic samplers.

So, the implication is that many of our national data sets, like the International BMP Data Base, do not fully describe the characteristics of sediment transported by runoff, which we refer to as TSS. In the case of Livonia and Jackson (described below), many of the estimated sediment removals from cleaning practices are for sediments that others have not traditionally measured.

Quantifying the Impact of Catch Basin Cleaning and Street Sweeping on Stormwater Quality, City of Jackson, Michigan, Tetra Tech MPS

As a sub-consultant to Tetra Tech MPS, Mr. Sutherland acted as the Project Manager and Principal Investigator for a comprehensive stormwater quality evaluation effort of Jackson's

current and future practices regarding catchbasin and street cleaning. The objective was to estimate the area-wide pollutant reduction benefits that could be realized from improvements to these cleaning practices throughout the City of Jackson. The pollutants of interest were TSS, COD, TP, TCu, and TZn. Mr. Sutherland designed the modeling study, developed the monitoring plan, trained Tetra Tech MPS staff in the data collection procedures, reviewed the monitoring data, participated in the modeling itself, and was the primary author of the Technical Report submitted to Tetra Tech MPS. The project monitored the accumulation of street dirt and catchbasin sediments for six representative pilot study areas located in an urbanized tributary of the Grand River Basin over a period of six months. The street dirt data, along with the hourly precipitation depths for the 50+ rainfall events that occurred between street dirt samplings, were used to calibrate the SIMPTM model, which in turn was used to determine the most cost-effective and optimal pollution reduction cleaning program.

Combined Sewer Overflow (CSO) Interim Measures Study, City of Portland Bureau of Environmental Services, Oregon

The CSO Interim Measures Study was a condition of the Stipulated and Final Order (SFO) from the court ruling that mandated creating and implementing a CSO Facilities Management Plan. Mr. Sutherland was the Project Manager and the Principal Investigator for a sub-consultant team tasked with studying the City's current street sweeping practices. Mr. Sutherland designed the modeling study, developed the monitoring plan, trained the sun consultant staff in the data collection procedures, reviewed the monitoring data, participated in the modeling itself, and was the primary author of the Street Sweeping Technical Memorandum submitted to HDR Engineering. The monitoring plan called for the collection of street dirt data both before and after scheduled street sweeping operations on three separate pilot study areas monthly for an entire year. The street dirt samples were sieved and composited into three different particle size ranges, where each was analyzed for approximately 30 containments. SIMPTM was used to estimate the annual pollutant reduction benefits of the existing street cleaning practices for each of the three CSO basins. Using previously obtained street sweeper pick-up performance data, SIMPTM was used to estimate the annual pollutant reductions associated with several alternative sweeping practices. One practice was described as a tandem sweeping operation where a vacuum-assisted sweeper followed a mechanical sweeper. This practice proved cost-effective for a monthly sweeping frequency operating on the city's residential streets.

CSO and Separate Stormwater Pollutant Loads Estimation, Combined Sewer Overflow (CSO) Facilities Planning, City of Portland Bureau of Environmental Services, Oregon

Mr. Sutherland was the Project Manager and Principal Investigator for a sub-consultant modeling team that participated in a joint modeling effort to simulate continuous pollutant loadings and concentrations for discharges from both CSO and separate stormwater systems that drained some 87.9 square miles of watershed contributing to the Willamette River. Mr. Sutherland's team used SIMPTM to project stormwater pollutant loadings from the 40.1 square miles of non-CSO urban drainages. In addition, SIMPTM was also used to integrate with the City's hybrid version of the EPA SWMM model to simulate the CSO pollutant loadings for the 47.8 square mile CSO watersheds. SWMM provided the overflow hydrographs and the sanitary sewerage pollutant contribution, and SIMPTM provided the upland stormwater loadings that were mixed to generate realistic CSO loadings, which were compared to monitored values at nine different locations. This CSO and separate stormwater modeling package were then linked with an in-stream water quality model of the Willamette River. The model calibration data set was extensive water quality data collected in the river at 17 different transects spread along the 8-mile reach of interest. The data was collected about a half dozen times throughout a 0.5-inch mid-September 1992 storm event with a month-long antecedent dry condition. The critical input parameters to the modeling package were then adjusted to accurately reproduce the receiving water quality conditions observed throughout the 18-hour duration event. Using fifteen years of hourly rainfall data observed at multiple rainfall gauges scattered throughout the contributing

watersheds, the calibrated modeling package was then used to estimate the event-by-event stormwater and CSO volumes and pollutant loadings being discharged to the Willamette River from the City's drainage systems. These simulations and others similar formed the basis for the award-winning CSO plan development that estimated the design criteria needed for the massive 1.4-billion-dollar Combined Sewer Overflow Management Program that followed.

Washoe County Urban Stormwater Management Program, Washoe Council of Governments, Reno, Nevada
Mr. Sutherland was the Project Manager and Principal Investigator for developing a comprehensive stormwater management plan for some 24,900 acres of urban and urbanizing lands throughout the Reno-Sparks metropolitan area. The plan was published in a four-volume set, and its development involved the services of several sub-consultants, each managed by Mr. Sutherland, who acted as the Prime Project Manager. The plan included four separate volumes, two led by sub-consultants. Mr. Sutherland led the work needed to complete the other two plan volumes. One volume documented the work required to project annual pollutant loadings for 37 separate tributary sub-watersheds to the Truckee River Basin that totaled 38.9 square miles.

The pollutants of interest were TSS, COD, TP, TN, TZn, TCr, and TPb. This volume featured the first commercial application of the Simplified Particulate Transport Model (SIMPTM) that Mr. Sutherland created as part of his graduate studies at the University of Maryland starting in 1973. Dr. Robert Pitt led another volume that documented the street particulate collection and analyses with assistance from Mr. Sutherland. This work included monitoring street dirt accumulation and the pickup performance of many street sweepers under various real-world sweeping conditions. These observed street dirt loadings were used to calibrate the SIMPTM model that provided the pollutant loading estimates. The final volume addressed public work practices and developed the region's first-ever stormwater quality management program. It looked at each practice and recommended significant changes to the region's street-sweeping programs. This final volume also included the development of an area-wide implementation plan to reduce TSS and associated pollutant loadings to the Truckee River and its tributaries.

BMP Performance Assessments

Potential Effectiveness of Two Regional Stormwater Facilities, City of Lake Oswego, Oregon
Mr. Sutherland investigated the potential pollutant removal effectiveness of two previously recommended regional stormwater treatment facilities. The two facilities were recommended for design and construction in 1992 as part of the City's Surface Water Management (SWM) Plan that Mr. Sutherland co-authored. This study aimed to evaluate the feasibility of developing the LBF2 and SB120 Pollutant Reduction Facility (PRF) Sites for removing phosphorus and sediment from stream flow discharged from their respective watersheds, Lower Boones Ferry and Springbrook Creek.

The previous SWM Plan identified these sites as the two most promising sites in the City. However, when the SWM Plan was developed, there was very little data on the actual pollutant removal effectiveness of wet ponds and/or constructed wetlands; essentially, no data existed for Western Oregon watersheds. However, since then, considerable additional data on wet pond and wetland pollutant removal has been obtained. The newer data suggested that these two sites' lack of land area would result in extremely low pollutant removal. The study included a modeling effort using six years of continuous stream flow data and the best available water quality data to estimate sediment and phosphorus removals.

Stormwater Treatment BMP Evaluation, Port of Seattle, Seattle, Washington
Mr. Sutherland served as the Project Manager and principal author of evaluating selected stormwater treatment best management practices (BMP's) for the Port's marine terminals. The study's objective was to evaluate the effectiveness of stormwater pollutant removal with new

high-efficiency pavement sweepers in combination with conventional sediment-trapping catchbasins. The study determined that this combination technology was equivalent to wet vaults' pollutant removal efficiencies. The study used the SIMPTM program calibrated to reproduce the observed accumulation and washoff behavior of an existing marine container handling site. Using high-efficiency sweeping will represent a $16 million savings in the design and construction of wet vaults for a 250-acre facility expansion.

All Known and Reasonable Technologies (AKART) Search for Stormwater Treatment, Port of Seattle
Mr. Sutherland was the Project Manager and Principal Investigator for an AKART search of stormwater management practices and passive stormwater treatment devices available around 1995. Four search categories were identified: street sweeper equipment, passive end-of-the-pipe sedimentation devices, passive end-of-the-pipe infiltration devices of similar unit processes, and catchbasin filters. Promising technologies of the era were identified through a literature search, and each was evaluated. Recommendations were developed and documented in a Technical Memorandum, of which Mr. Sutherland was the primary author.

Caltrans Stormwater Training, Caltrans District 7, North Hollywood, California
As a sub-consultant, Mr. Sutherland participated in developing and presenting a stormwater quality training course for Caltrans maintenance workers. The training focused on making these workers aware of the everyday activities they conduct in an arid and dry environment and how these activities could impact stormwater quality.

Sediment Management Plan, Bureau of Environmental Services, City of Portland, Oregon
Mr. Sutherland was the Project Manager responsible for evaluating the handling, treatment and disposal options available to the City for sediments removed from the City's storm drainage system. Provided estimates of future sediment quantities associated with cleaning and maintaining sumps, sedimentation manholes, catchbasins, roadside ditches, grassy swales, detention ponds, and leaf compost filters.

Surface Water Management Planning and Design

West Linn Stormwater Master Plan, City of West Linn, Oregon
Mr. Sutherland was the Project Manager and worked closely with the City of West Linn on developing a stormwater master plan for the City's UGB of approximately 5200 acres. The planning involved developing and using a detailed HEC-HMS model for 21 major watersheds throughout the study area. SIMPTM was used to estimate stormwater pollutant loadings and evaluate the effectiveness of catchbasin and street cleaning practices. The City conducted a public involvement effort that led to the development of a CIP program needed to reduce flooding, improve stormwater quality, and enhance natural resource areas. Mr. Sutherland helped prepare and review the final planning documents adopted by the City Council in 2006, which can be found on the City's web page.

Johnson Creek Resources Management Plan, City of Portland, Oregon
Mr. Sutherland was the project manager analysing flooding problems along Johnson Creek. The project involved HEC-1 hydrologic modeling using GIS technology to extract hydrologic model input parameters using flood frequency analysis for 47 years of gauged records. Hydraulic modeling was completed for 18 miles of creek using the HEC-2 computer program, alternative analysis, and identifying early action projects to remove constrictions in the frequent flooding area. Mr. Sutherland also served as Project Manager for water quality analysis under Phase 1 of the project. This evaluation included rainfall analysis, water quality sampling, stormwater quality monitoring, industrial area nonpoint source modeling, alternative analysis, and report preparation.

Johnson Creek Stormwater Master Plan, City of Gresham, Oregon
Mr. Sutherland was the Project Manager for developing a comprehensive stormwater master plan for a 4200-acre area of Gresham that drains to Johnson Creek. The planning involved

developing and using a detailed XP-SWMM model for the detailed planning area and the 8800 acres upstream of the City. SIMPTM was used to estimate stormwater pollutant loadings and evaluate the effectiveness of catchbasin and street cleaning practices. As part of the planning process, Mr. Sutherland created and presented a single-day workshop focused on establishing project goals and objectives, drainage design criteria, and reviewing the various stormwater-related regulatory programs that influence the development of the master plan. The recommended $9.4 million CIP involves some 54 projects, including natural resources enhancements, water quality improvements, and pipe and culvert replacements. The plan documentation has been published and posted on the city's web page.

Fanno Creek Watershed Management Plan, Clean Water Services, Washington County, Oregon
Mr. Sutherland served as the Project Manager and led a multi-disciplinary team in developing an action plan designed to improve water quality and reduce flooding in this highly urbanized 32-square mile watershed located in Washington County. The plan identified the specific structural and non-structural projects and programs that would have to be implemented to achieve the numerous planning objectives, including reducing different types of pollutants. He supervised the development and calibration of an HEC-1 hydrologic model with over 200 subbasin areas needed to provide peak flows to identify and solve flooding problems. In addition, the SIMPTM program was used to estimate stormwater pollutant loadings throughout the watershed and the effectiveness of various basin-wide activities, including the use of regional water quality facilities. After the plan's publication in 1996, several of the recommended regional facilities have already been constructed.

Sea-Tac Stormwater Management Plan, Port of Seattle, Seattle, Washington
Mr. Sutherland was a sub-consultant project manager for HDR, developing a stormwater management plan for the Sea-Tac International Airport. His role was to predict existing and future stormwater pollutant loading characteristics from the 1.6-square mile facility. The SIMPM program was used. This highly accurate stormwater quality model was calibrated to reproduce the observed event-by-event water quality response for the three monitored outfalls. As part of this, Mr. Sutherland conducted an "All Known and Reasonable Technologies" (AKART) search for passive stormwater treatment devices, which led to the recommendation of pursuing two promising filtration devices.

Surface Water Management – Subbasin Strategies, Clean Water Services, Washington County, Oregon
Mr. Sutherland served as Project Manager and principal investigator for the hydrologic/hydraulic and water quality analyses for the 3300-acre Butternut Creek subbasin. The subbasin plan identified eight high-priority projects needed to solve serious flood problems within the subbasin. In addition, Mr. Sutherland led the development of nomographs for stormwater pollutant loads from typical land uses found throughout urban Washington County. The purpose of the work as a sub-consultant to Brown and Caldwell was to provide an easy-to-use technique needed to estimate seasonal sediment and phosphorus pollutant loadings in stormwater. Nomographs were developed on a unit area basis to show the reduction of pollutant loadings through street sweeping, catch basin cleaning, and grassy swale drainage.

Columbia Slough Water Quality Management Plan, City of Portland, Oregon
Mr. Sutherland managed the portion of the water quality planning services that included the characterization and potential control options for stormwater volumes and pollutant mass loadings for an average or representative rainfall year. Stormwater control measures evaluated included street sweeping, sediment trapping catchbasins, grass-lined swales, and wet detention ponds. Combined sewer overflow volumes and pollutant mass loadings entering the slough were also estimated, and potential contracts were evaluated.

Lake Oswego Surface Water Management Master Plan, City of Lake Oswego, Oregon
Mr. Sutherland served as overall Project Manager and principal investigator for the hydrologic/

hydraulic and water quality analyses for the 7,690 acres of watershed that drains the City of Lake Oswego's urban services area. Managed a diverse consultant team from five different firms and actively participated in a project policy committee comprised of City Council members, Natural Resources Commission members, City staff, citizens, and representatives from other governmental agencies that monitored and directed the preparation of the SWM Master Plan. The plan, which the City Council adopted, recommended the design and construction of eight pollution reduction facilities (PRFs) throughout the study area and documented the SIMPTM computer program that provided estimates of both sediment and phosphorus load reductions associated with each project.

La Grande Surface Water Management Plan, City of La Grande, Oregon
Mr. Sutherland led the hydrology analysis of a 10-square mile (20+ subbasins) watershed in eastern Oregon. Used HEC-1 model tightly integrated with customized in-house spreadsheet routines to expeditiously perform model calibration and alternative scenario evaluation.

Eugene Areawide Drainage Master Plan, City of Eugene, Oregon
Mr. Sutherland served as project manager for developing a drainage master plan for approximately 24,000 acres of urban and suburban land in Eugene. Directed the creation and calibration of hydrologic and hydraulic models needed to simulate floodwaters' flow, volume, and elevation along the City's 85 miles of major open and closed drainageways. He assisted in the identification of 166 capital improvement projects whose total cost was estimated at 18.5 million dollars.

Oregon City Drainage Master Plan, City of Oregon City, Oregon
Mr. Sutherland was the Project Manager, completing drainage planning criteria development, hydraulic analysis, hydrologic modeling, alternative analysis, capital improvement programming, financial planning, drainage standards development, and report preparation.

Drainage Master Plan Review for Multnomah County Drainage District No. 1, Portland, Oregon
Mr. Sutherland conducted a technical review of the drainage master planning process being used by another consultant to develop a drainage plan for the district. The requested review focused on estimating input parameters to the hydrologic modeling to ensure that peak flows and large storm volumes were not being overestimated.

Sea-Tac Business Park Master Drainage Plan, King County, Washington
Mr. Sutherland managed the portion of the master drainage plan developed for a proposed business park in the newly created city of Sea-Tac. He also assisted in the development and calibration of an urban runoff quality model needed to evaluate the park's impact.

Stormwater Treatment Facility Design

Stormwater Quality Facility Designs, Clean Water Services, Washington County, Oregon
Mr. Sutherland served as the project manager for this interdisciplinary project, which involved designing and constructing three regional facilities specifically designed to remove sediments and reduce downstream nutrient concentrations. All three projects were in degraded wetland and stream environments that were significantly enhanced due to the improvements, which relied heavily on carefully planned vegetation, wood, and rock placements. The designs required an integration of community values, ecosystem functions and values, water quality and quantity needs, and regulatory requirements. The project sites are on Beaverton's South Johnson Creek in THPRD's Brookhaven Park, Butternut Creek, and Hedges Creek. The Butternut Creek facility was a METRO area 1999 stormwater award winner located in a natural area just off SW Bany Road in Aloha.

Phillips Creek Stormwater Detention Facility, Clackamas County, Oregon
Mr. Sutherland participated in the design of a 20-acre foot-off-line detention facility on Phillips Creek. He led the hydrologic/hydraulic analysis, which featured applying the HEC-1 and HEC-2

models. The facility was also designed to function as a man-made wetland and wildlife habitat by diverting a controlled stream flow through the three separate off-line storage areas. Mr. Sutherland assisted with preparing construction drawings and specifications for the facility, and the various permit applications.

Tanner Creek Diversion – Phase 4, Bureau of Environmental Services, Portland, Oregon
As part of the City of Portland's Combined Sewer Overflow (CSO) Abatement Program, Mr. Sutherland provided water resources engineering services to Parametrix, Inc., which was responsible for the design of an 8000 linear foot pipeline needed to divert stormwater from 300 acres of the upper Nicolai Creek drainage to the mainline Tanner Creek diversion being designed by others. The pipeline alignment was along West Burnside Road and throughout portions of Northwest Portland. The services Mr. Sutherland provided include the development of a hydrologic model of the upper Nicolai Creek drainage and the evaluation of the hydrologic impacts of utilizing regional detention storage at two potential sites. He also identified the need to design passive water quality treatment facilities or pollutant reduction facilities (PRFs) to treat the diverted stormwater before it entered the pipe system.

Certifications, Training and Teaching (limited list)

Hydrologic Engineering Center – Hydrologic Modeling with HEC- 1 – 1980

Hydrologic Engineering Center – Hydraulic Modeling with HEC- 2 – 1981

Principal Instructor for HEC-1, HEC-2, & SIMPTM Short Courses – 1985 to 1990

West Consultants – Two-Dimensional Surface-Water Modeling with FESWMS – 2D – 1989

National Highway Institute – Stream Stability and Scour at Highway Bridges - 1990

Instructor EPA SWMM Version 4.3 OSU Workshop – Water Quality Modeling Enhancements Needed for SWMM – 1995

University of Wisconsin Faculty Member – Designing Best Management Practices for Stormwater Quality Improvement Short Course – 1990 to 2003

Wisconsin DNR & DOT Principal Instructor – Characterization and Control of Urban Runoff Pollution Using SIMPTM – 1999

Principal Instructor – New Technologies and Concepts in Stormwater Treatment – 2002 to 2003

Honors and Awards

2004 – Educational Service Award from University of Wisconsin – Madison Department of Engineering Professional Development

1997 – Honor Award from METRO's Stormwater Design Award Competition – Butternut Creek Water Quality and Detention Facility

Publications and Selected Presentations

"Enhanced Street Sweeping Guidelines: How to Develop a Maximum Value Sweeping Program,"

Sutherland, R.C., and R. Kidwell-Ross, presented at California's Stormwater Awareness Week,

September 23-27, 2024.

"Street Sweeping: America's First Line of Defense for Stormwater Pollution Runoff Abatement," Sutherland, R.C., and R. Kidwell-Ross, presented at California's Stormwater Awareness Week, September 25-29, 2023.

"Thea Foss Waterway Urban Streets Pollutant Load Generation and Street Cleaning Effectiveness Evaluation", Sutherland, R.C., T. M. Thornburg, D. B. de Leon and M. L. Henley, presented at STORMCON 2014, Portland Convention Center, Portland OR, August 7 – 11, 2014.

"Street Dirt: A Better Way of Measuring BMP Effectiveness", Sutherland R.C., presented through Forester University webinar series, November 2013.

"Cleaner Streets, Cleaner Water", J. Keating and edited by R. C. Sutherland, Stormwater, Vol 14 No. 4, pp. 46-53, June 2013.

"An Enhanced Street Sweeping Pilot Program – The Road to Heavy Metals TMDL Reduction Compliance", Sutherland, R.C., and C. Minton, presented at STORMCON 2013, Myrtle Beach Sheraton, Myrtle Beach, SC, August 18 – 22, 2013.

"Clean Streets Mean Clean Streams", Sutherland R.C., presented through Forester University webinar series, May 2013.

"Cost-effective Basin-wide Best Management Practices for Reducing Stormwater Pollutant Loads in Urban Watersheds", Thornburg T.M., S.K. Page, G.M. Bolin, R.C. Sutherland, M.L. Henley, & D. B. de Leon, poster presentation at Remediation of Contaminated Sediments Conference, Dallas, TX, Feb 2013.

"A Demonstration of SIMPTM's Ability to Predict Fine Sediment Discharges from Existing Urbanized Landscapes Tributary to Lake Tahoe", Sutherland, R.C., presented at the 2012 Tahoe Science Conference, Incline Village, NV, May 2012.

"The Role Street Sweeping Must Play in Achieving Numeric Pollutant Limits", Sutherland, R.C., Stormwater, Vol 12 No. 8, pp. 8-13, Guest Editorial, November/December 2011.

"Use of SIMPTM to Estimate Stormwater Pollutant Loadings for the Cross Israel Highway and Verification of Loading Estimates", Sutherland, R.C. & S. L. Jelen, presented at STORMCON 2011, Anaheim Marriott, Anaheim CA, August 22 – 25, 2011.

"Street Sweeping 101: Using Street Sweepers to Improve Water and Air Quality", Sutherland, R.C., Stormwater, Vol. 12, No. 1, pp. 20-30. January/February 2011.

"Sweeping for Stormwater Pollutant Reduction", Sutherland, R.C., presented at the NEBC Managing Stormwater in Washington Conference, SeaTac, Washington, March 2010.

"Street Dirt: A Better Way of Measuring BMP Effectiveness", Minton, G.R., and R.C. Sutherland, Stormwater, Vol. 11, No. 2, pp. 12-21, March/April 2010.

"Urban Myths Associated with Street Cleaning", Sutherland, R.C., APWA International Public Works Congress & Exposition, Columbus, Ohio, September 2009.

"Recent Street Sweeping Pilot Studies are Flawed", Sutherland R.C., APWA Reporter, Vol. 76, No. 9, pp. 50-53, September 2009.

"Real World Street Cleaner Pickup Performance Testing", Sutherland, R.C., presented and published STORMCON 2009, Anaheim, California July 2009.

"A Proposal for a New Research Direction " Sutherland, R.C., and G.R. Minton, Conceptual Modelling of Urban Water Systems - Monograph 17, Editor-in-Chief Dr. William James, Co-editors Doctors Kim N. Irvine, James Li, Edward A. McBean, Robert E. Pitt, and Steven J. Wright, CHI Publications, Guelph ON, Canada, 2008.

"Sweep Before You Treat", Sutherland, R.C., presented at STORMCON 2007, Phoenix Arizona, August 2007.

"A Proposal for a New Research Direction", Sutherland, R.C., presented at STORMCON 2007, Phoenix Arizona, August 2007.

"When Concerned About Toxic Stormwater Pollutants in the Built Environment: Sweep Before You Treat", Sutherland, R.C. and G.R. Minton, presented at the 2007 Georgia Basin Puget Sound Research Conference, Vancouver, British Columbia, March 2007.

"Sweep Before You Treat", Sutherland, R.C., and G.R. Minton, presented at the CASQA 2006 Conference, Sacramento, California, September 2006.

"Street Cleaner Pick-up Performance Testing", Sutherland, R.C. and T. Martin, presented and published STORMCON 2006, Denver, Colorado, July 2006.

“Minimizing Stormwater Runoff Pollution through Sweeping Program Maximization”, Sutherland, R.C., and Ranger Kidwell-Ross, presented at Pavement Cleaning BMPs for California Roadway Sweeping Seminar, Costa Mesa and San Jose, California May 2006.

“Stormwater Quality Modeling of Cross Israel Highway Runoff”, Sutherland, R.C., G.R. Minton and U. Marinov, Intelligent Modeling of Urban Water Systems - Monograph 14, Editor-in-Chief Dr. William James, Co-editors Doctors Kim N. Irvine, Edward A. McBean, and Robert E. Pitt, CHI Publications, Guelph ON Canada, 2006.

“Modeling the Water Quality Benefits of Pavement Cleaning on Cross Israel Highway Runoff”, Sutherland, R.C., G.R. Minton and U. Marinov, presented and published STORMCON 2005, Orlando, Florida, July 2005,

“Monitoring Stormwater Pollutants from the Cross Israel Highway”, Minton, G.R., R.C. Sutherland, U. Marinov and N. Keshet, , presented and published STORMCON 2005, Orlando, Florida, July 2005.

“SIMPTM Diagnosis, A Technique for Accurate Urban Runoff Load Estimation”, Sutherland R.C. and S.L. Jelen, Water Environment & Technology, Vol. 15, No. 9, pp. 59-66, 2003.

“Stormwater Quality Modeling Improvements Needed for SWMM”, Sutherland, R.C. and S.L. Jelen, Best Modeling Practices for Urban Water Systems, Volume 11, edited by Dr. William James, CHI Publications, pp. 253-289, 2003.

“A Technique for Accurate Urban Runoff Load Estimation”, Sutherland, R.C. and S.L. Jelen, Proceedings of the National TMDL Science and Policy 2002 Specialty Conference, Water Environment Federation, Phoenix, Arizona, November 2002.

“Quantifying the Optimum Urban Runoff Pollutant Load Reductions Associated with Various Street and Catchbasin Cleaning Practices”, Sutherland, R.C. and S.L. Jelen, Global Solutions for Urban Drainage, Proceedings of the 9th International Conference on Urban Drainage, American Society of Civil Engineers, Portland, Oregon. September 2002

“Development of Accurate Urban Runoff Pollutant Loads for TMDL Analyses”, Sutherland, R.C. and S.L. Jelen, Proceedings of StormCon 2002, the North American Surface Water Quality Conference and Exposition, Forester Communications, August 2002.

“Quantifying the Stormwater Pollution Reduction Benefits of Traditional Public Works Maintenance Practices”, Sutherland, R.C., R. J. Myllyoja and S.L. Jelen, Best Modeling Practices for Urban Water Systems, Volume 10, edited by Dr. William James, February 2002.

“Recent SCAQMD Test Ignores PM-10 Efficiency Issue”, Sutherland, R.C., American Sweeper, Vol. 7, No. 2, 1999, p. 9.

“High-Efficiency Sweeping as an Alternative to the Use of Wet Vaults for Stormwater Treatment”, Sutherland, R.C. S.L. Jelen and G.R. Minton, Advances in Modeling the Management of Stormwater Impacts, Volume 6, edited by Dr. William James, January 1998.

“Contrary to Conventional Wisdom: Street Sweeping Can Be an Effective BMP”, Sutherland, R.C. and S.L. Jelen, Advances in Modeling the Management of Stormwater Impacts, Volume 5, edited by Dr. William James, January 1997.

“Studies Show Sweeping has Beneficial Impact on Stormwater Quality”, Sutherland, R.C. and S.L. Jelen, APWA Reporter, Volume 63, No. 10, November 1996.

“Sophisticated Stormwater Quality Modeling is Worth the Effort”, Sutherland, R.C. and S.L. Jelen, Advances in Modeling the Management of Stormwater Impacts, edited by Dr. William James, January 1996.

“Characterization of Portland’s Stormwater Quality Using SIMPTM”, Sutherland R.C. and S.L. Jelen, Proceedings of National Symposium on Water Quality, AWRA, November 1994.PP

“Simplified Particulate Transport Model SIMPTM User’s Manual”, Sutherland, R.C. and S.L. Jelen, Version 3.2, Pacific Water Resources, Inc., December 1998.

“Characterization of Portland Stormwater Quality”, Sutherland, R.C. and S.L. Jelen, Proceedings, 1993 Runoff Quantity and Quality Modeling Conference, Reno, Nevada, November 1993.

“Modeling of Urban Runoff Quality in Bellevue, Washington Using SIMPTM”, Sutherland, R.C., Proceedings of Nonpoint Source Pollutions: The Unfinished Agenda for the Protection of Our Water Quality, State of Washington, Water Research Center, Report 78, 1991.

“User’s Guide for Particulate Transport Model-PTM”, Sutherland, R.C., W.M. Alley and F.W. Ellis, U.S.G.S., Reston, Virginia, September 1980.

“An Overview of Stormwater Quality Modeling”, Sutherland, R.C., Proceedings, International Symposium on Urban Storm Runoff, Lexington, Kentucky, July 1980.

“Toward a More Deterministic Urban Runoff Quality Model”, Alley, V.M., F.W. Ellis and R.C. Sutherland, Proceedings, International Symposium on Urban Storm Runoff, Lexington, Kentucky, July 1980.

“New Methodologies to Evaluate BMP’s”, Ellis, F.W., R.C. Sutherland and W.M. Alley, presented at the Nonpoint Pollution Control: Tools and Techniques for the Future Symposium, Gettysburg, Pennsylvania, June 1980.

“Modeling the Particulate Characteristics of Sediment Urban Runoff”, Sutherland, R.C. and F.W. Ellis, Proceedings, Symposium of Surface Water Impoundments, Minneapolis, Minnesota, June 1980.

“An Approach to Urban Pollutant Washoff Modeling”, Ellis, F.W. and R.C. Sutherland, Proceedings, International Symposium on Urban Storm Runoff, Lexington, Kentucky, pp. 325-340, July 1979.

“Simulation of Urban Nonpoint Source Pollution”, Sutherland, R.C. and R.H. McCuen, Water Resources Bulletin, Vol. 14, No. 2, April 1978.

“Management of Urban Nonpoint Pollution”, Sutherland, R.C. and L.F. Brazil and D.M. Mades, presented at the 13th American Water Resources Conference, Tucson, Arizona, October 31 to November 3, 1977.

“The Relative Importance of Factors Influencing Pollution Loadings in Runoff from Urban Streets”, Sutherland, R.C., R.H. McCuen and R.L. Powell, ASCE Urban Water Resources Research Program, Technical Memorandum No. 31, pp. 85-98, July 1976.

“A Mathematical Model for Estimating Pollution Loadings in Runoff from Urban Streets”, Sutherland, R.C. and R.H. McCuen, Mathematical Models for Environmental Problems, University of Southampton, England, September 1975, Pentech Press, London, pp. 283-297,1976.

“A Mathematical Model for Estimating Pollution Loadings and Removals from Urban Streets”, Sutherland, R.C., Master of Science Thesis (unpublished), University of Maryland, College Park, Maryland, January 1975.