

STORMWATER MANAGEMENT STRATEGIES USA, NEW ZEALAND & NSW

Geoffrey John Hunter
Stormwater Management Engineer, Blacktown City Council, NSW, Australia

Abstract

In 1997, at the 9th Local Government Engineering Conference in Melbourne Geoff Hunter was awarded the IMEA/SKM Bursary, to investigate ***Comprehensive Stormwater Management*** in New Zealand and the United State of America. The itinerary allowed him to investigate stormwater management practices at a number of Regional, City and County Councils throughout Auckland (NZ), and Oregon and Washington states in the USA. He also visited with Civil Engineering consultants in Oregon and Indiana, and Universities in Oregon, Georgia and Florida. This paper attempts to put into words many of the stormwater programs and practices Geoff investigated during the 5 week tenure of the Bursary.

Key Words: stormwater management, environmental education, aquatic weeds, wetlands, source control, stream rehabilitation, total maximum daily loads (TMDLs)

Introduction

Sinclair Knight Merz, through the Institute of Municipal Engineering Australia, provided the funds for a Local Government Engineer to visit other parts of the world, and investigate practices relevant to Local Government Engineering in Australia. I was awarded this Bursary in 1997 with the specific task of investigating *Comprehensive Stormwater Management* in New Zealand and the USA. The \$8,000 provided in the Bursary supported me, with some infusion of my own funds, to spend a total of 5 weeks overseas during June and July, 1998. This allowed me to follow up on investigations I had carried out over a period of 17 weeks in 1996, as part of a Winston Churchill Memorial Trust Fellowship into *The Use of Wetlands for Soil and Water Management*.

My itinerary included, in order:

- Auckland Regional Council (NZ)
- Oregon Department of Transport
- Eugene City Council, Oregon
- Department of Bio-resource Engineering, Oregon State University
- Woodward-Clyde, Portland Oregon
- Camp Dresser and McKee, Portland Oregon
- Aquatic Weed Management Program, Thurston County, Lacey Washington
- Washington Department of Ecology
- Olympia City Council, Washington
- Seattle City Council, Washington
- Snohomish County Council, Everett Washington
- J.F. New and Associates, Walkerton Indiana
- Lake Maxinkuckee Environment Committee, Culver Indiana
- Biology Department, Georgia Institute of Technology, Atlanta Georgia

- Department of Soil and Water Science, University of Florida, Gainesville Florida

In order to develop a comprehensive stormwater management program it is necessary to develop strategies that address all the issues related to Total Catchment Management (Australia) or Integrated Watershed Management (USA). Each of the places visited, on this study tour, had a Stormwater Management Plan or had engaged specific activities that directly impacted on stormwater management programs in the area. This paper will attempt to detail, in a few pages, 5 weeks of investigations into various elements of stormwater management as demonstrated at each of the locations visited or as developed by the various practitioners interviewed.

Education

All of the places visited during my investigations had extensive community education and awareness programs. Each had focussed on some aspect of the environment that was of value to the community. In Auckland NZ it was shellfish and vegetation, in the Pacific North West of the USA it was Salmon and Wetlands, and in Florida the focus was on protecting the Everglades and the Florida Keys. Most had kerb stencilling and educational programs. The material for these was generally freely available to the community. A brief description of some of the programs follows.

Auckland Regional Council (ARC) promoted a competition between graphic design students from the local tertiary colleges to develop a theme, and design posters focusing on stormwater management. "Drain Man" was the winner and the theme of 2 eyes within a kerb inlet promoting "*I Only Drain Rain*" has been promoted extensively and successfully throughout the media. A survey, to determine the effectiveness of the program, found that the television advertisements and billboards achieved the best results in raising community awareness with regard to stormwater pollution issues. In addition to the advertising program there is an extensive literature package and a 24 hour pollution hotline.

Eugene City Council in Oregon focused its attention on the wetland resources of the region and the ability of the Willamette River and Amazon Creek waterways to support Salmon runs. Extensive use has been made of a frog logo, "*Lily*" and an educational program titled, *SPLASH*, which has been incorporated into the local schools water quality curriculum as "*Stormwater Pollution: Learn and Share*". Since 1995, the *SPLASH* message of **we all live downstream** has been introduced into 240 classrooms and presented to 1,710 school students, throughout Eugene.

Seattle City Council focused their attention on the water quality and sediment contamination associated with the increased industrial and urban development around Puget Sound and Lake Washington. Much of

the watershed is urbanised and the loss of many of the streams, which provided spawning habitat for Salmon, has initiated a program to “Daylight the Creeks” and provide Salmon runs. The “*Salmon to Sound Trail*” along Pipers Creek, within the city limits of Seattle is a good example of stream rehabilitation incorporating a walking trail and educational material focused on watershed protection to provide habitat for Salmon.

Washington Department of Ecology (WADEC) has adopted *WET*, which is an educational program designed to increase teacher and student understanding of local watershed form and function, and inspire and ethic of stewardship for pollution prevention and water conservation. Each Washington County has tailored its program to address local issues eg runoff, sedimentation, septic tanks and groundwater and the impacts each have on shellfish and salmon. The program focuses on educating the educators through hands-on workshops, field trips, hands on groundwater flow models and tabletop watershed models. An evaluation of the program in May 1998, showed that before the program only 39% of the teachers had a detailed knowledge of their watershed, whereas after the program this number had increased to 73%. Almost 60% of the teachers were using the program in the classroom, and had involved their students in watershed related projects such as, stream rehabilitation monitoring, clean ups, kerb stencilling, salmon raising, using less water and fertiliser, keeping animals out of the creeks and conservation of the riparian vegetation. (Hunter *et al*, 1998)

Catchment Management

Auckland Regional Council has a comprehensive set of Technical Reports detailing its Stormwater Management Strategy. The contents of these are summarised below:

- Technical Report No.1; Introduction to stormwater management in the Auckland Region;

- Technical Report No.2; Information on the environmental quality and catchment characteristics;
- Technical Report No.3; Prioritises areas across the Region for stormwater management;
- Technical Report No.4; Road pricing transport study;
- Technical Report No.5; Methods and options for stormwater management;
- Technical Report No.6; Costs and benefits of stormwater management.

A significant amount of long term data has been collected on aquatic biota, sediment chemistry and land and water interactions to allow ARC to establish baseline criteria. The Aquatic Biota Contaminants Inventory allows for early intervention and determination of long-term impacts. Sediment chemistry provides a yardstick to determine cause and effect, and land and water interaction models allow the objectives to be set. At present sediment control is the main issue for the catchments but the emphasis is changing to contaminants and urban pollution. Mr. Chris Hatton, Manager – Resource Quality, with Auckland Regional Council warned of the legal implications of setting high water quality standards for receiving waters:

“In the event that very high values are set for Water Quality in receiving waters, and the authority/owner of the waterbody or whoever sets the value, fails to monitor and implement strategies to ensure compliance with the higher standard, then it could leave itself open to liability in the event of non-compliance.”

The position taken by the ARC for its new development at Long Bay is to incorporate “flexible standards to achieve innovative and ecologically sensitive designs” and by doing so, protect valued natural resources, such as the beach and dunes and the Okura Marine Reserve (E. Shaver pers. com.). After much deliberation and public comment the development of the Long Bay catchment is to proceed but the non-urban catchments to the north are to be left undeveloped, monitored

and used as a control to monitor the development of the Long Bay catchment.

King County, Seattle, engaged teams of experts to walk each stream to assess its health, quantify the existing resource and qualify the impacts of development. A Watershed Management Plan, identifying landuse and stormwater controls with priorities for retro-fitting and guidelines for controlling development, was prepared for each watershed on the basis of this detailed assessment. These individual plans have proven expensive to produce, and do not result in works on the ground. Consequently funding has been diverted to capital works and taken away from the Forward Planning process.

Section 319 of the federal Clean Water Act in the USA, specifically targets nonpoint source pollution and each State must submit a Nonpoint Source Assessment Report which:

- *Identifies navigable waters that do not meet applicable water quality standards.*
- *Identifies categories of nonpoint sources that add significant pollution to the waters not meeting water quality standards.*
- *Describes the process for identifying BMPs (Best Management Practices) to address the identified nonpoint sources.*
- *Identifies and describes state programs for controlling pollution from identified nonpoint sources.*

(USEPA, 1993)

The Endangered Species legislation requires that the water of various stream reaches, must comply with water quality standards that protect the integrity of the watercourses for particular uses. For the states of Washington and Oregon this means establishing water quality objectives that protect adult salmon runs and juvenile salmon habitat.

The State of Washington is required (under the federal Endangered Species Act) to have in place a Salmon Management Plan by 1999. The National Oceanographic and

Atmospheric Administration (NOAA) are threatening to invoke legislation to remove the planning powers of the state unless such a Plan is established. Politically this is not an option for the State Legislature.

WADEC is promoting a **Watershed Approach**, which incorporates three (3) major components to meet the statutory requirements:

- Quantitative Assessment to address flows and volumes;
- Qualitative Assessment to describe the problems in relation to water quality issues; and
- Establishment of local priorities in line with the context of the guidelines and watershed priorities.

This represents an integrated approach to stormwater management and requires water quality standards to be set for critical reaches of watercourses including the estuaries and harbours to ensure salmon runs and spawning. As a minimum these standards must achieve the following goals:

- Adequate flow rate.
- Temperature range suitable to support salmonid species.
- Minimal sedimentation.
- Stable stream banks.
- In-stream habitat.
- Sufficient Dissolved Oxygen to prevent eutrophication.

Once the numerical water quality standard is set for each of these goals, Total Maximum Daily Loads (TMDLs) can be defined based on the current condition of the stream reaches.

When assessing a watershed to establish water quality standards, the following questions need to be answered:-

- Are there problems?

- If so what are they?
- What are the goals for the waterways?
- How do I establish targets to sequentially achieve the goals?
- What monitoring and re-evaluation is necessary?

TMDLs represent a mechanism for assessing the effectiveness of Best Management Practices that have been implemented to achieve a desired goal.

To be successful they need to be:

- Based on scientific data.
- Based on all identified sources of pollution.
- Agreed to by all stakeholders.
- Established through an open process.
- Implemented.
- Enforced.

Consequently a definition of “**clean water**” for each site has to be established, the problems within each watershed clearly identified, the TMDLs established to meet the definition of “**clean water**”, and then an Integrated Stormwater Management Plan established that identifies the practices required to achieve the TMDLs. Adaptive Management techniques will allow for existing programs to be incorporated into any new proposals. However, a consistency in objectives, implementation and enforcement is essential if compliance with the TMDLs is to be assured.

Setting the TMDLs for all the watercourses, estuaries, lakes and harbours within the state of Washington, is a daunting task. WADEC is required by law to set approximately 2,000 individual TMDLs for 660 stream reaches in the next 15 years, all without any additional federal funding.

Water Quality Controls

TMDLs require a scientific investigation into a particular waterbody to determine existing future and desired water quality criteria. They are a **source control** that brings together all other water quality programs in the watershed and allocates achievable loading rates to each activity that can be sustained. However, they require large amounts of capital investment in monitoring, with little work on the ground to show for all the expense. They represent a quality assurance on the BMPs and must be continually monitored. The funds for these programs are generated by a Drainage Rate payable to the local Drainage Utility, which in most cases is Local Government. The following table identifies the range in Regional Drainage Rates, for residential properties, applied by various utilities in the state of Washington in 1998.

Municipality	Average Annual Bill
Seattle	\$43.08
Lake Forest Park	\$44.07
Everett	\$45.00
Renton	\$62.76
Auburn	\$66.00
Portland	\$82.68
King County	\$85.02
Tacoma	\$102.84
Mercer Island	\$106.32
Bellevue	\$116.40

The Drainage Rate provides funds, to establish and maintain the TMDL monitoring program, to install structural options for the control of water quality and quantity, and to maintain the infrastructure.

Stormwater Management is a company, located in Portland Oregon, which manufactures a unique filtration device to treat stormwater, called the **StormFilter™**. They can be accessed through the Internet at www.stormwatermgt.com. The **StormFilter™** is a passive flow-through system housed in concrete vaults utilising refillable filter cartridges. This structural device filters stormwater through cartridges containing media, which traps particulates and adsorbs dissolved material such as metals and hydrocarbons. After passing through the filter media, the stormwater can be channelled into a formal drainage system or discharged directly into the receiving water. The type of media used in the cartridges is dependent on the pollutants targeted for removal. Compost media provides a high organic carbon content, suitable for denitrification and cation exchange reactions necessary to remove heavy metals, sediment, and oils and grease. Geo-textile fabrics remove fine particulates based on the size of the pores in the fabric. Perlite ("puffed" volcanic ash) is highly porous and is very effective in removing fine particles, and oil and grease. Zeolite exhibits very high cationic exchange properties and has the capacity to adsorb soluble phosphorus. (Jim Lenhart pers. com.)

The northern regions of Indiana (IN) have lost in excess of 500,000 ha of natural wetlands to agricultural activities and urban development, since European occupation. The loss of these natural wetlands has led to a general decline in water quality and the loss of aquatic habitat. J.F. New & Associates, of Walkerton Indiana, utilises the technology of constructed wetlands (nature's filters) to rehabilitate urban streams and manage and treat stormwater and wastewater. They specialise in the use of native vegetation to mitigate the impacts of urbanisation on streams and to assist in pollutant retention within subsurface and free-water surface wetlands.

Juday Creek, which flows through Notre Dame University, South Bend Indiana, was channelised and straightened in the 1800s to provide land suitable for agricultural activities. More recently, the creek has become polluted with urban runoff, as development

occurred within the catchment. The aquatic macro-invertebrates have disappeared along with the salmon and trout. The rehabilitation of this creek (September 1997), in conjunction with the construction of a golf course for the University, has provided aquatic habitats necessary for macro-invertebrates, which in turn provide a food source for fish. The fairways on the golf course have been excavated and replaced with a sandy loam substrate that acts as a sand filter, filtering particulates and promoting anaerobic conditions, which allows denitrification to occur.

Lake Maxinkuckee is a picturesque lake located about 100 miles south of Lake Michigan in central Indiana. It is used extensively for summer holidays and has an exclusive Military Academy located on its foreshores. The lake is virtually land locked and its water supply is from runoff from the surrounding agricultural and urban developments. The gradual and incremental increase in nutrients within the lake has led to it converting from a lake with moderate nutrient levels, to one high in nutrients and productivity (eutrophic). A series of free water surface wetlands have been constructed in strategic locations on creeks leading into the lake. Small groups of residents have pooled their resources and purchased land suitable to construct subsurface wetlands to control their wastewater, and a community education program has been initiated, to reduce nutrient loads discharging into the lake.

Sand Creek is a new residential subdivision on the outskirts of South Bend, IN and it is a good example of a **Treatment Train or Series Treatment** approach to stormwater management. Primary Treatment is afforded by coarse particulate controls close to the residences (At Source). Secondary Treatment occurs in the water quality control ponds throughout the Golf Course (In Line). Tertiary Treatment is allowed for in the final water quality control ponds (End of Line) which have a 7 days hydraulic retention time before the runoff is allowed to discharge to the stream.

Oregon State University (OSU), Georgia Institute of Technology (GATECH) and the

University of Florida (UF) are involved in the use of wetlands, mainly free water surface, for controlling agricultural runoff and urban stormwater. GATECH, is about to construct a small demonstration wetland as an Outdoor Classroom at Chattahoochee High School. This "Pocket Wetland" is situated in an area that was once a swamp and has been filled in to provide playing fields for the school. Runoff from the school grounds will be controlled and mitigated and the operation of the wetland and its performance will be closely monitored as part of the environmental curriculum for the school.

OSU and FU have comprehensive extension programs involving undergraduate and postgraduate students and specialising in wastewater and stormwater remediation. OSU concentrates its activities in the Pacific North West, specialising in small wetland treatment systems for dairies, land fill and industrial wastewater. UF specialises in aquatic weed management and is involved in the design and management of an 8,000 ha constructed wetland to control polluted agricultural runoff before it enters the Everglades.

Conclusion

It is very hard to draw comparisons between the Stormwater Management Programs in all three countries. Each country has its own suite of Legislation, as well as different climatic and geological conditions that require site specific solutions. However, the initiatives taken recently by the NSW EPA with regard to their *Solution to Pollution and Urban Stormwater Management Programs* is keeping pace with programs in other parts of the world.

Unfortunately, the Stormwater Management Plans, which have to be prepared in NSW, deal only with urban stormwater pollution. To really make a difference these plans should be **Catchment Management Plans** and address all the issues within a catchment, that impact adversely on the receiving waters. Objectives for the receiving waters need to be set based on biological and chemical criteria and an extensive monitoring and education program initiated in each

watershed to ensure that the objectives are reached in the timeframe. Without funds this cannot be achieved, and in my opinion the system of Drainage Utilities used in the USA, is probably the best and the most equitable system for collection and allocation of funds for water quantity and quality control.

This paper only touches briefly on the investigations undertaken, and there has not been sufficient space to go into any detail on:

- Herbicides, weed blankets or hand removal of aquatic weeds as used in WA and FL.
- Value Engineering techniques used by George Riek of Camp Dresser and McKee, Portland OR.
- Best Management Practice assessment by Eric Strecker of URS Griener Woodward-Clyde, Portland OR.
- Stream rehabilitation and impervious surface runoff management by Oregon Department of Transport.
- StormFilter™ technology from Stormwater Management, Portland OR.
- Wastewater management using subsurface flow wetlands developed by J.F. New & Associates, Walkerton IN.

Each of these requires its own detailed presentation and there is not enough room to do them justice in this paper.

Acknowledgments

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Apart from the assistance provided by SKM and the IMEA, my wife and family had to do without me making a mess around the house for 5 weeks. Without their assistance I would not have been able to complete these

investigations, and for their support I am eternally grateful.

A special thanks to QANTAS for their assistance in organising all the flight and connection details.

This Bursary has allowed me to renew a number of old acquaintances and make many more, and for their time and generosity I can only express my sincere gratitude. I hope that the following list provides some recognition from myself to those individuals who without question, gave up their time to assist me whilst I was in NZ and the USA in June and July of 1998. If I have missed anybody, I do sincerely apologise but the list is long and I have only my daily crib sheets to remind me.

Auckland Regional Council — Earl Shaver, Lyle Babington, Nigel Ironside, Chris Hatton, Mike Birch, Ken Becker, Eddie Grogan, Jami Williams, Donovan McCarthy.

Thurston County Noxious Weed Agency, Lacey WA — Eric Williams, Mike McKay, Mark Swartout. Sayward Ayre.

Washington Department of Ecology — Kathy Hamel, Ed O'Brien, Ann Wessell, Jennifer Parsons, Ron McBride, David Roberts, Rhonda Hunter, David Peeler.

Oregon State University — Dr. Jim Moore.

Oregon Department of Transport — William Fletcher, Paul Wirfs, Jeff Moore, Elaine Kuehn.

Eugene City Council, Oregon — Kathy Eva

Camp Dresser & McKee, Portland OR — George Riek

URS Griener Woodward-Clyde, Portland OR — Eric Strecker.

Stormwater Management, Portland OR — Jim Lenhart, Craig Cannon

City of Olympia, WA — Mark Blosser.

King County, Seattle WA — Luanne Coachman

Pierce County, Seattle WA — Heather Kettleby

Seattle City Council, WA — Cheryl Paston, Bob Chandler, Neil Thibert.

Snohomish County, Everett WA — Bill Leif

J.F. New & Associates, Walkerton IN — Jim New, Judy New.

Lake Maxintuckee Environment Committee, Culver IN — Tina Hissong.

Georgia Institute of Technology, Atlanta GA — Dr. Lloyd Dunn, Travis Dunn, Sue Dunn, Dell Pamplin.

University of Florida, Gainesville FL — Patrick Anglett, Dr. K. Reddy, Dr. Bill Haller.

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Appendix

Logos and Captions from various Education Programs followed and the USA.



I ONLY DRAIN RAIN!

"Drain Man" Auckland Regional Council

What you can do to help:

- Do not use the storm sewer for disposing of motor oil, anti-freeze, pesticides, paints, solvents, or other materials.
- Clean up leaves or grass clippings that accumulate on your driveway, sidewalk or in the street.
- Sweep (do not wash) fertilizer and soil off driveways and walkways.
- Minimize your use of salt on sidewalks and driveways during the winter.
- Dispose of pet wastes by flushing them down the toilet or by burial.
- Redirect down spouts from paved areas to vegetated areas.
- Wash your car on the lawn—not the driveway.



For more information call your county Land Conservation or Extension office.
A publication of the University of Wisconsin-Extension (UWEX) in cooperation with the Wisconsin Department of Natural Resources under funding from the Wisconsin Nonpoint Source Water Pollution Abatement Program (7/92).

"Stormie" City of Portland, Oregon

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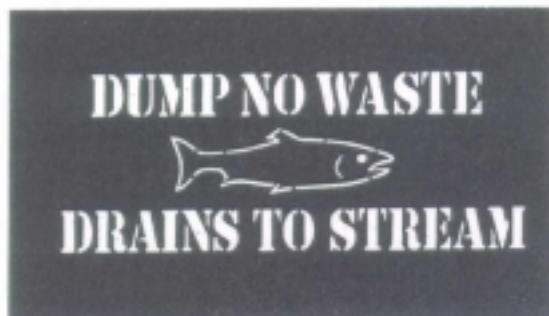


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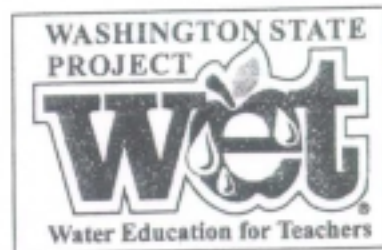
Eugene's Stormwater Management Program

<http://www.ci.eugene.or.us/Pw/storm/stormpg.htm>



Generic Drain Stencils "Earthwater" Stencils

<http://www.earthwater-stencils.com>



Project "WET"

e-mail: nwet@msu.oscs.montana.edu

June

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13 OF 843 Sydney to Auckland City Control Hold +64-9-337-3188
14 IDNR National Maritime Museum Auckland	15 ARC Lyle Robinson (Division & Sediment Cont. on Construction Sites)	16 ARC Earl Sherrin (Stormwater Mgt. Systems)	17 ARC Chris Harris (Stormwater Monitoring)	18 ARC Nigel Tomasko (Stormwater Mgt. Plans)	19 OF 181 Auckland to LAX DL 124 LAX to Salt Lake City	20 DL 1827 Salt Lake City to Portland E. Williams & M. McKay (M&E - Long Lake)
21 E. Williams & M. McKay (L&E - Shellfish research, Puget Sound)	22 CDM George Rink (Value Added Engineering)	23 ODOT Bill Hatcher, Paul Walls and Jeffrey Moore (Storm Rehab & SW Mgt for Metro-Link)	24 City Of Eugene OR Kathy Evans (Division Education Present OSF Jim Moore (Mgt. Ag. Road))	25 Woodward-Clyde Lisa Swickler (Integrated Stormwater Mgt)	26 Stormwater Management Jim Leebart (Compost Filters)	27 Thurston County WA E. Williams & M. McKay (Aquatic Weed Mgt.)
28 EMR Eric Williams Olympia WA	29 WADRC Ann Winstead & Ed O'Brien Shanda Hunter (Stormwater Mgt. Prog. & Environmental Education)	30 WADRC Jennifer Peterson (Lake Habitat Assessment) City Of Olympia Mark Blomse (Stormwater Management)				

1998

July

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1 Thurston County Mike McKay Long & Scott Lakes (Aquatic Weed Control)	2 Thurston County Mike McKay Summit & Deep Lakes (Aquatic Weed Control)	3 Independence Day Eric Williams (Olympic Mountains)	4 Paving Field Management of Cooper Ranch
5 RNR Eric Williams	6 WA State Legislature Setting TDECs as required by the Clean Water Act to comply with the Endangered Species Act	7 WADSW Ron McBride & D. Roberts (Stormwater Mgt Program)	8 Thurston County Mike McKay (Weed Shrubbery, Long Lakes)	9 City of Seattle Robert Chandler Cheryl Patton Paul Thibert (Urban Storm Retards)	10 Seberish County Bill Leif (Stormwater Mgt. Program)	11 DL 149 Seattle to Salt Lake City DL 1127 Salt Lake City to Chicago
12 RNR South Road DC (St. Joseph's, Rehabilitation)	13 J.F. New & Assoc. Stream Rehabilitation - Julie CL. Howe Dams Unit (Wildland Plant Nursery)	14 Lake Macintosh DC Tina Hansen (Stormwater Mgt., Eutrophication & Lake Mussels)	15 DL 367 Chicago to Atlanta Georgia Institute of Tech Lloyd Dorn (Chlorophyll, HUS Project S/land)	16 GA Tech Lloyd & Teresa Dorn (Phenomena & Toxication Rates)	17 GA Tech & U of FL L. Dorn & K. Emlay (Wildland Biogeochemistry)	18 GA Tech Lloyd Dorn Johnston Springs FL (Submerged Plants)
19 GA Tech Lloyd Dorn Marion Dorn, Seattle Suzelo L. GA (Estuarine Wetlands)	20 DL 1565 Atlanta to LAX QF 608 LAX to Sydney	21 Arrive Sydney	22	23	24	25
26	27	28	29	30	31	

1998

Author Biography



Geoff Hunter is the Stormwater Management Engineer at Blacktown City Council and has 29 years experience in Stormwater Management, 16 years in Local Government and 13 years with private Consultants and Contractors. Blacktown is the most populace City in New South Wales and is located approximately 40 kms west of Sydney.

Geoff holds qualifications in Surveying and Environmental Management and was awarded a Churchill Fellowship in 1996 to investigate "*The Use of Wetlands for Soil and Water Management*" in the USA. His areas of interest include Constructed Wetlands, Bio-filtration, sand filters, natural resource management and stream rehabilitation. In the last 5 years, Geoff has presented numerous papers on Environmentally Sensitive Stormwater Management, structural stormwater controls and the impacts of urbanisation on aquatic ecosystems.

He is the Local Government representative on the Stormwater Industry Association (NSW), provides technical assistance to the State Stormwater Advisory Committee and is a member of the Environment Panel of the Institute of Municipal Engineering Australia (NSW).

Postal Address: Geoff Hunter, Stormwater Management Engineer, Blacktown City Council, PO Box 63, BLACKTOWN, NSW, AUSTRALIA 2148

E-mail: hunterg@mail.austasia.net