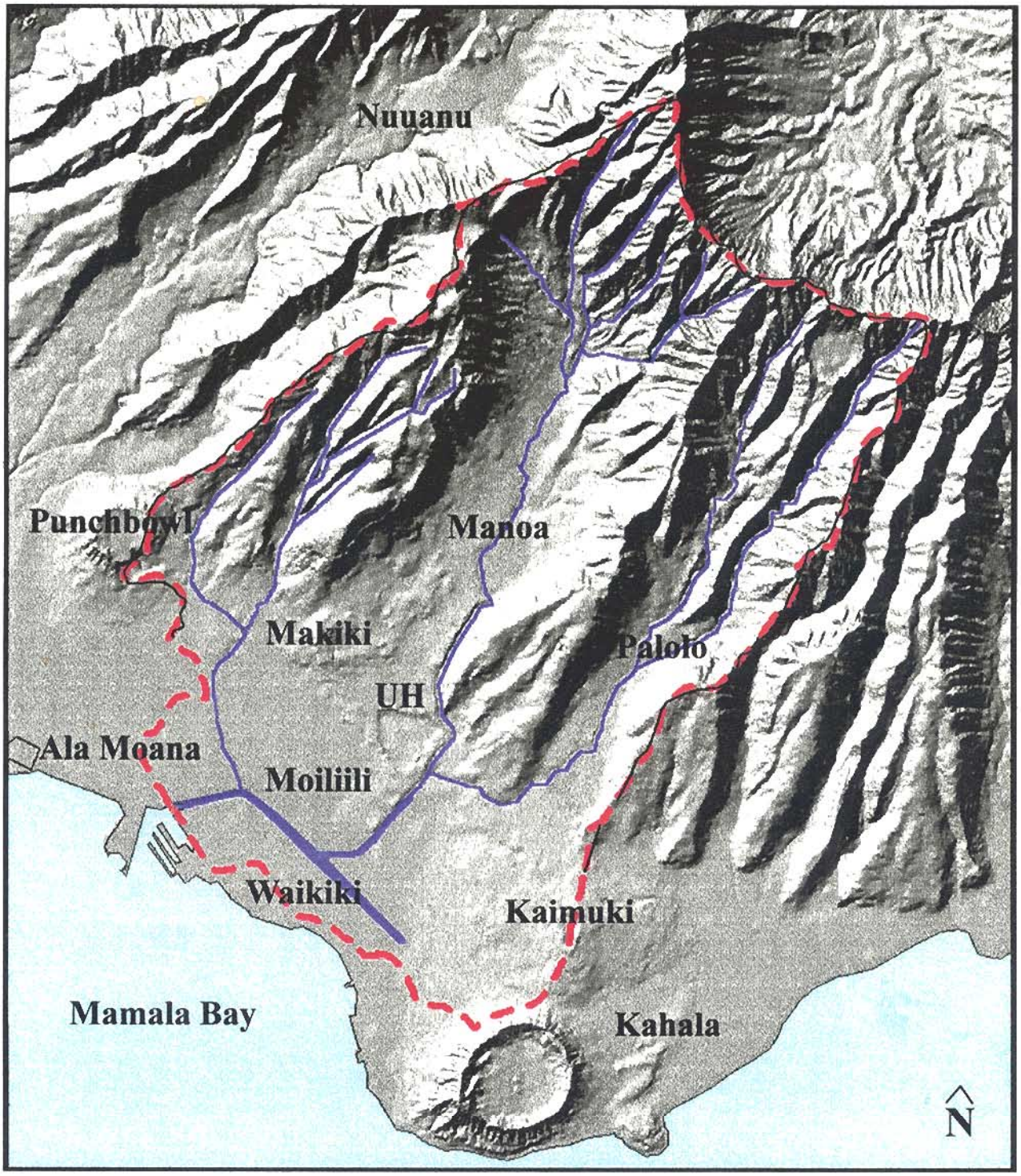

Ala Wai Canal Watershed Water Quality Improvement Project - April 1998

MANAGEMENT & IMPLEMENTATION PLAN -- VOLUME II TECHNICAL APPENDICES

Prepared by: The Steering Committee, City and County of Honolulu, State of Hawai'i

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APPENDIX A

CONSENT DECREE

PROJECT DESCRIPTION

CITY-DOH PROJECT AGREEMENT

The following projects will be funded from the escrow governed by the Escrow Agreement.between the City and County of Honolulu ("City"), Hawaiian Trust Company, Limited ("HTC"), and the Department of Health, State of Hawaii ("DOH"), Dated May 29, 1995, Account No. 185030251, Account Name "Hawaiian Trust Company, Limited, as Escrow Agent for City and County of Honolulu, U.S.A. and State of Hawaii and Lawrence Miike, M.D. v. City and County of Honolulu," as amended.

Funding of the projects from the escrow shall be conditional upon approval of these projects by the U.S. District Court for Hawaii.

The Escrow Agreement shall be amended to attach this Project Agreement as an Exhibit, to the extent that the U.S. District Court of Hawaii shall approve, or approve with amendments, the projects below.

The projects will be implemented as described below.

I. Ala Wai Canal Watershed ("AWCW") water quality improvement project

Estimated cost: $150,000

A. Mission: Improve the quality of both surface waters and ground waters in the drainage basins for Manoa, Palolo and Makiki Streams, and in the Ala Wai Canal through a long term, community-based, public-private program of non-point source management activities in the watershed.

B. Project Goals:

1. Improve the water quality of surface and ground waters in the drainage basins for Manoa, Palolo and Makiki Streams, and in the Ala Wai Canal.

a. The long term (5 years and longer) goal is to make measurable progress toward meeting state water quality standards for the Canal and the streams.

b. The short and intermediate term goals are to improve the aesthetic and recreational values of the waters (e.g. remove and prevent litter and dumping into and next to the waters) and to implement best management practices to improve water quality.

2. Choose the appropriate means to improve water quality through a process that coordinates City, State, and Federal agencies, and incorporates public participation.

Watershed management organizes stakeholders to identify community values, problems, and best management practices (BMPs) to solve problems; to implement BMPs; and to monitor BMPs' effectiveness.

All options may be considered, although implementation will depend on agencies' jurisdictions and resources, and the options include:

a. Controlling and reducing erosion and sediment;

b. Reducing use of fertilizers and pesticides;

c. Reducing illegal dumping and litter accumulations in streams;

d. Re-vegetating stream banks where possible;

e. Inspecting and enforcing municipal stormwater permit conditions and grading-and-grubbing permit conditions;

f. Dredging of the Canal;

g. Increasing flushing rates in the Canal;

h. Minimizing raw sewage leaks or spills, and sewering areas on cesspools or septic systems; and

i. Coordinating with the DOH School-based Volunteer Water Quality Monitoring Project.

C. City and DOH responsibilities:

1. The City and DOH shall jointly select a Management Coordinator ("coordinator").

2. DOH shall retain and properly supervise a Management Coordinator ("coordinator") to ensure compliance with the requirements of this project.

3. The DOH shall approve payments from the escrow identified above to fund the coordinator's

retention and appropriate costs related to the coordinator and the implementation of this project (including implementing BMPs, testing their effectiveness, and laboratory analyses).

a. Payment shall be conditional upon satisfactory progress and completion of work for this project in accordance with this agreement.

b. Total payments shall not exceed the limit of estimated cost, above.

D. Project Benchmarks and Deadlines:

1. The City and DOH shall select the coordinator, and DOH shall retain the coordinator.

1a. The coordinator, working jointly with DOH and the City, shall establish deadlines for the items listed below, so that final Steering Committee Management and Implementation Plans can be completed in two years, as required by section G.4.m, below.

2. The coordinator, working jointly with the DOH and the City, shall establish an Ala Wai Canal Watershed Steering Committee.

a. First joint solicitation by the coordinator, City, and DOH of community participants to be on Ala Wai Canal Watershed Management Committee ("Steering Committee"):

b. Establishment of the Steering Committee:

c. First meeting of Steering Committee:

3. The coordinator and steering Committee shall select sites for implementing and evaluating BMPs to the maximum extent practicable.

4. The coordinator and Steering Committee shall start and finish the first volunteer project for monitoring the effectiveness of BMPs:

5. If requested by the DOH/coordinator/Steering Committee the City shall perform before-and-after and upstream/downstream water quality monitoring by field observations to evaluate effectiveness of:

a. The BMPs; and

b. Any other projects chosen for implementation.

This monitoring is not intended to replace routine or other DOH monitoring.

6. If requested by the DOH/coordinator/Steering Committee, the escrow fund may be used to pay for lab analyses of water quality samples on an as needed basis.

7. The Steering Committee shall submit to the City and DOH draft Ala Wai Canal Watershed management and implementation plans:

   a. The Steering Committee shall recommend which Best Management Practices (BMPs) need to be implemented and where;

   b. The Steering Committee shall consider any available water quality data and reports, and results of any volunteer monitoring project in making the recommendation.

8. The Steering Committee shall publish notice of the plans, solicit written comments, and hold public hearings on the draft plans.

   a. The first notice shall be published on:

9. The Steering Committee shall submit to the City and DOH its recommended final Ala Wai Canal Watershed management and implementation plans:

E. <u>Ala Wai Canal Watershed Steering Committee</u>

1. The Steering Committee will be a focal point for a long term, community-based, public-private program of non-point source management activities in the watershed.

2. Steering Committee shall be chaired by the coordinator and shall consist of representatives from relevant State, City, and federal agencies, the University of Hawaii, environmental groups, the regulated community, interested community groups, and the public.

3. The Steering Committee, with its members' and the coordinator's help, shall reach out to the public and encourage public participation.

4. The Steering Committee may set up separate watershed management committees in each of the three major drainage basins in the Ala Wai Canal Watershed - Manoa, Makiki and Palolo. Each basin committee could elect a chairperson, who could guide the local group and attend Steering Committee meetings.

5. The Steering Committee shall produce a Watershed Management Plan and an Implementation Plan, which may be combined, which shall recommend management measures, and explain how they will be implemented, to achieve project goals.

   a. The Steering Committee shall produce at least one draft of management and implementation plans for City, DOH, and public review before adopting its final recommendations.

   b. The draft plans shall be submitted for review before the end of the term of the Management Coordinator.

F. Public outreach and participation

1. Public outreach shall inform local residents of ongoing and planned watershed management activities; the ways in which these activities benefit the community; and encourage people to participate. After establishment of the Steering Committee, such encouragement shall include incentive programs (contests, awards, etc.).

2. The nature and amount of public participation shall be documented.

G. Management Coordinator ("coordinator")

1. Selection. The coordinator will be selected jointly by DOH and the City.

2. Term. The coordinator will be retained for at least two years.

3. Supervision. The DOH will supervise the coordinator.

4. Major responsibilities:

   a. The coordinator shall work jointly with the City and DOH to establish the Steering Committee.

b. The coordinator shall serve as chair of the Steering Committee and plan, organize and conduct the meetings.

If the Steering Committee forms subcommittees or basin committees, the coordinator shall coordinate and integrate their work.

c. The coordinator shall work directly with relevant State departments. E.g.

1) The Department of Health (DOH), especially staff working on Ala Wai Canal watershed management projects underway as part of the State/EPA integrated water program workplan for the Ala Wai Canal (Clean Water Branch, Safe Drinking Water Branch, Wastewater Branch, and Environmental Planning Office - Nonpoint Source Pollution Control, Groundwater Protection, and Water Quality Standards Programs);

2) The Department of Land and Natural Resources (DLNR);

3) The Department of Transportation (DOT);

4) The University of Hawaii (UH);

5) The Department of Agriculture (DOA); and

6) The Department of Education (DOE).

d. The coordinator shall work directly with the relevant City departments. E.g.

1) The Department of Public Works (DPW), especially with the Division of Engineering, Storm Water Quality Section, on the implementation of the water quality management plan within the Ala Wai Watershed as outlined in the City's storm water NPDES permit requirements.

2) The Department of Transportation Services (DTS);

3) The Department of Parks and Recreation (DP&R);

4) The Office of Waikiki Development;

5) The Building Department; and

6) The Department of Wastewater Management.

e. The coordinator shall work directly with relevant federal agencies.

f. The coordinator shall develop and implement public outreach and public participation activities, both for setting up the Steering Committee and to help the Steering Committee after it is formed.

The coordinator shall document the nature and amount of public participation.

g. The coordinator shall assist in reviewing volunteer monitoring, applied research, and project implementation proposals. The coordinator shall be or become familiar with prior work done on the Ala Wai Canal Watershed to avoid unnecessary duplications of effort. E.g.

"Revised Total Maximum Daily Load Estimates for Six Water Quality Limited Segments on Oahu," W. Freeman (Nov. 1993)

"Management Plan for the Ala Wai Canal Watershed," Fox & Freeman for Noda & Assoc. (Oct. 1992)

"Ala Wai Canal Improvement Project Feasibility Report," Noda & Assoc. (Sept. 1992)

"Maintenance Plan for the Ala Wai Canal, Noda & Assoc. (Sept. 1992).

h. The coordinator shall summarize information in reports from different monitoring and management projects in progress in the Ala Wai Canal Watershed and keep all interested parties informed of results on at least a quarterly basis.

i. The coordinator shall coordinate contractual projects in the Ala Wai Canal watershed and develop timetables to achieve projected benchmarks and schedules.

j. The coordinator shall provide quarterly reports to the Chief Engineer and DOH on progress toward meeting project goals, benchmarks, and schedules.

k. The coordinator shall help the Steering Committee develop a watershed management plan and accompanying implementation plan that explains how the recommended management measures will be implemented in the watershed.

l. The coordinator shall present a written draft of the Steering Committee watershed management and implementation plan to the City, DOH, and the public for review before the end of the coordinator's contract.

m. The coordinator shall present the final Steering Committee management and implementation plans to the City and DOH.

2. Ultraviolet disinfection research ("UV") project.

Estimated cost: $70,000.

A. Project goal: Determine the characteristics of effluent from wastewater treatment facilities on Oahu to determine the suitability of those wastewater effluents for disinfection by ultraviolet (UV) radiation. The Kailua Regional WWTP is excepted because UV disinfection for it is being covered in a separate case, SOBB v. City, U.S.D.Ct. Civ. No. 92-00263 DAE. The goal is not to determine whether UV disinfection is feasible in the abstract, but to determine which specific treatment facilities can use UV disinfection. The details of the UV project are described in the proposal attached as Exhibit "UV."

1. Contingency. The scope of the UV project will be reevaluated after the Mamala Bay Study Commission releases its report. The report may address the need for disinfection of effluent discharged into Mamala Bay and may have implications for discharges elsewhere. The report is expected to be released on September 30, 1995.

B. Researcher: The DOH will contract directly with the University of Hawaii Water Resources Research Center (UH WRRC) for the research. The research will be subject to peer review during the research design stage and after project completion.

C. Schedule: The research report shall be submitted to DOH within 18 months after the project contract is signed.

3. Contingencies.

A. $30,000 shall be held in reserve to be applied to the UV project, only if and to the extent that UH WRRC in writing justifies to the satisfaction of DOH and the City, the need for additional expenditures to complete the UV project. Any such DOH and City approval shall be in writing.

B. Any part of the $30,000 held in reserve and not spent on the UV project shall be used to supplement the Ala Wai Canal Watershed water quality improvement project in ways consistent with that project and jointly approved by DOH and the City in writing.

Executed this 27th day of September, 1995.

CITY AND COUNTY OF HONOLULU:

By: _____
RUSSELL M. MIYAKE
Director of Finance
City and County of Honolulu

By: _____
FELIX B. LIMTIACO
Director of Wastewater
Management
City and County of Honolulu

By: _____
KENNETH SPRAGUE
Director of Public Works
City and County of Honolulu

STATE OF HAWAII
DEPARTMENT OF HEALTH

By: _____
BRUCE S. ANDERSON
Deputy Director of Health

APPROVED AS TO FORM
AND LEGALITY

_____
DUANE PANG
Deputy Corporation Counsel

_____
LAURENCE K. LAU
Deputy Attorney General

APPENDIX B

LIST OF STEERING COMMITTEE MEMBERS

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
	Apao Gearheard	Billee	
	Bachman	W.	
	Bell	Richard	Coach
	Bertilson-friedman	Petra	
	Bienfang	Paul	
	Blaich	Gary	
	Brady	Shell	
	Brodeur	Charles	
	Chau	Lisa	
	Clark	John	
	Costa	Christina	
	Cummins	Kerri	
	Cushnie	Mike	
	Deal	Christopher P.	
	Dobbs	Joannine	
	Eliaslof	Mark	
	Fergeson-bray	Pam	
	Furu	Scott	
	Gates	Marilyn	
	Guard	Allison	
	Hallett	Lili	
	Hendrix	Thomas G.	
	Ho	Momi	
	Hollyer	Jim	Taro Researcher
	Howard	Tom	
	Hufshmidt	Maynard	
	Hummel	Paul	Civil Engineer
	Ikeno	Debra	
	Ingoglia	Mark	
	Kingery	Frank	
	Kordof	Mary Alice	
	Leong	Nicole Robertson	
	Levin	Penny	
	Lienert	Barry and Mahiai	
	Ling	William	
	Loren	Steve	

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
	Luersen	Paul	
	Makano	Harvey	
	Matson	Michelle	
	Matsuo	Shane	
	Maza	L-marina Cabanilla	
	Montano	Stacey	
	Morganweck	Bob	Respected Citizen
	Natunding	Lani Goode	
	Newfield	Faye	
	Okano	Ben	
	Okubo	Shungo	
	Overmyer	Gene	
	Paoa	Henry	
	Pensker	E.	
	Schroboer	Lilo	
	Sears	Michael	
	Shapiro	Howard	
	Slade	Jr	
	Spoehr	Hardy	
	Stoller	Betsy	
	Sturges	Libby	
	Sumitomo	Robert	
	Tabar	Andrew J.	
	Town	Mike	
	Yamamoto	Terry	
	Yin	Joanne	
	Yoshimatsu	Kim	
Ahupuaa Action Alliance	Kubota	Steve	Steering Committee
Ahupuaa Action Alliance	Cruz	Lynette	
Ahupuaa Action Alliance	Brady	Kat	
Ala Wai Gateway Tenants Assoc	Snow	Rodger	President
Ala Wai Wtshd Comm Net.	Lech	Bill	President
Ala Wai Watershed Project	Kemmer	Christina	President
Ala Wai Marina Board	Johnson	Richard	Chair
Ala Wai Watershed Project	Morgenwick	Bob	
Ala Moana Res Advisory Council	Fuchigami	Brian	

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
Architects Hawaii	Sakaguchi	Bill	
Austin Tsutsumi & Associaties	Kawahigashi	Ted	President
Belt Collins Hawaii	Goody	John	Vice President Dir of Envr Plng
Canoe Club	Napoleon	Nappy	
Canoe Club Healani	Nacua	Shannon	
Canoe Club	Brown	Gardner	Coach
Canoe Club Waikiki Usc	Potter	David	
Canoe Club Kamehameha	Gardner	Shervelle	
Canoe Club Hawaii Canoe Racing Assoc	Freitas	Toni	Paddler
Canoe Club Outrigger	Grant	Kawika	
Canoe Club Waikiki Surf	Gomes	Kuumea	
Canoe Club Hawaii Canoe Racing Assoc	Tongg	Michael	President
Canoe Club Koa Kai	Chee	Galen	
Canoe Club Waikiki Surf	Lau	Lindsey	
Canoe Club Hui Lanakila	Waters	Tommy	
Canoe Club Kamehameha	Vasold	Barbara	
Canoe Club Lokahi	Tottori	Steven	
Canoe Club Hui Lanakila	Mann	Lani	
Canoe Club Hawaii Canoe Racing Assoc	Cottrell	Curt	Paddler
Canoe Club Ushckt	Puakea	John	
Cbc	Mullahey	Ramona & Mike	
CH2M Hill	Peters	Dennis	Environmental Engineer
Chapman Consulting	Chapman	Gordon	
Citizen Action Project	Hill	Dave	Coordinator
City & County Dept Public Works	Takayesu	Gerald	Chief, Storm Water Section
City & County Dept Wastewater Management	Sprague	Kenneth	Director
City Council	Bainum	Duke	Councilmember
City & County Dept Parks & Rec	Morrill	Lanky	
City and County Planning Dept	Mcgraw	Bob	
City & County Dept Parks & Rec	Hildebrand	Terry	Planner
City Counci.	Hanneman	Mufi	Councilmember
City & County Dept Transport Services	Soon	Cheryl	Director
City Council	Mirikitani	Andrew	Councilmember
City & County Dept Public Works	Libby	Roland	Dep. Dir.

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
City & County Dept Public Works	Ho	Alex	
City & County Dept Public Works	Rath	Raj	Civil Enginer
City & County of Honolulu	Harris	Jeremy	Mayor
City & County Dept of Planning	Takahashi	Eugene	
City Council	Yoshimura	Jon	Councilmember
City & County Dept Public Works	Miyata	Mel	Road Maintenance
City & County Dept Public Works	Shimada	Jonathan	Director
City & County Dept Land Natural Res	Lowe	Aaron	Trails & Access Specialist
City & County Dept Transport Services	Char	Marvin	Chief
City & County Board of Water Supply	Usagawa	Barry	
City & County Dept Wastewater Management	Nagamine	Dave	
City & County Dept of Planning	Onishi	Patrick	Director
City & County Dept Land Utilization	Sullivan	Jan	Director
City & County Board of Water Supply	Kuioka	Bert	Planning Branch Head
City & County Building Dept,			Director
City & County Dept Parks & Rec			Director
City & County Dept Transport Services	Chong	Lois	Ce
City & County Office of Waikiki Development	Aton	Doug	Executive Director
City & County Board of Water Supply	Sato	Raymond	Manager & Ch Engineer
Comm Vision Committee	Steiner	Don	Chair
Convention Cntr Comm Network	Levin	Jack	Coordinator
Coral Reef Initiative	Che'	Carol	
Dames & Moore	Krasnick	George	
Discover Moiliili	Zimmelman	Lue	
Ekna	Noda	Edward	President
Friends of the Harbor	Moran	Capt. Patrick D.	
Gmp Assoc	Street	Michael	
Hawaii Yacht Club			Commodore
Hawaii Hotel Association	Towill	Murray	Executive Director
Hawaii Assoc of Conserv Districts	Tulang	Mike	
Hawaiian Fertilizer	Ogasawara	Troy	V.p.
Honolulu Advertiser	Tenbruggencate	Jan	
Honolulu Advertiser	Dingman	Debbie	
Honolulu Weekly	Clemo	Pamela	Report

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
Honolulu Advertiser	Infante	Esme	Staff Writer
Honolulu Waldorf School	Tautenslager	Sue	
Hoolaulima O Palolo	Walther	Carolyn	President
Hospice Hawaii	Shirland, Rn	Barbara	Director Clinical Programs
J.p. Errett Inc	Errett	Lee Ann	Pres.
Japanese Cul Cntr Hawaii			Program Coordinator
Kapiolani Park Preserv Soc	Voronaeff	Allan	President
Kawananakoa School	Inouye	J. S.	
Life of Land	Curtis	Henry	
Makawai	Young	Tom Sr	
Mālama O Mānoa	Cooke	Mary	President
Moiliili Community Center	Ryan	Rebecca	Director
National Res. Def. Council	Miller	Susan	
Neighbor Board Mccully-moiliili	Kaapu	Kekoa	Chairperson
Neighbor Board Waikiki	Hamilton	Scott	
Neighbor Board Ala Moana	Lee	Wu Ji	
Neighbor Board Kaimuki	Iwasa	Henry	Chairperson
Neighbor Board Manoa	Baron	Brian	Chairperson
Neighbor Board Makiki	Steelquist	John	Chairperson
Neighbor Board Ala Moana	Jennings	Bobbie	Sec-treas
Neighbor Board Waikiki	Bren	Sam	Chairperson
Neighbor Board No. 9	Johnson	Betty	
Neighbor Board Palolo	Nemiroff	Alan	Vice-chair
Oahu Rc&d	Gross	Fred	Chairman
Oceanic Institute	Ziemann	Dave	
Outdoor Circle	Steiner	Mary	Ceo
Palolo Tenant Assoc.	Asuega	Dahlia	President
Palolo Comm Council	Pacheco	Edward J.	President
Queen Lili'uokalani Children's Cntr	Corpuz	Maria	Palolo Pride Coordinator
Re2	Kaanapu	Peter	
Royal Hawaiian Rowing Challeng	Johl	Robyn	
School Mckinley High	Kikuta	Henriann	
School Kaimuki High	Higa	Wendell	
School Kaimuki High	Nanratana	Sandy	

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
School Kaimuki High	Phan	Wen	
School Kaimuki High	Kama	Robert	
School Kaimuki High	Angrand	Christine	
School Kaimuki High	Fidele	Landon	
School Mckinley High	Tamura	Sheila	
School Mckinley High	Sugihara	Diane	
School Kaimuki High	Yamanaka	Mark	
School Manoa			Principal
School Mckinley High	Bauer	Jim & Terry	
School Stevenson Intermediate	Woodside	Byron	
School Mckinley High	Hu	Sophia	
School Anuenue	Kapololu	Lani	Principal
School Lunalilo	Shimomoto	Kerrie	
School Ala Wai	Okano	Susann	
School Mckinley	Murakami	Suzanne	
School Kaimuki High	Khamkhoy	Dominic	
School Kaimuki High	Look	Wil	
Sierra Club	Sutter	Dr. Sharon K.	Leader
So Oahu Soil & Wat Consv Dist	Yamada	Edsel	Chairman
St Louis Hts Comm Assoc	Ah Mai	Karen	
Star Bulletin	Ambrose	Greg	
Star Bulletin	Pendelton	Ray	
State Dept Land Natural Res	Devick	William	Acting Admin Aquatic Res Div
State Dept of Health: Envr Plng Off.	Harrigan	June	
State Legislature	Yoshinaga	Terry Nui	Representative
State Dept Health Off Envr Quality Control	Gill	Gary	Director
State Dept Education	Murakami	Colleen	Envir Ed Dir.
State Dept Attorney Gen.	Matsuda	Carolyn	
State Dept of Health	Miike	Lawrence	Director
State Hawaii Conv Center Auth	Hayashi	Alan	Executive Director
State Dept Transportation	Hayashida	Kazu	Director
State Dept Agriculture	Nakatani	James	Director
State Dept EDT Off Plng	Egged	Rick	Director
State Legislature	Fox	Galen	Representative
State Comm Water Resources Mngt	Higa	Dave	

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
State Legislature	Fukunaga	Carol	Senator
State Dept Land Natural Res	Coloma-agaran	Gil	Deputy Director
State Dept EDT Off Plng	Maki	Lorene	
State Legislature	Hiraki	Kenneth	Representative
State Dept Land Natural Res	Horiuchi	Don	
State Legislature	Ihara, Jr.	Les	Senator
State Hawaii Conv Center Auth	Inaba	Patty	Comm. Rel. Coordinator
State Dept Land Natural Res	Ching	Wayne	
State Legislature	Matsunaga	Matt	Senator
State Dept Land Natural Res	Monden	Andrew	Engineer
State Dept Defense	Price	Roy	
State Dept Health AWCWIP	Morita	Clyde	
State Dept Health	Rush	Randy	Coordinator Polluted Runoff
State Dept Attorney General	Lau	Laurence	Deputy Do Not Forward
State Legislature	Saiki	Scott	Representative
State Dept Transportation	Cabana	Felipe	
State Dept Transportation - Highways Div	Sakamoto	Roy	
State Dept Land Natural Res	Buck	Mike	Chief, Foresty Div
State Legislature	Say	Calvin	Representative
State Dept Agriculture	Kinro	Gerald	
State Dept Land Natural Res	Yamamoto	Mike	
State Dept Land Natural Res	Cottrell	Curt	Prog Mngr Na Ala Hele
State Office of Hawaiian Affairs			Administrator
State Dept Land Natural Res	Wilson	Michael	Director
State Dept Health	Smith	Gordon	Planner
State Hawaii Conv Center Auth	Varada	Suzanne	
State Dept Land Natural Res	Uchida	Dean	
State Dept Transportation - Airports Div	Shlapak	Ben	Head Planning Engineer
State Comm Water Resources Mngt			Director
State Dept Health	Anderson	Bruce	Deputy Director
State Dept of Education			Director
State Dept EDT Off Plng	Tom	Doug	
State Legislature	Taniguchi	Brian	Senator

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
State Legislature	Tam	Rod	Senator
State Dept Health: Envr Mngmt Div	Arizumi	Tom	Chief
State Dept Defense	Price	Roy	
State Legislature Sen Taniguchi	Higaki	Janis	
Summer Palace	Kevesque	H. M.	Board Member
The Estate of James Campbell	Ehrhorn	Charles	Land Planning Coordinator
The Queen Emma Foundation	Lzat	Danielle	
Timari Trading- Pier 23	Eggers	Loch	
Uh Seagrant	Woolaway	Chris	
UH Dept Geography	Shier	Anita	
UH Dept Ethnic Studies	Kelly	Marion	
UH Envr Center	Miller	Jackie	Associate Coordinator
UH Dept Planning	Kim	Carl	Professor
UH Cntr Sea Studies Shaps	Oharrow	Stephan	Director
UH Lyon Arboretum	Hirano	Robert	Assoc. Specialist
UH Envr Center	Harrison	John	Director
UH Ag Res Econ	Vieth	Gary	Professor
UH Lyon Arboretum	Baker	Ray	
UH Ctr Hwn Studies	Young	Kanalu	Dr
UH Dept Oceanography	Decarlo	Eric	(Rep. Mālama O Mānoa)
UH	Asato	Rani	
UH Law School	Jarmen	Casey	
UH Dept Geography	Woodcock	Debra	Professor
UH Dept Oceanography	Spencer	Khal	Assoc. Spec.
US Envr Protect Agency	Liu	Ed	
US Army Corps of Engineers			Division Engineer
US Geological Survey	Hill	Barry	
US Geological Survey	Brasher	Anne	Aquatic Ecologist
US Envr Protect Agency	Tsuhako	Vicki	Mngr Pac Is Con Office
US Senate	Inouye	Daniel	Senator
US Army Corps of Engineers	Pennaz	Jim	Hydraulic Engineer
US House	Mink	Patsy	Representative
US Dept Ag National Res Consv. Svcs	Smith	Chris	Soil Scientist
US Dept Ag NRCS	Mills-pako	Pamela	Dr

STEERING COMMITTEE MEMBERS			
Agency/group	**Last Name**	**First Name**	**Title**
US Envr Protect Agency	Strauss	Alexis	Director Water Division
US Dept Ag National Res Consv. Svcs	Nakamura	Shirley	Resource Conservationist
US Envr Protect Agency	Schulz	Michael	Assoc Director Water Division
US Dept Interior National Park Service	Stonier	Linda	
US Dept Ag National Res Consv. Svcs	Kaneshiro	Ken	
US Fish & Wildlife Service	Willis	Chris	P.o. Box 500088
US Envr Protect Agency	Li	Corinne (Wtr-6)	
US Envr Protect Agency	Wiltse	Wendy	
US House	Abercrombie	Neil	Representative
US Army Corps of Engineers	Lee	Mike	Aquatic Biologist
US Envr Protect Agency, Office of Regional Council	Lau	Laurence	Epa Region 9
US Senate	Akaka	Daniel	Senator
USAF - Hickam	Grannis	Bill	Environmental Engineer
Waikiki Yacht Club	Milano	Carol	
Waikiki Health Center	Chong	Frank	
Waikiki News	Smith	Cooper	
Waikiki Improve Association	Dodge	David	President
Waikiki Yacht Club	Doyle	Dan	Commodore
Waikiki Community Cntr	Apaka	Jeffrey	
Yacht Harbor Towers	Gordon	Richard	Bd of Dir Yht
Yacht Harbor Towers	Mitchell	H. Hugh	President Aoao Yht
Ymca Central Branch			Director
Youth for Environ Services	Casey	Sean	

APPENDIX C

BEST MANAGEMENT PRACTICES (BMP) WORKSHOP REPORT

Best Management Practices Workshop

A summary of the workshop with papers and materials submitted by participants

Held AT
Ala Wai Canal Watershed Water Quality Improvement Project
February 27 (Thursday), 1997 -- 8:00 AM to 4:00 PM

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D Criteria for Handling Drainage Discharge from Buildings and Appurtenant Structures, Gerald Takayesu, Chief, Storm Water Section, Department of Public Works, City & County of Honolulu

E Suggested BMPs for Litter and Debris Problems, Alex Ho, Environmental Engineer, DPW, C&C

F Gabion Streambank Protection Project Note, Richard Frey, Engineering Solutions, Inc, Aiea.

G Contaminants: Sources, problems, typical BMPs, Eugene Akazawa, Clean Water Branch, DOH.

H Streambank Vegetation BMPs, and Vegetation Types Suitable for the Ala Wai Canal Watershed, Lisa Farrantinos, Watershed Consultant.

I Contribution of Stream Channel Erosion to Sediment Yield from an Urbanizing Watershed, June Harrigan, Ph.D., DOH.

J Suspended Sediment Production from Forested Watersheds on Oahu, Hawaii, Submitted by U.S. Forest Service and DLNR Division of Forestry.

K Channel-Lock: Flexible Concrete Revetment, Manufacture's Literature.

L Copper, Brake Pads, & Water Quality, City of Palo Alto, DPW.

M Waikakalaua Stream Realignment Project, Troy Ogasawara, Hawaiian Fertilizer Sales.

N Port of Seattle Study Recommends that Sweepers Can Replace More Expensive BMP's for Removing Metals, Jackie Parnell, Environmental Planning Consultant, Honolulu.

O Volunteer Monitors Aspire to Better Data

P Water Quality Monitoring Report – May 1996 – 1997 Ala Wai Canal Watershed Project, DOH

Q Stockpile Runoff Project – Chromium Leachate Exceeded Standards, Khal Spenser, UH.

R Trapping Metals in Stormwater from Highway Runoff.

S Metal Removal from Stormwater in Street Storm Drain Catch Basins – Fossil Filters

T List of Manufacturers Contacts for Storm Water Treatment Devices, per Joanne McLaughlin.

U Aquashield Stormwater Filters for Street Storm Drain Catch Basins

V Stormceptor Stormwater Filters for Street Storm Drain Catch Basins

W Timari Pavement Grease & Oil Waterless Cleaner. Honolulu, David Buck

A Schedule of Presentors

SCHEDULE FOR BMP TECHNICAL WORKSHOP AND PANEL PARTICIPANTS

TIME	EVENT	AGENCY	Paper
8:30 to 8:45	Introduction and Purpose of Meeting: Identify BMPs (Best Management Practices) for the Ala Wai Canal Watershed to Improve Water Quality in the Canal and in the Streams (Palolo, Manoa and Makiki).	Gene Dashiell	Yes, summary report.
8:45 to 9:30	PANEL: Users and Uses of the Ala Wai Canal & Watershed Streams -- Water Quality Goals. The Canal serves as an urban storm drain. Its water quality must meet certain standards for: 1) recreational users (paddlers and fishers); 2) passive users (people who view or smell the canal); ocean receiving waters (floating debris kill ocean mammals, birds and fish).	DOH -- Gordon Smith	Yes
		DPR -- Terry Hildebrand	
		Oahu Canoe Racing Assoc -- Mike Tongg	
		DAR -- Mike Yamamoto	
9:40 to 10:20	PANEL: Urban Stream Restoration: Symbolic & Practical Importance to a Cleaner Canal. Improvement of the stream water quality is vital pre-requisite to improved Canal water quality. Stream restoration will add beauty to the urban environment and create long-term awareness in the community of the need for clean water.	DAR -- Mike Yamamoto	
		DPR -- Terry Hildebrand	
10:20 to 11:30	PANEL: Contaminants: Sources, Problems, Typical BMP's Dieldrin and chlordane from termiticides; lead and other metals from vehicles; litter and debris from streets; metals and sediment in-filling the Canal; and unhealthy bacteria are some of the contaminants in the Canal and streams. What are some of the Best Management Practices we can begin to apply? How effective will these initial measures be? What do we need to do for the longer term? Need more data? Need more money for remedial measures?	Pesticides -- DOA -- Gerald Kinro	
		Vehicles -- DPW -- Gerald Takayesu	Yes
		Litter and Debris -- DPW -- Alex Ho	Yes
		Metals & Sediment -- UH -- Khalil Spencer	
		Bacteria -- DOH - Eugene Akazawa	Yes
Lunch 11:30 to 1:00	Keynote Panel: Watershed Financing and Governmental Structure. How can recurring infrastructure costs be funded? Would a watershed governance body make sense in this situation? What governance alternatives should we consider during preparation of the watershed management plan?	Peter Kaanapu, Economist; RE^2 Casey Jarman, Attorney (U.H. Law School) and State Land Use Commissioner	
1:00 to 2:15	Vegetation for buffers and erosion control) -- addition vegetation for ground cover to prevent erosion and to filter storm runoff is one of our top BMP's. What plants are best?	Lisa Farrentinos (U.H. Dept. Agronomy & Soil Sci) Bob Hirano (Lyon Arboretum)	Yes
	Structural erosion control -- Some situations may undergo such erosion force (certain stream banks) that vegetation alone cannot withstand high velocity water flow. What structural measures (short of concrete lining) are available to us as environmental options?	NRCS -- Shirley Nakamura, Chris Smith J. P. Errett Inc. -- Lee Ann Errett	Yes Yes,
	Stream and Trail Restoration and Erosion Control - What are some of the present techniques being applied in the Ala Wai Canal Watershed?	Youth for Environmental Service DLNR/Forestry/Na Ala Hele	
2:25 to 3:40	Flooding Impacts -- The existing stream network (and the Ala Wai Canal) are flood control structures. How to meet recreational and water quality objectives ?	DPW/Drainage Div. (Richard Suzuki) USGS (Barry Hill)	
	Dredging recurrence intervals and impacts on aquatic life in the Canal(s) and streams -- Is the impact of recurring dredging adverse to aquatic habitat?	DAR (Mike Yamamoto) USF&WS (Chris Willis)	Yes
	Storm Drains - Can we retard storm runoff before it reaches the drains? Can we filter the runoff? How do we approach the massive complexity of the storm drainage system to improve water quality?	DPW (Gerald Takayesu) DOH (Alec Wong)	Yes

B Summary of BMP Workshop Presentations, Questions and Answers

ALA WAI CANAL WATERSHED
WATER QUALITY IMPROVEMENT PROJECT
BEST MANAGEMENT PRACTICES (BMP) WORKSHOP
FEBRUARY 27,1997
8:00 a.m. - 4:00 p.m.

Introduction by Gene Dashiell

The purpose of this meeting is to identify the Best Management Practices (BMPs) for the Ala Wai Canal Watershed to improve water quality in the Canal and the streams that feed into the Canal (Manoa, Palolo and Makiki).

These BMPs will be included in the Plan due on October 1, 1997.

Topics: Users and Uses of the Ala Wai Canal and Watershed Streams - Water Quality Goals

vGordon Smith - (DOH)

There are two components to water quality:

1. Designated Uses that are set by management goals and public policy;
2. Water quality criteria to support designated uses. These criteria are either basic or specific.

There are certain tools in developing BMPs:

1. Identify waters that consistently exceed water quality standards. The Ala Wai Canal and Watershed consistently exceed these standards.
2. Provide numerical estimates of water quality standard exceedence. For example provide a nutrient load calculation.
3. The Canal and Watershed must have monitoring strategies in place to provide information.

vMike Tongg - (Oahu Canoe Racing Association)

The main concerns for the paddling community are:

1. They need a healthy and safe environment for the Paddlers. There has been a major rise in health problems in the last 5 years. The BMP practices that are employed for the Canal and Watershed need to be implemented in all of Hawaii, and then the world.
2. In order to create a healthy and safe environment, everyone must be educated about the environment and the preventive measures needed to keep the Canal and Watershed clean. The education should include both children and adults. People must understand that keeping the Canal and Watershed clean and safe not only impacts paddlers, but the entire environment which in turn affects the aesthetic value of the area as well.

BMPs:

1. Must start with educating the public. Develop education program through the Department of Education to target the youth in society. They are more open and receptive to environmental concerns, and are ready to help.
2. There must be a monitoring system implemented. The paddlers would volunteer to assist in the monitoring process.
3. (Gene) Provide additional showers for paddlers to use. Mike Tongg's response was that it's a good idea, there are various sites already available, but they could always use more and even upgrade the existing shower areas.
4. Maybe create a wave machine to keep the Canal clean.

In closing Mike Tongg stated that the Canal has great potential to be a worldwide water activity attraction.

vMike Yamamoto - (DLNR):

The DLNR is responsible for the management and conservation of the water and fish in the State. The Canal and Watershed are fishery management areas. They are very concerned with the water quality and its impact on the fish.

Right now the fisheries cannot manage the exotic fish populations. In addition, the water quality is so bad that a cancer risk assessment done on the talapia showed that you mustn't each the fish. The public must be educated about the health risks.

vTerry Hildebrand - (DPR):

There are several parks that border the Canal and Watershed areas. The public must be educated as to the best way to use the land surrounding these areas. The must understand the impact they have on the land and the Canal and Watershed.

BMPs:
Avoid stockpiling dirt near streams, stop spilling trash and garbage into streams, and prevent storm water from flowing over parking lots and into storm drains.

Question: Where does the Ala Wai Canal water go?
Answer: The water can flow to Ala Moana or to Diamond Head. There has been a higher bacteria count at beaches directly related to the Canal.
Question: Will the Humpback Whale Sanctuary will be affected by the Canal.
Answer: Don't know. (Mike Tongg)
Comment: To see where the Canal water flows into the ocean, watch after a big storm and you can see where the water flows.

Topic: Urban Stream Restoration

vMike Yamamoto - (DAR)

Aquatic resources in Canal and Streams. There are various fish types in the streams and canal. They have had problems with exotic fish in the Canal and Streams, they cannot control the populations.

There are five native O'opu (fish) species in the streams. They spawn in the estuaries and the larvae live in the ocean, then make their way back to the stream.

vTerry Hildebrand: - (DPR)

BMPs during construction:
Must use geobinding materials; matting stabilizes the soil until vegetation takes hold. Everyone must be aware of all the areas that could cause contamination of the Canal and Streams.

BMP:
Promote Greenways along the Streams. Using Greenways would promote public awareness and desire to keep the Streams and surrounding areas clean.

vLanky Morill: - (DPR)

By planting along the Canal and Streams, you are planting ownership. The users, neighbors, especially areas that feed Canal will benefit. The community must become involved, that is the solution.

BMPs:

The public needs to be involved. The government can facilitate, provide expertise, but there isn't enough money in government to handle the entire problem. You must start with education, and you should start with the young. Kids are more enthusiastic and take the message about the environment to heart and home. Their actions affect their parents, who have been less likely to change their ways. Kids put pressure on their parents to stop littering. You can end litter by stopping people from littering. Continue with the Adopt-A-Park program with the City. This will lead to better awareness among the public.

Topic: Contaminates: Sources, Problems, Typical BMP's.

vGerald Kinro - (DOA)

The majority of pesticide contamination is from termicides. There are different types of termite control processes available. Chemical barriers are pumped into the ground and bind to the soil. The soil then washes into the Canal and Streams.

BMPs to prevent this type of problem:

1. Control runoff.
2. Monitor, or better yet, instigate Integrative Pest Management (IPM). IPM would require economic /aesthetic threshold to apply IPM.
3. Need to modify construction, design and landscaping practices to help control runoff.
4. Use alternative termite products such as basaltic termite barriers in conjunction with treated wood, or use termite bait systems.

Question: Are basaltic termite barriers mandatory?

Answer: No, not yet.
Question: What is the reapplication rate for the chemicals?
Answer: There is no set rate. Only spot treatments are done if needed. Some studies show a 6 year rate.
Question: What was the wood treatment controversy?
Answer: Some chemicals didn't penetrate wood, the other was that the chemical did penetrate the wood but wasn't effective.

vVehicle Pollution: Gerald Takayesu - (DPW)

Vehicle pollution includes leakage of fuel, oil, batteries.

BMP:

1. **Need to clean streets, storm drains and streams, thereby eliminating pollution into the Canal and Streams.**
2. **Must have public education, such as workshops to provide information on how people affect the Canal and Streams. Condo car washes were discussed as a source of the pollution.**
3. **We must explore alternative sources of fuel.**

vOngoing City Programs: Alex Ho - (DPW)

There are various ongoing City programs to help prevent and clean litter. Education is key to preventing litter. Everyone must understand the problems associated with littering. There must be Community participation in these efforts. Various programs that are in effect and have been effective are: the stenciling of storm drains, Adopt-A-Stream program, Adopt -A- Highway program (State), Adopt-A-Park program, and installing floating booms to catch debris.

Question: What kind of litter have you been finding?
Answer: All kinds.
Question: Any information on the extent of pollution that comes from drivers, licensed or unlicensed companies?
Answer: They are monitoring catch basins near industrial and residential areas. Operation Kokua collected a lot of the bulk garbage that had been lying around the City.
Question: Why can Condos use car washes now? They were stopped for a while.
Answer: Interpretation of the law changed. Condos are now included in the single family residence category (per EPA).

vMetals and Sediment: Khalil Spencer - (UH)

Lead pollution (metals) stay bound to soil. The soil transports the pollutants to the Canal.
BMP: Prevent soils from going into streams.

Metal content of streams is progressively worse as you go down the streams. Metals are still leaching out of the streams. Lead is coming from older homes with lead paint, cars, busy roads (Lead content gas).

BMP: Control what is already out there and prevent future contamination. For example: Erosion control around older homes and heavier used roads through vegetation.

Dumping controls, reinstate periodic junk pickups. There must be education to teach the importance of prevention and the impacts these pollutants have on the environment.

Question: Do these metals ever go up stream (copper)?
Answer: They usually come from residential properties.
Question: Erosion control would mean keeping the contaminants where they are now. (in the ground around the older homes). Wouldn't letting the contaminants flow into the streams and then collecting it all in one place be easier?
Answer: How much money do we have to clean up? Prevention would help.

vBacteria Contaminants: Gene Akazawa - (DOH)

BMP - Managing public health risk.

What have they learned from the indicator bacteria?

No water quality standard will guarantee complete safety, it's relative. They have set a local level. The density of bacteria is always heavier immediately after a heavy rain. The same months that have heavy rainfall are the same months that show high levels of indicator bacteria. The sources can also be attributed to nonpoint pollution. Bacteria are found in soils, vegetation, birds, it's naturally occurring. Therefore the existing water quality tests won't tell us the acceptable level of risk.

BMPs:

1. **Must try to prevent sewage spills/breaks. We will always have spills/breaks so we must have a plan to reduce health risks when they occur.**
2. **There are risks associated with handling and disposal of toxic materials. What are the risks associated with consumption of contaminated fish or shellfish?**
3. **We can reduce the risks by educating the users of the Canal. Inform them of the precautions they can take (showers?) if they fall in the water. An idea would be to have chlorine dispensers attached to the showers.**
4. **We must determine how safe the Canal is for the users.**

In closing he stated that the water quality standard for streams in Hawaii is set at 200 fecal coliform units. That would be the same as dumping one gallon of untreated sewage into a 10,000 gallon pool that is not chlorinated. Would you swim in it?

Question: Do we have any evidence of health problems?
Answer: There have been cases of paddlers getting ill, but nothing documented.
Comment: Need to be aware that showers at Ala Moana Beach are very close to the ocean and soaps is getting into the sand and then into the ocean.
Comment: There is no specific information as to who gets sick, but now paddlers will be completing surveys on their health.
Comment: Boat cleaners in the Ala Wai Harbor should be surveyed since they are in the water everyday.
Comments: Lead content drops off as you go up the valleys. Different vegetables soak up different levels of contaminants.

Topic: Watershed Financing and Governmental Structure
General Discussion with Group

vPeter Kaanapu - (RE2, Economist)

The current clean up will be funded by a municipal bond. (10 million to 12 million). This creates a never ending cycle of paying for clean up with borrowed money.

BMP:
The City should instead start saving money and putting it away into a specific fund.

You need to identify who benefits from the Canal and Streams. The users, property owners, Waikiki (benefits due to the Canal's flood control.)
Should we over dredge the Streams? It's easier to clean them than the Canal. However, the native species in the Streams may be adversely affected.

vComments by Casey Jarman, Esq. - (Attorney UH Law School)

It is very easy to slip into a "planning" mode, with no implementation. We lack money to initiate the program. One way to get things going is for there to be a crisis. Unfortunately, the Canal is not seen as being at a crisis level yet.

How do we take all the players involved and put them together into one entity in charge of cleaning and managing the Canal and Streams. The State believes it's a City problem. We need joint cooperation between the City and State. Have the State create a single entity that manages the Canal, include the City and all appropriate entities.
Comment: Are we looking long term here, or just this one clean-up?
Response: We are looking to the future and how to manage this complex system.
Comment: Money can bring everyone together. Legislate an entity to deal with it.

Various examples were given of other entities in the U.S. dealing with similar problems. Casey gave as an example the Mississippi Gulf Coast Authority. They were in charge of the waste water facilities in a 2 county area, and were in charge of planning, funding, building, permitting. All requests went through them. They have different Boards for policy and day to day operation. They had an advantage because they charged user fees.

Another example was the Alameda system.

Various Comments:
- Overall it would be ideal to create an Authority that has its own authority and is not just advisory in nature.
- One way to get the Plan enacted is to go through Legislation.
- You could house this "Authority" in another government agency without creating a new department since the number of government departments is limited by law.
- There is general frustration in the public that something should be done, but government is passing the buck.
- There is also the problem of what to do with all the dredged materials.

Question: What's the probability of citizens' groups banding together to work with government?
Answer: Not much chance, however, that would be the best way.

Topic: BMPs for
Vegetation for Buffers and Erosion Control, Structural Erosion Control, Stream and Trail Restoration and Erosion Control

vVegetation - Lisa Farrentinos - (UH Dept. of Agronomy & Soil Science)

There are various plants available to use as vegetation buffers and for erosion control. Generally people use rock/concrete banks or vegetation or a combination of both. Why would you use vegetation? It would protect streambeds, it provides habitat for aquatic life, and acts as a buffer for runoff into streams. Forested buffers are preferred, however what is below the trees is more important than the trees. You need to be aware that there is still erosion in the forests.

BMP:
Try to regrade stream systems and incorporate vegetation. You could create terraces, use fascine systems, install brush layers that build up bank, use gabions with vegetation, bioretention systems, swales construction.

There are various and numerous types of vegetation available with good root systems.
Question: Would bamboo work?
Answer: No, and its use would be controversial.

Comment: You need to have cooperation to help with establishing system and maintaining the system.

vVegetation - Bob Hirano - (Lyon Arboretum)

Sedimentation occurs during heavy rainfall, landslides contribute the most into the streams. The average month the stream runs clear. Big culprits to erosion are the trails and pigs, who deplete the vegetation. There is very little native plant life left in Manoa valley.

Question: Have you seen many changes over the past years?
Answer: Insects. Made big push to re-establish native plants but they are difficult to grow in areas that have been taken over by exotics.
Question: How much stream land is under your control?
Answer: Little more than 1/2 mile.
Question: Do you have bank problems?
Answer: Not too many bank problems - new vegetation grows quickly.

vStructural Erosion Control: Chris Smith - (NRCS)

There is a need to start focusing on urban issues in this area. There are various examples of construction maintenance problems in the area. You could reconstruct concrete stream beds to change the velocity of the water.

BMP:
Building inspectors should get out to the sites more often and check for soil erosion and require changes if needed. Building permits should be modified to include soil protection.

Question: What proportion of sediment comes from headlands vs. lowerlands?
Answer: Will always have problem because rocks are soft in Hawaii. Not much time has gone by in the time line of the Earth.

BMPs:
1. **We need inter-government/community cooperation to have one purpose and everyone must buy into the process. We must educate individuals so they understand what needs to be done to help solve and prevent erosion. This would be a long term solution.**
2. **There should be special BMPs for parking lots.**

Comment: new subdivisions in valleys only increase the erosion and flooding (roads and driveways).

vLee Ann Errett: Private sector supplier of erosion control products (i.e. gabions, fabric, mesh).

vStream and Trail Restoration - Brian Schatz - (Youth for Environmental Service (YES))

He visits schools to talk about watersheds and their affect on the environment.

BMPs:

1. **YES has adopted Manoa Valley Trail and assisted in providing erosion control measures. (replanting, keeping trails clear and clean). Their organization gets the kids involved and they are more willing to help and learn about the environment. They also remove debris from the Stream.**
2. **It is very important to get the community involved, you can generate a community ethic. Find ways to get community involved in activities that would have an immediate impact on the area, thereby generating a specific interest in that area.**
3. **YES has been involved in stenciling the storm drains. It's very easy to get kids out there to do it. The stenciling has generated a lot of TV coverage and therefore more awareness about dumping trash into the drains.**
4. **You need to understand that kids affect the adults. Their actions can help change adult behavior.**
5. **Trail users and the community must be educated so they understand how their actions affect the environment. Usually if you explain the problems to people, they are very receptive.**

Question: What kind of trash have you been picking up?
Answer: Old household items mostly. Picking up trash has positive effect, because when an area looks cleaner with less trash, less trash will be dumped in that area.
Question: Would it help to have transfer station for bulky trash?
Answer: The City already provides a bulk pick up service. Maybe the answer would be to get that information out to the public.

Comment: It could be that it's the commercial quantity dumping that is the problem.

vErosion Control - Troy _____

BMP:
Businesses who provide erosion control measures need to get there product information out to the public.

When thinking about implementing erosion control, there are certain erosion control factors to consider:

- Look at perimeters of your area. What are you trying to accomplish?
- Can the soil host vegetation?
- What kind of maintenance will be needed?
- Can I use new technologies?
- What do you desire and what can you accept?
- Money issues.

Topic BMPs
Flooding Impacts, Dredging and Storm Drain Systems

vStorm Drain Systems - Alec Wong (DOH)

Permits are needed to insure industrial companies comply with regulations.

Try to control/reduce pollutants from entering drains. Try to eliminate discharge into the drain system. Need to collect samples to test for contamination.

BMP:

1. **You must have a permit to discharge into the storm drain system. Industrial activity must have permit to discharge into storm drain system. Need to emphasize Source Control. Stop pollution at the source and eliminate the need for clean up.**
2. **Construction sites must have permits that state the site specific controls. These BMPs must be implemented before the construction starts. DOH doesn't dictate which BMP to use, as long as they are using them. The Contractor picks the BMP type that is appropriate to the site.**

Question: Are there BMPs that can work for auto pollution coming in from the City streets?
Answer: The streets must be kept clean, storm drains must be cleaned, public must keep their cars in good repair and clean. Clean up the catch basins.

vStorm Drains - Gerald Takayesu - (DPW)
(Questions are taken directly from the agenda)

Question: Can we retard runoff before it reaches the drains?
Answer: Yes. Built up areas are more difficult. Now developments are easier because erosion control measures can be built in from the start. All runoff can be directed into planted areas.
Question: Can we filter the runoff?
Answer: Yes, by running the runoff through planted areas.
Question: How do we approach the massive complexity of the storm drainage system to improve water quality?
Answer: Prevent pollutants from entering system! How? By using the various methods discussed today.
Question: What is the design?

Answer: They don't have one yet.

vBarry Hill - (USGS)

Barry described the USGS activities:

Stream flow record stations. Shows flow but not quality.
Crest 8 gauge (I'm not sure I heard that correctly)
They are involved in training with the DPW regarding water discharge and sediment.
The NWQAP (National Water Quality Assessment Program) will be implemented and will then be involved with the Canal.

vRichard Suzuki - (DPW, Drainage)

Flooding Impacts:

1. Try to get rid of the drainage.
2. The Basin has many flood zones and flood ways
3. Island wide problem, not just Canal and Streams
4. They are working on drainage standards, they are working with NPDS
5. The velocity of the water causes a lot of sedimentation. Sedimentation comes from conservation zone lands.
6. Getting rid of the dredged material will be very difficult. The cost will be very high.
7. Golf courses can help remove pollutants and help prevent runoff and erosion.

Question: What is flood level in Waikiki?
Answer: 2 or 3 feet
Question: Was 1968 most recent "big event" in the Canal and Watershed area?
Answer: Not sure. But there has been localized major storms instead. Hawaii Kai in late 80"s, recent flooding in Waianae.
Question: Stream maintenance. Does City maintain privately owned streams?
Answer: City does help if danger exists. Recent litigation shows that City does have obligation to maintain streams even if they are privately owned.
Question: Would catch basins help?
Answer: Yes, but very expensive.

Comment: Flood waters contain contaminants, the flood channels are undersized.
Comment: We need to look at recent storms, there has been a lot of flooding. Iniki waters flooded Waikiki/Ala Wai flooded into Waikiki.

vMike Yamamoto - (DAR)

Dredging affects on organisms.

There isn't much information available on this subject. He believes that the organisms will recover quite quickly. If necessary, you could restock the population from other streams. He wanted to be clear that the benefits of dredging far outweigh the affects on the organisms.

The impacts of dredging are immediate and short term, and it could even help the organisms and fish. Where will the sediments be disposed of? That is one of his major concerns, since it could impact other organisms.

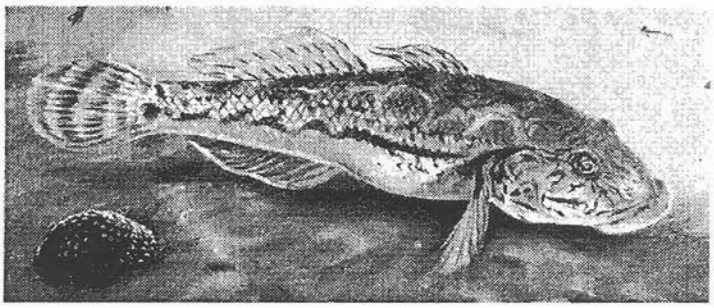
Question: What would be criteria for sediment dumping?
Answer: Upland redistribution of sediments if not contaminated. Ocean dumping.
Question: What would happen if the sediment basin was dredged in Manoa area? Would it impact fish?
Answer: The lower dwelling fish would be impacted.
Question: Did bulldozing affect the stream?
Answer: Yes, habitat affected if dredged deeper.
Question: Would sediment traps upstream be cost-effective? Or would it be better to accumulate in one place?
Answer:

Comment: The Canal sediment is maxed out. Dredging would be a positive move.

C Water Quality Standards in the Ala Wai Canal Watershed

Gordon Smith, Department of Health, Environmental Planning Office

Water Quality Standards
In the Ala Wai Canal Watershed



- Hawaii Administrative Rules Title 11, Chapter 54, Water Quality Standards.

BEST MANAGEMENT PRACTICES WORKSHOP
ALA WAI CANAL WATERSHED WATER QUALITY IMPROVEMENT PROJECT
February 27, 1997

Components of Water Quality Standards

- Designated uses of waterbodies -- management goals / public policy.
- Water quality criteria to support uses -- technical / scientific.
  - ✓ Basic criteria → narrative.
  - ✓ Specific criteria → numeric values.

Examples – Designated Uses and Criteria:

- **Designated use:** ***recreation in or on water*** **(management goal).**
- **Water quality criteria to support use:**
  - ✓ **Narrative: "*...waters shall be free from floating debris, oil, scum...*"**
  - ✓ **Specific: " < *200 colonies/100 ml fecal coliforms*"**

Inland Waters of Hawai'i				
Water types	**Ecological Subtypes**			
	Flowing waters	**Standing waters**	**Wetlands**	**Estuaries**
Fresh waters (<0.5 ppt)	* Streams	* Natural fresh-water lakes	* Elevated wetlands	
	* Flowing springs and seeps	* Reservoirs	* Low wetlands	
	* Ditches and flumes			
Brackish or saline waters (>0.5 ppt)		* Saline lakes	* Coastal wetlands	* Natural estuaries
		* Anchialine pools		* Developed estuaries

Water Quality Management
Environmental Planning Office - DOH

DESIGNATED USES FOR INLAND WATERS OF HAWAII

❀ CLASS 1: PRISTINE-PRESERVATION / NO WASTE DISCHARGE ALLOWED

✓ CLASS 1a: Non-consumptive
- scientific and educational purposes
- baseline references
- breeding stock
- compatible recreation
- aesthetic enjoyment

✓ CLASS 1b: Limited-consumptive
- domestic (drinking) water supplies
- food processing
- support and propagation of aquatic life
- compatible recreation
- aesthetic enjoyment

❀ CLASS 2: EXPLOITATIVE CONSUMPTIVE / DISCHARGE ALLOWED
- recreation (including bathing and swimming)
- agricultural and industrial water supply
- shipping and navigation
- protection and propagation of aquatic life

DOH Water Quality Management Programs Ala Wai Canal Watershed

Tools for BMP Development
Methods to Measure BMP Effectiveness

❀ 303d List – Water Quality Limited Waters: consistently exceed WQS.
✓ Ala Wai Harbor, Ala Wai Canal, Manoa Stream, Palolo Stream included in current revision.

❀ Total Maximum Daily Load – Numerical estimate of WQS exceedance.
✓ Calculated for nutrients in the Ala Wai Canal (with info on sediment load).
✓ 42.7 kg/day excess nitrogen, 22.4 kg/day excess phosphorous.
✓ Guidelines for reduction of nutrient input.

❀ 305b Monitoring -- Water Quality Report (Clean Water Branch Monitoring Section)
✓ Watershed-based water quality monitoring in Ala Wai watershed.

D Criteria for Handling Drainage Discharge from Buildings and Appurtenant Structures

Gerald Takayesu, Chief, Storm Water Branch
Department of Public Works
City & County of Honolulu

per Gerald Takayesu

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

JEREMY HARRIS
MAYOR

KENNETH E. SPRAGUE
DIRECTOR AND CHIEF ENGINEER

IN REPLY REFER TO:
95-15-0099

June 14, 1995

ENGINEERING AND POLICY MEMORANDUM NO. 2-95

TO: ALL ENGINEERS AND ARCHITECTS

FROM: KENNETH E. SPRAGUE, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

RANDALL K. FUJIKI, DIRECTOR AND BUILDING SUPERINTENDENT
BUILDING DEPARTMENT

FELIX LIMTIACO, DIRECTOR
DEPARTMENT OF WASTEWATER MANAGEMENT

SUBJECT: CRITERIA FOR HANDLING DRAINAGE DISCHARGE FROM BUILDINGS AND APPURTENANT STRUCTURES

Laws: Chapter 342D, Hawaii Revised Statutes, "Water Pollution"
Chapter 14, Articles 1 through 11, Revised Ordinances of Honolulu 1990, Sewer Ordinance

Chapter 14, Article 12, Revised Ordinances of Honolulu 1990, "Drainage, Flood and Pollution Control"

This supersedes our memorandum, No. 1-94, dated February 8, 1994.

By regulations (40 CFR Part 122, Subpart B) effective November 16, 1990, large and medium municipal separate storm sewer systems are required to have a National Pollutant Discharge Elimination System (NPDES) permit for storm water discharges. The regulations implement Section 402(p)(3)(B) of the Clean Water Act (CWA) which includes a requirement to effectively prohibit non-storm water discharges into the storm sewer.

On August 8, 1994, the Department of Health (DOH) issued NPDES Permit No. HI0021229 to DPW, effective September 7, 1994, for the City and County municipal separate storm sewer systems (MS4). The permit requires DPW to effectively prohibit non-storm water discharges through its storm sewer systems into State waters except runoff from fire fighting activities which is exempt by Federal

regulations. NPDES permitted discharges and certain non-storm water discharges that are not a source of pollutants may be discharged into the MS4 without an NPDES permit.

The following classes of non-storm waters may be discharged into the municipal separate storm sewer systems without an NPDES permit, provided the discharges are not a source of pollutants: landscape irrigation and irrigation water, excluding runoff from commercial agriculture; foundation and footing drains, not including construction related dewatering activities; water from crawl space pumps, including discharge from buildings with basements, and crawl space pumps used by utility companies to dewater utility manholes and other maintenance and operation substructure facilities; flows from riparian habitats and wetlands; air conditioning condensation; spring water; lawn watering; individual residential car washing; dechlorinated swimming pool water; street wash water; fire hydrant flushing and discharges from potable water sources.

NPDES permitted discharges include but are not limited to: storm water associated with industrial facilities; storm water associated with construction activities; treated groundwater from leaking underground storage tank remediation sites; once-through non-contact cooling water, 1 mgd or less; hydrotesting water, and construction dewatering. Non-storm water discharges and NPDES permitted discharges into the MS4 require an effluent discharge permit from the Storm Water Quality Section, Division of Engineering, DPW. Call 527-6104 for more information.

General guidelines in effect as of this date for handling drainage discharges from building and appurtenant structures are as follows:

1. In general, polluted waters shall be discharged into sanitary sewers, injection wells or dry wells. Pretreatment measures, as necessary, may be required by the Department of Wastewater Management for sanitary sewer connections; and need for treatment may be required by the DOH for disposal into injection wells or dry wells as stipulated under Chapter 11-23, Underground Injection Control (UIC), Hawaii Administrative Rules. The UIC regulations prohibit any underground injection, which is not authorized by a permit issued by the DOH.

2. Domestic wastewater and industrial wastewater shall be connected to sanitary sewers only after permits have been obtained from the Department of Wastewater Management. For industrial wastewater, an Industrial Wastewater Discharge Permit (IWDP) must be approved by the Department before a connection permit will be issued. Call 527-5377 for more information.

3. If discharge to sanitary sewers or storm sewers is not possible, dry wells and/or injection wells by UIC permit should be investigated. Contact the DOH Safe Drinking Water Branch at 586-4258 and the Clean Water Branch at 586-4309.

4. All connections to the municipal storm sewers require prior approval and a private drain connection license from the Storm Water Quality Section, Division of Engineering, DPW. Call 527-6104 for more information.

The following table indicates types of discharges and the system to which connections are generally permitted:

	Discharge	Sanitary Sewer	Storm Drain
1.	Indoor Commercial and Condominium Car and Equipment Wash Water with Pretreatment	Yes[1]	No
2.	Outdoor Commercial and Condominium Car and Equipment Wash Water without Roof with Pretreatment	Yes[1, 12]	No
3.	Drains for Storm Water Runoff and Roof Drains	No	Yes
4.	Floor Drains for Covered Parking Areas, Warehouse and Washdown Areas	Yes[2]	No[3]
5.	Floor Drains for Boilers, Hot Water Generators, Compressors, Relief Valve Drains or Steam Blowoff Separators, Freezers, Ice Machines	Yes	No
6.	Swimming Pool Water, Jacuzzis and Spa Drains	No	Yes[4]
7.	Swimming Pool Water, Jacuzzis and Spa where there are no Storm Drains	Yes[5]	N/A
8.	Swimming Pool, Jacuzzis and Spa Backwash Water	Yes	No[6]
9.	Indoor Fish Pond Drains and Backwash	Yes	No
10.	Outdoor Fish Pond Drains and Backwash	Yes[7]	No
11.	Sump Drains for Uncontaminated Ground Water Seepage	No	Yes
12.	Air Conditioning Cooling Tower Waste Water	Yes	Yes[8]
13.	Air Conditioning Once-Through Condenser Water	No	Yes[8]
14.	Air Conditioning Cooling Coil Condensate	Yes	Yes[11]
15.	Indoor Decorative Features including Backwash	Yes	Yes[8]
16.	Outdoor Decorative Features and Fountain including Backwash	Yes[7]	Yes[8]
17.	Equipment Cooling Water	Yes[9]	Yes[8]
18.	Elevator Sump	Yes[10]	No

NOTE: For discharges into sanitary sewers from Items 4, 5, 7, 8, 9, 10, 12, 14, 15, 16, and 17, the discharge rate should not exceed 200 gallons per minute (gpm).

[1]Discharge into sanitary sewers will be permitted only after dry well or injection well is not acceptable. Dry well and/or injection well must be approved by the State DOH Safe Drinking Water Branch. Pretreatment shall mean oil separators and settling basins. Wash water should be recycled if feasible before discharge into sanitary sewers.

[2]Pretreatment may be required. Outdoor washdown area require adjacent grade to slope away from washdown slab. Slab shall have overhead roof, otherwise floor drain shall be Fox 3DS wastewater diversion system or approved equal.

[3]Floor drains receiving storm water runoff from exposed floors or other similar adjacent surfaces shall be discharged into the storm drains.

[4]Swimming pool discharge shall not have any chlorine residual. A DPW effluent discharge permit is required and all discharges must be reported to and recorded by DPW, by the owner or a swimming pool contractor permittee.

[5]Only if there is no storm drainage system and discharge on lot and street will create a nuisance or hazardous condition.

[6]Discharges from single family residential swimming pools into storm sewer may be allowed if sanitary sewers are not available or household cesspools are located in critical wastewater disposal areas. Also see Footnote 4 above.

[7]Overflow shall discharge to storm drains via a separate pipe.

[8]Only if water is not a source of pollutants. An NPDES permit and a DPW effluent discharge permit are required. Planter box discharges do not require an NPDES permit.

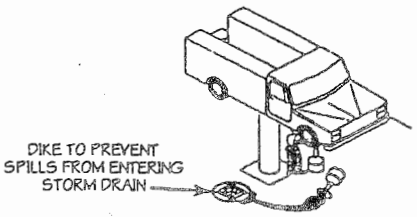
[9]Once-through systems shall discharge to storm drains via a separate pipe.

[10]Oil separator required for sumps serving hydraulic systems.

[11]Only if water is not a source of pollutants.

[12]Storm water runoff to storm drains via a separate pipe with proper valving.

BMP: VEHICLE LEAK AND SPILL CONTROL



Program Elements

- New Development
- Residential
- Commercial Activities
- Industrial Activities
- **Municipal Facilities**
- Illegal Discharges

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This BMP covers only prevention and cleanup of spills from vehicles. SC41 contains information on prevention and cleanup of spills from aboveground storage tanks. See SC4 in the Industrial Handbook for more information regarding BMPs for vehicle maintenance shops (such as municipal service centers or corporation yards).

APPROACH

Vehicles will leak and spill fluids. The key is to reduce the frequency and severity of leaks and spills, and when they do occur, to prevent or reduce the environmental impacts.

- Perform fluid removal and changes inside or under cover on paved surfaces.
- Properly store hazardous materials and waste.
- Have spill cleanup supplies readily available.
- Clean up spills and leaks immediately.
- Use dry cleanup methods.
- For a quick reference on disposal alternatives for specific wastes, see Table 4.1, SC50, Illegal Dumping Control.

REQUIREMENTS

- Cost Considerations
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.
- Regulations
  - This is not a major element of this best management practice.
- Administrative / Staffing
  - This BMP has no major administrative or staffing requirements.
- Equipment
  - Keep ample supplies of spill control and cleanup materials at municipal facilities, near storage and maintenance areas.
  - Update spill cleanup materials as changes occur in the types of chemicals on-site.
- Training
  - Training is crucial to reducing the frequency, severity, and impacts of leaks and spills.

PUBLIC EDUCATION / PARTICIPATION

- Encourage the general public to regularly inspect and maintain their vehicles.

LIMITATIONS

- For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Targeted Constituents

- ○ Sediment
- ○ Nutrients
- ● Heavy Metals
- ● Toxic Materials
- ○ Floatable Materials
- ○ Oxygen Demanding Substances
- ● Oil & Grease
- ○ Bacteria & Viruses

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ○ Regulatory
- ○ Staffing
- ● Training
- ○ Administrative

● High ○ Low

SC40

Best Management Practices

Additional Information — Vehicle Leak and Spill Control

Major spills on roadways and other public areas are generally handled by highly trained Hazmat teams from local fire departments or environmental health departments. The measures listed below pertain to leaks and smaller spills at vehicle maintenance shops (such as municipal service centers or corporation yards).

General Measures

- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.

Cleanup

- Clean up leaks and spills immediately.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.

Reporting

- Report spills to local agencies, such as the fire department; they can assist in cleanup.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- Perform all vehicle fluid removal or changing inside or under cover to prevent the runon of storm water and the runoff of spills.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Immediately drain all fluids from wrecked vehicles.
- Store wrecked vehicles or damaged equipment under cover.
- Place drip pans or absorbent materials under heavy equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

SC40

Best Management Practices

Additional Information — Vehicle Leak and Spill Control

Vehicle and Equipment Fueling

- Design the fueling area to prevent the runon of storm water and the runoff of spills:
  - Cover fueling area if possible.
  - Use a perimeter drain or slope pavement inward with drainage to a sump.
  - Pave fueling area with concrete rather than asphalt.
- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off" of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.

Municipal Spill Prevention/Response

For the purposes of developing a spill prevention and response program to meet the storm water regulations, municipalities should use information provided in this fact sheet, SC41, and the spill prevention/response portions of the fact sheets in Chapter 4, Industrial Hanbook, for specific activities. The program should:

- Integrate with existing emergency response/hazardous materials programs (e.g. Fire Department);
- Develop procedures to prevent/mitigate spills to storm drain systems;
- Identify responsible departments;
- Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures; and
- Address spills at municipal facilities, as well as public areas.

Examples of Effective Programs

The City of Palo Alto includes spill prevention and control as a major element of its highly effective program for commercial and municipal vehicle maintenance shops.

REFERENCES

Water Quality Best Management Practices Manual, City of Seattle, 1989.

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices, USEPA, July 1992.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

SC40

Department of Public Works
City and County of Honolulu
March 12, 1996

Fact Sheet: Vehicle Maintenance Shops and Nonpoint Source Pollution

How can vehicle maintenance shops help reduce pollutants from reaching our streams and the ocean? By using best management practices at the work place and proper disposal of vehicle and equipment wash water. The following list is taken from the U.S. EPA document titled "*Storm Water Management for Industrial Activities, Developing Pollution Prevention Plans and Best Management Practices*".

BEST MANAGEMENT PRACTICES

- Used oil and grease should be collected in containers and properly disposed of through one of the recyclers such as UNITEK or Industrial Technology.
- Avoid hosing down work areas.
- Use drip pans under vehicles which might leak while you work on it to keep oil off the floor.
- Use absorbent materials or other methods to pick up oil spills.
- Locate waste and recycling drums in properly controlled areas, preferably those with concrete slab floors and a secondary containment area.

VEHICLE AND EQUIPMENT WASH WATER DISPOSAL

On June 14, 1995, the City issued Engineering and Policy Memorandum No. 2-95, to architects and engineers. It addressed disposal of different types of discharges, including wash water.

- If the wash area is covered (not exposed to rain), wash water can be discharged into the sanitary sewer system provided it first passes through an oil-water separator.
- If the wash area is in an open area (exposed to rain), then the wash water must be separated from rain water using a diverter valve. With the hose bibb off, the rain water goes to the storm drain system. With the hose bibb on, wash water goes first to an oil-water separator, and then to the sanitary sewer system.

Discharge permits are required from the Department of Wastewater Management in both cases. And if the storm water goes to the separate storm sewer system, then a drainage connection permit is required from the Department of Public Works.

c:\jerry\factsht\veh_maint.311

E Suggested BMPs for Litter and Debris Problems, Alex Ho, Environmental Engineer, DPW, C&C

per Alex Ho

BEST MANAGEMENT PRACTICES WORKSHOP

February 27, 1997

Litter and Debris

Every time, after a heavy rain or an intensive shower, one common phenomenon in the Ala Wai Canal is that large amount of debris and litter is floating either in the canal or lying on the canal's bed. Roughly, one-third of all debris consists of tree leaves and large branches which may be the result of a combination of natural shredding and homeowners dumping tree trimmings behind their homes along streamsides that subsequently washed downstream. In addition, aluminum cans, food containers (i.e. beverage bottles, cups, plastic wrapper, and styrofoam cartons), cigarette butts are, by far, the most common litter floating on the canal. The areas where litter was found are near bridge crossings, and roadsides mauka of the canal.

The most effective way to control and reduce litter and debris dumping is through public education and public participation. Currently, the City has the following programs that would control and reduce litter/debris problems:

1. Storm Drain Stenciling

   With a joint effort between the City and the State Department of Health, a storm drain stenciling program was established in early 1996. The volunteers which consist of citizen groups, school students and environmental communities stenciled the City storm drains with a message of "No dumping, goes to ocean". Thus far, more than 9,000 storm drains have been stenciled and the program has been expanded to include military housing areas.

2. Adopt-A-Stream Program

   In September 1996, the City developed an "Adopt-A-Stream" program of which the purpose was to promote public environmental awareness and understanding related to nonpoint source control in order to preserve our natural resources and improve the quality of our lives. The program provides an opportunity for interested community groups to take ownership of their streams and to keep the stream free from litter and other pollutants. Each group will have a sign displaying the organization's name posted at the adopted section of the stream. The City will provide supplies and materials for stream litter cleanup and subsequent garbage bags pick-up. So far, 32 community groups have participated in this program.

3. Adopt-A-Park Program

   The Department of Parks and Recreation, City and County of Honolulu, has an "Adopt-A-Park" program which enlists public and private organizations and individuals to voluntarily maintain park lands including litter pick-ups. Presently, 115 of City parks have been adopted.

4. Public Education Program

   The City has produced various public education materials such as pamphlets, brochures, posters, door hangers, refrigerator magnets, video tapes, etc. for general dissemination. The City also holds public contests to raise citizens' environmental awareness. In addition, the City targets school students with various workshop and presentation and gets the message across.

5. Installation of Debris Booms

   The Ala Wai Canal Watershed Steering Committee plans to install debris booms at various channal outlets and bridge crossings along the Ala Wai Canal in order to catch the floating debris/litter before reaching the Ala Wai Harbor.

Post-it™ brand fax transmittal memo 7671	# of pages ▸
To GENE DASHIELL	From ALEX HO
Co.	Co. DPW
Dept.	Phone # 523-4150
Fax # 593-8530	Fax # 527-6103

F Gabion Streambank Protection Project Note

Richard Frey
Engineering Solutions, Inc, Aiea.

Engineering Solutions, Inc.
98-021 Kam Highway, Suite 211
Aiea, Hawaii 96701

Consulting Engineers
Phone: (808) 488-0477
FAX: (808) 488-3776

FAX TRANSMISSION

24 February 1997

TO: Ala Wai Canal Watershed Water Quality Improvement Project
1314 South King Street, Suite 951
Honolulu, Hawaii 96814-1354
FAX 593-8330

ATTN: **Mr. Eugene P. Dashiell, Coordinator**

FROM: Richard Frey Ref

RE: BMP Workshop

TOTAL NO. OF PAGES TRANSMITTED (including this sheet) 1

COMMENTS:

Thank you for the invitation to the workshop. Unfortunately we are moving our office on that day and I will not be able to attend. If possible, I would like to receive the written conference proceedings. Our new office location is:

Engineering Solutions, Inc.
213 Pearlridge Center, Uptown
98-1005 Moanalua Road
Aiea, Hawaii 96701

telephone 488-0477
facsimile 488-3776

Our gabion streambank protection project for the Manoa Village Homeowner's Association on Manoa Stream has received approvals from everyone except DLNR Land Division. We hope to receive their approval soon. If construction goes as planned, it should be finished by late summer. I will let you know when the project is finished, so you can take a look at it.

END

G Contaminants:
Sources, problems, typical BMPs

Eugene Akazawa, Clean Water Branch
DOH

Ala Wai Canal Watershed Water Quality Improvement Project
Technical Workshop
February 27 (Thursday), 1997
8:00 - 3:40 p.m.

10:30 to 11:30 Comments prepared by Eugene Akazawa, Dept. Of Health, Clean Water Branch.
Panel: Contaminants: Sources, problems, typical BMPs.

The subject of this panel session refers to various contaminants as shown on your agenda. It includes bacteria, the subject of my brief talk. But I would like to focus on the question: "What have we learned in all these years by using indicator bacteria as a basis for determining the safety of our recreational waters?

1. Let me begin by saying that no water quality standard will guarantee complete safety for everyone. I think this is a very fair statement to make, and perhaps everyone here agrees to this. What is risky for one person may be safe for another. But nonetheless, an appropriate standard for safe swimming should one that will ensure the safety of everyone using the water.

2. The density of the indicator bacteria that we use, enterococci, is always at a much higher level during and immediately after a heavy rainfall. Our heaviest rainfall period begins in November and ends around April . . . these are same months that show the highest density of bacteria in our waters.

3. By the last statement not only can we conclude that bacteria densities are higher during the wet season, but that the sources of bacteria also can be and is attributed to nonpoint pollution.

4. We also know better now that the indicator bacteria, enterococci, are in fact found in the soil, vegetation, birds, and other animals as well. Dr. Roger Fujioka and his co-workers at the University of Hawaii have discovered enterococci in Hawaii and other tropical islands that are naturally occurring in the environment.

5. This being the case, the existing recreational water quality standards and the tests we do will not actually tell us the acceptable level of risk.

As we improve the Ala Wai Canal in various other ways, aesthetically or structurally, there will always be a lingering concern among the users of the canal. Risk assessment is a difficult task. . . and as I have mentioned earlier, what is risky for one person may be safe for another. But more importantly is how do we deal with the management of public health risk? Briefly, the following are some of the important areas of risk management, that we as public health officials must concentrate on:

- Public health risks associated with sewage discharges. There will always be breaks in the sewer lines. The question is how do we reduce the threat to public health?

- Risks associated with handling and disposal of toxic materials. What are the risks associated with consumption of contaminated fish or shellfish?

- Reducing public health risks through education among critical target groups. Are users

of the water aware of potential dangers? What precautions can they take to reduce the chance of getting infected by diseases?

- Prioritizing and funding research needs on public health safety of recreational waters and among target groups. Should we be doing more in this area?

- And last but not least, for the Ala Wai Canal, find out the answer to the question: "How safe is the canal for water recreation?"

In closing I would like to say this. Under the water quality standard for streams in Hawaii the safe level is set at 200 fecal coliform units. At this level, the amount of fecal bacteria is the same as if I dump one gallon of untreated sewage into a 10,000 gallon swimming pool that is not chlorinated. Would you consider swimming in it?

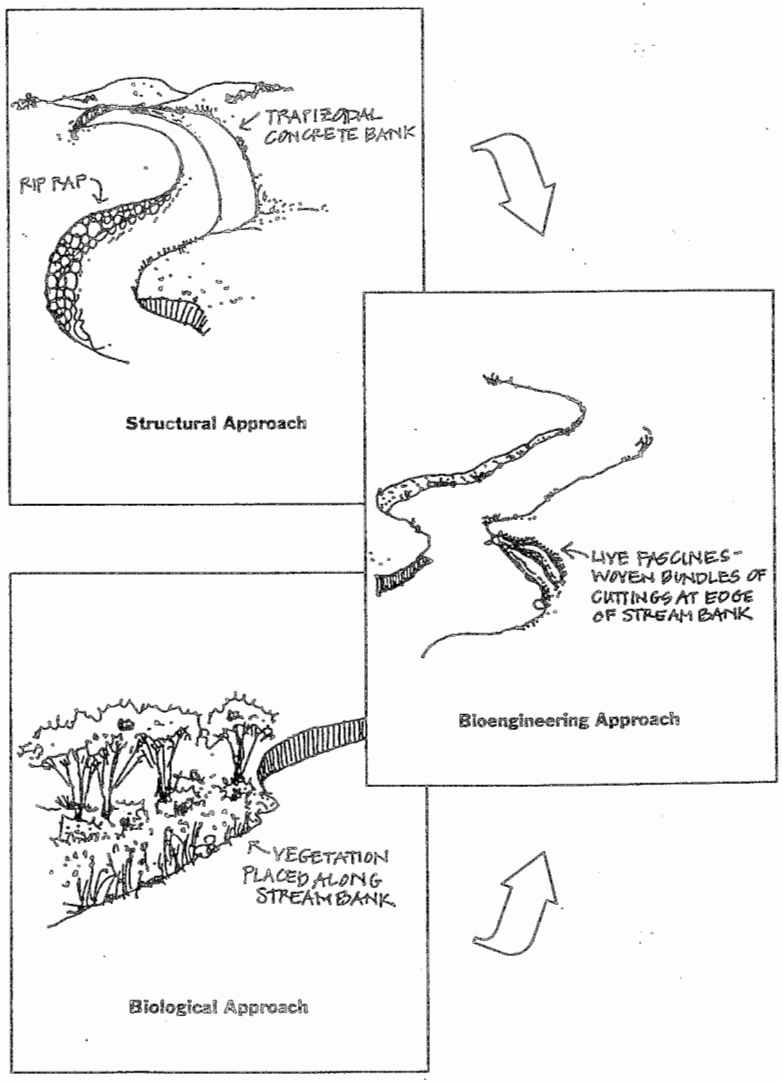
Notes:

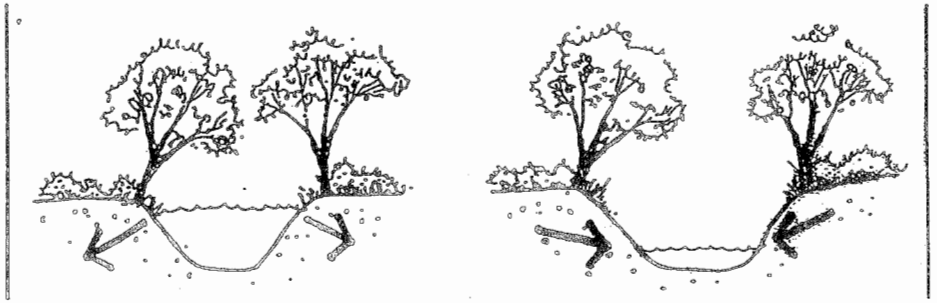
The Department of Health has established water quality standards for marine recreational waters based on the geometric mean density of enterococci bacteria at 7 CFU. What is the acceptable level of risk at this level? At this level the expected rate of gastrointestinal illness is one per 100 swimmers. The EPA criterion, however, is set at 35 CFU and the expected rate of swimming-associated gastrointestinal illness is two per 100 swimmers. We might say that the Hawaii Standards are twice as strict as the EPA guideline.

H Streambank Vegetation BMPs, and Vegetation Types Suitable for the Ala Wai Canal Watershed, Lisa Farrantinos, Watershed Consultant.

SOURCE: (1993) FIREHOCK, [illegible]
HAND BOOK. IZAAK WALTON LEAGUE OF AMERICA, INC.

Three Approaches to Stream Restoration

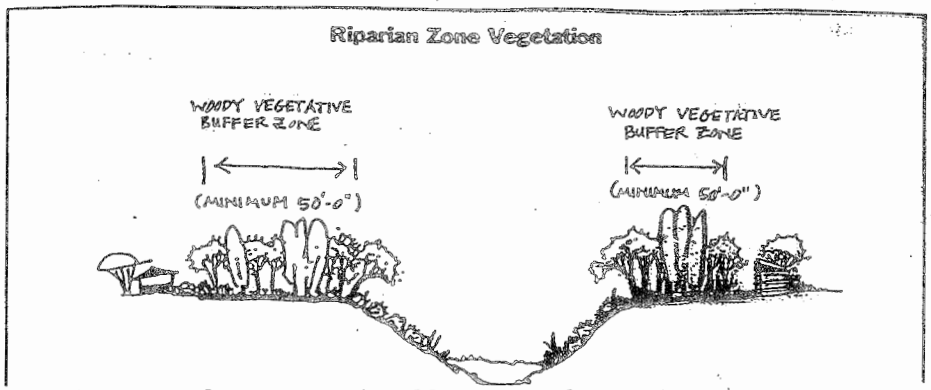




SOURCE: FIREHOCK

What is the role of streambank vegetation?

- Protects streambanks
  - Removes water and slowly releases it during dry periods
  - Improves stability
  - Slows the velocity of the water
- Provides habitat for aquatic life
  - Creates ripples and eddies- more oxygen
  - Leaves for food
  - Shade lowers water temperatures, increases oxygen
- Buffers streams from runoff pollution
  - Helps suspended materials settle
  - Breaks down pollutants through the action of soil and root microorganisms



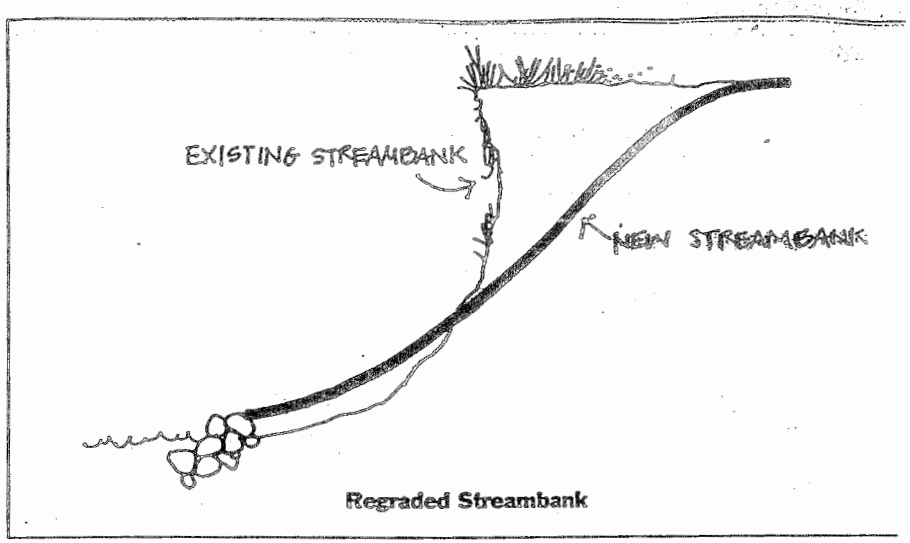
Why are forested buffers preferred?

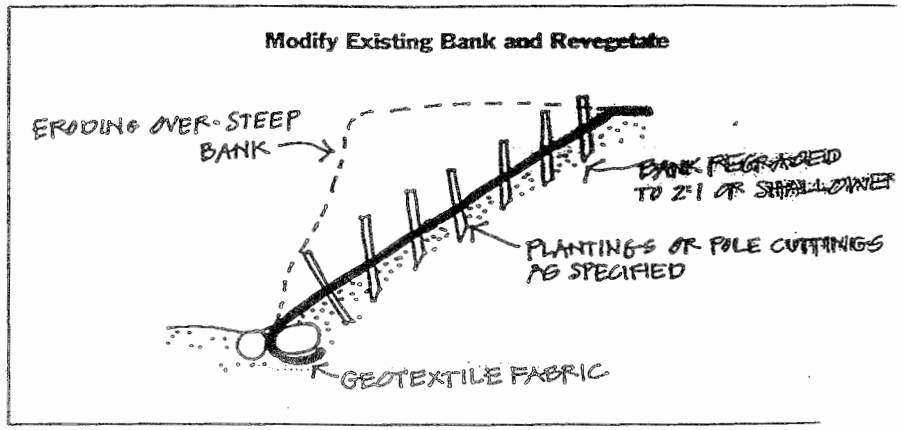
- Organic layer (duff) that traps and filters
- Deep and dispersed root systems that help filter groundwater

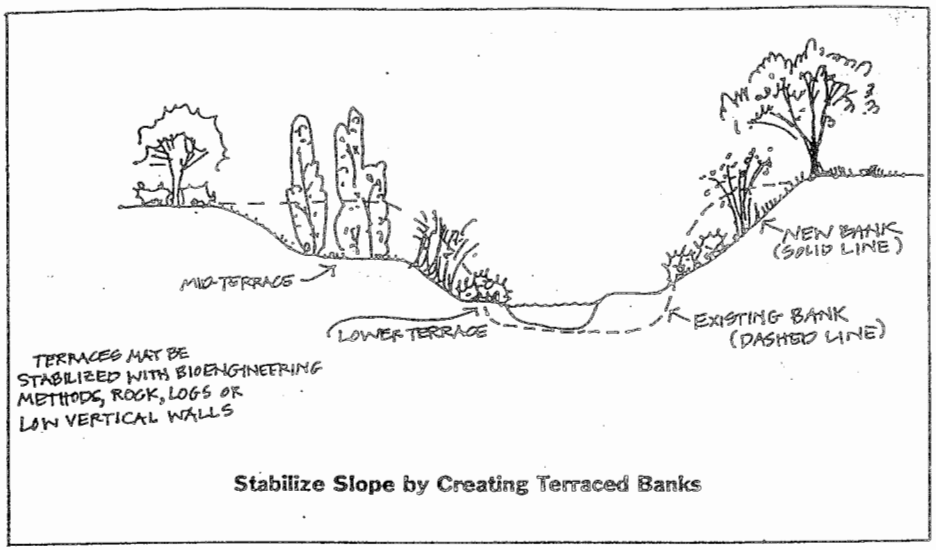
Why is there erosion from forests?

- When rain drops leave the trees
- Lack of groundcovers
- Lack of duff layer
- Reduced organic matter in soils
- Type of root systems
- Gully formation

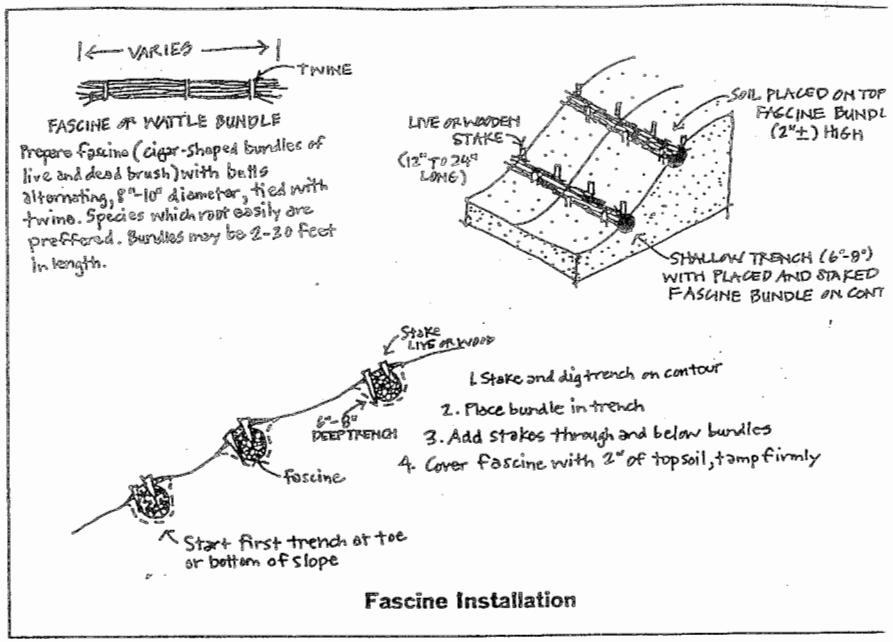
SOURCE: FISCHTOCK





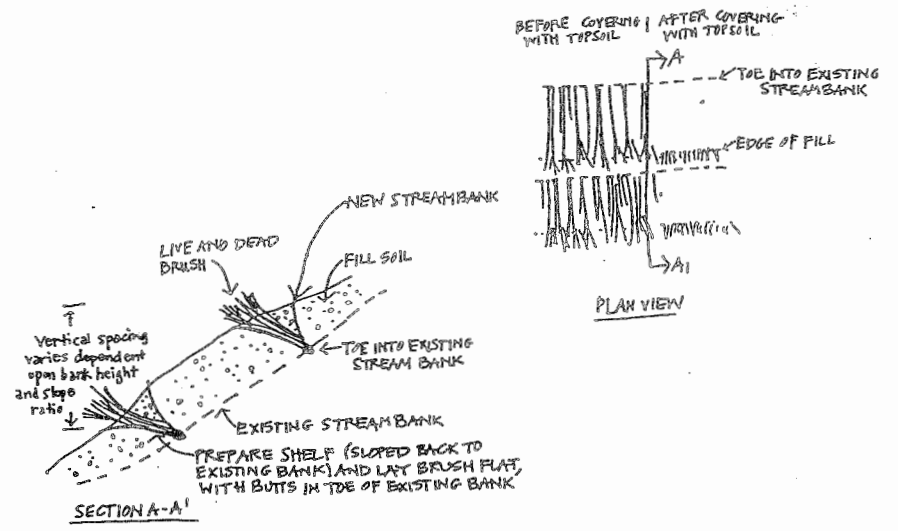


Stabilize Slope by Creating Terraced Banks

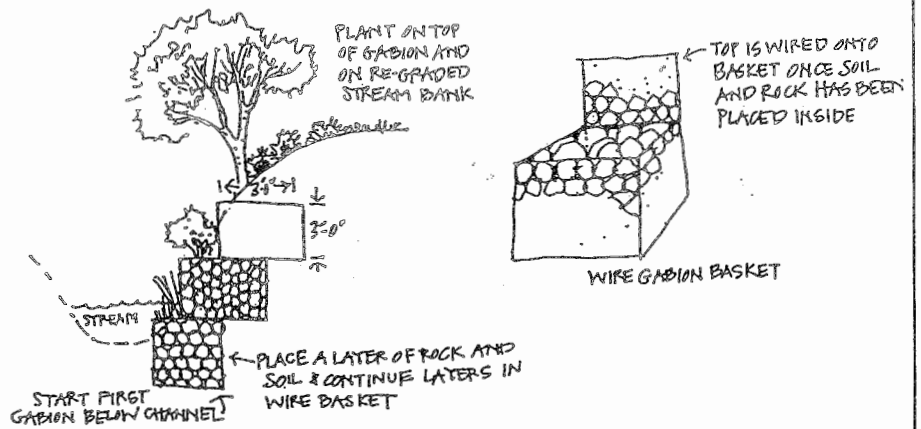


Fascine Installation

SOURCE: FIRESTEEL

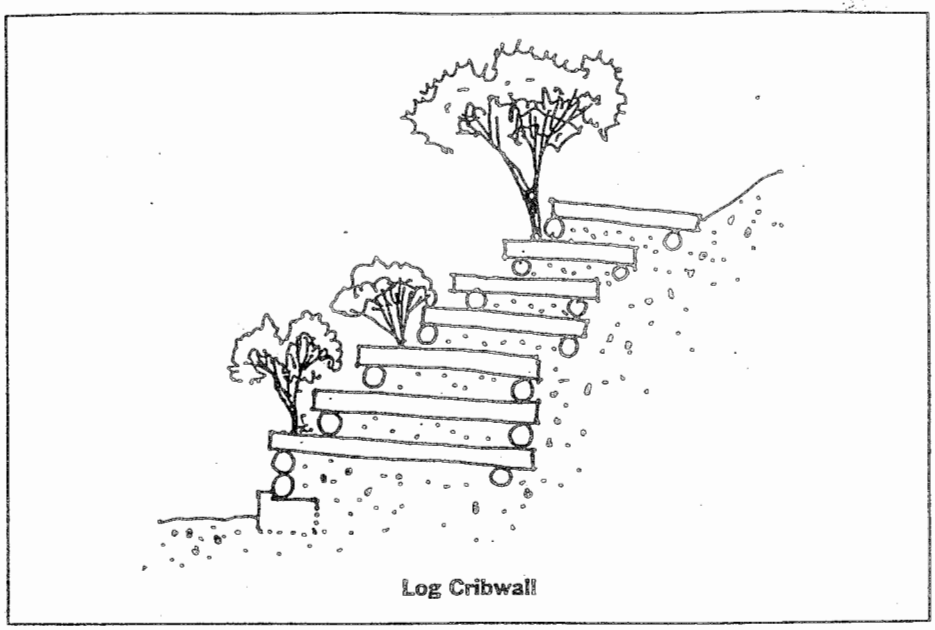


Installation of Brush Layers



Gabions

SOURCE: FRESHOCK



Log Cribwall

SOURCE: BIORETENTION MANUAL FOR STORMWATER MANAGEMENT PRINCE GEORGE'S COUNTY, MD. 1993

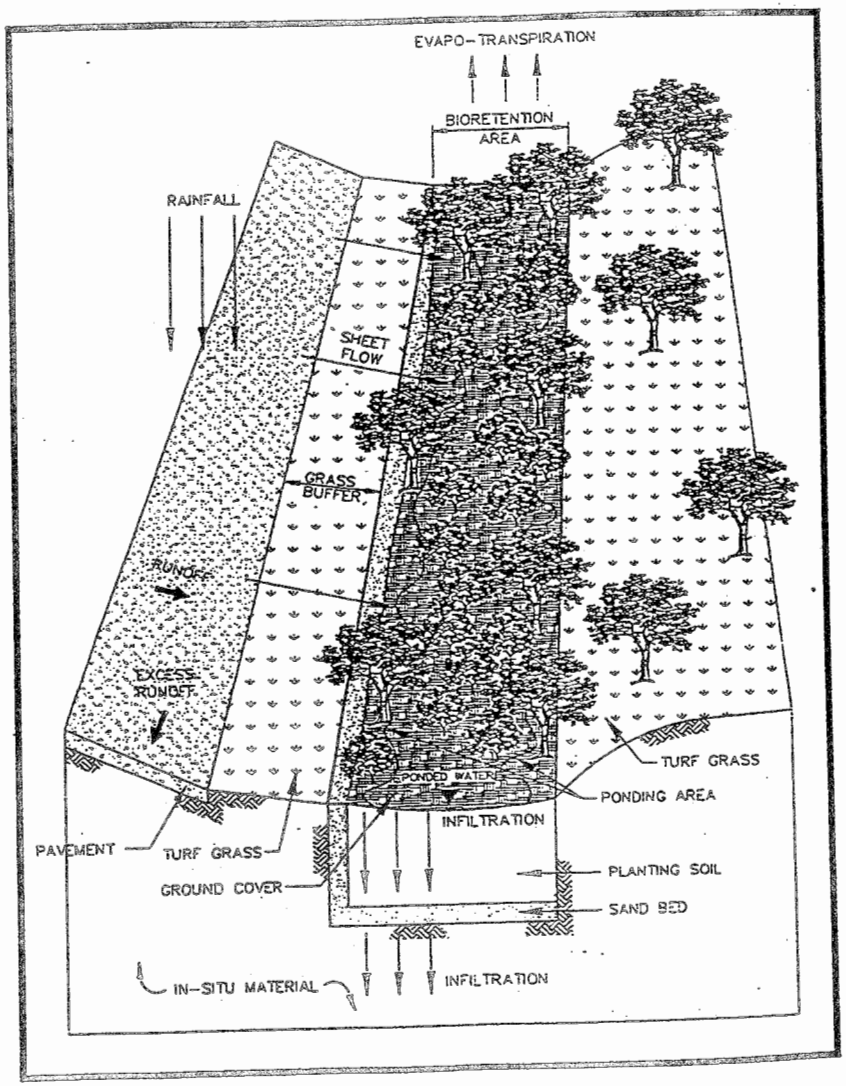


Figure II.1 Bioretention Area Conceptual Layout

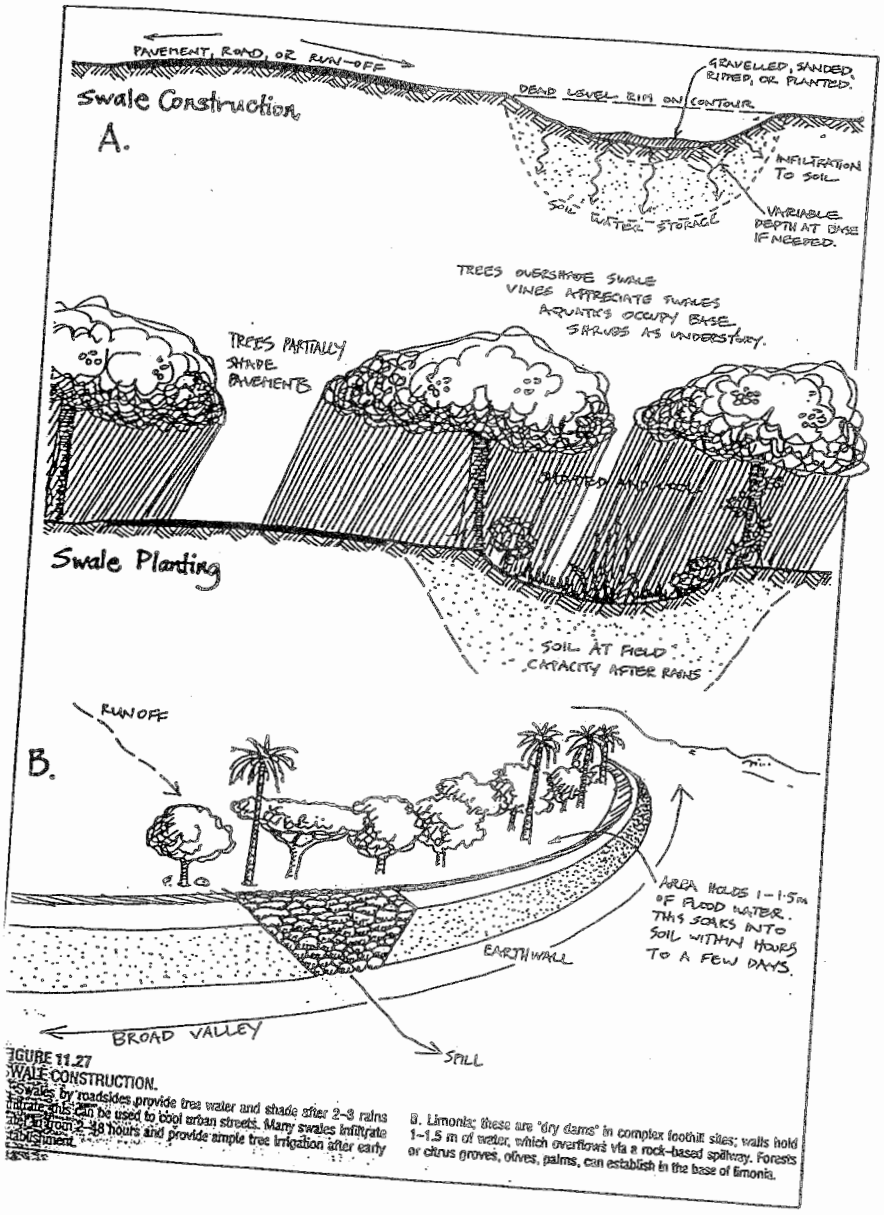


FIGURE 11.27
SWALE CONSTRUCTION.
Swales by roadsides provide tree water and shade after 2–3 rains infiltrate and can be used to cool urban streets. Many swales infiltrate in about 48 hours and provide ample tree irrigation after early establishment.

B. Limonia: these are "dry dams" in complex foothill sites; walls hold 1–1.5 m of water, which overflows via a rock-based spillway. Forests or citrus groves, olives, palms, can establish in the base of limonia.

SOURCE: PERMACULTURE DESIGN MANUAL MOLLISON

SOURCE: MOLLISON

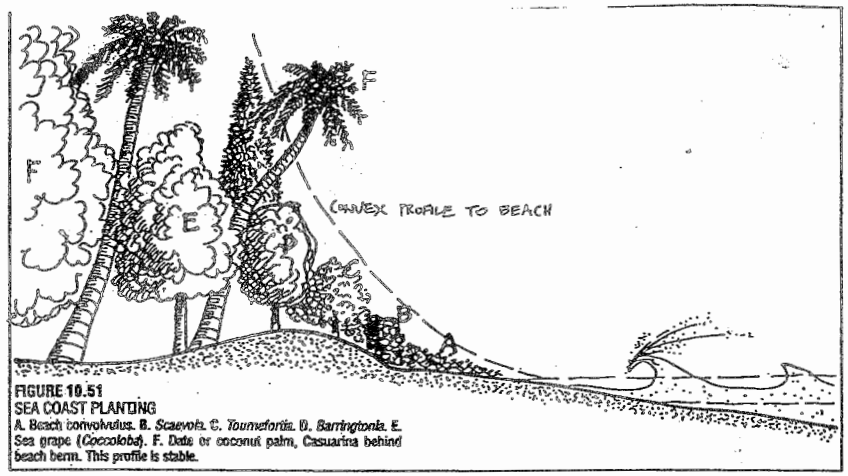
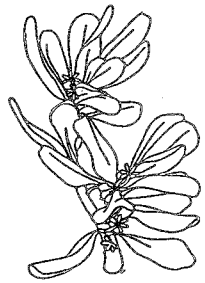


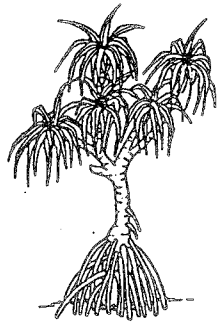
FIGURE 10.51
SEA COAST PLANTING
A. Beach convolvulus. B. *Scaevola*. C. *Tournefortia*. D. *Barringtonia*. E. Sea grape (*Coccoloba*). F. Date or coconut palm, Casuarina behind beach berm. This profile is stable.

Seashore paspalum	*Paspalum vaginatum*
`Aki`aki	*Sporobulus virginicus*
Nanea	*Vigna marina*
Pohuehue	*Ipomea pes-caprae*
Water hyssop	*Bacopa monnieri*
Nehe	*Lipochaeta integrifolia*
`Ilima papa	*Sida fallax*
Pohinahina	*Vitex rotundifolia*
`Akia	*Wikstroemia uva-ursi*
Pa`u o Hi`iaka	*Jacquemontia ovalifolia*
Naupaka	*Scaevola sericea*
Milo	*Thespesia populnea*
Hau	*Hibiscus tiliaceus*
Hala	*Pandanus tectorius*

Pōhuehue



Naupaka kahakai



Hala

Uala-Sweet potato	
`A`ali`i	
Kuku`i	
`Ulei	
`Olona	
Kolomona	
Manele	
Wiliwili	
Alahe`e	
Ti	

ʻUala

Kukui

ʻŪlei

Kukui

`Ohi`a `ai

Hala

Koa

`Ohi`a

Lama

Loulou

`Oha wai

`Ie`ie

Hapu`u

Koki`o

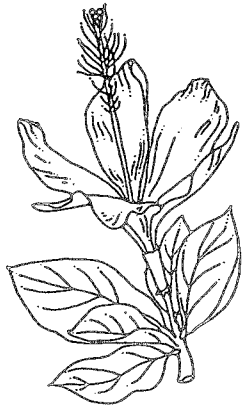
Mamaki

Olapa

Kupakupa

'Ōhi'a 'ai

Hāpu'u



Koki'o

`Ulei

`Awapuhi

`Uluhe

Palapalai

`Ala`ala wai nui

Water Plants

*Hyacinth	*Eichornia crassipes* *Monochoria vaginalis*
*Lemna	*Spirodella polyrrhiza* *Wolffia columbiana* *Lemna purpusilla*
*Water lettuce	*Pistia stratiotes*
*Water fern	*Azolla filiculoides*
Taros	*Colocasia* *Alocasia* *Cyrtosperma*
Aquatic fern	*Ceratopteris thalictroides*
Neke fern	*Cyclosorus interruptus*
Sedges	Cyperaceae - numerous

Lani Stemmerman A Guide to Pacific Wetland Plants
Army Corps of Engineers, 1981

*Danger- channel cloggers

NOT

Java Plum

Koa Haole

Christmasberry

Banyans

Australian Tree Fern

Guava and Strawberry guava

Kahili ginger

Fountain grass

Cane Tibouchina

Clidemia

Melastomes

Maybe Not?

Exotic grasses

Hau

Paul Weisich's Pearl Harbor Road Cut Study

Recommended:

`Ulei

`Akia

`Ilie`e (plumbaga)

A`ali`i

Naupaka

Wiliwili

ESTABLISHMENT

MAINTENANCE

Waialua, O`ahu

Stargrass *Cynodon plechtostachyus*

Figure 8. Vegetative System of Soil Conservation

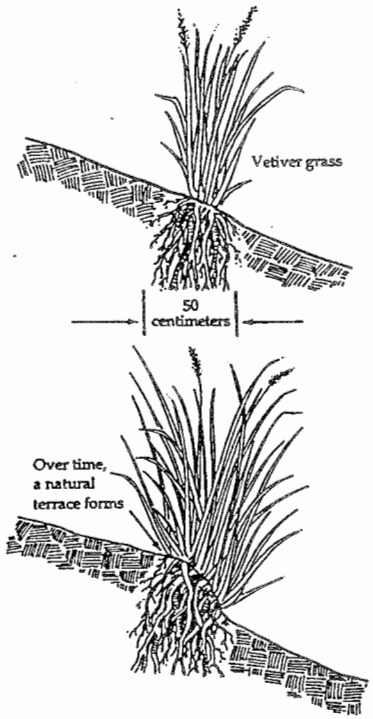


Figure 9. Drainage Under the Vegetative System

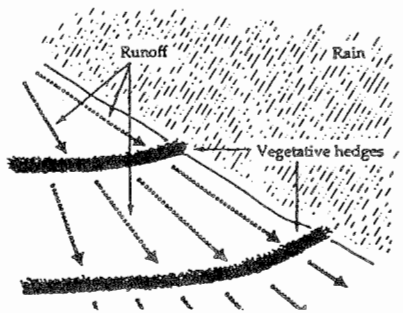
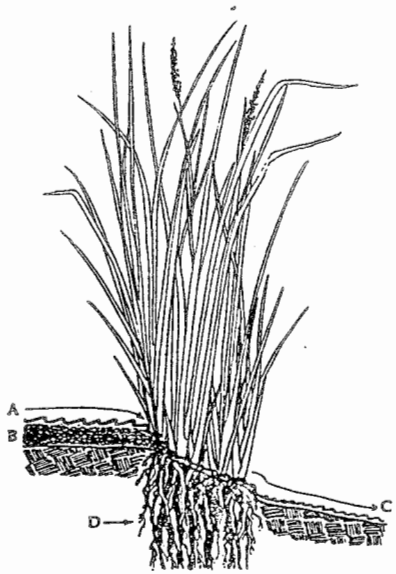


Figure 10. Cross Section of a Vetiver Hedge



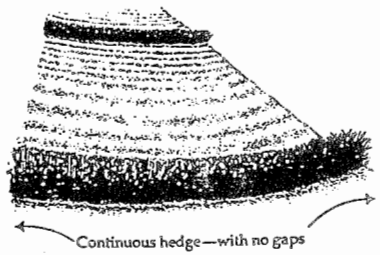


Figure 11. Vegetative System

SOURCE: SOIL CONSERVATION AND REHABILITATION, AND EMBANKMENT STABILIZATION. WORLD BANK TECHNICAL PAPER NO. 273. 1995

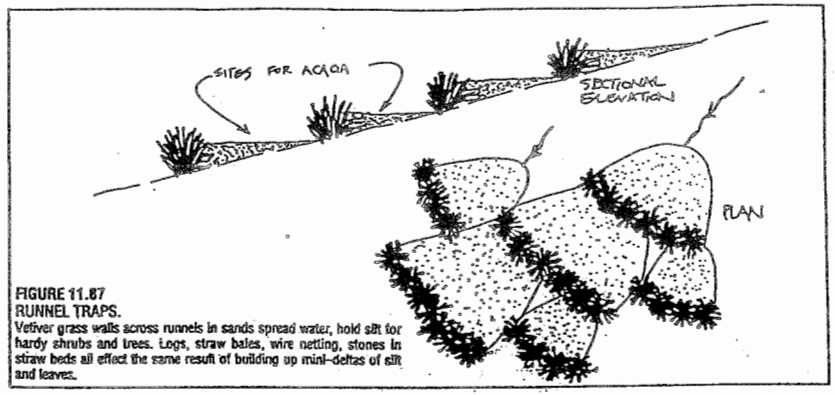


FIGURE 11.87
RUNNEL TRAPS.
Vetiver grass walls across runnels in sands spread water, hold silt for hardy shrubs and trees. Logs, straw bales, wire netting, stones in straw beds all effect the same result of building up mini-deltas of silt and leaves.

SOURCE: PERMACULTURE DESIGN MANUAL, MOLLISON ET AL.

I Contribution of Stream Channel Erosion to Sediment Yield from an Urbanizing Watershed

Submitted by:
June Harrigan, Ph.D., DOH.

Irene - F.Y.I. JF Hanzan IEPO (12/15/97)

where it is equally strong. Although presumably these latter wear surfaces are homologous with wear surfaces 5 and 1, respectively, of Crompton, there are no evident boundaries between them. Some evidence of wear surface 2 may be present on the anterior slope of the protoconid of M_1, but there is only the slightest evidence of wear surface 3 and none of wear surface 4 on the anterior and posterior sides, respectively, of the hypoconid. This distribution of wear facets might be expected of a fully tribosphenic mammal in which the unknown upper molars had prominent protocones with major wear surfaces on their tips together with their anterior and posterior slopes. In addition, these upper molars had well-developed wear surfaces on the paracrista (wear surface 1a of Crompton) or preparaconule crista (wear surface 1b of Crompton), or both. Unlike M_{1-2}, the M_3 is not damaged. Wear facets 1, 5, and 6 of Crompton are present but more subdued than on M_{1-2}. There is no sign of wear facets 2–4 on M_3.

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22. The holotype of *Tingamarra porterorum* is a right, lower molar identified as Eutherian Mammals, Order ? Condylarthra by R. Godthelp *et al.* [*Nature* 356, 514 (1992)] from the Tingamarra Local Fauna in southeastern Queensland reported as Early Eocene in age. Identification of this specimen as a placental has been questioned by F. S. Szalay [*Evolutionary History of the Marsupials and an Analysis of Osteological Characters* (Cambridge Univ. Press, Cambridge, 1994) and M. O. Woodburne and J. A. Case [*J. Mamm. Evol.* 3, 121 (1996)]. Furthermore, Woodburne and Case question the Early Eocene age of the Tingamarra Local Fauna, suggesting it may be Late Oligocene or Early Miocene.
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43. T.H.R and P.V.-R. acknowledge the long-term support of the Committee for Research and Exploration of the National Geographic Society. We thank J. Archibald, J. Bonaparte, W. Clemens, A. Crompton, F. Goin, J. Hopson, Z. Kielan-Jaworowska, D. W. Krause, J. Lillegraven, M. McKenna, R. Pascual, D. Sigogneau-Russell, R. Sloan, F. Szalay, L. Van Valen, M. Woodburne, and two anonymous reviewers for helpful commentary on this manuscript and F. Cotte, C. de Groot, A. Dyer, D. Galt, R. Jackson, P. Littlefield, S. Morton, I. Stewart, and P. Trusler for technical assistance.

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Contribution of Stream Channel Erosion to Sediment Yield from an Urbanizing Watershed

Stanley W. Trimble

Stream channel erosion has long been suspected as the major contributor to long-term sediment yield from urbanizing watersheds. For San Diego Creek in southern California, measurements from 1983 to 1993 showed that stream channel erosion furnished 10^5 megagrams per year of sediment, or about two-thirds of the total sediment yield. Thus, because channel erosion can be a major source of sediment yield from urbanizing areas, channel stabilization should be a priority in managing sediment yield.

Stream channel erosion can be the major source of sediment in urbanizing watersheds, with deleterious downstream effects (*1*). Increased storm runoff and stream channel changes resulting from urbanization have long been a concern, and work over the past three decades suggests that the relative contribution of long-term channel erosion to downstream sediment yield is substantial (*2*–*4*). However, the lack of hard data prompted the National Research Council to designate long-term channel erosion rates and sediment budgets for urbanizing watersheds as priority research needs (*5*). Additionally, much less is known about the geomorphologic effects of urbanization in arid regions than in humid regions (*6*). In most arid urban areas, irrigation increases antecedent soil moisture in vegetated areas, further increasing storm runoff. Moreover, urban development may, within the basin, displace rather than replace irrigated agriculture, so that agricultural impacts remain. Here I present data from an urbanizing basin in southern California and examine the role of channel erosion in augmenting sediment yield.

San Diego Creek, which drains a 288-km^2 basin in Orange County, California (Fig. 1), supplies sediment to Newport Bay, which is considered to be one of the primary estuarine wildlife habitats in the state. Urbanization has been rapid (Fig. 1) and is typical of many areas in the United States, especially the Southwest. A federal Clean Water Act study of the basin in 1981 concluded that the sediment sources were agriculture, steep foothills, and construction. Channel erosion was considered unimportant (*7*).

I began a long-term study of channel changes in the San Diego Creek watershed after a brief geomorphologic analysis (*8*) of the area in 1981 suggested that erosion from the largely earthen channel system could be a major contributor of sediment. An initial channel study using historical methods and aerial photogrammetry indicated that from the late 1930s to the early 1980s channel erosion supplied more than one-fourth of all sediment yield, but there were many uncertainties, especially regarding total sediment yield from the basin (*9*). Starting in 1983, I surveyed and installed 196 monumented (more or less permanently marked) channel cross-sections (profiles) at intervals along earthen channels of all types and sizes (Fig. 1). Over time, some profiles were invalidated by disturbance, and problems of property accessibility delayed or prevented measurements in some places. Thus, profiles had to be monitored annually, and new profiles were added as required throughout the decade (*10*). As a cooperator in the study, Orange County annually surveyed the downstream zones of sediment accumulation—trunk channels and in-channel sedi-

Department of Geography and Institute of the Environment, University of California, 405 Hilgard Avenue, Los Angeles, CA 90095-1524, USA.

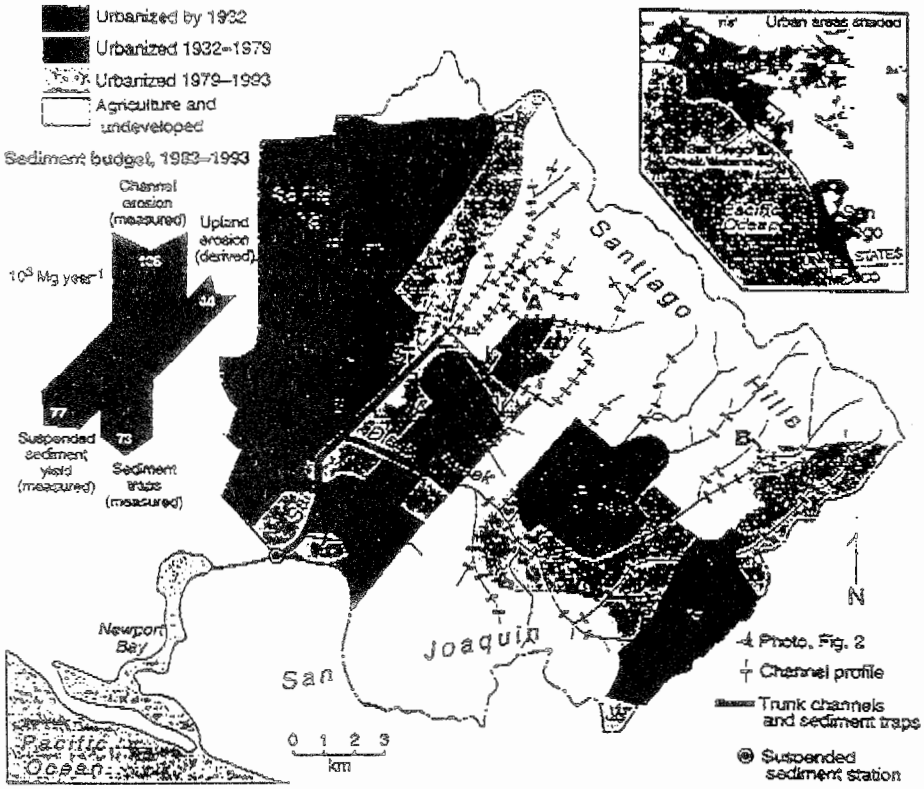

Fig. 1. San Diego Creek, showing the earthen stream channel network and the expansion of urban land, 1932–93. Paved channels and channels lying upstream from reservoirs were not included in the study. The cross-sectional channel profiles shown are those remaining in 1993. Sediment yield is that measured at the station plus accretion in the trunk channels and sediment traps. Inset is the sediment budget (balance). A and B indicate the profiles shown in Fig. 3.

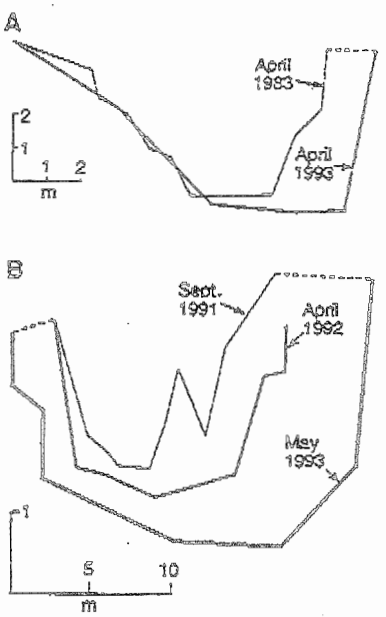

Fig. 3. Surveyed stream channel profiles. (A) Hicks Canyon Wash profile 6, 1983 and 1993 (Fig. 2). The rate of erosion at this profile was 0.47 m^3 $year^{-1}$ per meter of channel. At a bulk specific gravity of 1.44, this would be 0.7 Mg m^{-1} $year^{-1}$, a local erosion rate that was slightly less than the decadal mean for this type of channel. (B) Extreme erosion of Borrego Canyon Wash profile 3, directly downstream from an urbanizing area during the wet years of 1992–1993. The rate of erosion was about 20 m^3 m^{-1} $year^{-1}$ or about 29 Mg $year^{-1}$ per meter of channel. This reach has since been stabilized. See Fig. 1 for locations.

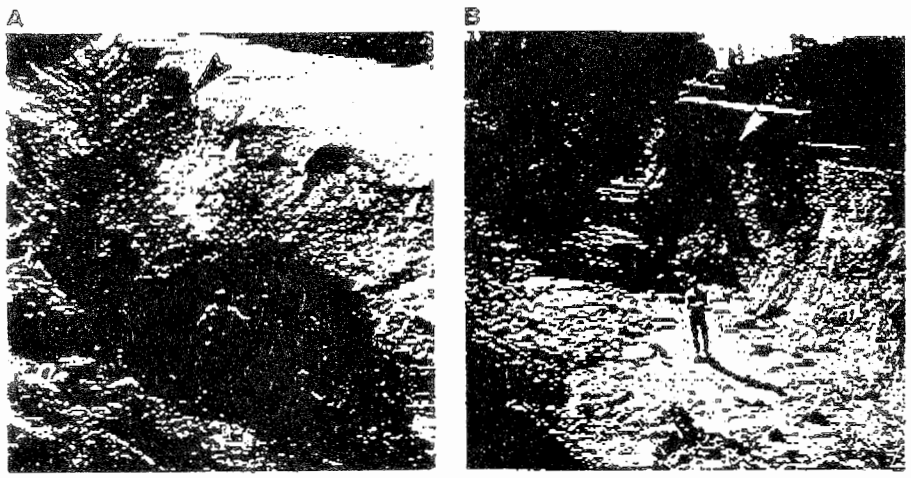

Fig. 2. An example of stream channel erosion in Hicks Canyon Wash, looking southeast at the confluence with Rattlesnake Canyon Wash (Fig. 1). (A) 1979. (B) 1993. A person stands at approximately the same location in both photographs. Note the retreat of the cut bank to the right. Arrows mark the location of surveyed profiles in 1983 and 1993 (Fig. 3).

ment traps (Fig. 1)—and kept an account of all sediment removed. The county also maintained a full-time suspended sediment measuring station about 2 km upstream of Newport Bay (Fig. 1).

All 103 usable profiles remaining in 1993 were resurveyed. The results indicated that the net average rate of channel erosion was 106×10^3 Mg $year^{-1}$ between 1983 and 1993. Time-lapse photography (Fig. 2) and the survey results (Fig. 3) give graphic evidence of channel enlargement. During the same period, net accretion in the trunk channels and sediment traps was 73×10^3 Mg $year^{-1}$; and suspended sediment yield at the station was 77×10^3 Mg $year^{-1}$, constituting a total sediment sink and efflux of 150×10^3 Mg $year^{-1}$ (see sediment budget, Fig. 1). Thus, channel erosion accounted for about two-thirds of the measured sediment yield from San Diego Creek. Average erosion rates show few signs of declining, and new development may locally accelerate channel erosion (Fig. 3B). Hence, amelioration of channel erosion is an appropriate management strategy for sediment control, but little had been done by 1993.

The usually perceived problem with stream channel erosion is that it has deleterious downstream effects in streams, lakes, and estuaries. However, the erosional process itself is also problematic because channel enlargement is often lateral, thus removing substantial areas of valuable urban land; damaging parkland, bridges, and other infrastructure; and making channels unsightly (2, 4) (Fig. 2).

The process of sediment loss in urbanizing basins is analogous to the formation of arroyos that occurred in the Southwest in the late 18th and early 19th centuries (12). However, rather than grazing or cli-

matic change, the present cause is the greater magnitude and frequency of peak stream flow in response to impervious urban surfaces. This study joins a growing literature on the role of sediment storage in general; and, in particular, shows that sediment storage loss from stream channel erosion over varied geographic regions can be a major source of sediment yield (*13*). In such cases, sediment yield per unit area can actually increase with basin area rather than decrease, as is commonly perceived.

Suspended sediment measuring stations in sand-bed channels can underestimate total sediment loads (*14*), and this may be the case for San Diego Creek. If substantial, the additional sediment yield could relegate channel erosion to a somewhat smaller proportion of total sediment yield but probably no less than half. Erosion of earthen channels will remain a substantial source of sediment yield from urban stream systems until proper ameliorative measures are taken.

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Adatom Pairing Structures for Ge on Si(100): The Initial Stage of Island Formation

X. R. Qin and M. G. Lagally*

With the use of scanning tunneling microscopy, it is shown that germanium atoms adsorbed on the (100) surface of silicon near room temperature form chainlike structures that are tilted from the substrate dimer bond direction and that consist of two-atom units arranged in adjoining substrate troughs. These units are distinctly different from surface dimers. They may provide the link missing in our understanding of the elementary processes in epitaxial film growth: the step between monomer adsorption and the initial formation of two-dimensional growth islands.

Because of its importance in microelectronics and its unique properties, the (100) surface of silicon has been extensively investigated. Driven by the capability of the scanning tunneling microscope (STM) to view this surface easily with atomic resolution, Si(100) in particular has been used as a model to understand the atomistic mechanisms of film growth (*1*). For both Si and Ge deposition, early stages of growth at low temperatures produce many stable adsorbed dimers (called ad-dimers), that is, two atoms that clearly remain bound to each other for extended times, as well as rows of many such ad-dimers (called islands) (*2*, *3*). Following classical nucleation theory, in which growth occurs by the addition of atoms to a "critical nucleus" (*4*), it was postulated that Si or Ge monomers deposited on the Si(100) surface diffuse to form ad-dimers and that the ad-dimer is the stable nucleus from which all subsequent larger growth structures (such as the ad-dimer row islands) evolve by addition of further monomers (*2*). Intermediate structures ("diluted-dimer islands"), in which alternate ad-dimers in ad-dimer row islands are missing (*5*) and in which the remaining ad-dimers are rotated (*6*), are thought to arise from individual ad-dimers and to represent an early growth stage (*5*, *7*). Yet this evolution from single ad-dimer to any of the larger structures has not been observable, despite the intrinsic ability of the STM to do so. Hence, a critical element of understanding is missing: the atomistic pathway from the initial adsorbed monomers to the existence of stable ad-dimer row islands. The role of the ad-dimer as the essential element in this pathway has so far not been questioned.

In this report, we describe high-resolution STM observations of structures formed during the initial growth of Ge on Si(100)(2 × 1) near room temperature, in which the Ge atoms exist as two-atom units that are distinctly different electronically and structurally from any dimer in or on the surface. We show that they provide a physically reasonable link between monomer adsorption and diluted-dimer island formation. We suggest that, at least at low temperatures, ad-dimers are not part of the nucleation-growth pathway.

The experiments were performed on Si(100) with a high-quality 2 × 1 surface and a defect density of <0.5% in an STM outfitted with an evaporation source from

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SUSPENDED SEDIMENT PRODUCTION FROM FORESTED WATERSHEDS ON OAHU, HAWAII[1]

R. D. Doty, H. B. Wood, and R. A. Merriam[3]

ABSTRACT: Suspended sediment from forested and agricultural watersheds was sampled over a five-year period on the island of Oahu. A variety of storm conditions were sampled, giving a measure of the extreme variability in suspended sediment production. Total annual suspended sediment from all watersheds sampled ranged from 8400 kg/km^2 to 617,000 kg/km^2. Normally, about 90 percent of the total suspended sediment was produced during less than 2 percent of the time. Suspended sediment concentrations rapidly increased during rising stream flow resulting from rain storms. Time to peak of less than two hours is common, with a similarly rapid return to prestorm conditions. The data presented indicate the great variability of suspended sediment yields, making establishment of effective standards difficult.
(KEY TERMS: suspended sediment; forests; water quality; standards; Hawaii; storm flow.)

Attempts to control flooding and sediment production on Oahu by reforestation date back to 1882 (Honolulu Board of Water Supply, 1948). Little has been reported, however, on the production of suspended sediment from forested areas in Hawaii. Neither erosion nor sediment were included as separate index entries in a bibliography of water resources in Hawaii published in 1971 (Pfund and Steller, 1971). Nearly all the data available on sediment production in Hawaii to date were collected at gaging stations which sample a cross section of forest, agricultural, and urban areas. Because the forested areas generally have steep slopes and receive large amounts of rainfall, it is often assumed that these areas produce high sediment yields, but confirmation has been lacking.

This report summarizes the suspended sediment records for Oahu for watersheds with two or more years of records. The data provide a measure of the variability and magnitude of sediment yields, and should help to provide a basis for establishing sediment control techniques and regulatory procedures.

The watersheds described here drain the steep slopes of the Koolau Mountains of Oahu (Table 1). The larger watershed, Waikele, also includes the flatter agricultural lands of the central plain of Oahu (Figure 1). The forested areas of Kāpapa, Kalihi, and Moanalua are primarily native ohia-koa (*Metrosideros collina, Acacia koa*). However, 40 percent of the forest covered areas of Kalihi are exotic species planted for watershed protection 60 to 70 years ago. About 50 percent of the shrub and herbaceous cover on Kamoalii is a combination of pastures, banana plantations, and a large golf course. The 31 percent cultivated area of Waikele is divided between pineapple and sugarcane fields which occupy the flatter areas. The forested areas primarily occupy the areas of slope greater than 30 percent (Table 1).

The soils information in the table is a summary from the soil survey of Hawaii (U.S. Soil Conservation Service, 1972). Runoff and erosion hazard levels generally increase with slope steepness; thus there is potentially severe erosion in the mountainous areas if the soil is exposed to high rainfall. Stream flow conditions shown indicate the rapid rise to peak and extremely high peak flow that are characteristic of these watersheds.

METHODS

The data reported here come primarily from published records of the U.S. Geological Survey (USGS) stations equipped with automatic pumping sediment samplers (Model USPS-69) at stream gaging stations. Kalihi was hand sampled by U.S. Forest Service personnel during storm runoff periods, using a DH-59 depth integrating sampler. A total of 250 hand samples were collected from Kalihi during the period November 1974 through September 1978. All samples were analyzed for suspended sediment concentrations at the USGS laboratory in Honolulu.

In the method used at stations maintained by the USGS, individual sample values for suspended sediment concentration were plotted directly on the stream flow hydrographs. A smooth curve was hand fitted through the points. This curve was then used to calculate the total sediment yields on a daily basis, which were reported in USGS annual reports (U.S. Geological Survey, 1973-78).

Sediment yields from Kalihi were determined by a method similar to one described by Miller (1951) and used in Hawaii by Jones, *et al.* (1971). Instantaneous water discharges were correlated with instantaneous suspended sediment discharges to develop a sediment transport curve. A stream flow duration

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curve was then used to calculate total sediment production on an annual basis from values for the amount of time the flow was at various levels.

To compare the procedure used at Kipapa with that at Kalihi, we selected days in which samples were available from both. A water discharge/sediment discharge relation for Kipapa was developed based on those samples. Sample values from Kipapa and Kalihi include a range of flows from minimum through storm values that lies in the upper 10 percent of all flows recorded at the stream gaging stations.

TABLE 1. Watershed Characteristics.

Watershed[1]	Drainage Area[2] (km^2)	Elevation Range[3] (m)	Percent Slope[4] Class	Percent of Total Area in Class	Soil Characteristics by Slope Class[7] Permeability	Runoff	Erosion Hazard	Vegetation Types and Percent of Total Area	Mean Annual Precipitation[5] (mm)	Record Peak Discharge[2] ($m^3/s/km^2$)	Average Discharge (hm^3/yr)
Kalihi 16-2290	6.76	180-790	0-10	nil	Moderate Rapid	Slow	Slight	Forest–82%	3100	51.92	6.00
			11-20	8.0	Moderate	Medium	Moderate	Shrub-Herbaceous–18%			
			21-30	1.0	Moderate	Medium to Rapid	Moderate to Severe	Urban–Trace			
			>30	91.0	Moderate	Rapid	Severe				
Kipapa 16-2128	11.10	240-790	0-10	0.6				Forest–97%	4420	14.49	9.47
			11-20	nil				Shrub-Herbaceous–3%			
			21-30	nil							
			>30	99.4	Moderate to Rapid	Medium to Very Rapid	Severe to Very Severe				
Waikele 16-2130	118.4	1-950	0-10	46.0	Moderate	Slow to Medium	Slight to Moderate	Forest–61%	1780	3.25	33.80
			11-20	5.0	Moderate	Medium to Rapid	Moderate to Severe	Shrub-Herbaceous–2%			
			21-30	2.0	Moderate	Medium to Rapid	Moderate to Severe	Cultivated–31%			
			>30	47.0	Moderate	Medium to Rapid	Severe	Urban–6%			
Moanalua 16-2275	2.43	201-762	0-10	5.0	Rapid	Slow	Slight	Forest–95%	3090	17.80	1.10
			>30	95.0	Area Unclassified			Shrub-Herbaceous–5%			
Kamoalii 16-2722	9.87	22-762	0-10	30.0	Moderate to Rapid	Slow	Slight	Forest–10%	2540	2.78[6]	Not established
			11-20	5.0	Rapid	Slow to Moderate	Slight to Moderate	Shrub-Herbaceous–80%			
			21-30	5.0	Moderate to Rapid	Rapid	Moderate to Severe	Cultivated–5%			
			>30	60.0	Area Unclassified			Urban–5%			
Kamoalii 16-2705	8.31	36-762 (Slope, Soils, and Vegetation Values Included in Totals for Station 16-2722)							2540	36.80	9.74

[1] Watershed numbers correspond to U.S. Geological Survey reference numbers.
[2] U.S. Geological Survey, 1978, Water Data Report HI-78-1.
[3] U.S. Geological Survey, topographic maps of Oahu.
[4] Murabayashi and Kuwahara, 1969.
[5] Honolulu Board of Water Supply, 1963, Isohyetal map.
[6] Period of record 1976-1978.
[7] U.S. Soil Conservation Service, 1972.

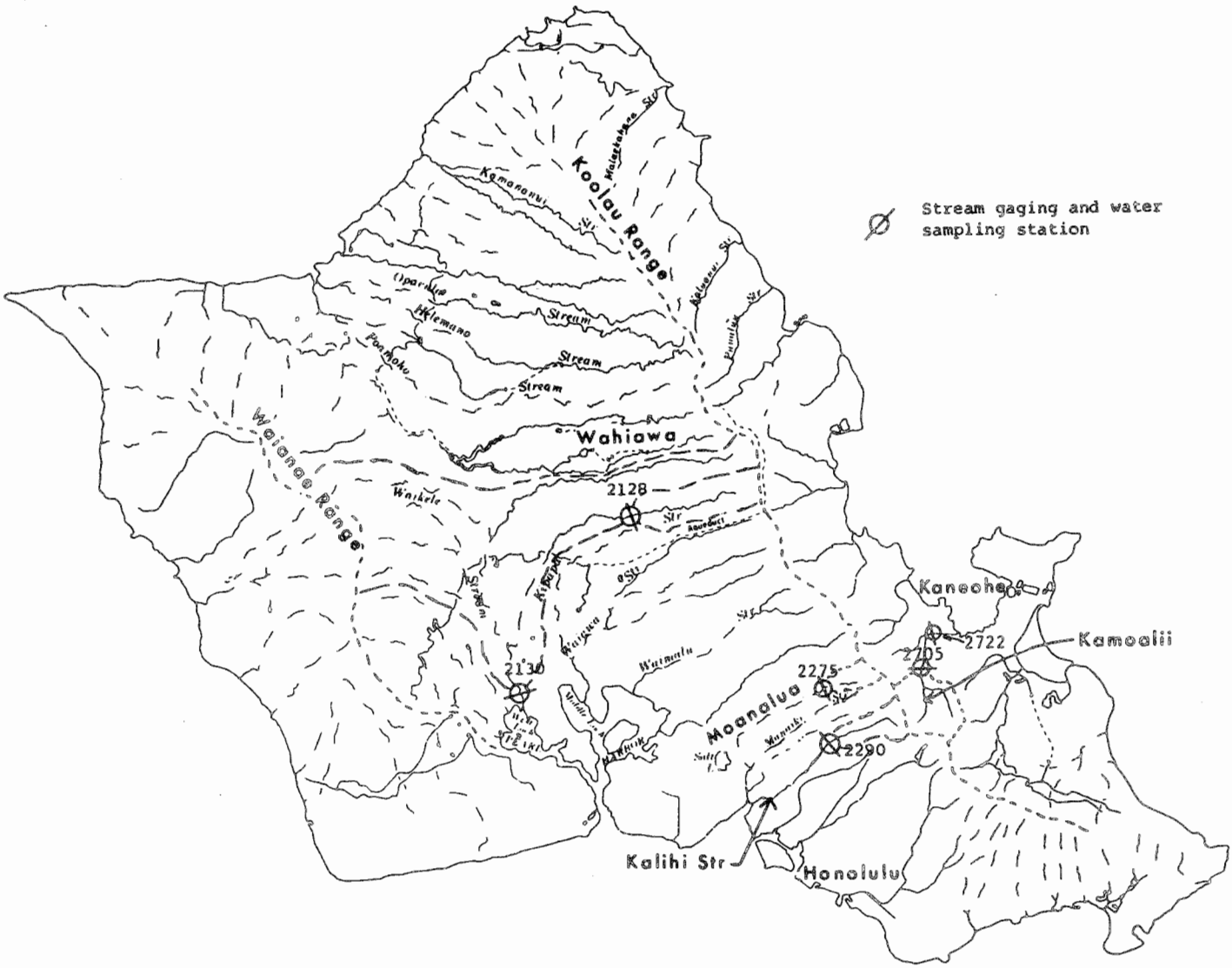

Figure 1. Map of Oahu Showing USGS Stream Gaging Sites Where Water Samples Were Taken for This Study and Other Studies Referred to in the Text.

RESULTS

The data in Table 2 summarize the suspended sediment records on Oahu for stations with records covering more than two years, for which sufficient samples were taken each year to calculate a total annual suspended sediment. Volume of sediment per year ranged from 9.7 Mg/km^2 to 617 Mg/km^2. The range of values cuts across all watersheds.

Because Kipapa Stream is a tributary to Waikele Stream, it is interesting to compare the relative suspended sediment production from these two watersheds. The watershed area of Kipapa (11.14 km^2 represents 9.4 percent of the total area of Waikele (118.4 km^2). During this study, Kipapa produced 27 percent of the total water yield, while producing 10 percent of the suspended sediment discharge.

In addition to total sediment yield, we should look at the distribution of the suspended sediment discharge. Generally, more than 80 percent of the annual suspended sediment discharge was produced during less than 2 percent of the time (Table 3).

Two or three storms each year usually stand out as the major contributors to the annual total suspended sediment discharge.

Stream flow conditions in this study were similar to those reported for Hawaii by others (Jones, *et al.*, 1971; Wang, *et al.*, 1970; Jones and Ewart, 1973; Ekern, 1976). The extremely rapid rise to peak flows resulted in corresponding high sediment yields during the rising stage and generally a more rapid drop in suspended sediment during the falling stage (Figures 2 and 3). Several storms were analyzed with similar results. A significant relationship exists between instantaneous stream flow and sediment discharge (Table 4, Figure 4). A covariance analysis comparing the different years of data from Kalihi indicated no significant difference in slope or position of the regression line for each year's data. Consequently, the pooled

TABLE 2. Water Discharge and Suspended Sediment Discharge From Watersheds on Oahu, Hawaii.*

Watershed	Year	Water Discharge: Annual Volume (m^3x10^6)	Water Discharge: Peak Discharge ($m^3/s/km^2$)	Suspended Sediment Annual Discharge: (Mg/yr)	Suspended Sediment Annual Discharge: (Mg/km^2)	Mean Suspended Sediment Concentration (mg/ℓ)
Kalihi/16-2290	1974	5.60	4.62	390.0	57.7	10
	1975	4.00	5.95	830.0	123.0	5
	1976	3.40	3.45	140.0	20.7	3
	1977	3.20	4.48	320.0	47.3	12
	1978	1.40	1.32	210.0	31.1	20
Kipapa/16-2128	1974	14.30	12.50	6,860.0	617.0	10
	1975	7.30	4.82	1,490.0	134.0	5
	1976	8.40	3.55	1,800.0	162.0	5
	1977	6.20	4.13	6,640.0	148.0	6
	1978	3.70	2.37	1,380.0	124.0	4
Waikele/16-2130	1967-69	46.00	1.76	29,000.0	245.0	N/A
	1973	17.60	0.23	1,380.0	15.0	18
	1974	46.70	2.12	52,450.0	443.0	26
	1975	33.20	1.94	29,240.0	247.0	26
	1976	35.40	0.66	30,190.0	255.0	36
	1977	18.00	0.24	3,230.0	28.0	32
	1978	10.20	0.27	3,110.0	26.0	25
Moanalua/16-2275	1972	0.88	5.66	172.0	70.7	1
	1973	0.82	1.23	22.8	8.4	0
	1974	1.42	7.94	328.0	135.0	2
	1975	0.46	8.54	74.8	30.8	3
	1976	0.51	2.91	163.0	67.2	1
	1977	0.40	2.91	23.6	9.7	1
Kamoalii/16-2705	1967-69	16.98	36.81	2,068.0	249.0	N/A
	1972	7.45	3.48	335.0	40.3	4
	1973	4.39	0.28	245.0	2.9	5
	1974	8.96	4.09	870.0	105.0	8
	1975	8.55	9.85	600.0	721.0	8
	1976	5.23	1.51	174.0	21.0	7
Kamoalii/16-2722	1977	2.84	2.78	1,110.0	112.4	12
	1978	5.13	0.63	310.0	31.9	28

*Some data from U.S. Geological Survey, 1973-1978 and Jones and Ewart, 1973.

data could be used to calculate average annual yield. However, better estimates of annual yields are obtained by applying the separate regression equations.

DISCUSSION

The suspended sediment data presented here indicate what might be expected in magnitude and timing of suspended sediment discharge from forested watersheds on Oahu. The total suspended sediment yields were found to be quite variable (Table 2). Kipapa produced a very high yield per unit area in 1974, as a result of one or two precipitation events -- storms which produced high runoff rates in the Kipapa area. In 1977, stream flow was well below normal outside of the Kipapa drainage, with a corresponding low sediment yield as recorded by the Waikele Station. A two- to threefold lower stream flow from Waikele resulted in a tenfold reduction in sediment in 1977 and 1978. This suggests that the available flow was insufficient to flush the stream. Peak flows were equally low, a major factor in moving sediment.

Also important is the timing of the suspended sediment discharge, as it affects current consideration of alternative ways of setting State water quality standards (State of Hawaii, Department of Health, 1978). The rapid change in suspended sediment concentrations during storms and the short duration of storm events make it difficult to observe any additional "disturbance created" sediment. Such sediment may be masked by the large influx of "normal" sediment during a storm. The fact that natural variation in sediment production between drainages further complicates setting standards is evident from a comparison of the actual values and the 1978 standards (Table 3). Concentration values for some streams

TABLE 3. Timing of Suspended Sediment Production From Watersheds on Oahu, Hawaii.

Watershed	Year	Concentration ≤ (mg/ℓ)			Percent of Total Annual Sediment Discharged	
		98% of Time	90% of Time	50% of Time	2% of Time	10% of Time
Kalihi/16-2290	1974	63	32	10	89	95
	1975	59	25	5	95	98
	1976	27	13	3	92	96
	1977	63	34	12	84	92
	1978	74	47	20	65	75
Kipapa/16-2128	1974	161	66	10	95	99
	1975	90	33	5	94	98
	1976	102	43	5	84	95
	1977	53	29	6	79	98
	1978	100	25	4	76	97
Waikele/16-2130	1973	124	40	18	70	82
	1974	400	92	26	84	90
	1975	161	58	26	90	93
	1976	149	82	36	93	98
	1977	137	59	32	65	92
	1978	190	60	25	69	87
Moanalua/16-2275	1972	45	3	<1	92	99
	1973	20	4	0	89	99
	1974	72	15	2	90	99
	1975	20	5	3	96	99
	1976	40	8	<1	98	99
	1977	50	10	<1	82	99
Kamoalii/16-2705	1972	100	7	4	84	95
	1973	18	8	5	23	43
	1974	100	20	8	87	94
	1975	80	12	8	95	98
	1976	50	10	7	78	86
Kamoalii/16-2722	1977	70	30	12	93	95
	1978	180	90	28	30	52
Standard for wet season*		80	50	20		

*Department of Health, 1977.

already exceed the standards, while others are so far below them that significant increases would be allowed. Such standards may be useful in detecting long term trends and as an index value for all streams. The 1978 standards do not establish a means of measuring the impact of a short-term activity on suspended sediment production. As an example, if a developer cleared a large area before construction began and then a storm occurred, suspended sediment production would likely be much greater than if no disturbance had occurred. However, the event could easily fall within the "less than 2 percent of the time" category, where the 1978 standards allow any sediment discharge level. One storm and one development may or may not be significant, but the accumulated effect of all disturbances during one storm may be very significant.

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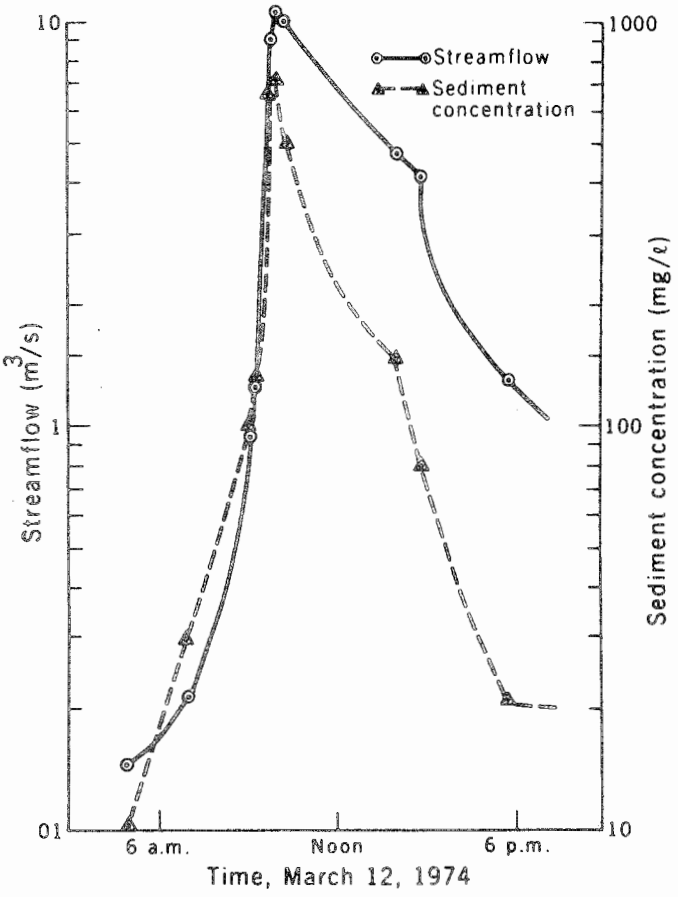

Figure 2. Stream Flow and Sediment Concentrations During a Moderate Rainfall Event, Kipapa Stream.

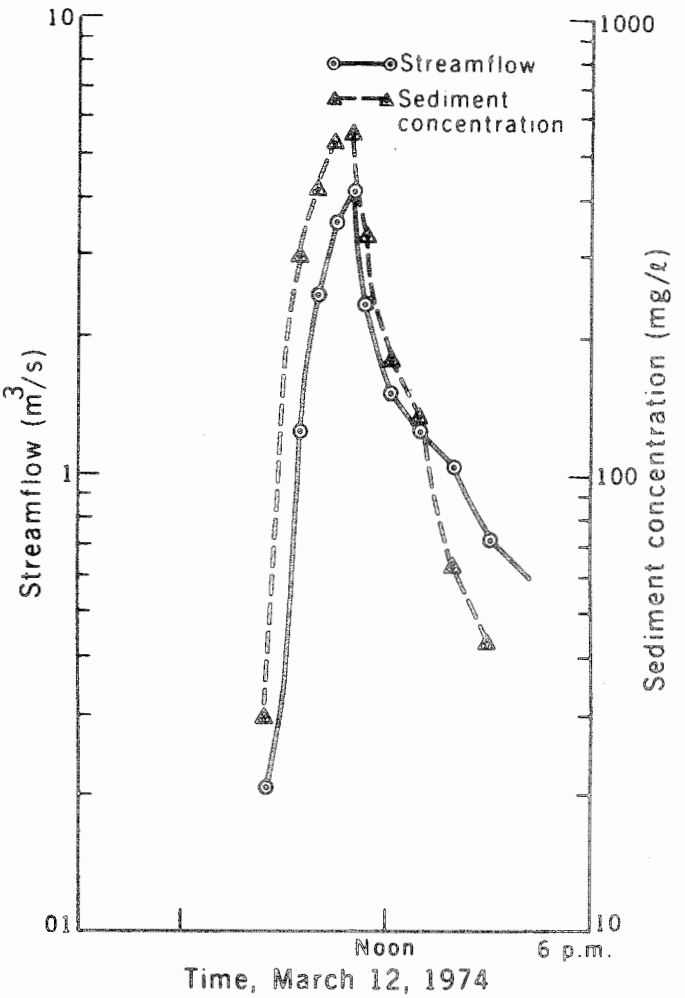

Figure 3. Stream Flow and Sediment Concentrations During a Moderate Rainfall Event, Kalihi Stream.

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TABLE 4. Relation of Instantaneous Stream Flow to Instantaneous Suspended Sediment Discharge on Two Watersheds, Oahu, Hawaii.

Watershed	Year	Number of Samples	r	Equation*
Kalihi/16-2290	1974	96	0.78	$Y = 0.014X^{1.76}$
	1975	34	0.96	$Y = 0.0069X^{1.95}$
	1976	49	0.90	$Y = 0.005X^{1.82}$
	1977	28	0.95	$Y = 0.018X^{1.68}$
	1978	43	0.82	$Y = 0.040X^{1.50}$
	Pooled	225	0.87	$Y = 0.011X^{1.78}$
Kipapa/16-2128	Selected Data	106	0.93	$Y = 0.0056X^{1.92}$

*Y = suspended sediment discharge (kg/day); X = water discharge (m^3/s).

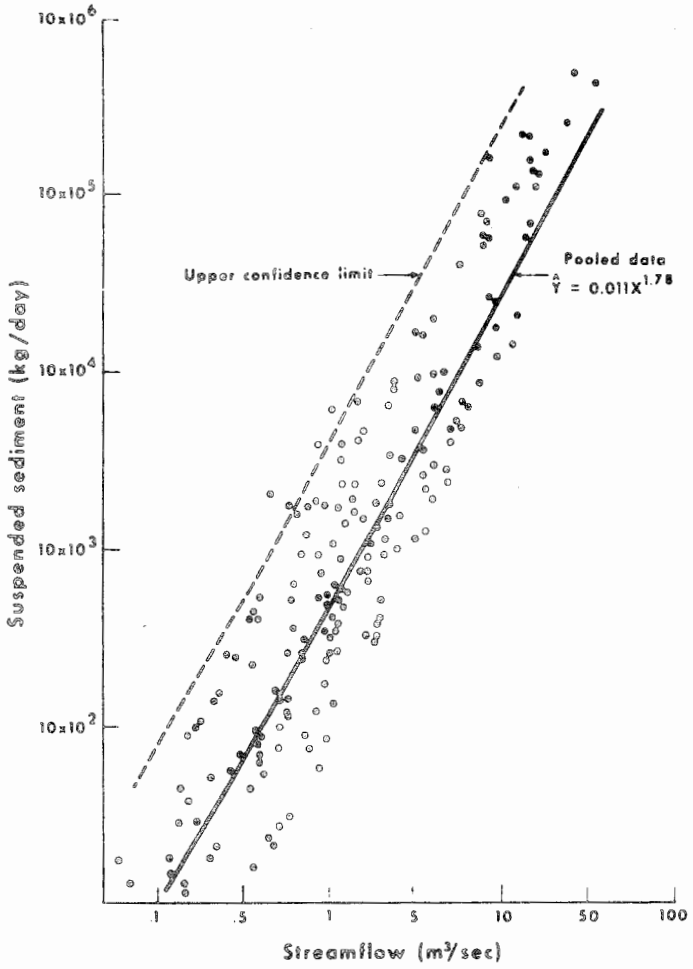

Figure 4. Suspended Sediment Discharge Plotted Against Stream Flow, From Kalihi Stream (relationship based on the pooled data where Y = estimated suspended sediment [kg/day] and X = stream flow [m^3/sec]).

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Grouted Mattress
Grouted Rock Rip Rap
Poured Concrete
Gabions and Reno Mattress

Channel-Lock™

Blocks	**450**	**550**
Height	4½ in.	5½ in.
Weight Per Sq. Ft. (Approx.)	32 lbs.	40 lbs.
Surface Area	1.78 sq. ft.	1.78 sq. ft.
Weight of Block	57 lbs.	71 lbs.
Concrete Strength	4,000 psi	4,000 psi
Open Area (Approx.)	20%	20%
Mattress (With Cables)	**450**	**550**
Standard Width	8 ft.	8 ft.
Standard Length	40 ft.	40 ft.

U.S. Patent No. 5,556,228

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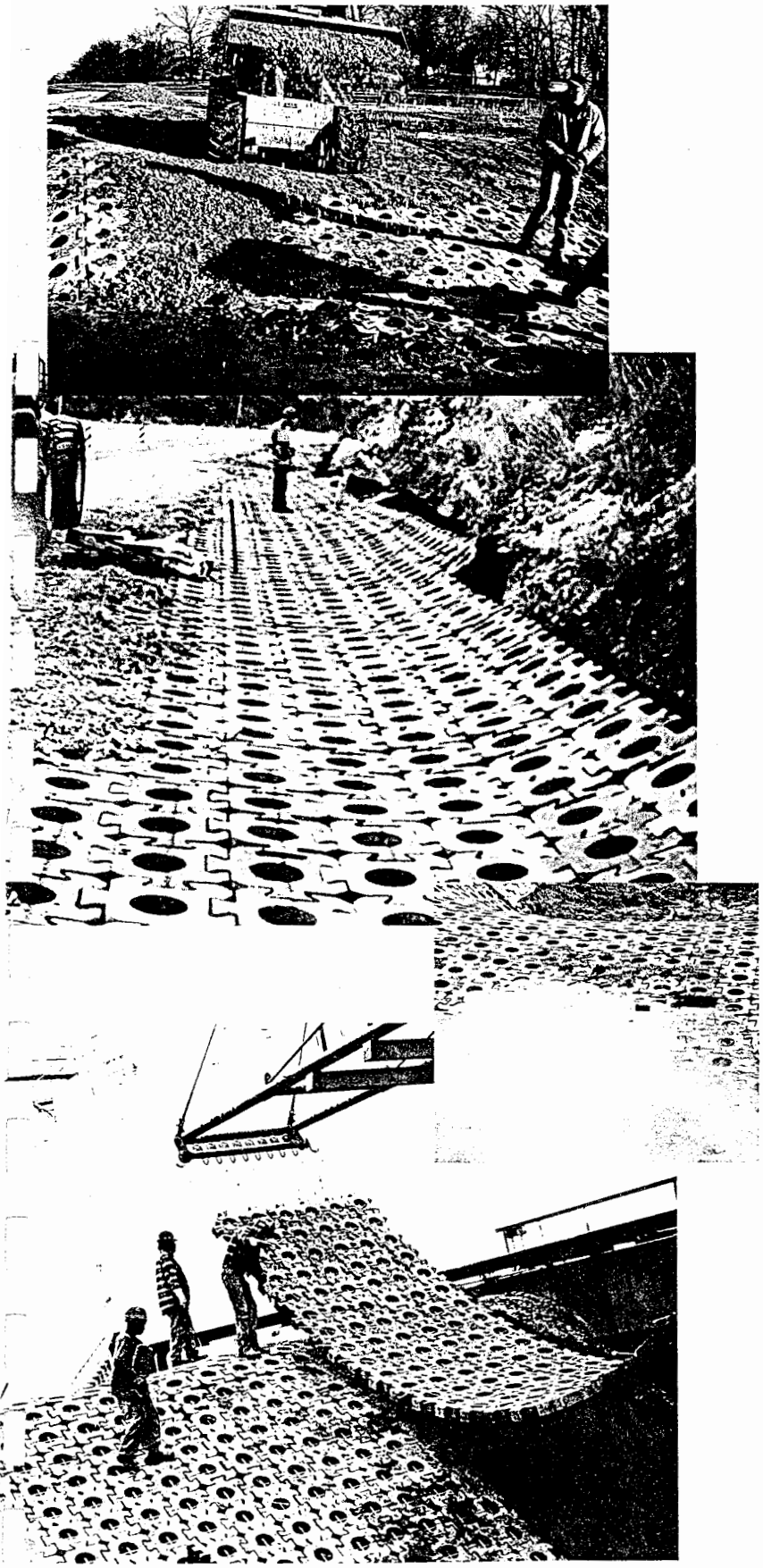


Advantages of **Channel-Lock**™

Channel-Lock™ **does a superior job of erosion control:**

Stable – Unique, strong, interlocking blocks make the whole job one integral system.

Flexible – The design allows the whole system to adjust to changing grades.

Relieves Hydraulic Pressure – Approximately 20% of the system is open, relieving hydraulic uplift forces, preventing cracking or displacement that can lead to system failure.

Appearance – **Channel-Lock**™ allows for revegetation in the voids in the system or allows fill with native materials to enhance appearance. No sharp, rough surfaces to cause injury or collect debris.

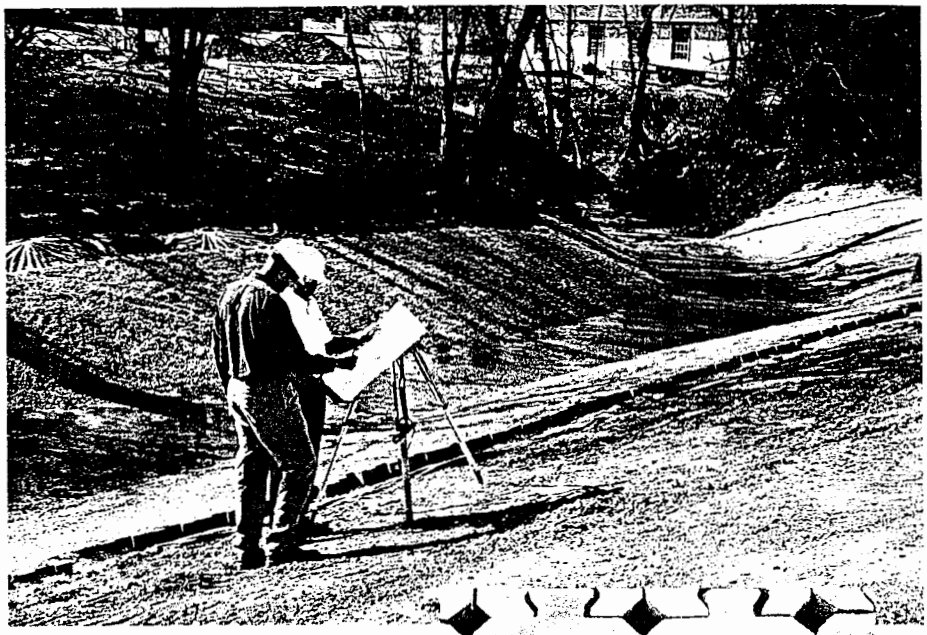
Accessibility – **Channel-Lock's**™ finished, uniform surface area allows for normal maintenance equipment and pedestrian traffic.

Durable – Constructed of 4,000 PSI concrete for long life, yet flexible to adapt to changing grade and hydraulic conditions without failing.

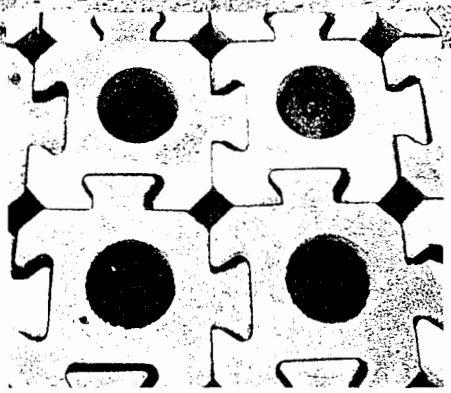
Environmentally Friendly – Open areas in this stable yet flexible system allow for maximum adaptation to the original environment. Native vegetation, soil or rock can be used to return the site to its natural state.

Ease of Installation – **Channel-Lock**™ can be hand-placed without the use of heavy equipment or is available in mats with cables.

Channel-Lock™



Channel-Lock™ is an economical, environmentally friendly and effective solution to erosion problems. In many cases, it is the superior alternative to conventional erosion control materials for revetment and channel



The unique, octagon-shaped, interlocking concrete block are placed on engineered geotextile filter fabric to protect against soil erosion. The open areas in the system allow for relief of hydraulic pressures to ensure system integrity throughout the installation. The interlocking block allows for flexibility throughout the system to adjust for changing soil conditions while maintaining the lateral stability of the system.

L Copper, Brake Pads & Water Quality, City of Palo Alto, DPW.

Copper, Brake Pads, & Water Quality

Briefing Packet

Developed by the City of Palo Alto and
Common Ground for the Environment

date: post-1994

Brake Pads And San Francisco Bay Questions and Answers

Copper and other toxic metals threaten the health of many wildlife species in San Francisco Bay. Brake pads are a major source of copper in the environment. This document explains the situation and what can be done about it.

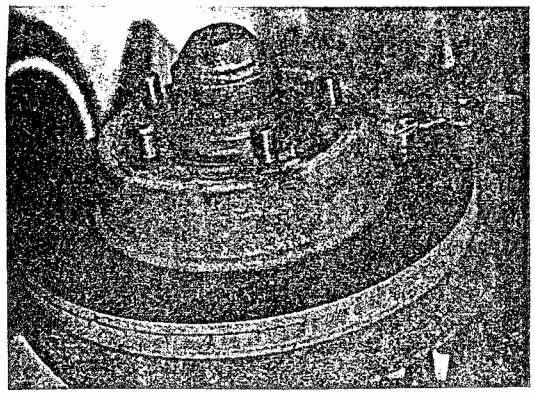
What's The Problem?

Copper and other heavy metals are a problem for San Francisco Bay. Copper, lead, and other heavy metals are toxic to aquatic life in very low concentrations (parts per billion). Heavy metals can accumulate in the food chain, concentrating in larger species such as fish.

An assessment of copper concentrations in the Bay shows that much of San Francisco Bay exceeds the adopted water quality objective for copper. Due to evidence of water quality impacts related to copper, lead, and other metals, the United States Environmental Protection Agency (U. S. EPA) has designated the southern reach of San Francisco Bay (south of the Dumbarton Bridge) as an impaired water body under Section 304 (l) of the Clean Water Act.

Local and regional agencies charged with protecting the Bay's water quality—such as municipal wastewater treatment plants and stormwater pollution prevention programs—are undertaking numerous programs and strategies to reduce the levels of copper and other heavy metals in the Bay. Special efforts have been made to reduce copper discharges, including a broad-based copper discharge reduction plan (containing a 20% reduction requirement for most sources) adopted by the San Francisco Bay Regional Water Quality Control Board. Everyone is looking for the best way to achieve the needed copper discharge reductions.

Businesses have played an important role in the metals discharge reduction effort. Regulatory programs to reduce copper discharges have had a particularly significant impact on the operations of San Francisco Bay Area manufacturing, metal plating, and computer industries.



Automobile Wheel with Disc Brake

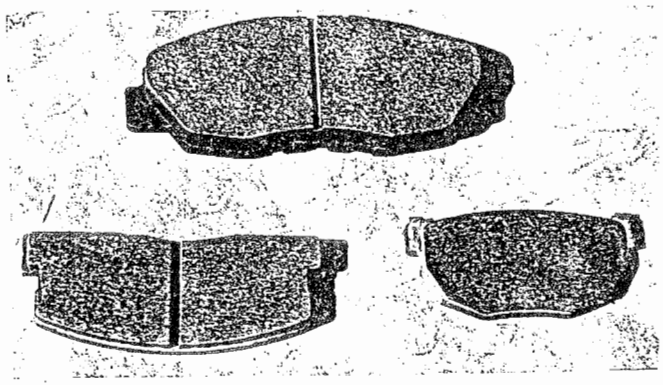
Why Is Brake Pad Dust A Concern For Water Quality And Environmental Protection?

About 35 percent of the total amount of copper and 1 to 4 percent of total lead discharged to southern San Francisco Bay comes from vehicle disc brake pads. This means that disc brake pads are one of the largest sources of copper discharge to the Bay, and a significant contributor to the Bay's copper problem.

The estimates above do not include possible contributions from drum brakes. Although drum brakes used to be popular, they are gradually being phased out by disc brakes. Many cars today have disc brakes on all four wheels or disc front-drum rear braking systems. Since trends indicate that disc brakes will probably increase in popularity in the future, research to date has focused on disc brakes.

What are Brake Pads Made of?

Brake pads are made from one of several types of "friction materials," that are generally classified as "metallic," "semi-metallic," or "organic." Organic brake pads contain little or no metal. While organic brake pads have contained asbestos in the past, most manufacturers have removed asbestos from their formulations for safety reasons. "Metallic" and "semi-metallic" brake pads are so called because of the presence of iron.



Automobile Brake Pads

Some—but not all—brake pads contain copper and other heavy metals. The use of copper in brake pads is limited by the relatively high cost of copper compared to the cost of alternative materials.. Copper content can vary from manufacturer to manufacturer and even among pads made by the same manufacturer. The range of copper content in a group of disc brake pads analyzed by the Santa Clara Valley Nonpoint Source Pollution Control Program was from essentially zero (below 0.00625 percent) to 20.5 percent. Lead and zinc have also been found in some brake pads. All types of brake pads (organic, semi-metallic, and metallic) can contain copper.

How Do Brakes Work?

Automobile Drum Brake

Most cars today have disc brakes. Disc brakes work like bicycle hand brakes: depressing the car's brake pedal causes a pair of brake "pads" to squeeze a metal disc on each wheel. Friction caused by the brake pads squeezing the disc slows and eventually stops the car. While the car is stopping, friction also wears away a tiny amount of brake pad material. Eventually, after about 30,000 to 50,000 miles, the pad must be replaced because so much brake pad material has worn off.

Drum brakes use two semi-circular brake pads ("brake shoes") mounted inside a covered cylinder (the "drum"). To stop a car, the brake shoes move outward, applying force against the walls of the cylinder. Like disc brake pads, drum brake shoes wear away, and eventually need replacement. Since the brake cylinder is a loose container, some of the brake pad dust remains inside the cylinder until it is opened for a repair.

Although a small amount of the dust that comes off of brake pads during stopping sticks to the wheel (or stays in the brake cylinder, in the case of drum brakes), the rest falls off onto the roadway or washes off in the rain or when the car is washed. Unless a street sweeper collects the brake pad dust that lands on the road, this "friction material" is eventually washed to a storm drain by rain.

How Does Brake Pad Dust Get Into San Francisco Bay?

Once it comes off a car, brake pad dust can fall on a road or travel through the air. Either way, the dust can fall into or be washed into the Bay.

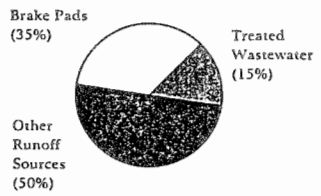
In most parts of the San Francisco Bay Area, as in most of the U.S., storm drains flow directly to creeks and the Bay without wastewater treatment. (In some older downtown areas around the U.S.—including much of San Francisco—storm drain systems are connected to sanitary sewers, so that storm water receives wastewater treatment prior to discharge.) In general, anything that gets into a storm drain ultimately flows into creeks, rivers, and bays.

Some brake pad dust is so fine that it can travel through the air for some distance. Dust that originally falls on a road surface can be broken into very fine particles and churned up into the air by moving vehicles. This particulate matter, often called PM_{10} (particulate matter less than 10 microns in diameter) can remain suspended in the atmosphere for some time, eventually washing back out of the air with rain and dew. Brake pad dust that washes out of

the air can settle directly into a creek or the Bay, or can fall onto land where it can be washed by rain into storm drains.

How Much Brake Pad Dust Gets Into San Francisco Bay?

A study by the Santa Clara Valley Nonpoint Source Pollution Control Program (a local government stormwater pollution prevention program) estimated that about half of brake pad dust probably reaches the Bay, either through storm drains, or through deposition from the air. This estimate was based on a series of studies conducted by the Federal Highway Administration on highway stormwater runoff.



South San Francisco Bay Copper Sources

Do Brake Pads Cause Problems For Other Water Bodies?

While the relationship between water pollution and brake pads has not been studied in other parts of the country, many other rivers, lakes, and bays (including Chesapeake Bay and Narragansett Bay) have copper problems. Brake pads are a likely contributor to these problems. State and Federal government agencies like the U. S. EPA have the data necessary to identify water bodies where brake pads may be a significant contributor to water pollution.

What Can Be Done?

Preventing pollution by eliminating the use of copper, lead, and other toxic metals in brake pads would be substantially more effective than attempting to control this pollution through efforts such as street sweeping. Because zero-copper and low-copper brake pads are currently certified as safe and used in many vehicles, it appears that the presence of copper is not necessary for brake pads to function properly. Therefore, reducing or eliminating the presence of copper in brake pads should be technically feasible.

But *eliminating* copper in brake pads may not be necessary to effect significant improvement in the health of the Bay. For the southern reach of the Bay, a 50 percent reduction in the copper discharge from brake pads would mean about a 17 percent reduction in total copper discharge—more than would be achieved by shutting down all three Santa Clara Valley sewage treatment plants! In conjunction with other copper pollution prevention efforts, a reduction of this magnitude might be enough to get the Bay close to or even in compliance with water quality standards.

A 50 percent reduction in copper discharge from brake pads could be accomplished in one of two ways: either by eliminating copper from the highest-copper brake pads, or by removing half of the copper from all copper-containing brake pads.

How Safe Are Brake Pads That Don't Contain Copper?

While copper is used in some brake pad formulations (apparently to provide friction stability), other brake pads contain little or no copper. Copper is used extensively in semi-metallic brake pads, particularly in European and Japanese vehicles, but also may appear in metallic and "organic" brake pads. Copper-free brake pads of all types (metallic, semi-metallic, and organic) are widely available and in common use.

Because zero-copper products are currently used in many vehicles in accordance with federal vehicle safety standards, it appears that the presence of copper is not necessary for brake pads to function safely.

How Can We Reduce The Copper Content of Brake Pads?

A voluntary partnership between industry and public agencies offers the best and most expeditious solution to the problem of copper pollution from brake pad wear. EPA's Green Lights initiative is one example of a successful program, designed to encourage businesses to switch to energy-efficient lighting. Reductions in the copper content of brake pads may similarly be achieved through a voluntary partnership with vehicle, brake pad, and friction material (pad surface) manufacturers. By reformulating brake pads to contain less copper, manufacturers can save on the cost of raw materials and enhance their images as environmentally responsible companies.

Alternatively, water pollution from brake pads could be controlled through federal or state regulation. While a regulatory approach is possible, it would involve substantial time and potentially significant costs for both government and industry.

With active, effective partnership between government and manufacturers, a voluntary solution is possible. To succeed, the U. S. EPA, California EPA, local governments, community members, automobile manufacturers, brake pad manufacturers, and the makers of friction materials will need to work together to protect the environment.

The photographs in this document were obtained with the assistance of Larry's AutoWorks (Mountain View, California). Sample brake pads shown in the first photograph were provided by Larry's AutoWorks (Mountain View, California) and Anderson Honda (Palo Alto, California).

How Can We Reduce the Amount of Copper in Brake Pads?

A voluntary partnership between industry and public agencies offers the best and most expeditious solution to the problem of copper pollution from brake pad wear. EPA's Green Lights initiative is one example of a successful program, designed to encourage businesses to switch to energy-efficient lighting. Reductions in the copper content of brake pads may similarly be achieved through a voluntary partnership with vehicle, brake pad, and friction material (pad surface) manufacturers:

- Copper-free brake pads are readily available and meet safety and performance standards.
- Industry mechanisms and business structures could provide incentives for the necessary changes without regulatory action.
- The industry's voluntary reduction of asbestos use in brake pads provides a successful precedent.

By reformulating brake pads to contain less copper, manufacturers can save on the cost of raw materials and enhance their images as environmentally responsible companies. For government agencies, a voluntary partnership provides the opportunity to move beyond the traditional command and control approach and towards a cooperative effort aimed at a sustainable economy and environment through prevention of pollution at the source. The Brake Pad Partnership can become a model for addressing other pollutants identified through regulatory programs.

Next Steps

Initial coordination of the Brake Pad Partnership has begun. Answers to some of the more pressing questions have already begun to be identified, including: the nature of the industries involved, the national significance of copper pollution, and the potential for voluntary copper reductions. Contacts with and briefings of key stakeholders have also been initiated, including local, state, and federal government agencies as well as industry associations and technical experts. The Partnership should begin business meetings in 1996.

The next steps in the development of the Brake Pad Partnership include:

- Continue discussions with vehicle, brake pad, and friction material manufacturers. Begin to explore voluntary reductions in the amount of copper in brake pads. Issues to be explored in the Partnership dialog include:
  - How much copper is used in brake pads and what function does it serve?
  - What are the future trends in industry's use of copper in brake pad formulations?
  - What capacity does the brake pad industry have for change in copper levels?
  - How would alternative formulations affect the environment?
- Confirm that a reduction in the copper content of brake pads does not affect braking safety. Since many no-copper brake pads are currently available and meet safety standards, there does not appear to be a relationship between the presence of copper and braking safety; nevertheless, this assumption should be confirmed by manufacturers.
- Identify other water bodies that are impacted by copper and other heavy metals found in brake pads. Data from the U. S. EPA and other sources can be compiled and analyzed to confirm the national significance of copper pollution and to evaluate the national implications of copper discharges from brake pads.
- Improve understanding of the relationship of copper released from brake pads to toxicity in aquatic ecosystems. Past, current, and future studies can provide a more detailed understanding of the relationship of brake pad copper releases to water quality and effects on aquatic ecosystems.

Resources to support the Partnership through its completion will be needed. Elements of the Partnership most likely to require funding are administrative costs and research. Technical research will likely be necessary to supplement existing data with regard to the relationship between brake pad wear and surface water quality.

Sources of Copper

Copper is discharged to surface water from many sources, including both stormwater runoff (which typically receives no treatment) and municipal and industrial wastewater treatment plants. Copper also reaches creeks, bays, and estuaries through deposition of airborne materials, via leachate flows from abandoned mines, and from agricultural runoff containing pesticides. The relative importance of these copper sources varies among water bodies.

Sources of Copper Discharge to San Francisco Bay

The San Francisco Bay Regional Water Quality Control Board has determined that stormwater runoff and abandoned mines are by far the greatest sources of copper discharge to the Bay. In some areas, stormwater is the major source.

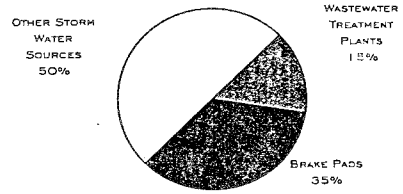
Almost everywhere in the San Francisco Bay area, stormwater runoff is carried by storm drains or creeks directly to the Bay. It is not treated prior to discharge. For many reasons, it is generally considered impractical to provide treatment for runoff. Preventing pollution, by eliminating the discharge of pollutants at the source is the most practical and cost-effective method of reducing storm water related pollution of creeks and the Bay.

A study prepared by the Santa Clara Valley stormwater program (*Contribution of Heavy Metals to Storm Water from Automotive Disc Brake Pad Wear*, Woodward Clyde and Santa Clara Valley Nonpoint Source Pollution Control Program, October 1994) indicates that brake pads are one of the largest single sources of copper in stormwater runoff. In no particular order, other sources of copper in storm water runoff include:

- clutch pad wear;
- motor vehicle exhaust;
- deposition of air pollutants;
- automotive fluid leaks;
- automotive wrecking yards;
- outdoor use and storage of metals;
- vehicle tire wear;
- improper disposal of paint, oil, coolant, and other wastes;
- illicit storm drain connections and illegal discharges to storm drains;
- vehicle wash water;
- water supply;
- corrosion of copper piping;
- cooling water discharges;
- use of copper-containing pesticides (including root killers, cooling tower additives, pool algaecides, landscaping products, gardening products, and agricultural products);
- discharges from mobile cleaning operations (such as steam cleaners, mobile vehicle washing, building and plaza cleaning, parking lot cleaning, and carpet cleaning);
- swimming pool, spa, and fountain discharges.

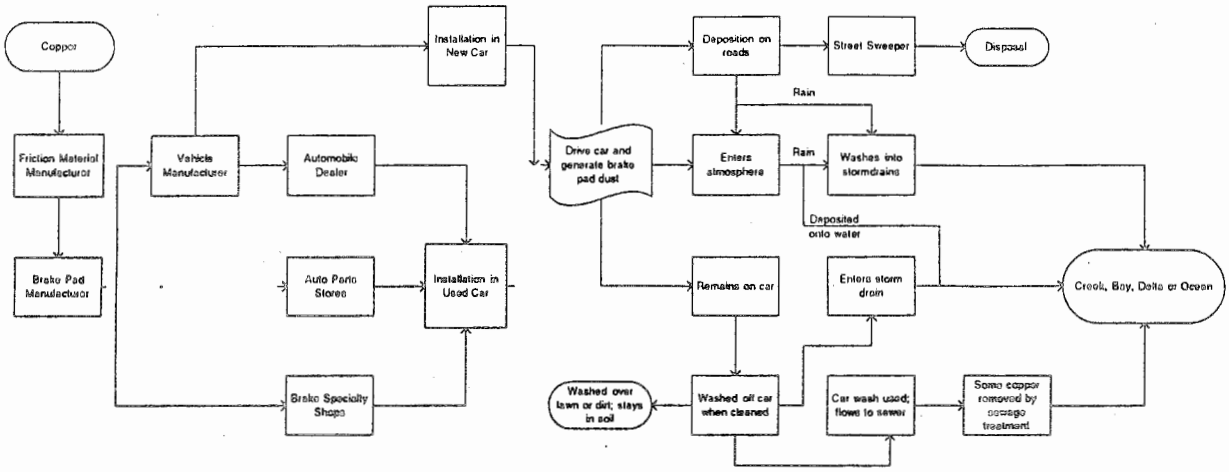
Quantitative Estimate of Copper Sources

Using data assembled in the *South Bay Copper Reduction Dialog Memorandum of Understanding* (1994), it is possible to estimate the significance of brake pads as a source of copper discharge to the southern reach of San Francisco Bay (south of the Dumbarton Bridge). Copper from disc brake pads is estimated to make up more than one third of all copper discharge to the southern reach of the bay—more than twice as much copper as discharged by all three wastewater treatment plants combined.



Sources of Copper in South San Francisco Bay

Such estimates have yet to be prepared for other portions of the Bay and for other water bodies. Nevertheless, given the relative importance of brake pads as a copper source for South San Francisco Bay, it is likely that brake pads are a significant contributor to copper problems in other water bodies in urbanized areas.



THE FATE OF COPPER IN BRAKE PADS: A SUMMARY

M Waikakalaua Stream Realignment Project

Troy Ogasawara
Hawaiian Fertilizer Sales.

Waikakalaua Stream Realignment Project

by Troy A. Ogasawara, Vice President, Hawaiian Fertilizer Sales, Inc., and Alan C. Joaquin, President, The King's Landscape Company

Introduction

LAND continues to become a precious commodity in Hawaii, as in many other areas. The relatively high cost of land in Hawaii has forced designers to employ innovative approaches to maximize developable areas. In order to prepare building pads and road bases on the valley floor, cut and fill techniques are essential. The establishment of vegetative cover on steep and highly erodible slopes has always presented a challenge at Launani Valley, located in central Oahu, Hawaii. Gilbert Scott, representing Towne Realty, was the developer for Launani Valley.

A condition of the development permits required Waihuna Joint Venture to vegetate all cut and fill slopes. In total there were in excess of 2.43 hectares (6 acres) of slope face created during construction. These slopes ranged from 2:1 to 0.5:1 and in some cases vertical. Slope heights varied from approximately 18.29-33.53 m (60-110 ft) and between 19.14-18.29 m (30-60 ft) cut and fill, respectively. Being situated along the valley walls, these slopes remained relatively inaccessible from their tops. In addition, the Waikakalaua stream ran along the base of approximately two-thirds of the slopes. In such instances, a 21.34-27.43 m (70-90 ft) span over the stream rendered these slopes inaccessible from both top and bottom. These conditions added further constraints in utilizing conventional stabilization and vegetation techniques.

An initial soil test indicated an extremely poor nutritional status. This soil was infertile, exhibited an extremely high hydrogen base saturation percentage and low phosphorous levels. Being of volcanic origin, extremely low soil pH and situated in a high rainfall zone, it would be plausible to consider aluminum and manganese toxicity as an additional factor in the establishment of any vegetative cover. In 1994, the National Weather Service reported over 254 cm (100 in) of rain at its adjacent Mililani Mauka Station between January 1994 and July 1995.

Historically, the standard planting and erosion control practice consisted of hand broadcasted Weidelia trilobata stolons covered by jute netting, then capped with tackified mulch. This method proved to be effective on moderate slopes, consisting of fertile soil types. Slopes with a grade of 1:1 and greater, which consisted of friable infertile saprolite, presented difficulties in complete vegetation via this means.

Site Considerations

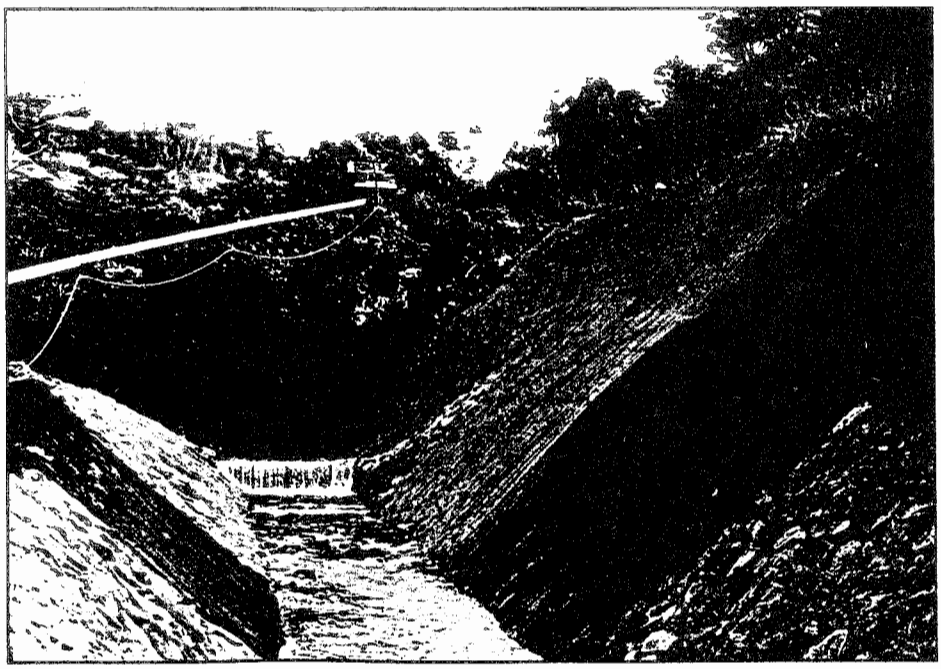
Taking into consideration the many inhibiting factors, standard planting practices were not feasible, nor effective. With respect to establishment, the depleted soils encouraged root development into the bonded fiber matrix and jute net blanket used for erosion control rather than the soil substrate.

Success of the project would be contingent upon properly addressing each of the following factors.

1. Ability to cost-effectively stage and safely install materials under the prevailing site conditions.
2. The stabilization of friable soil to the stable underlying substrate. This layer ranged from 5-15 cm (2-6 in) in depth.
3. The ability to provide for "transitional binding" (erosion control) which would allow for gradual degradation as the selected plant material secures its roots deeply into the soil profile.
4. The extreme nutritional deficiencies of phosphate, potassium, magnesium and calcium required corrective action.
5. Due to the occasional high wind gusts, severe slopes, long slope faces, unpredictable weather, and inaccessibility, proper irrigation distribution presented an obstacle.
6. Being in close proximity to a stream, the methods employed must not present an environmental hazard.

Material Selection and Design Considerations

A cementitious gypsum base geobinder



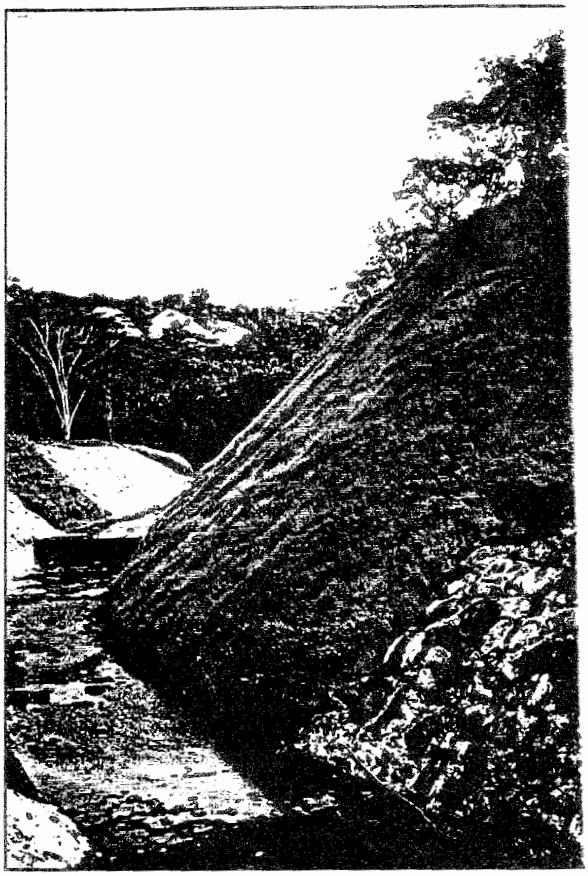
Man-Lift extended across stream bank.

(Airtrol™), in conjunction with a recycled cellulose fiber mulch, was selected for its ease of application through standard hydraulic planting equipment. This eliminated the need for dangerous rapelling, stapling, and expensive crane and riggings associated with blanket installations. An inexpensive 24.38 m (80 ft) Man-Lift enabled the applicator to hydraulically apply the slurry coats via a cannon mounted to its basket. The mobility of the Man-Lift allowed the three slurry coats to be applied from a multi-directional trajectory. Shadowing and voids were eliminated via this process. The ability to apply the material uniformly across the slope is of critical importance in mitigating water sheeting erosion.

Gypsum based geobinders, when applied using modified techniques, have the ability to penetrate and bond the friable surface material to its stable substrate. Gypsum plaster degrades gradually when exposed to water, allowing for "transitional binding". In addition, a corn starch based tackifier (FISCH-STIK) accelerated "set time", delayed degradation of the gypsum based geobinder, and also enhanced the "transitional binding".

An added benefit of utilizing gypsum plasters in this particular infertile soil type is its ability to supply available calcium and sulfur to the germinating seedlings. Calcium as a soil amendment would also aid in the mitigation of potential aluminum toxicity. A high phosphorus slow release fertilizer and a nitrogen fixing legume, Crotalaria jungea (Tropical Sun Hemp) was combined in the hydraulic slurry to provide long-term fertilization.

Kikuyugrass (Pennisetum clandestinum) was selected due to its aggressive growing habit, drought tolerance and extensive root and stolon structures. Annual ryegrass (Lolium multiflorum) served as a nurse crop whose fibrous root structure provided short-term soil stabilization. Tropical Sun Hemp provided for a natural long-term nitrogen



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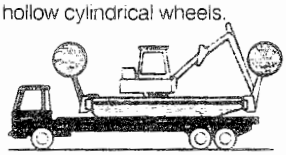

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supply on an otherwise difficult to fertilize slope.

A drip irrigation system was selected to overcome high wind conditions, severe slopes and limited water supply. Furthermore, a conventional irrigation system would have been susceptible to damage during flash flood conditions. Such floods have been known to increase stream levels up to 15 feet. Therefore, a vertical system was installed along the stream bank slopes. A horizontal system was installed on the remaining slopes.

Observations and Conclusions

Step 1: The bonded fiber matrix served to adhere the underlaying stable parent material to the unstable friable surface material. The high volume of aqueous Gypsum Based Land Plaster/Geobinder, combined with Organic Starch Based Tackifier, penetrated the profile and created a an effective erosion control technique. When allowed to harden and cure, the loose crumbly soil particles became a stable nutrient-fortified base for seeding.

Step 2: Proper distribution of the seed and fertilizer components to achieve intimate contact with the stabilized soil surface. This technique promoted deep root growth into the soil. An indicator dye was also utilized to ensure even deposition of this seeding mixture.

Step 3: The heavy bonded fiber matrix application provided an armor-like coat which protected the seed and fertilizer from rainfall impact, wind erosion and water sheeting. When installed properly, this 0.32 to 0.64 cm (1/8 to 1/4 in) coating has the texture and hardness of a paper egg carton. After curing, subsequent rainfall and irrigation slowly dissolved the Gypsum based material, which in turn fortified the soil with additional calcium and sulfur. As germination and establishment progressed, the "transitional binding" agents gradually lost their effectiveness, while the long-term vegetative stabilization matured.

Normal irrigation was initiated approximately 24 hours after the final coat application. Germination of ryegrass occurred in 4 days. Full establishment of the Kikuyugrass and Tropical Sun Hemp was attained in 2 months.

A minor failure occurred on a near-vertical portion, in a single instance. A 91.4 cm (3 ft) diameter section fell as a result of poor penetration of the initial Step 1 profile binding coat. Initially, a small colloid detached from the face of the slope. The small opening in the armor coating and poor profile attachment to the parent material caused this incident. The small void, undermined by irrigation and rainfall, developed into a large bare spot. This demonstrates the necessity of the initial Step 1 profile binding technique.

This three-step application process accomplished the stabilization desired with complete and uniform establishment of vegetation, while also being a cost-effective and environmentally sound method. **L&W**

Revised reprint from International Erosion Control Association Proceedings of Conference 27.

For more information, contact Troy A. Ogasawara, Vice President, Hawaiian Fertilizer Sales, Inc., 94-155 C Leowaena St., Waipahu, HI 96797, (808)677-8779, fax (808)671-5919, or Alan C. Joaquin, President, The King's Landscape Company, 428 North Kainalu Dr., Kailua, HI 96734.

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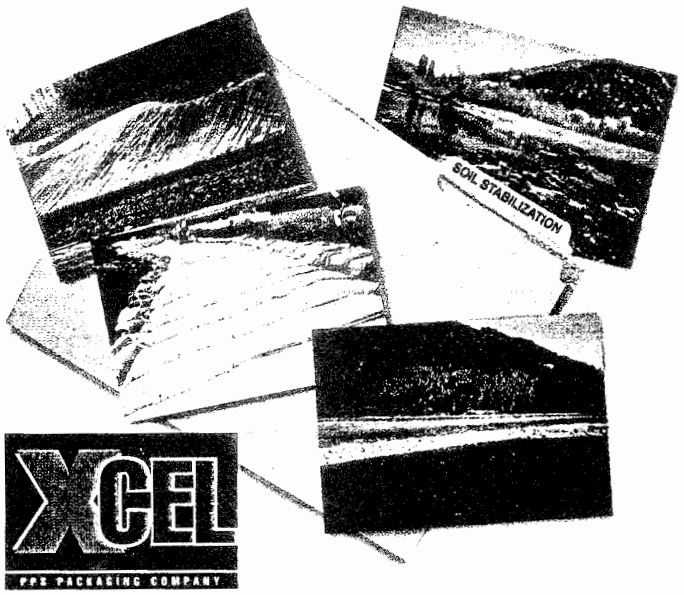

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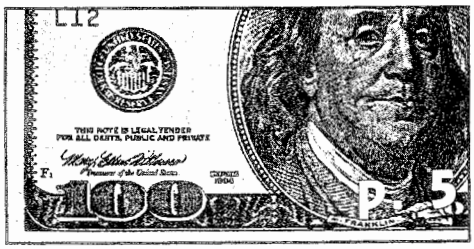
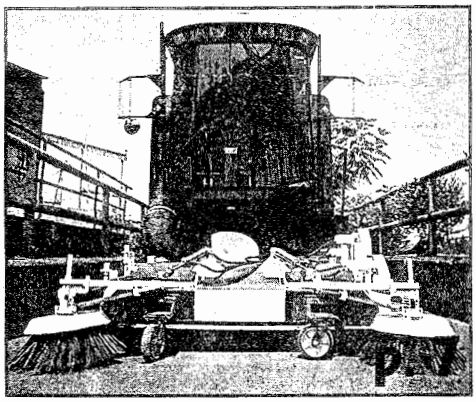
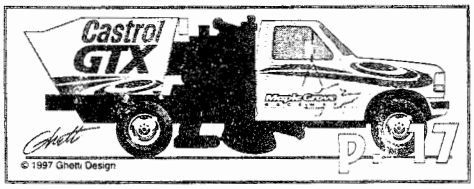
N Port of Seattle Study Recommends that Sweepers Can Replace More Expensive BMP's for Removing Metals

Submitted by:
Jackie Parnell
Environmental Planning Consultant
Honolulu.

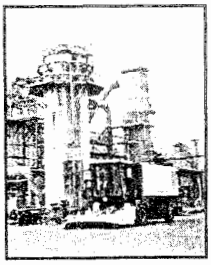






About our cover...

This Schwarze EV1 pavement cleaner is shown at work at the Doe Run Company's lead smelter in Herculaneum, Missouri. By using the EV1, the smelter can now clean in below freezing weather conditions, and a single operator can perform an 8 hour shift because the EV1's filtering system reduces the concerns about lead poisoning.



Schwarze Industries

AMERICAN SWEEPER℠

Magazine

Volume 6 Number 2 1997

Features

Where It All Started p. 5

This excerpt from Benjamin Franklin's autobiography shows why this icon of American history is considered by many to be the 'Father of Street Sweeping.'

Air Quality Sweeper Testing p. 6

Another veteran sweeper researcher calls for comprehensive national testing standards.

Setting Their Sights On Perfection p. 10

Atlanta Sweeping is working to re-define quality in contractor-based sweeping services.

Raceway Sweepers Must Really Perform p. 16

When a sweeper is used at racetracks, there's no room for error. Representatives of America's newest NASCAR facility and an NHRA track manager provide insight.

Port Of Seattle Commissions Sweeping Study p. 18

Study recommends that new EV-series pavement cleaners can replace more expensive BMPs.

United We Sweep p. 20

Northern California contractors form an association dedicated to professionalism.

Refurbish Those Older Sweepers p. 28

The purchasing manager of one America's largest property development firms shares what she's learned about the wisdom of sweeper refurbishment.

Roto-Milling p. 30

Many contractors describe sweeping after a roto-mill as the toughest job in the business. Three seasoned contractors discuss why you need experience — and tough equipment.

Planning, Quality, Honesty p. 33

BJ Sweeping does the job the old fashioned way, by providing quality service every time.

Cleaning Up After Mardi Gras p. 34

Cleaning up after what may be America's biggest party is a logistical nightmare. To the veteran sweeping team in New Orleans, it's just another parade, just another year.

Landfill Fees and Space p. 39

What can we expect for future tipping fees and landfill space constraints? Jim Thompson, president of Chartwell Information, Inc., provides an insightful look at this topic.

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Schwarze Industries' purchase of the patented EnviroWhirl waterless sweeping technology moves the industry's best available technology from 'sweeping' to 'cleaning.' This analysis by company president Mark Schwarze provides his insight on this new breakthrough.

Industry Update p. 22

New products, new changes in the industry.

Feedback From the Field p. 27

Schwarze Industries' warranty manager discusses why it's so important to get warranty advice on tires before they get worn.

THE EDITOR'S PERSPECTIVE

We All Must Listen To The Wind

There's no longer any denying our country's environmental winds of sweeping change. The first whispers started just a couple of years ago, as a soft onshore breeze striking only America's coastlines. In recent times, however, the force from along our waterways has become a gale, and now the first breezes are being felt from the heartland.

As with every unasked-for change, some have pretended that nothing is happening. Others, resisting disruptions in their status quo, are hoping it will simply go away. An increasing number, though, are recognizing that this movement represents the dawning of an exciting new era for sweeping. As with any dynamic situation, however, to prosper will require education about, and adaptation to, the emerging requirements.

Benjamin Franklin, one of our foremost statesmen and pioneers of the entrepreneurial spirit, epitomized the ability to succeed through 'inventive adaptation.' We start this issue with the portion of his autobiography in which he modestly proposed, back in the 1750's, the basic advantages to be found by sweeping the streets of London. This word-for-word excerpt shows why many consider Franklin to be the 'Father of Street Sweeping.'

Another such person is inventor Ken Wilkerson, a man whose brilliant adaptations in the train derailment industry are now having a broad-based impact on sweeping. In combination with another person of vision, Mark Schwarze, president of Schwarze Industries, Inc., Wilkerson's EnviroWhirl technology is propelling sweeping to a new level of effectiveness and professionalism. Although this won't take place overnight, it *will* occur — because the need for this advancement is so great. Schwarze Industries' purchase and usage of the EnviroWhirl technology has already changed forever some of the most fundamental, basic, premises of sweeping. When you read about this quantum technological leap, covered on pages 14 and 22, I believe you'll agree there's no going back.

Chuck Satterfield provides his insight (page 6) on how sweeping can affect air quality and introduces some important ideas on reducing dust output even on current mechanical broom sweepers. Well-known researcher, Roger Sutherland, also unveils the results of his new study commissioned by the Port of Seattle (page 18). This is the most conclusive evidence so far that advanced technology pavement cleaning can have a very positive impact on reducing pollutants in stormwater runoff.

In this issue you'll also be reading about some other people who are committed to producing the best results possible. We take a look at Atlanta Sweeping (page 10), a company that's advancing at breakneck speed not because they provide low cost services, but because of a total commitment to attaining zero customer complaints. Our other featured contracting firm, BJ Sweeping (page 33), has also attained its success by making the provision of quality services a company trademark.

Ever wonder what some of the toughest sweeps in the country might be? We cover three contenders for that category: racetracks (page 16), sweeping after a rotomill (page 30), and cleaning up debris you have to see in order to believe, the aftermath of Mardi Gras (page 34). Additional inspiration comes from the director of America's newest sweeping association, the United States Street Sweeping Association (page 20), as well as from the person in charge of the sweeping program for Crown American, one of the largest property management firms in the U.S. (page 28).

There's a host of useful information packed into this issue of *American Sweeper*. As you read the ideas from this wide cross-section of innovative people, I challenge you to formulate ways to use it to create a positive impact within your own organization. Armed with the knowledge packed into these 40 pages, you can have a tremendous influence on the policies and quality level around you. Don't just read about it: In the immortal words of Star Trek's Jean Luc Picard, "Make it so."

Ranger

Ranger Kidwell–Ross, Editor

Schwarze Industries
AMERICAN SWEEPERsm
Magazine

is published to enhance the professional information available to those in the power sweeping industry. Subscriptions are provided free of charge to those in the industry.

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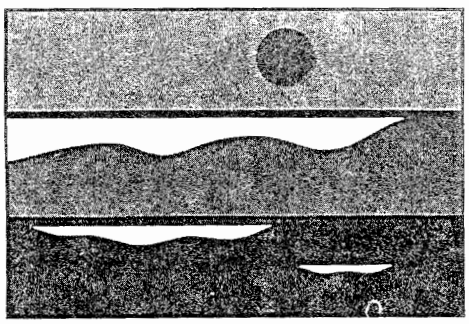
Port of Seattle Commissions Sweeping Study

Sweeping up fines could save $16 million over the cost of previous stormwater runoff control solutions.

by Ranger Kidwell-Ross

One of the latest sweeping studies involves the 250 acre expansion of a container storage facility by the Port of Seattle. The yard at the proposed site, as well as that of the current location, is 100% paved. At the site, containers are taken off of ships, then moved around, stacked, put onto trailers, etc. Plus, semi trucks bring in containers and leave with full ones. The Port facility is a major shipping nexus of the west coast, and so is a very active operation.

As part of their expansion requirements, the Port was faced with an $18 to $20 million stormwater control cost. For this type of expansion, one of the best management practices recommended by the Washington State Department of Ecology (WDOE) is the installation of huge underground boxes, called 'wet vaults.' These are designed to catch stormwater runoff and then settle it. Because of the cost, the Port of Seattle hired Roger Sutherland, of Kurahashi and Associates, Inc. to conduct a study. Sutherland's mandate was to see if an alternative to the wet vaults might work just as well, but cost less.

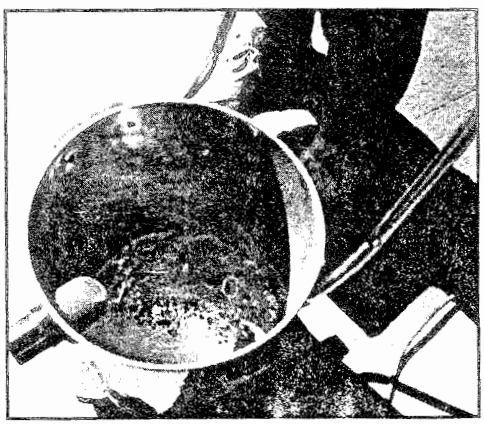


WASHINGTON STATE DEPARTMENT OF ECOLOGY

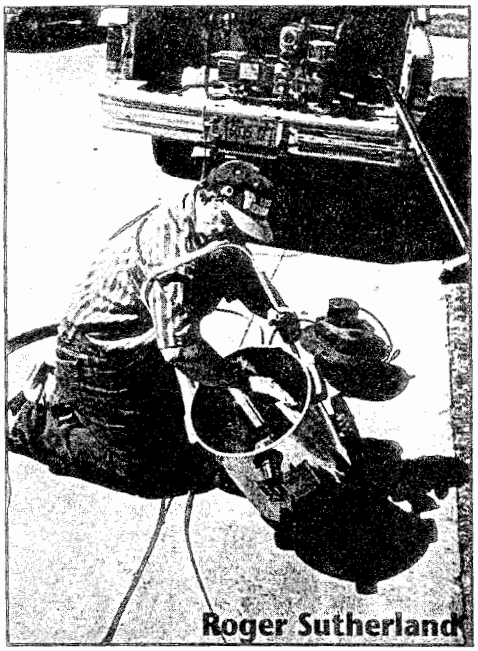
"We collected 2 months worth of data," said Sutherland, "which is the accumulation of sediments on an existing yard almost identical to the proposed expansion." A Seattle stormwater consultant, Gary Minton of Resource Planning Associates, hand-vacuumed the sedimentation that collected at 9 test sweeping sites, each 2,000 square feet in size. At varying frequencies, ranging from weekly to every four weeks, he went out and collected what was on the pavement surface at the various accumulation sites, using a hand broom and a shop vac. That provided the information on how rapidly material accumulates on the pavement after each time it is hand cleaned. During this two month time frame, eight significant rainfall events occurred, and their depths over time were recorded.

"We used our SIMPTM computer model," continued Sutherland, "to evaluate whether a street sweeping technology can be competitive with [the pollution load that can be collected by] the wet vaults. This model uses the data we collected in Las Vegas, NV and Centralia, IL, using the advanced technology EnviroWhirl sweeper's ability to pick up street dirt. We have conducted several studies on this machine, and have found it to be far superior to any other sweeper in the marketplace.

"Through the real data collected, along with the results of the computer modeling study that went along with it, the conclusion is that high efficiency pavement sweeping, conducted on a weekly basis in conjunction with annual catch basin cleaning, can be, and appears to be, competitive with the wet vaults. The wet vault appears to be more efficient than the net result of the sweeping along with traditional catch basins. However, when it is understood that there is a soluble amount of certain types of pollutants, like metals, that exist in the material that's lying on the pavement surface in a dry format, it appears that the sweeping can be just as competitive as the wet vault, if not more so, when it



Sweeping can be more effective than wet vaults at removing difficult pollutants like dissolved metals.


Roger Sutherland

comes to removing these very difficult pollutants like dissolved metals.

"The bottom line of the results from this model study is that when the large wet vault concept is compared to weekly sweeping (along with annual catch basin cleaning), then the wet vaults have a 90% reduction in annual Total Suspended Solids (TSS) washoff by stormwater runoff. The sweeping/catch basin concept has a TSS reduction of 65% annually. However, in total phosphorus removal the two methods appear to be close, at 45% annually for wet vaults and with sweeping/catch basins at 55%. Wet vaults are projected to remove 80% of lead annually, with the sweeper/catch basin technology reducing it by 60% annually. And with zinc, which tends to be a more dissolved metal, wet vaults are projected to remove 45% annually and sweeping/catch basins at 50%. All of these reductions are in relationshiup to an annual rainfall simulation with no control assumed to be in place.

"The answer appears to be 'Why spend $18 million to install a wet vault when, over a life cycle basis, the sweepers can be purchased and operated for about $2 million?' We think the results of this study may establish a direction for high efficiency street sweeping, especially since the empirical results show it to be better than some of the other traditional Best Management Practices (BMPs) which have historically been used and are therefore grandfathered in."

Stan Ciuba, an environmental engineer with the WDOE, is involved with the decision on behalf of that agency. As part of his job, Ciuba is currently working on an update to the Stormwater Management Manual, which will then become the new Washington State stormwater manual.

"Our requirement at WDOE is that the Port of Seattle will have to install appropriate BMP's to control pollutants and runoff," said Ciuba. "That's why they're considering the EnviroWhirl [now Schwarze EV-series] sweeper. The remaining pollutants may need just some basic additional cost-effective best management practices. What that will be has yet to be determined. We have not yet decided, between the Port of Seattle and Ecology, what will be an acceptable BMP for what remains after sweeping. They're talking about using some efficient catch basin technology, as opposed to wet vaults, and we're also looking into catch basin inserts, as a newer technology for removing the pollutants — mostly suspended solids —that are left.

"The Port's study showed that the EnviroWhirl sweeper removed more of the soluble pollutants than the wet vault, and that's all to the good. However, one of the concerns is that, although sweeping may have been shown to be efficient for some particles, it could only get to a certain percentage of the yard. I think in one section of the yard it can only get to about 8-10%.

Sweeping is also not as effective during rainfall conditions, at which time some pollutants may be discharged. So it's that safety net, and the loading that would be discharged during those times when the sweeper is either not effective or not available, that we have to look at for additional pollutant control.

"The Port is looking for a more cost-effective approach, and nobody could argue with that. We have to look at it from the standpoint of residual pollutants, ones that remain after applying the appropriate BMPs and that are acceptable in terms of water quality impacts."

Dave Torseth is an engineer with the Port of Seattle, and has been working closely on the Port's expansion plan alternatives. "Based upon the study by Kurahashi and Associates," said Torseth, "the Port of Seattle feels comfortable in our proposal for using an EnviroWhirl technology machine as a BMP. We're now in the position of trying to make the Washington State Department of Ecology (WDOE) feel comfortable with it.

"The Port of Seattle is pretty convinced that the EnviroWhirl technology represents a significant leap in terms of what the sweeping industry has to offer, and that's why we've gone as far as we have. In the demonstration we saw in September of 1996, the machine did a pretty amazing job of picking up the particulates. It did a good job on both wet and dry pavement. The biggest issue we're facing with the agencies is that they're not that familiar with it yet, so they're not as comfortable with what the machine has to offer. As it becomes accepted throughout the industry, that will help with places [like government agencies]. From what we have seen, and from the results indicated in the study by Kurahashi and Resource Planning revealed, we think this project merits the use of one, and perhaps two Schwarze EV-series sweepers, as soon as we can win approval from Ecology [WDOE].

"There are two issues going on [regarding WDOE's hesitation]. One is that we're trying to compare this new sweeping technology against a wet vault alternative, and there's some question about

...continued on p. 37

KURAHASHI & ASSOCIATES, INC.

The sweepers can only go half a block before dumping.

sort of thing on them. Most people quickly realize that's not a good idea, however," he said with a chuckle.

The French Quarter poses even more problems, due to its narrow streets and unbelieveable curb line debris piles. "In the Quarter, the sweepers can only go half a block before dumping," said Terrell. "Everything but the bar stools are in the street. The debris piles are so high that we have people out in front walking and poking it, making sure there's nothing in there that shouldn't be swept. Police on horses go ahead of the equipment, and it's virtually wall-to-wall people when we start in.

"Technically, the streets like Bourbon Street are only two sweeper-widths wide. We stagger one sweeper on each curb, then run another machine directly behind each of those, then one up the middle and two on each side behind that one. Debris is so thick that about every half block the lead sweepers have to dump, and as fast as we get the trash out of the street, the people will fill it back up because then the bars start to sweep out their doorways, etc. It's quite a sight to see, and takes a high level of coordination on everyone's part."

After seeing it for myself, I couldn't agree more. The city and BFI crews do a great job under some of the most challenging conditions imaginable. I can hardly wait to go back and have another look — as well as to see more of Mardi Gras again. Besides, I still need a picture of Richard Browning.

BJ Sweeping builds reputation for quality.

...continued from p. 33

"I also try to have the same operators run the same sweepers, so they become familiar with that exact unit. And I let them know what they can expect from certain engines, what to be careful about." He gives his drivers some maintenance training so they can explain to him over the phone what the problems are. "By doing that, I can tell them how to fix most breakdowns so they can at least get through the night."

Jones makes it a point to become familiar with each new sweeper he purchases by running it himself first. Then he often uses the newer truck for his back up. "When I pay a sweeper off, I don't trade it in. A lot of people do trade in their machines, but I've found that if you take care of your equipment, you can keep it a long time."

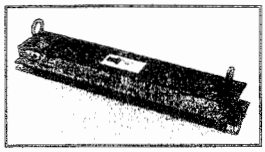
Jones also advocates keeping extra parts — even engines — for emergencies. "If I have even a complete engine go out, I can have it repaired in a couple of days. Good preventive maintenance, and stocking standard wear and critical parts, is a key to staying afloat."

Jones says he is very happy with his Schwarze equipment, and the support from Rickey Hyatt, who for a number of years has been his salesperson there. "Their sweepers have been doing the job for me," he said. "I can easily work on the sweepers myself. For example, Schwarze sweepers are built so that if a hydraulic line breaks, I can just take that line loose, put on another one and keep on going. I don't have to run all over, or wait, to find parts."

His advice for new sweeper businesses? "Build a reputation on giving good service for a reasonable price. Learning to bid is the toughest part when you're just starting out. There were a few accounts that I bid too low, but I still gave them the same quality. After awhile, I talked to the property managers and told them I needed to raise prices. Because I had done a good job, they were always happy to keep me at the higher price."

Providing top service, training employees, and knowing his equipment — BJ Sweeping Service is an industry success because Bobby Jones does business the old-fashioned way.

MAGNETIC SWEEPERS



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Port of Seattle Sweeping Study

...continued from p. 19

what a wet vault really does. I think we've done a good job of proving what an EnviroWhirl technology sweeper will do, but there doesn't seem to be as much data on wet vaults. Problem number two is that WDOE is still concerned about other contaminant-type issues that are normally considered for BMPs, such as oil and grease removal. The Port didn't feel these were appropriate. The WDOE now indicates it may want us to expand our investigation to include these other pollutants. We're talking through the issues right now."

Kurahashi and Associates is located in Tigard, Oregon. You may reach Roger Sutherland by calling 503-968-1605.

O Volunteer Monitors Aspire to Better Data

August/September 1997
#49

Nonpoint Source News-Notes

The Condition of the Water-Related Environment
The Control of Nonpoint Sources of Water Pollution
The Ecological Management & Restoration of Watersheds

Notes on the National Scene

American Heritage Rivers Initiative — Restoring America's Majestic River Systems

Criteria for selecting the first "American Heritage Rivers" have been announced, following a series of 12 meetings across the nation. Hundreds of people participated in developing the guidelines that will be used to implement President Clinton's State of the Union vow to "designate 10 American Heritage Rivers [and] to help the communities alongside them revitalize their waterfronts and clean up pollution."

Through, the American Heritage Rivers Initiative (AHRI), communities will nominate rivers for the designation. President Clinton will then select 10 of the nominees, and a task force will work with each community to identify technical and funding needs. Though only a few rivers will be designated the first year, all communities that nominate sites will benefit from project-related workshops and other information tailored to their needs.

A federal liaison will be appointed to work with the communities whose rivers are selected. The liaison will help the community access existing federal services.

River Communities Charged with Nominating Rivers

Meetings held in various cities during April and May resulted in an abundance of ideas for the program and an early consensus: namely, that the rivers should symbolize America's traditional water heritage and represent a variety of stream sizes and surrounding land uses. They embrace a wide range of values, including strong community support, a vision of the river's historic and

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All issues of *News-Notes* are accessible on the *NPS Information Exchange* on EPA's World Wide Web Site: http://www.epa.gov. See page 26 for log-on information.

The matrix influences, but doesn't dictate, the way data is used. For example, Level One data, gathered through general field observations, can be used for general public awareness. Level Four, using technical guidelines for toxic substance sampling, bioassays, and taxonomic classification qualifies for use in impact assessments, planning, permitting, and enforcement.

Survey Taps Volunteer Monitors

[Adapted from *Watch Over Washington Survey Report* (October 1996). Responses to this survey came from 158 groups representing over 11,500 people.]

Volunteer profile

- ✔ 7,567 volunteers monitor some aspect of water — surface or groundwater, quality or quantity, lakes, streams and rivers, or estuaries
- ✔ 6,258 monitor benthic macroinvertebrates;
- ✔ 6,120 monitor vegetation;
- ✔ 8,620 monitor wildlife;
- ✔ 2,168 monitor wetlands;
- ✔ 6,314 monitor things such as weather, land use, sediments, and/or construction sites. (Most monitor more than one resource.)

Over half the volunteers are students; the rest are members of neighborhood associations or the general public. Of the student monitors, 21% are elementary students, 22% attend middle school, 40% are high school students, and 17% are college or graduate students.

Many classrooms are affiliated with GREEN (Global Rivers Environmental Education Network), NatureMapping, or Adopt-A-Stream; many community groups were trained by Adopt-A-Stream.

The average number of years these groups have been in operation is 4.9. Nearly two-thirds use email.

How credible is their work?

5,456 monitors collect data at Level Two on the matrix; 2,317 at Level One; 1,894 at Level Three.

Why do they monitor?

61% education/awareness, 21% to collect baseline data, and the rest checked various reasons — red flag/early warning, enforcement/compliance, research, a specific project, or land use impact.

Using the matrix will "facilitate better, more consistent monitoring," said Phillips. It was also the first step, she says, in achieving recognition by agency scientists. "It was kind of a bargain. If the volunteer group is willing to work *this* hard, we will look at their data for *these* purposes. But if they only want to go *this* far, we will only look at it for *this* purpose."

The matrix has gone a long way toward convincing skeptics that volunteer monitoring can go beyond outreach. Some are even acknowledging that the very highest quality volunteer data could be used for 305(b) reports and the state's 303(d) list, if certain requirements are met.

Washington's volunteers seem more than ready to accept the challenge. Three-quarters of the volunteer coordinators surveyed would like their groups to receive training, and half want to monitor additional resources or parameters. "Our survey showed most volunteers are eager to meet high standards. We want to help the volunteers develop skill levels which will support their needs," said Phillips.

To accommodate the widespread enthusiasm for volunteer monitor training, Ecology is linking volunteers through "Watch Over Washington," or WOW. Using a Web site (http://www.wa.gov.gov/ecology/wq/wow.html) as a virtual central meeting place, volunteer monitors can locate other monitoring activities in their areas and access training opportunities. Coordinators of monitoring groups can keep abreast of what other groups are doing and contact each other to combine resources. They can also learn about, and announce, events, resources, tools, new methods, environmental reports, and success stories on the Web site. There will also be a section, or FAQ as it is called, for frequently asked questions about monitoring.

Support for such a citizen monitoring network is overwhelming. Almost three-quarters of the volunteers surveyed indicate that they are very interested in participating. Although new and still fairly informal, a number of contacts have already occurred via the network's roster of members organized by watershed. Phillips is active as a catalyst as well. She explained, "When I learn of a project starting up, I tell them about other projects in the area that might act as mentors or partners. For instance, I recently put two college instructors in the Puyallup River watershed in contact with each other. One was hoping to start up a monitoring program; the other had already established his. I thought they might share equipment and lab services."

[For more information, contact Annie Phillips, Environmental Education Specialist, Washington State Department of Ecology, P.O. Box 47600, Olympia, WA 98504-7600. Phone: (360) 407-6408; fax (360) 407-6574; email: aphi461@ecy.wa.gov. Or contact Beverly Isenson, Special Assistant, Governor's Council on Environmental Education, P.O. Box 40900, Olympia, WA 98504-0900. Phone: (360) 407-7317; email: beverlyi@parks.wa.gov.]

Washington Volunteer Monitors Aspire to Better Data

No one knows exactly how many volunteer monitors there are in the United States (the last official count, in 1993-1994, tallied over 340,000), but Washington state has nearly 160 groups with 8,000 volunteers monitoring water alone. All this activity generates a lot of data — and a potential nightmare for quality assurance.

A 1996 survey of the state's volunteer monitors revealed that most are eager to have their data used by state and local agencies, but according to Annie Phillips, a Washington Department of Ecology environmental education specialist, "Different groups use different methods, standards, and levels of quality." This disparity can make it difficult for agencies to use data from volunteers.

The survey, conducted by the Department of Ecology (Ecology) and the Governor's Council on Environmental Education, produced a statewide list of the location of monitoring projects, the parameters measured, and the methods and quality assurance protocols used by the monitors. "It became clear that each of the various groups did things their own way, and therefore, their data were inconsistent and of unknown quality," Phillips said.

To solve this problem, Ecology developed a matrix to characterize the methods and quality of the data collected by volunteers. The agency categorizes data from each volunteer monitoring group according to criteria such as quality assurance/quality control protocols, monitoring methods, and the education and training of the monitors. "We developed the matrix as a kind of ranking system to give a standard description for the quality of data produced for a specific project," explained Phillips.

Level	Quality Assurance/Control (QA/QC) Protocols	Examples of QA/QC Guidelines	*Examples* of Activities	*Desired* Education/ Training	*General* uses of Data by Ecology
One	No formal QA/QC plan required	Field observations on standard forms; EPA Streamwalk	General field observations, including the number and diversity of organisms	Volunteer or student with brief orientation	Educational, general awareness
Two	Basic written plan - purpose, parameters, methods, sites, schedule	GREEN field manuals; Color comparator kit instructions	Field sampling; analysis using field kits; observing categorical abundance*** of organisms and identifying them to the order level	Volunteer, student or technician supervised by an expert monitor	Educational; watershed characterization; red flag or early warning
Three	Formal QA plan (*i.e. meets 24 requirements of EPA's new Vol. Mon. Guide to QAPP, 1996*); all tests needing lab analysis done at an accredited lab	Technical guidelines (*e.g., Adopt-A-Stream's Streamkeepers Field Guide, 1995; Michaud's Citizen's Guide to Monitoring, 1991; EPA's Volunteer Monitoring Methods Manuals*)	Using calibrated meters for field measurements or following the protocols in a current *APHA Standard Methods*; collecting and analyzing water samples; identifying benthics to the family level; volunteer portion of Ecology's lake water quality assessments	Trained volunteer (*e.g., Streamkeepers); technician with experience or training or a participant in an established volunteer monitoring program*	Screening level information; scoping phase of watershed approach; 305(b) Report*; Best Management Practices (BMP) evaluation data; water quantity/ flow data
Four	Follows formal QA plan and documents exactly how it is implemented; sample chain of custody	Ecology technical guidelines (*e.g. Cusimano 1994, Coots 1995*); *Plotnikoff's Instream Biological Assessment Monitoring Protocols, 1994*	Toxic substance sampling; sampling for enforcement purposes; bioassays; identifying benthics to the genus/species level	Professional/ Qualified individual with degree and specific training *or equivalent experience*	Baseline, impact and ambient assessments; action planning/ policy development; permitting; compliance/enforcement; 303(d) List**

**Ecology's 305(b) Report shows whether waterbodies support beneficial uses such as swimming and fishing - or whether these uses are impaired. Contributions of data are solicited from various sources, but must meet high standards (see Level 3).*

***Ecology's 303(d) List shows impaired and threatened waters that don't or probably couldn't meet applicable water quality standards. Ecology accepts data for this list from outside sources, but it must meet the highest professional standards (see Level 4). Both are published every two years.*

****Categories of abundance: absent, rare, present, abundant, very abundant*

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P Water Quality Monitoring Report
May 1996 – 1997
Ala Wai Canal Watershed Project, DOH

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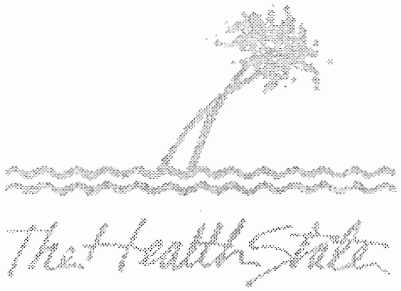
Water Quality Monitoring and Assessment

Water Quality Monitoring Report - May 1996-97
Ala Wai Canal Watershed Project



Prepared by:
Clean Water Branch
Department of Health
December 1997

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EXECUTIVE SUMMARY

The report describes nonpoint source pollution that is consistent with its diverse and widely dispersed (diffused) characteristics which add to the complexity of the problem. It emphasizes the importance of source-specific and events-triggered pollutants having a direct impact on human health and, in most part, the overall cause of water quality impairment and degradation of the Ala Wai Canal. In essence, the status of water quality in the Ala Wai Canal is clearly a condition attributed to the watershed from which pollutants originate.

Nitrogen levels in the Ala Wai Canal exceed the Standard more than 97 percent of time in the area between the Manoa/Palolo Stream mouth and the Kapahulu Library end. Similarly, phosphorus levels exceed the mean concentration more than 83 percent of the time. Instream nitrogen levels in the Ala Wai Canal watershed exceed the Standards in all categories of the criteria applicable to streams in Hawaii. Also, phosphorus concentrations in the Makiki watershed are exceptionally high for ambient (normal low flow) levels and during a storm event sampling. A comparison of instream phosphorus concentrations indicates that phosphorus in the Makiki watershed is significantly greater than the levels found in Manoa and Palolo watersheds.

Investigators in the past have noted increased phosphorus loadings with urbanization, particularly with large percentages of commercial and multiple-family housing, and it may not be surprising at all to expect higher levels of phosphorus in the lower Makiki watershed, as well. The close relationship between phosphorus and total suspended solids in the Makiki watershed and the high urban density may account for the levels found by this survey. The findings also reemphasize the importance of erosion control, construction site BMPs, impervious surfaces, forest management practices, ground cover, urban street dust, etc., in controlling sediment as well as phosphorus loadings in receiving waters.

Palolo Stream recorded the highest median concentration of nitrogen and followed by Makiki and Manoa Streams. If the levels of nutrients in the Palolo and Makiki watersheds are closely examined, the results appear to show the significance of the two watersheds in terms of their nutrient concentrations. Due to the distinct ambient concentrations in both watersheds, nutrient management which leads to reduction in phosphorus (Makiki watershed) and nitrogen (Palolo watershed) can be specifically prioritized. To implement a more manageable approach to nutrient management, the results suggest the use of parameter-specific TMDLs for each watershed rather than the use of a multiple parameter TMDL for the Ala Wai Canal.

Sampling results in the Palolo watershed reveal exceptionally high levels of indicator bacteria. Fecal coliform, enterococci, and *Clostridium perfringens* exceed background levels normally observed in streams. Water quality objective for achieving acceptable levels of bacteria for the Ala Wai Canal can be established by setting *C. perfringens* densities no greater than 90 CFU. Values above that level clearly suggest sources of sewage origin. With continued monitoring, the accomplishment of such objective can be readily and objectively monitored by noting the changes in bacterial densities. The monitoring results illustrate how management objectives can be established for bacterial contamination in the Ala Wai Canal. Effective BMPs, enforcement actions and other corrective measures to mitigate sewage contamination should result in restoring water quality to acceptable levels for water recreation in the Ala Wai Canal.

INTRODUCTION

It widely known that storm events have a significant impact on water quality impairment. Polluted runoff from land is the primary cause of water pollution in our streams and coastal waters. Nutrients, toxic materials, suspended and particulate matter are major concerns that have a major influence in the alteration and degradation of water quality, as well as to the physical and biological habitat. Such impairment causes water quality standards violation and often restricts the beneficial and protected uses of our resource. Polluted runoff problems are the result of activities that take place in the watershed, which is the focus of this project. The monitoring project is currently ongoing and is part of a larger, targeted watershed approach in addressing nonpoint source pollution issues and problems.

The report presents the findings and results of water quality monitoring of three major streams in the watershed: the Manoa, Makiki and Palolo streams. The discussion on water quality is presented with particular reference to the high levels of indicator bacteria and nutrients observed during the aftermath of a specific storm event in the Manoa/Palolo watershed. Water quality tests have shown high levels of pollutants that suggest the presence of sources that may have a direct role in the degradation of instream water quality and waters of the Ala Wai Canal.

The Ala Wai Canal is known to be heavily deposited with sediment, as well. After moderate rain storms, muddy water with the accumulation of urban litter and debris transforms the canal into a blight that often lasts for at least two or more days. Both natural (erosion from forest reserve) and human activities (construction projects) contribute to these problems. Other pollutants of concern, that are not as apparent but are just as important, include bacteria/viruses (pathogens), automobile lubricants, toxic metals and pesticides as a result of surface runoff from streets and highways, parking

lots, shopping centers, residential areas, parks and other recreational lands.

Table 1 gives the area estimate in conservation land and part of the area in urban lands in the three major watersheds. The land use types in the watershed includes both urban and conservation lands.

Table 1. Estimated Area of Land Use Types Above Sampling Sites in the Manoa, Palolo and Makiki Watersheds

	Conservation		Urban		
Watershed	Acres	Percent	Acres	Percent	Total Acres
Manoa	4,065	56.1	3,181	43.9	7,246
Palolo	2,279	56.7	1,704	43.3	3,983
Makiki	1,710	48.6	1,809	51.4	3,519

Source: Department of Health GIS. The boundaries for the urban areas have been modified to reflect drainage areas above the sampling sites.

About 45 percent of the Ala Wai Canal watershed is in conservation and agricultural lands and the remaining 55 percent of lands in residential subdivisions, condominium and apartment complex, business/commercial, and parks and recreational lands. The report describes nonpoint source pollution that is consistent with its diverse and widely dispersed (diffused) characteristics that add to the complexity of the problem. It emphasizes the importance of source-specific pollutants that have a direct impact on human health and, in most part, the overall cause of water quality impairment and degradation of the Ala Wai Canal.

BACKGROUND

Nonpoint source pollution is often contrasted with point source pollution as a discharge of pollutants originating from a diffused source as compared with the latter originating from a discrete source (note: storm drain outlets are considered point source). Although the distinction between the two major categories of pollution may be clear, the methods of treatment and control of nonpoint sources are vastly more complex due to their nature and origin of pollutants. To further complicate matters, the magnitude and potential risk of background pollution in the urban setting are often ignored or unrecognized as pollutants originate and accumulate in early (antecedent) stages prior to surface runoff events. During such events, pollutants wash through storm drains and eventually appear in surface waters where it turns into a visible plume of muddy water combined with an accumulation of litter and debris. However, other pollutants such as bacteria and viruses occur and are invariably undetected by traditional (indicator) monitoring, unless the effort is targeted to both events-triggered monitoring and source-specific identification of pathogens. (In this experience, exceptionally high numbers of indicator bacteria, *Clostridium perfringens*, during rainfall events suggested the presence of fecal contamination. An investigative approach was then initiated as a practical alternative.) Also, the historic data on water quality not only showed high levels of nutrients, but as a consequence phytoplankton blooms have severely reduce water clarity of the canal. In essence, the status of water quality in the Ala Wai Canal is clearly a condition attributed to the watershed from which pollutants originate.

As with other watersheds in the State, the Department has started a watershed approach in assessing nonpoint source pollution. Between other community outreach programs and in partnerships with government agencies, water quality monitoring is included as part of an integrated effort to accomplish watershed protection and management goals of the State. This project is part of a support activity to the Department of Health's (DOH) watershed protection initiatives, e.g., Ala Wai Canal Watershed Improvement Projects[1].

[1] FY 1996 Omnibus Appropriations and Rescissions Act for the Ala Wai Canal Watershed Improvement Project; and the Ala Wai Canal Watershed Water Quality Improvement Project, State of Hawaii and Lawrence Miike, M.D. v. City and County of Honolulu.

SURVEY METHODOLOGY

Monitoring Approach

The monitoring plan is routinely designed to include measurements of water quality over a given period (yearly minimum) at a set frequency. Although the sampling coverage by this method covers both wet and dry periods, the observation "window" is considered very narrow. Storm water flows, i.e., mass loadings, that significantly influence the characteristics of water quality may not be reflected in the monitoring data, unless automated to sample water specifically during these events. The required sampling frequency for a certain level of confidence in total load is discussed by Marsalek (1975). The fixed-station grab sampling method, as a result, will not always coincide with environmental variables that have significant impacts at a certain time and place. In other words, a grab sample taken at a given day and time makes the assumption that all samples taken at other times are equal. Because the monitoring design has this inherent bias, an accurate estimate of water quality is often compromised without a proper sampling design. Pollutant contributions can be considerably many times greater during wet weather than during dry weather.

However, in spite of the complexity of monitoring wet weather events, a simpler approach will serve the purpose for which the monitoring has been designed. In this case, the monitoring approach has certain merits, particularly for problem-specific investigations or in observing trends. Considerable sampling time and effort were spent on problem-specific monitoring, as shown by the number samples taken at site-specific locations during the course of the monitoring activity. These findings are considered important and are noteworthy of further discussion later.

Sampling Sites and Parameters

Water quality sampling stations were established at three major streams, Makiki, Manoa and Palolo streams, of which the latter two have the largest flows. Water sampling started in May 1996 and is currently ongoing. The selected sites are shown on the attached map (Figure 1). Grab samples of water from six stations were routinely checked on a weekly basis for pH, temperature, dissolved oxygen, and conductivity. Salinity was included where tidal brackish waters existed. The nutrients tested twice per month included particulate nitrogen, nitrate-nitrite nitrogen, ammonia nitrogen, Kjeldahl nitrogen, phosphate and orthophosphate. Chlorophyll *a*, turbidity and total suspend solids (TSS) analyses were also included at the same time with nutrient testing.

Field measurements of the physical parameters were taken *in situ* with the use of a HydroLab Data Sonde® multi parameter probe. Water samples for nutrient, chlorophyll *a*, and TSS were collected in plastic cubitainers, kept chilled in storage prior to transport to the DOH Laboratory.

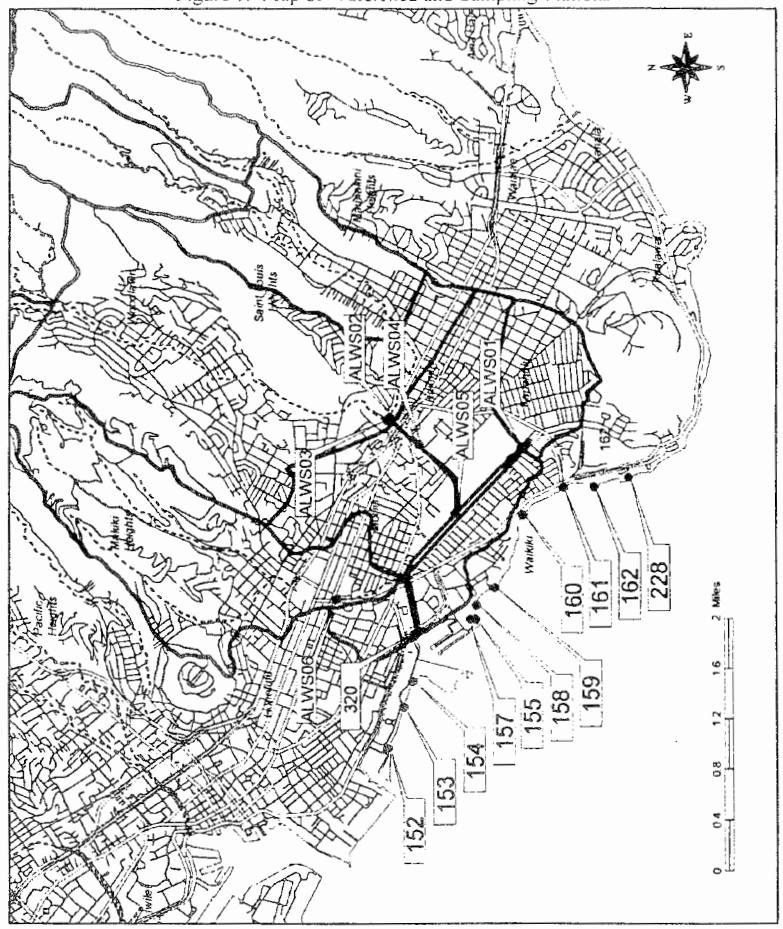
RESULTS

Ala Wai Canal - Kapahulu Library End, Manoa Stream Mouth and Ala Moana St. Bridge.

Water quality impairment in the canal is most severe at the Diamond Head end which is approximately two miles from the mouth of the canal. The average water depth is about five feet with very poor water exchange. Also, located at this end is a major drainage outlet that discharges polluted runoff from the Kaimuki, Kapahulu and parts of Diamond Head business and residential districts.

Nutrient levels progressively decline from the Diamond Head end to the Ala Moana Bridge toward the Ala Wai Yacht Harbor. The results of mean (log) concentrations of total nitrogen and total phosphorus observed in the Ala Wai Canal are shown in Table 2. Contrary to the general trend, however, there is a slight increase in phosphorus at the Ala Moana Bridge site. Of particular note

Figure 1. Map of Watershed and Sampling Stations



is the additional input of nutrients from Makiki Stream which is located approximately 0.4 miles upstream of the Ala Moana Bridge site.

Table 2. Mean (Log) Concentrations of Total Nitrogen and Total Phosphorus At Selected Sites in Ala Wai Canal.

Location	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Kapahulu Library End	1.160	0.464
Manoa/Palolo Stream Mouth	0.480	0.0323
Ala Moana Bridge	0.326	0.039

Total nitrogen concentrations in the canal exceed the State Water Quality Standards (Standard) by nearly six fold and total phosphorus by nearly twice the amount of the Standard.

The normalized frequency distributions of nutrient levels are used to predict violations in water quality standards. The values applicable to estuaries are compared with the projected frequency at the geometric mean concentration and at the 2 percent level (Table 3).

Table 3. Projected Frequency of Nutrients Exceeding State Water Quality Standards at Various Locations in Ala Wai Canal

		Percent of Samples in Violation of Stds.	
Site	Parameter	>Geometric Mean	>2% of Time
Kapahulu Library End	Total Nitrogen	97.0	85.0
Manoa/Palolo Str. Mouth	Total Nitrogen	98.5	50.0
Ala Moana Street Bridge	Total Nitrogen	77.0	28.0
Kapahulu Library End	Total Phosphorus	86.0	21.0
Manoa/Palolo Str. Mouth	Total Phosphorus	83.0	1.0
Ala Moana Street Brdg	Total Phosphorus	76.0	10.0
Water Quality Standards:	Total Nitrogen (mg/L)	0.200	0.500
	Total Phosphorus (mg/L)	0.025	0.075

Mean nitrogen levels exceed the Standard more than 97 percent of time in the area between the Manoa/Palolo Stream mouth and the Kapahulu Library end. Similarly, phosphorus levels exceed the mean concentration more than 83 percent of the time. The data were transformed to logarithms and tested for normality using the K-S Test (Conover, 1980). The log normal data were plotted to show their frequency distribution or probability of Standards violation. The frequency of nutrients exceeding the Standards at other parts of the canal is listed in Table 3.

Makiki Stream - Compliance with Water Quality Standards

Nutrient levels in particular exceed the Standards in all categories of the criteria applicable to streams in Hawaii, as shown in Table 4. Phosphorus concentrations have been noted to be exceptionally high for ambient (normal low flow) levels and during the storm event. With regards to water clarity and particulate matter, respectively, mean turbidity shows compliance part of time, however, noncompliance of total suspended solids (TSS) occurs most of the time.

Table 4. Makiki Stream Compliance with State Water Quality Standards

	Geometric Mean		≥ 10% of Time		≥ 2% of Time	
Parameter	Wet	Dry	Wet	Dry	Wet	Dry
Total N	No	No	No	No	No	No
NO_3+ NO_2 N	No	No	No	No	No	No
Total P	No	No	No	No	No	No
Turbidity	Yes	No	Yes	No	Yes	No
Total Susp. Solids	No	No	No	No	No	Yes

Note: "Wet" refers to wet season from November 1 through April 30. "Dry" is from May 1 through October 31.

Makiki Stream - Wet versus Dry Period

The wet period samples taken from November 1 through April 30 and were compared with samples taken during the dry period from May 1 through October 31. The results are shown in Table 5 are considered ambient levels since most of data were collected during normal flows. The survey results in general show no significant change in water quality during wet and dry periods. Only nitrate-nitrite nitrogen and TSS levels indicated significant difference between the two periods with higher levels during the wet period. The nonparametric procedure, Mann-Whitney Rank Sum Test, was used to determine the differences between the observed levels.

Table 5. Ambient Water Quality Comparison Between Wet and Dry Periods in Makiki Watershed

	Median Concentrations	
Water Quality Parameter	Wet Period	Dry Period
Total N - mg/L	0.620	0.420
NO_3+ NO_2 N - mg/L	**0.450**	**0.270**
Total P - mg/L	0.141	0.156
Turbidity - NTU	3.4	1.5
Total Susp. Solids - mg/L	**4.0**	**6.0**

Note: Bold values indicate significant difference; *P value 0.05*

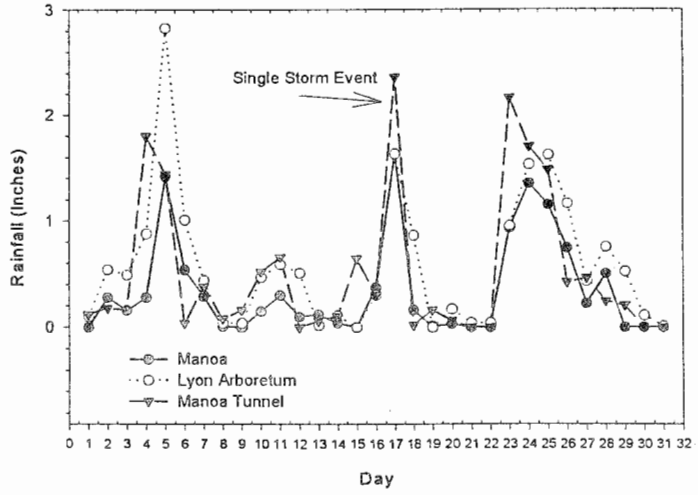
It is interesting to note that TSS is greater during the dry rather than the wet period, in contrast to nitrate-nitrite levels that show an increase during the wet period. Monitoring over a longer period may be necessary to make any definitive conclusions at this time.

Makiki Stream - *Impact from Storm Event*

As previously implied, sampling storm event loadings require statistically representative number of sampling during storms of varying intensity and durations. The reason storm event loading values are critical can be illustrated by sampling during such an event. A sampling opportunity developed during a run conducted by the City and County Honolulu (CCH), Storm Water Monitoring Program, in which the impact from the storm event on water quality is discussed. The rainfall for the 24-hour period recorded by the National Weather Service rainfall gaging station at Manoa Tunnel showed as much as 2.36 inches of rain during the 24-hour period on March 17, 1997.

Total phosphorus levels in the Ala Wai Canal is normally expected to decline spatially with mixing and tidal flushing toward the mouth of the canal, as opposed to the Diamond Head end.

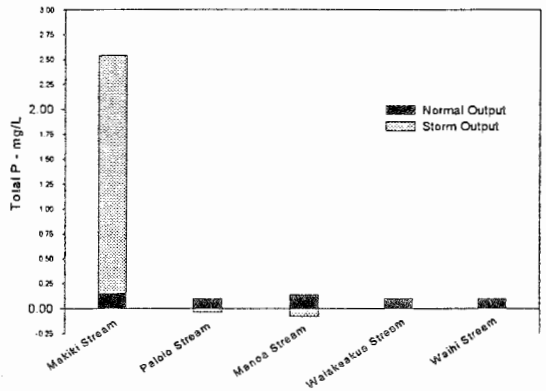
Figure 2. Daily Rainfall for March 1997 in Upper Manoa Watershed
Source: National Weather Service, NOAA, US Dept. of Commerce



However, as shown previously in Table 3 phosphorus levels show a marked increase (>0.075 mg/L) in 10 percent of the samples taken at the Ala Moana Street Bridge site, that is only a short distance from the open ocean. A similar observation was made by Laws, et al., (1993) in their water quality study of the Ala Wai Canal, during which a significant increase in phosphorus was shown after a rainfall in samples taken near the Makiki Stream.

The monitoring results observed by the CCH in their storm water monitoring of Makiki

Figure 3. Net Output in Total Phosphorus after Single Storm Event



Data Source: Dept. of Public Works
City & County of Honolulu

Stream may explain the reason. The output of phosphorus from the Makiki Stream is shown in Figure 3, in which phosphorus dramatically increases soon after a rainfall. The plotted result from a single rainfall event is compared with that of the baseline level at King Street sampling site. During this event, the combined baseline levels of phosphorus in Palolo and Manoa Streams amounted to only 0.32 mg/L. By comparison, the concentration of phosphorus from Makiki Stream during the storm

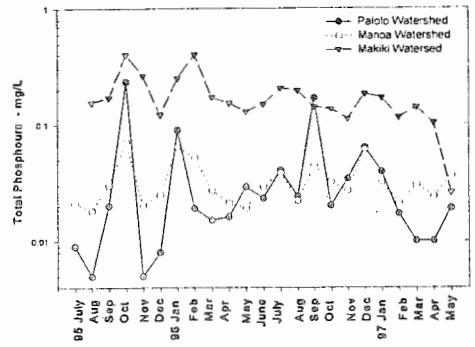
event was nearly eight times greater than the levels observed at Palolo and Manoa Streams combined. Although far from showing a complete profile of the discharged quantity, the foregoing in general illustrates the impact from a single storm event and possibly gives a clue to the elevated levels of phosphorus found at the lower end of the canal. There is further evidence suggested by the survey results that show elevated ambient levels of phosphorus in Makiki Stream.

Table 6. Total Phosphorus (mg/L) Concentrations in Major Watersheds, May 1995 through June 1997

Watershed	Median	Lower 25%	Upper 75%	Comparison	P < 0.05
Palolo Watershed (Pa)	0.020	0.011	0.038	Mk vs. Pa	Yes
Manoa Watershed (Ma)	0.029	0.021	0.038	Mk vs. Ma	Yes
Makiki Watershed (Mk)	0.155	0.129	0.196	Pa vs. Ma	No

A comparison of instream phosphorus concentrations from the Makiki, Manoa and Palolo watersheds is shown in Table 6 and also in Figure 4. The median concentration of phosphorus in the Makiki watershed is significantly greater than the levels found in Manoa and Palolo watersheds. The sources that contribute to the high concentrations in polluted runoff from the Makiki watershed are yet unknown, however.

Figure 4. Comparison of Total Phosphorus Concentrations in Makiki, Manoa and Palolo Watersheds



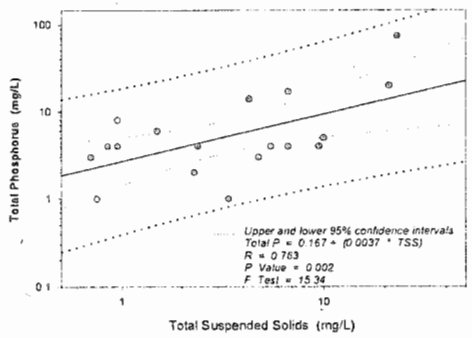
The survey results show no significant difference between levels of phosphorus found in Palolo and Manoa watersheds. Also, no difference in median concentrations of TSS and turbidity appear in each

watershed. The Kruskal-Wallis one way analysis of variance on ranks and a pairwise multiple comparison procedure (Dunn's method) was used in the statistical analysis.

Association between Total Phosphorus and TSS

Although the data reflect concentrations of grab rather than flow weighted samples, the results appear to show an association between phosphorus and particulate matter (TSS) transported by storm water runoff. Load runoff relationships similar to this have been shown in the past by Bedient, et al. (1980). The following chart (Figure 5) shows the relationship of phosphorus and total suspended solids in the Makiki watershed. Phosphate loadings are known to increase with urbanization, particularly with large percentages of commercial and multiple-family housing (Colston, 1974; Neil, 1975; Whipple, et al., 1974; Whipple, 1978). It may not be surprising at all to expect higher levels of surface runoff pollutants, e.g., phosphorus, in the lower Makiki watershed, considering the urban density, extent of impervious surface areas and drainage network. These findings reemphasize the importance of erosion control, construction site BMPs, impervious surfaces, forest management practices, ground cover, urban street dust, etc., and related sediment control measures that can result in controlling nutrients in receiving waters, as well. The effectiveness of BMPs can be measured by monitoring phosphorus in receiving waters in combination with documentation of environmental "indicators" on land. Although detail

Figure 5. Relationship Between Total Suspended Solids and Total Phosphorus in Makiki Stream



investigation on nutrient and sediment loadings is beyond the scope of this study, the findings appear to indicate Makiki Stream as an important source of phosphorus. Makiki Stream is considered a relatively a small urban stream based on the average flow, however. Measurements of both ambient and storm event concentrations of phosphorus from the Makiki watershed are significantly greater than the levels of either Manoa or Palolo watersheds. A next step for this study would be to take a closer look at potential sources in the watershed.

Also, of interest are the levels for total nitrogen reported by the CCH storm water monitoring program. The excess output of total nitrogen during the single storm event in the Makiki watershed is considerably higher than the levels observed in the Manoa and Palolo watersheds. The concentration of total nitrogen in the Makiki watershed is twice the amount of the combined concentrations in the Manoa and Palolo watersheds.

Unlike the phosphorus levels reported by the CCH, results from this survey show the highest nitrogen concentrations occurring in the Palolo rather than the Makiki watershed. As shown in Table 7, the levels of nitrogen are significantly different in each watershed. Both normality and equal variance tests on log-transformed data met the required assumptions for one way analysis of variance procedure that was used in comparing median values of each data set. The Student-Newman-Kuels test was used for the pairwise multiple comparison.

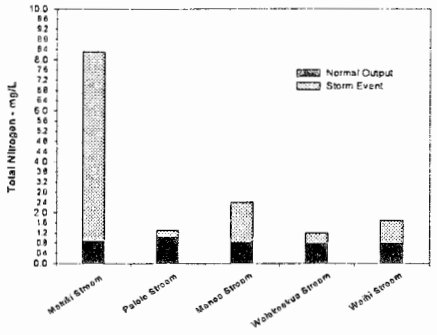
Table 7. Total Nitrogen (mg/L) Concentrations in Major Watersheds, May 1995 through June 1997

Watershed	Median	Lower 25%	Upper 75%	Comparison	P < 0.05
Palolo Watershed (Pa)	0.850	0.633	1.058	Mk vs. Pa	Yes
Manoa Watershed (Ma)	0.290	0.228	0.440	Mk vs. Ma	Yes
Makiki Watershed (Mk)	0.515	0.340	0.650	Pa vs. Ma	Yes

Palolo Stream recorded the highest median concentration of nitrogen and followed by Makiki and Manoa Streams. However, the levels recorded during the single storm event, Makiki Stream showed an increase in nitrogen concentration (Figure 6), in marked contrast from ambient levels.

Although elevated levels of pollutants are expected as a result of surface runoff, the source of nutrients in the Makiki watershed is unknown. With respect to climatic conditions alone, it can be reasonably assumed that sources are readily subject to surface runoff as shown, and that the quantity of pollutant discharge is directly attributed to varying characteristics of rainfall. Under such conditions, particulate concentrations in a given area will be influenced by such factors as antecedent rainfall, persistent low-flow discharges, and other hydrologic characteristics. The investigation as to the source, cause and extent of pollutants is not yet completed.

Figure 6. Net Output in Total Nitrogen after Single Storm Event



Lower Manoa Stream (above Palolo Stream confluence)

The lower Manoa Stream sampling site is located approximately 100 feet above the confluence with Palolo Stream (Figure 7). The results of nitrogen, phosphorus, turbidity and TSS levels are compared with the Standards at various levels of the criteria shown in Table 8. Nitrogen levels observed at the Manoa Stream site exceed the water quality standards during both wet and dry seasons.

Table 8. Manoa Stream Compliance with State Water Quality Standards

	Geometric Mean		> 10% of Time		> 2% of Time	
Parameter	Wet	Dry	Wet	Dry	Wet	Dry
Total N	No	No	No	No	No	No
NO_3+ NO_2 N	No	No	No	No	No	No
Total P	Yes	Yes	Yes	Yes	Yes	Yes
Turbidity	Yes	No	Yes	No	Yes	No
Total Susp. Solids	Yes	Yes	Yes	Yes	Yes	Yes

Note: "Wet" refers to wet season from November 1 through April 30. "Dry" is from May 1 through October 31.

TSS and total phosphorus on the other hand meet the Standards in all categories. Turbidity levels meet the wet criteria, but exceed the dry criteria.

Palolo Stream

As noted previously, instream levels of nitrogen in the Palolo watershed are markedly different from that of other watersheds, but in all cases the same parameters (nitrogen) invariably exceed the applicable Standards. If the levels of nutrients in the Palolo and Makiki watersheds are closely examined, the results appear to show the significance of the two watersheds in terms of their nutrient concentrations. Nutrient management which leads to reduction in phosphorus (Makiki watershed) and nitrogen (Palolo watershed) in the two watersheds can be prioritized due to the distinct ambient concentrations.

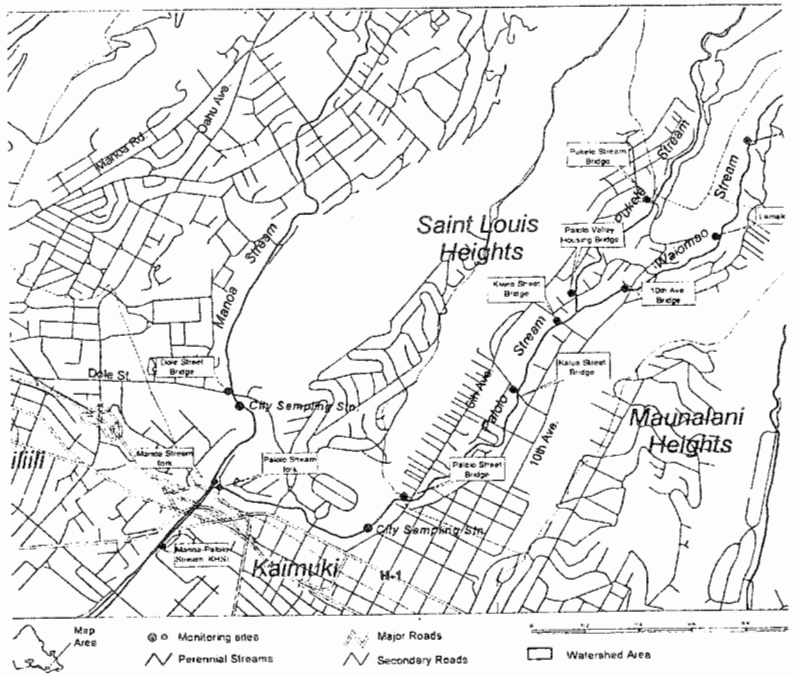
Table 9. Palolo Stream Compliance with State Water Quality Standards

	Geometric Mean		> 10% of Time		> 2% of Time	
Parameter	Wet	Dry	Wet	Dry	Wet	Dry
Total N	No	No	No	No	No	No
$NO_3 + NO_2 N$	No	No	No	No	No	No
Total P	Yes	No	Yes	Yes	Yes	Yes
Turbidity	Yes	No	Yes	No	Yes	No
Total Susp. Solids	Yes	Yes	Yes	Yes	Yes	Yes

Note: "Wet" refers to wet season from November 1 through April 30. " Dry" is from May 1 through October 31.

To implement a more manageable approach to nutrient management, the results suggest the use of parameter-specific TMDLs for each watershed rather than the use of a multiple parameter TMDL for the Ala Wai Canal. Nitrogen levels are not in compliance in all categories, as shown in Table 9. Phosphorus and turbidity levels partially exceed that Standards applicable to dry periods only.

Figure 7. Map of Sampling Stations in Palolo and Manoa Watersheds



Palolo Watershed - Bacteria Contamination

Sampling results in the Palolo watershed have revealed exceptionally high levels of indicator bacteria. Fecal coliform, enterococci, and *Clostridium perfringens* exceed background levels normally observed in streams. Repeated high levels of bacteria were noted in samples taken from Palolo Stream at a site just above the confluence of the two streams (Manoa and Palolo Streams). Tests were continued with additional sites in Palolo Stream, as shown on the attached map (Figure 7), to identify bacterial densities along the stream.

Table 10. Median Densities of *Clostridium perfringens*(CFU) at Selected Sites in Palolo Watershed

Location	Median	25th Percentile	75th Percentile
Kaimuki High School	103	42	130
Palolo Stream Fork	270	232	340
Palolo Street Bridge	490	345	1700
Kalua Street Bridge	535	450	980
Aiwila Street Bridge	460	200	5260
10th Avenue	114	84	240
Lamaku Place	44	18	1030
Keaolele Place	9	4	15
Palolo Housing	310	150	625
Pukele Stream	15	11	22
Manoa Stream	34	31	69

The use of *C. perfringens* in tropical climate has been shown by Fujioka and Shizumura (1985); Fujioka and Byappanahalli (1996) to be a more reliable indicator of fecal pollution than either fecal coliform or enterococcus, although both are presently in the Standards for recreational waters. In another study by Hardina and Fujioka (1991), the investigators have shown that enterococci and *Escherichia coli* are naturally present in Hawaiian streams as a result of their origin in the soil, thereby making it difficult to distinguish human from soil-borne bacteria. As a result, the DOH is

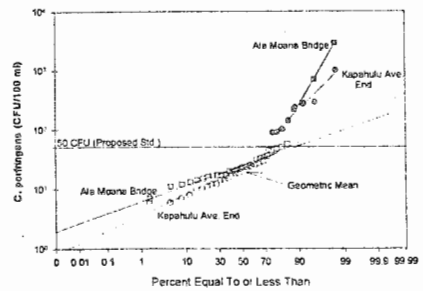
considering the use of *C. perfringens* as a standard for inland and marine recreational waters. Geometric mean densities greater than 50 CFU in streams is considered by the DOH as unacceptable, although the specific densities associated with the level of health risks are yet unknown.

For comparison, the median values of normally distributed data are reasonably assumed to be comparable to the geometric mean. Table 10 gives a summary of the results observed in the Palolo watershed, in addition to Manoa Stream. The high values in the Palolo watershed are found at the lower Pukele and Waiomao Streams, and downstream of the Palolo Housing area and the 10th Avenue bridge. The results reflecting lower background levels are from sampling sites at Lamaku Place, Keaolele Place and Pukele Stream bridge, all located in the upper watershed and just below the forest reserve. The Water Resource Research Center (WRRC) at UH Manoa also assisted in confirmation of the DOH results. The DOH levels in the Palolo watershed were found in well agreement with the WRRC findings. The results strongly suggest that the source in the Palolo watershed is confined to the residential district in upper Palolo Valley. Sewer line leaks, as well as known cesspools in the area, may be subject to periodic discharge during high flow (rainy) period as noted during the sampling under those conditions. The City & County of Honolulu, Public Works Division is currently assisting the DOH in the investigation of the source.

Recreational Water Quality Objective for the Ala Wai Canal

The high bacteria levels observed in the Ala Wai Canal, particularly with the levels associated with storm water runoff and possibly of sewage origin, can be identified in the following chart. The probability plot shown in Figure 8 illustrates the impact from bacterial contamination at both ends of the Ala Wai Canal. The normal

Figure 8. Frequency Distribution of Clostridium perfringens Densities in Ala Wai Canal



distribution of *C. perfringens* is drawn across the chart, as shown with the broken and solid lines. The geometric mean for the Ala Wai Canal theoretically complies with the proposed standards at 50 CFU, the midpoint of the chart as noted. However, well above the proposed standards are levels that are anomalously distributed, representing levels that are clearly unacceptable. Thus, the illustration on the chart can be used to establish the water quality objective for achieving acceptable levels of bacteria for the Ala Wai Canal. *C. perfringens* densities greater than 90 CFU on the chart is considered to be levels significantly above the normally expected distribution, thereby suggesting the occurrence of contaminated levels.

With continued monitoring, the accomplishment of such objective can be readily and objectively monitored by noting the changes in bacterial densities. The monitoring results illustrate how management objectives can be established for bacterial contamination in the Ala Wai Canal. Effective BMPs, enforcement actions and other corrective measures to mitigate sewage contamination should result in restoring water quality to acceptable levels for water recreation in the Ala Wai Canal.

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APPENDIX

DESCRIPTIVE STATISTICS[1]

Ala Wai Canal at Kapahulu Ave. End

	Size	Median	Mean	Std Dev		Std. Error	Max	Min
NO2	23	1.140	1.408	1.056	0.220	3.770	3.800	0.0300
NH4	23	0.070	0.0787	0.0314	0.00654	0.110	0.160	0.0500
Kjeld	23	0.300	0.230	0.0926	0.0193	0.300	0.400	0.1000
TN	23	1.420	1.631	1.052	0.219	3.870	4.000	0.130
OP	23	0.028	0.0410	0.0351	0.00733	0.134	0.139	0.00500
TP	23	0.048	0.0549	0.0327	0.00682	0.139	0.149	0.01000
Chlr	23	339.0	663.028	908.998	189.539	3247.6	3251.0	3.400
NTU	23	5.00	5.683	3.078	0.642	11.000	13.000	2.000
TSS	23	13.0	13.348	7.964	1.661	36.000	38.000	2.000

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
5/06/69	2.3	0.11	0.2	2.6	0.025	0.042	224	2	11
5/21/96	0.63	0.05	0.3	0.93	7e-3	0.024	782	3.6	14
6/18/96	0.18	0.05	0.3	0.48	0.043	0.059	681	11	38
6/04/96	1.26	0.05	0.2	1.46	0.011	0.033	622	4.3	14
7/23/96	1.86	0.07	0.1	1.86	0.024	0.033	594	3.6	11
7/9/96	1.12	0.07	0.3	1.42	0.02	0.048	339	10	29
8/20/96	0.34	0.05	0.1	0.34	5e-3	0.026	1594	3.1	13
8/06/96	0.92	0.08	0.1	0.92	0.026	0.055	1274	4.6	16
9/10/96	0.16	0.14	0.4	0.56	0.077	0.099	191	7.2	15
9/23/96	1.14	0.08	0.2	1.3	0.035	0.051	135	2	11
10/08/96	1.7	0.16	0.3	2	0.046	0.057	242	5	14
10/22/96	0.48	0.08	0.3	0.78	0.028	0.045	521	6	11
11/06/96	1.07	0.09	0.3	1.37	0.139	0.149	6.14	13	5
11/18/96	2.94	0.13	0.3	3.24	0.101	0.112	3.4	7.3	5
12/03/96	0.03	0.05	0.1	0.13	0.011	0.034	3204	4.5	5
1/07/97	3.47	0.06	0.1	3.57	0.093	0.108	13.7	2	2
2/11/97	0.99	0.05	0.2	1.19	0.025	0.055	3251	2.8	11
3/04/97	0.25	0.07	0.3	0.55	0.013	0.036	730	5.2	16
3/18/97	3.8	0.05	0.2	4	0.09	0.01	98	9.6	3
4/08/97	2.2	0.05	0.1	2.3	0.017	0.03	130	2.4	14
4/22/97	2.03	0.09	0.3	2.33	0.047	0.059	605	7.3	16
6/02/97	1.42	0.09	0.3	1.79	0.031	0.046	5	6.5	13
6/16/97	2.1	0.09	0.3	2.4	0.03	0.051	4.4	7.7	20

Ala Wai Canal at Manoa Stream Mouth

	Size	Median	Mean	Std Dev		Std. Error	Max	Min
NO2	23	0.200	0.256	0.173	0.0361	0.630	0.710	0.0800
NH4	23	0.080	0.108	0.0610	0.0127	0.210	0.260	0.0500
Kjeld	23	0.300	0.274	0.118	0.0245	0.400	0.500	0.1000
TN	23	0.500	0.527	0.189	0.0395	0.740	0.930	0.190
OP	23	0.022	0.023	0.0131	0.0027	0.0430	0.0490	0.00600
TP	23	0.036	0.036	0.0122	0.0025	0.0500	0.0630	0.0130
Chlr	23	348.0	522.67	731.968	152.62	3457.500	3460.000	2.500
NTU	23	4.3	4.917	2.467	0.514	9.500	11.000	1.500
TSS	23	13.0	14.217	9.751	2.033	45.000	47.000	2.000

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
5/06/96	0.1	0.05	0.4	0.5	6e-3	0.028	254	4.6	22
5/21/96	0.14	0.1	0.4	0.54	0.031	0.038	654	6	47
6/04/96	0.08	0.13	0.1	0.2	0.013	0.034	404	6.3	25
6/18/96	0.13	0.08	0.3	0.43	0.048	0.05	95.6	11	13
7/03/96	0.2	0.18	0.2	0.4	0.018	0.022	263	5.2	12
7/09/96	0.32	0.14	0.3	0.62	0.035	0.043	1049	5.8	14
8/06/96	0.15	0.12	0.3	0.45	0.014	0.013	1078	4.4	13
8/20/96	0.19	0.06	0.1	0.19	8e-3	0.03	3460	4.1	10
9/10/96	0.3	0.12	0.3	0.6	0.023	0.037	496	3.7	18
9/23/96	0.15	0.05	0.2	0.35	0.011	0.033	160	3	21
10/08/96	0.16	0.16	0.4	0.56	0.022	0.036	378	3.3	14
10/22/96	0.17	0.05	0.3	0.47	0.029	0.043	386	3.4	14
11/06/96	0.52	0.06	0.3	0.82	0.049	0.054	19.8	9.5	2
11/18/96	0.71	0.05	0.2	0.91	0.026	0.029	2.5	3.3	2
12/03/96	0.21	0.07	0.2	0.41	0.012	0.027	854	2.7	7

Ala Wai Canal at Manoa Stream Mouth

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
1/07/97	0.63	0.08	0.3	0.93	0.039	0.049	18.8	1.5	2
2/11/97	0.28	0.07	0.1	0.38	8e-3	0.021	1015	1.7	13
3/04/97	0.2	0.15	0.3	0.5	0.024	0.043	752	3.6	12
3/18/97	0.49	0.05	0.2	0.69	0.037	0.044	15.4	6.1	5
4/08/97	0.32	0.06	0.1	0.42	0.01	0.021	348	3.1	8
4/22/97	0.2	0.15	0.3	0.5	0.017	0.027	303	4.3	12
6/02/97	0.13	0.26	0.5	0.63	0.042	0.063	4.4	9.3	25
6/16/97	0.11	0.24	0.5	0.61	0.019	0.048	11	7.2	16

Ala Wai Canal at Ala Moana Bridge

	Size	Median	Mean	Std Dev		Std. Error	Max	Min
NO2	20	0.135	0.212	0.196	0.0439	0.810	0.850	0.0400
NH4	20	0.069	0.072	0.0286	0.00640	0.110	0.160	0.0500
Kjeld	20	0.200	0.210	0.0912	0.0204	0.200	0.300	0.1000
TN	20	0.410	0.403	0.263	0.0588	1.050	1.150	0.1000
OP	20	0.022	0.032	0.0250	0.00560	0.0830	0.0890	0.00600
TP	20	0.034	0.045	0.0280	0.00625	0.0890	0.107	0.0180
Chlr	20	74.90	120.54	129.867	29.039	515.500	518.000	2.500
NTU	20	1.55	2.720	3.295	0.737	11.150	12.000	0.850
TSS	20	6.50	7.600	2.761	0.617	11.000	12.000	1.000

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
5/06/96	0.14	0.07	0.3	0.44	0.018	0.038	56.9	1	12
5/21/96	0.13	0.05	0.3	0.43	0.013	0.018	86.9	0.85	10
6/04/96	0.08	0.07	0.2	0.28	0.018	0.033	36.3	1.5	11
6/18/96	0.12	0.08	0.1	0.12	0.028	0.034	50.6	3.3	6
7/09/96	0.22	0.07	0.1	0.22	0.024	0.042	125	1.1	10
8/06/96	0.08	0.05	0.1	0.1	0.02	0.022	39.4	1	11
8/20/96	0.07	0.05	0.1	0.1	6e-3	0.019	518	1.4	5
9/10/96	0.29	0.11	0.3	0.59	0.023	0.028	106	1.8	6
9/23/96	0.08	0.05	0.1	0.18	0.011	0.028	166	1.6	10
10/08/96	0.22	0.11	0.3	0.52	0.022	0.031	70.6	1.3	5
10/22/96	0.09	0.1	0.3	0.39	0.029	0.039	99.1	1.5	6
11/06/96	0.04	0.08	0.1	0.1	0.078	0.092	64.6	12	6
11/18/96	0.85	0.16	0.3	1.15	0.063	0.071	2.5	4.7	6
12/03/96	0.1	0.07	0.2	0.3	0.012	0.022	338	1.7	6
2/11/97	0.12	0.068	0.3	0.42	0.068	0.107	213	0.85	10
3/04/97	0.2	0.05	0.2	0.4	0.018	0.034	288	1.6	9
3/18/97	0.56	0.05	0.3	0.86	0.064	0.074	65.4	12	7
4/08/97	0.37	0.05	0.2	0.57	0.037	0.048	79.2	1.4	1
6/02/97	0.16	0.06	0.3	0.46	0.013	0.022	2.9	2.1	9
6/24/97	0.32	0.05	0.1	0.42	0.089	0.1	2.5	1.7	6

Makiki Stream at King Street

Column	Size	Median	Mean	Std Dev		Std. Error	Max	Min
NO2	22	0.360	0.408	0.266	0.0568	1.190	1.370	0.180
NH4	22	0.050	0.0509	0.00426	0.000909	0.0200	0.0700	0.0500
Kjeld	22	0.200	0.218	0.137	0.0292	0.400	0.500	0.1000
TN	22	0.515	0.585	0.367	0.0782	1.490	1.670	0.180
OP	22	0.124	0.149	0.0743	0.0158	0.338	0.350	0.0120
TP	22	0.155	0.177	0.0884	0.0188	0.377	0.403	0.0260
Chlr	22	28.7	58.377	76.489	16.308	300.600	302.000	1.400
NTU	22	2.35	4.920	6.250	1.332	22.500	23.000	0.500
TSS	22	4.0	8.818	15.408	3.285	73.000	74.000	1.000

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
5/21/96	0.41	0.05	0.2	0.6	0.123	0.156	164	1.3	7
6/04/96	0.38	0.05	0.1	0.38	0.14	0.17	33.3	1.5	6
6/18/96	0.25	0.07	0.4	0.65	0.35	0.402	65.1	23	74
7/09/96	0.21	0.05	0.1	0.21	0.226	0.265	27.1	4.3	14
7/23/96	0.18	0.05	0.1	0.18	0.106	0.122	16.6	2.4	4
8/06/96	0.39	0.05	0.5	0.89	0.194	0.251	81.2	21	20
8/20/96	0.57	0.05	0.5	1.07	0.317	0.403	119	6.7	17
9/10/96	0.31	0.05	0.2	0.51	0.147	0.172	10.7	9.5	4
9/23/96	0.18	0.05	0.1	0.18	0.124	0.153	2.5	0.95	8

Makiki Stream at King Street

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
10/08/96	0.27	0.05	0.1	0.27	0.111	0.129	30.3	0.7	3
10/22/96	0.22	0.05	0.2	0.42	0.118	0.149	3.2	0.75	1
11/06/96	0.85	0.05	0.3	1.15	0.18	0.206	10.4	5.5	4
11/18/96	1.37	0.05	0.3	1.67	0.182	0.196	2.5	3.4	1
12/03/96	0.22	0.05	0.3	0.52	0.115	0.141	134	4.8	3
1/07/97	0.34	0.05	0.1	0.34	0.124	0.136	10.7	0.95	4
2/11/97	0.52	0.05	0.1	0.62	0.102	0.112	302	0.85	4
3/04/97	0.53	0.05	0.4	0.93	0.17	0.184	173	6.7	4
3/18/97	0.45	0.05	0.2	0.65	0.152	0.17	47.2	10	5
4/08/97	0.4	0.05	0.1	0.4	0.103	0.115	30.5	2.3	2
4/22/97	0.29	0.05	0.1	0.29	0.093	0.14	17.2	0.6	2
6/02/97	0.38	0.05	0.1	0.38	0.093	0.103	1.4	0.5	1
6/16/97	0.25	0.05	0.3	0.55	0.012	0.026	2.4	0.55	6

Palolo Stream above Manoa Stream Confluence

	Size	Median	Mean	Std Dev		Std. Error	Max	Min
NO2	23	0.650	0.686	0.308	0.0642	1.090	1.300	0.210
NH4	23	0.050	0.0517	0.00650	0.00136	0.0300	0.0800	0.0500
Kjeld	23	0.200	0.187	0.110	0.0229	0.400	0.500	0.1000
TN	23	0.850	0.842	0.302	0.0629	1.250	1.490	0.240
OP	23	0.012	0.0296	0.0459	0.00957	0.191	0.196	0.00500
TP	23	0.020	0.0400	0.0558	0.0116	0.231	0.236	0.00500
Chlr	23	224.0	578.543	1398.269	291.559	6869.400	6872.000	2.600
NTU	23	1.80	4.593	6.740	1.405	29.250	30.000	0.750
TSS	23	04.0	9.783	18.261	3.808	85.000	86.000	1.000

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
5/06/96	0.55	0.05	0.1	0.55	5e-3	9e-3	75.8	0.75	2
5/21/96	1.19	0.05	0.3	1.49	5e-3	5e-3	768	1.2	3
6/04/96	0.9	0.08	0.1	0.9	0.011	0.02	425	1.8	5
6/18/96	0.33	0.05	0.5	0.83	0.196	0.236	430	30	86
7/09/96	0.24	0.05	0.1	0.24	5e-3	5e-3	214	2.3	3
7/23/96	0.21	0.05	0.1	0.31	7e-3	8e-3	224	2.2	4
8/06/96	0.34	0.05	0.3	0.64	0.062	0.09	265	12	16
8/20/96	0.63	0.05	0.1	0.63	9e-3	0.019	304	1.2	6
9/10/96	0.29	0.05	0.2	0.49	7e-3	0.015	1037	3.3	2
9/23/96	1.03	0.05	0.1	1.13	8e-3	0.016	236	1.4	10
10/08/96	1.06	0.05	0.1	1.06	0.02	0.029	821	1.4	5
10/22/96	0.38	0.05	0.2	0.58	0.014	0.023	137	1.2	2
11/06/96	0.65	0.05	0.2	0.85	0.033	0.04	184	5.3	4
11/18/96	0.87	0.05	0.2	1.07	0.02	0.024	13.6	4	1
12/03/96	0.73	0.05	0.4	1.13	0.133	0.169	6872	13	36
1/07/97	0.99	0.05	0.1	0.99	0.012	0.02	43.8	1.3	1
2/11/97	1.3	0.06	0.1	1.3	0.025	0.034	451	1.2	8
3/04/97	0.55	0.05	0.3	0.85	0.044	0.063	376	13	14
3/18/97	0.58	0.05	0.2	0.78	0.032	0.039	158	3.9	3
4/08/97	0.6	0.05	0.1	0.7	6e-3	0.017	94.2	1.2	1
4/22/97	0.78	0.05	0.1	0.88	6e-3	0.01	171	0.9	2
6/02/97	0.85	0.05	0.2	1.05	8e-3	0.01	2.6	1.2	4
6/16/97	0.72	0.05	0.2	0.92	0.012	0.019	3.5	1.9	7

Manoa Stream above Palolo Stream Confluence

	Size	Median	Mean	Std Dev		Std. Error	Max	Min
NO2	23	0.200	0.228	0.144	0.0301	0.560	0.600	0.0400
NH4	23	0.050	0.0500	(NAN)	(NAN)	0.000	0.0500	0.0500
Kjeld	23	0.100	0.143	0.0590	0.0123	0.200	0.300	0.1000
TN	23	0.290	0.337	0.152	0.0316	0.660	0.800	0.140
OP	23	0.023	0.0259	0.0132	0.00275	0.0500	0.0630	0.0130
TP	23	0.029	0.0332	0.0152	0.00317	0.0530	0.0710	0.0180
Chlr	23	24.0	35.100	36.651	7.642	136.640	137.000	0.360
NTU	23	2.80	3.922	3.122	0.651	10.800	12.000	1.200
TSS	23	4.0	5.391	4.304	0.897	16.000	17.000	1.000

Manoa Stream above Palolo Stream Confluence

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
5/06/96	0.04	0.05	0.1	0.14	0.016	0.021	100	1.5	3
5/21/96	0.06	0.05	0.2	0.26	0.018	0.018	67.5	2.8	6
6/04/96	0.09	0.05	0.2	0.29	0.021	0.03	31.3	2.4	4
6/18/96	0.21	0.05	0.2	0.41	0.063	0.071	6	12	17
7/09/96	0.28	0.05	0.1	0.28	0.017	0.02	48	1.9	5
7/23/96	0.2	0.05	0.1	0.2	0.018	0.025	38.6	2.8	8
8/06/96	0.15	0.05	0.3	0.45	0.05	0.064	76.8	4.8	15
8/20/96	0.25	0.05	0.1	0.25	0.037	0.052	38.3	8.7	9
9/10/96	0.38	0.05	0.1	0.48	0.023	0.027	63	3.7	6
9/23/96	0.19	0.05	0.1	0.19	0.013	0.021	6.6	1.8	3
10/08/96	0.07	0.05	0.1	0.17	0.014	0.019	13.7	1.7	4
10/22/96	0.06	0.05	0.2	0.26	0.019	0.029	10.3	3.5	3
11/06/96	0.3	0.05	0.2	0.5	0.03	0.038	24	4.6	4
11/18/96	0.6	0.05	0.2	0.8	0.02	0.022	2.5	2.1	2
12/03/96	0.26	0.05	0.2	0.46	0.034	0.044	80.6	5	4
1/07/97	0.47	0.05	0.1	0.47	0.024	0.032	4.5	1.2	1
2/11/97	0.15	0.05	0.1	0.15	0.023	0.027	9.9	1.5	2
3/04/97	0.13	0.05	0.2	0.33	0.052	0.061	137	11	13
3/18/97	0.4	0.05	0.1	0.4	0.025	0.032	10.5	3	3
4/08/97	0.37	0.05	0.1	0.37	0.017	0.021	11.8	1.8	2
4/22/97	0.29	0.05	0.1	0.39	0.013	0.03	25.2	1.9	3
6/02/97	0.17	0.05	0.1	0.27	0.024	0.024	0.36	2.1	2
6/16/97	0.12	0.05	0.1	0.22	0.024	0.036	0.83	8.4	5

Manoa Stream at Kaimuki High School

	Size	Median	Mean	Std Dev		Std. Error	Max	Min
NO2	22	0.320	0.345	0.144	0.0307	0.560	0.700	0.140
NH4	22	0.050	0.0500	-	-	0.000	0.0500	0.0500
KJELD	22	0.200	0.177	0.0973	0.0207	0.400	0.500	0.1000
TN	22	0.450	0.502	0.184	0.0393	0.690	0.900	0.210
OP	22	0.027	0.0305	0.0237	0.00506	0.102	0.108	0.00600
TP	22	0.031	0.0385	0.0285	0.00608	0.112	0.126	0.0140
CHLR	22	47.05	56.417	79.865	17.027	387.670	388.000	0.330
NTU	22	2.50	3.905	3.832	0.817	14.900	16.000	1.100
TSS	22	5.0	8.864	10.339	2.204	37.000	39.000	2.000

Date	NO2	NH4	Kjeld	TN	OP	TP	Chlr	NTU	TSS
5/06/96	0.18	0.05	0.1	0.28	6e-3	0.015	9.2	1.5	4
5/21/96	0.25	0.05	0.2	0.45	0.028	0.028	49.1	2.4	7
6/04/96	0.33	0.05	0.1	0.33	0.021	0.033	45.6	2.3	6
6/18/96	0.3	0.05	0.3	0.6	0.108	0.126	48.6	16	38
7/09/96	0.34	0.05	0.1	0.44	0.016	0.022	72.5	2	10
7/23/96	0.21	0.05	0.1	0.21	0.02	0.022	84.9	3.8	15
8/06/96	0.39	0.05	0.5	0.89	0.088	0.116	388	14	39
8/20/96	0.31	0.05	0.1	0.31	0.03	0.04	55.6	5.2	14
9/10/96	0.41	0.05	0.2	0.61	0.033	0.04	66.8	3.5	4
9/23/96	0.48	0.05	0.1	0.48	0.018	0.026	45.9	2.1	5
10/08/96	0.14	0.05	0.3	0.71	0.042	0.054	48.2	2.3	7
10/22/96	0.17	0.05	0.2	0.37	0.029	0.038	0.33	2.6	8
11/06/96	0.47	0.05	0.2	0.67	0.036	0.045	95.1	5.4	12
11/18/96	0.7	0.05	0.2	0.9	0.026	0.029	2.5	3.1	2
1/07/97	0.59	0.05	0.1	0.59	0.028	0.035	9.1	1.3	2
2/11/97	0.45	0.05	0.1	0.45	0.022	0.026	28.6	1.1	2
3/04/97	0.24	0.05	0.2	0.44	0.035	0.035	72.8	3.6	5
3/18/97	0.48	0.05	0.2	0.68	0.028	0.037	76.9	3.8	3
4/08/97	0.41	0.05	0.1	0.41	0.015	0.021	13.8	1.7	3
4/22/97	0.27	0.05	0.2	0.47	0.011	0.014	26.2	1.4	2
6/02/97	0.27	0.05	0.1	0.37	0.016	0.018	0.46	1.5	2
6/16/97	0.19	0.05	0.2	0.39	0.016	0.027	0.98	5.3	5

[1] Note: Values in mg/L except for turbidity (NTU).

Q Stockpile Runoff Project
Chromium Leachate Exceeded Standards
Khal Spenser, UH.

Return-Path: <khal@soest.hawaii.edu>
X-Sender: khal@akule.soest.hawaii.edu
Date: Tue, 21 Oct 1997 08:19:23 -1000
To: "Eugene P. Dashiell" <dashiell@lava.net>
From: "Gregory E Granato, Hydrologist, Marlborough, MA "<ggranato@usgs.gov> (by way of khal@soest.hawaii.edu (Khalil J. Spencer))
Subject: Asphalt as a source of pollutants

Latimer, J.S., Hoffman, E.J., Hoffman, G., Fasching, J.L., and Quinn, J.G., 1990, Sources of Petroleum Hydrocarbons in Urban Runoff: Water, Air, and Soil Pollution, v. 52, p. 1-21.

is a good ref.

Also:

MN DOT did a report that may be helpful:

Sadecki, R.W., Busacker, G.P., Moxness, K.L., Faruq K.C., and Allen, L.G., 1996. An Investigation of Water Quality in Runoff from Stockpiles of Salvaged Concrete and Bituminous Paving: Minnesota Department of Transportation Report MN/PR-96/31, 112 p.

Abstract

The Stockpile Runoff Project addressed environmental concerns regarding the quality of runoff water from salvaged pavement stockpiles. Three experimental stockpiles were studied, one pile consisted of coarse concrete, a second consisted of fine concrete material, and the third consisted of salvaged bituminous material (recycled asphalt product) obtained from a pavement milling project.

The leachate water from piles flowed through a sampling flow monitoring system with data loggers and automated sequence samplers. Composite water samples were analyzed using EPA approved methods and quality control protocols. Comparing the observed median values for the stockpile runoff with Minnesota standards for surface waters, the pH exceeded and chromium may have exceeded the standards. Although there are sediment and leachates emanating from stockpiles, the long-term concern reduces to suspended and dissolved solids, and pH. Polynuclear aromatic hydrocarbons (PAH) concentrations from the bituminous millings pile were near or below detectable limits.

Planning for stockpile storage sites should include management practices of controlling runoff similar to those that are used for construction sites. Berms, straw bales, grass or other filter channels, and locating stockpile sites some distance from surface waters may be appropriate practices. Possible impacts on the ground water system should be considered.

****

The PAH values may have been affected by sampling materials (PVC plastic) and by the fact that the sampling system had several open channel waterfalls in the flow train.

For information about highway runoff please consult our web pages:

http://wwwrvares.er.usgs.gov/osw/fhwa/

under water quality. The pages are still a work in progress, input would be appreciated.

Opinions are my own & do not reflect those of the USGS or the Federal govt.

****

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R Trapping Metals in Stormwater from Highway Runoff.

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University of Cincinnati researchers devise system to "trap" metals in storm water from highway runoff

OHIO A new system to trap dangerous pollutants in highway storm water runoff has been developed by researchers at the University of Cincinnati College of Engineering. This system was tested last fall along Ohio's second busiest stretch of interstate highway.

Doctoral candidate John Sansalone developed the system to reduce the amount of toxic metals that wash into our streams from highways. Sansalone is now testing the partial exfiltration trench (PET) system under the guidance of Steven Buchberger, a University of Cincinnati associate professor in civil and environmental engineering.

PET is a modification to existing highway drainage technology, easy to install and relatively inexpensive. There are two main components of the system. The first component is a bed of oxide-coated sand that attracts and holds heavy metals in the storm runoff.

Laboratory experiments have shown that concentrations of pollutants such as lead, cadmium, copper and zinc are dramatically reduced by this sand. The second part of the system is a layer of porous pavement concrete block, which prevents the movement of solids. "The system is a very effective trap for solids that are washed off the highway," says Sansalone. "Solids are stopped right at the surface of the porous pavement. They can accumulate there, and as part of routine maintenance, they can be vacuumed back off the surface." The concrete also neutralizes acidic rainwater and actually raises the pH of the water to the level where the sand layer works best.

Laboratory tests of the system indicate PET can virtually eliminate nickel, cadmium, lead and zinc from storm water for up to 10 years. PET has been shown to be effective even in severe storms.

The system was field tested in the fall of 1996 to determine if real-world results mimic the laboratory results. The researchers must monitor the system for several months to see how well it survives under the freeze-thaw cycles of winter and spring, and to see how road salt and other deicing chemicals affect it. The field testing continues.

(University of Cincinnati News, October 1, 1996. Contact: Chris Curran - chris.curran@uc.edu)

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University of Cincinnati Environmental Engineers Demonstrate Effective Method For Reducing Pollution From Highway Runoff

Sept. 29, 1997
Contact: Chris Curran
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Cincinnati -- Researchers in the University of Cincinnati College of Engineering have shown that a modified filtration system along interstate highways can prevent heavy metals from polluting nearby water supplies.

The system, known as a partial exfiltration trench (PET), was designed and built by research assistant professor John Sansalone as part of his doctoral research in the department of civil and environmental engineering at UC. The PET replaces the normal sand used in highway storm drainage systems with an iron oxide coated sand. That makes the sand signficantly more effective at trapping heavy metals such as cadmium, copper, lead and zinc.

"Polluted water flows in, and clean water flows out," explained Steven Buchberger, associate professor of environmental engineering and Sansalone's thesis adviser.

Sansalone presented data from a year-long field test during the recent World Congress of the International Association for Hydraulic Research (IAHR) in San Francisco. A prototype PET system was installed along a stretch of Interstate 75 near downtown Cincinnati. It is the second busiest stretch of interstate highway in the state of Ohio.

The effectiveness of the PET system varied for each specific metal, but the overall trapping efficiencies ranged from 82 to 97 percent. The PET even holds up well during heavy rainstorms. The system can handle up to one inch of rain per hour. That's when Sansalone discovered a side benefit to his novel system.

"The PET not only works as a water quality device, but it can act like a water quantity control device to reduce surface flooding," said Sansalone. That discovery was completely unexpected in the Cincinnati area where clay soils are common.

Sansalone will continue his research by looking at ways to make the system more economical and efficient. It took ten tons of coated sand to treat 20 meters of highway during the field test, so Sansalone must find a consistent and simple method for producing huge quantities of coated sand.

"When we made the prototype, we made more coated sand than has ever been artifically produced on Earth. It was a real undertaking," said Sansalone.

He will also work on modifying the coating itself to increase its trapping efficiency and lifetime. The goal is to have a system which can last as long as the typical highway pavement about 15 years. Lab tests indicated Sansalone's coating could last approximately 40 years. The field tests indicated a much shorter life expectancy, but one very close to the final project goal.

"Conditions in the field are always more severe than you can simulate in the lab," said Sansalone. "Based on the results we've seen so far, a 10 to 15 year life is reasonable."

"Our laboratory work has shown great promise for what we intend to do in the field with this prototype PET installation. We think the system, by the nature of its design, is cost effective. It is not a new component for urban highways. It is essentially an upgrade."

But it will take more than one storm to determine how well the PET prototype works in the real world. The researchers must monitor the system for several months to see how it holds up under the freeze-thaw cycles of winter and spring and to see how road salt and other de-icing chemicals affect it.

The research is funded by the Ohio Department of Transportation.

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Research News Releases
Public Relations Home Page
University of Cincinnati Home Page

University of Cincinnati Engineers Field Test New System To Trap Heavy Metals in Stormwater Runoff

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Cincinnati -- Researchers in the University of Cincinnati College of Engineering have designed a new system to trap dangerous pollutants in highway stormwater runoff. The system is being field tested this fall along the second busiest stretch of interstate in Ohio.

Doctoral candidate John Sansalone developed the new system. Sansalone's adviser is Steven Buchberger, associate professor in civil and environmental engineering at UC. Sansalone calls the system "PET" for partial exfiltration trench. It's a modification of the current systems used to improve drainage under highways, so it's expected to be easy to install and relatively inexpensive.

There are two key components to the system. The first is a bed of oxide-coated sand which attracts and holds onto heavy metals in the storm runoff. Lab-scale experiments demonstrated the special sand can dramatically reduce the concentrations of pollutants such as lead, cadmium, copper and zinc. This component takes care of the dissolved metals.

The second part of the system, a layer of porous pavement concrete block, acts as a giant strainer. "The system is a very effective trap for solids that are washed off the highway," said Sansalone. "Solids are stopped right at the surface of the porous pavement. They can accumulate there, and as a part of routine maintenance, they can be vacuumed back off the surface."

The concrete also neutralizes acidic rainwater and actually raises the pH to the level where the sand layer works best.

Sansalone has spent the last year testing a laboratory version of the PET system. Experimental results reported at the Seventh International Conference on Urban Stormwater Drainage in Germany this month indicate that the system can virtually eliminate nickel, cadmium, lead and zinc from stormwater runoff for up to ten years. And it doesn't matter how bad the storm is.

"Everything was based on peak flows or the heaviest flows, and we're still getting good results," said Sansalone.

The PET system is being installed along I-75 in a heavily traveled and industrial section of Cincinnati. The UC researchers have been trapping rainwater along that stretch of highway for the last two years to determine exactly what pollutants are present. Those same stormwater samples were used to test the lab- scale PET system, so the researchers expect the field-scale model will work effectively and inexpensively.

Even more important than lifespan is the ability to clean or recharge the PET system easily. In the next phase of the project, Sansalone will try to demonstrate that the trapped metals can be removed by a simple back-washing. That's important, because if you can't remove the toxic pollutants for disposal, you wind up with tons and tons of toxic waste.

Lab-scale experiments indicate the back-washing process is feasible. However, field tests are required to test the procedures on a large-scale operation.

Sansalone's research is funded by the Ohio Department of Transportation and the National Science Foundation. His presentation in San Francisco was recognized by the IAHR's John F. Kennedy Award for Hydraulic Research. The award is named for an engineering researcher who specialized in hydraulics.

-30-

chris.curran@uc.edu
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S Metal Removal from Stormwater in Street Storm Drain Catch Basins Fossil Filter Company, Manufacturer

KriStar Enterprises, Inc., 422 Larkfield Center, Suite 271, Santa Rosa, CA 95403 (800) 579-8819

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COMPANY: _____

FROM: Kristar Enterprises

RE: _____

PAGES _____ (inc. Cover)

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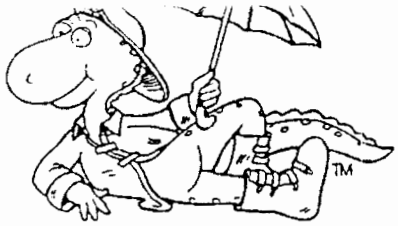
Thanks

POLLUTION from stormwater runoff??? *Fossil Filter*™ is the **SOLUTION**!!!



patent pending

KriStar Enterprises, Inc., 422 Larkfield Center, Suite 271, Santa Rosa, CA 95403
(800) 579-8819

IMPORTANT QUESTIONS & ANSWERS

1) WHAT IS FOSSIL FILTER™?

Fossil Filter™ (patent pending) is a trough apparatus, installed in surface water drainage inlets, that incorporates EPA-approved adsorbents which collect petroleum hydrocarbons and other contaminants while permitting the undisturbed passage of water. Units are available to fit square, rectangular, round and single-sided (curb-type or trench drain) inlets and can be used in new or post-construction projects. **Fossil Filter™** is a product of KriStar Enterprises, Inc. of Santa Rosa, California.

2) HOW DOES FOSSIL FILTER™ WORK?

Regarding the removal of petroleum hydrocarbons, all versions of the **Fossil Filter™** function as follows: As the surface water flows into the inlet, it passes throughout the **Fossil Filter™** where the installed adsorbent material removes petroleum-based contaminants. The **Fossil Filter™** with Silt Basin has the added capability of removing "heavy metals". The **Fossil Rock™** adsorbent material used in **Fossil Filter™** removes contaminants from the water through a process called "adsorption" (acts like a magnet) rather than "absorption" (acts like a sponge).

3) WHAT MATERIALS ARE USED IN THE MAKING OF FOSSIL FILTER™?

All Components for the square, rectangular and curb-type models of **Fossil Filter™** are of galvanized steel. The round units and **Fossil Filter™** with Silt Basin are of fiberglass. (See #9 for a discussion on the incorporated adsorbent media.)

4) WHAT ARE THE MOST APPROPRIATE USES OF FOSSIL FILTER™?

The use of **Fossil Filter™** is most appropriate where motor vehicles' park, are refueled or are serviced. Customer and employee parking lots and corporation yards are excellent prospects for the installation of **Fossil Filter™**.

5) WILL THE USE OF FOSSIL FILTER™ SATISFY CURRENT FEDERAL EPA NPDES CRITERIA? CAN FOSSIL FILTER™ BE INCLUDED AS A COMPONENT OF A COMMUNITY'S SWPPP (STORMWATER POLLUTION PREVENTION PROGRAM)?

The federal EPA's NPDES program, designed to control the discharge of pollutants to waters of the United States, cites a definition of oil/water separator as "A device installed, usually at the entrance to a drain, which removes oil and grease from water flows entering the drain." That accurately describes **Fossil Filter™**. EPA further mandates the use of BAT (Best Available Technology) while being "economically feasible". **Fossil Filter™** meets that criteria.

As a device "which removes oil and grease from water flows entering the drain," the use of **Fossil Filter™** is very appropriate for inclusion in SWPPP's as a means of mitigating stormwater runoff pollution.

Sep-12-97 11:35A KriStar Ent. 707-525-0973 P.02

6) HOW IS FOSSIL FILTER™ INSTALLED:

IN A FOUR SIDED-DROP INLET?

There are two options for the four-sided inlet: The first is four galvanized corner sections are cut to appropriate length to fit the inside dimensions of the inlet and connected together. The apparatus is then installed either by hanging the unit on the grate bearing surface or with the use of lag bolts. The filter cartridges (4) are cut to length, filled to about 3/4 full with **Fossil Rock™** (the approved adsorbent material,) and installed in the **Fossil Filter™** troughs.

The second option is a pre-formed one piece fiberglass **Fossil Filter™** with Silt Basin. The unit's trim-to-fit flange is cut to fit inside the inlet and rest on the grate bearing ledge. The unit's filter cartridge process is as above.

IN A CURB INLET or TRENCH DRAIN?

Straight rail sections are cut to the length of the curb or trench drain opening and end caps are installed on both ends. The apparatus is then installed just below the surface level across the opening using concrete anchor bolts. The filter cartridge process is as above.

IN A ROUND INLET?

The round units are installed by merely removing the inlet grate and lowering the unit to where the adjustable flanges rest on the grate bearing ledge. The lower screen is put in place, the **Fossil Rock™** Adsorbent is poured on top of the bottom screen, and the top screen installed.

7) WHEN INSTALLED, WILL THE FOSSIL FILTER™ INHIBIT THE FLOW OF WATER?

No. **Fossil Filter™** is designed to remove harmful pollutants during initial and low flows ("first flush"), when the bulk of the surface-accumulated contaminants enter the inlet. Furthermore, the hydrophobic characteristics of the installed **Fossil Rock™** adsorbent allows the water to flow smoothly through the filter. In the event of very heavy flows which exceed flow-through capability, the filter's design allows the excess water to flow over the inside edge of the filter rail, into the overflow bypass area, and then on into the drainage system.

8) HAS THE FOSSIL FILTER™ BEEN SUBJECTED TO HYDROLOGICAL TESTING?

Yes. Late May 1995 tests by Sandine Engineering Associates of Santa Rosa, California showed that installed **Fossil Filter™** did not impede maximum design flow of the inlet and they would effectively filter in excess of 10 gallons per minute per linear foot of filter.

9) WHAT IS THE ADSORBENT? IS IT HAZARDOUS?

According to the manufacturer's supplier, **Fossil Rock™**, the PH-attracting adsorbent material, is a natural material known as Amorphous Alumina Silicate, an inert blend of minerals that contain non-hazardous ingredients, as defined by the Federal EPA, OSHA (Occupational Health and Safety Administration) and WHO (World Health Organization). However, if the material is used in a confined area, or if the person replacing the filter material is allergic to dust, we recommend using a paper mask to avoid coughing from inhalation of fine particles. **Fossil Rock™** contains no reactive chemicals, is non-carcinogenic, non-biodegradable and non-leaching, non-toxic, non-flammable and non-injurious to asphalt, cement, carpet, tile, soil, or plant life. (See the product's Material Safety Data Sheet.) **Fossil Filter™** with Silt Basin incorporates a "Heavy Metal Skirt" which is a polyester substrate that is treated with Zeolite, a product used to remove heavy materials from water through an "ion exchange" process. Once collected, the metals, etc., will not leach unless exposed to sodium chloride salt, as used in snow removal. The product is not hazardous in any way because Zeolites are natural products and the polyester is a synthetic non-woven fabric with no toxicity.

Sep-12-97 11:35A KriStar Ent. 707-525-0973 P.03

10) HAVE THE ADSORBENT MATERIALS BEEN TESTED FOR EFFICIENCY?

According to KriStar's supplier, **Fossil Rock™** will adsorb approximately 1.92 gallons of liquid contaminate per cubic foot of adsorbent. Therefore, a typical 24"x24" filter, which contains approximately .56 cubic foot of **Fossil Rock™**, would adsorb approximately 1.08 gallons of liquid contaminant. Regarding the Zeolite/polyester Heavy Metal Skirt, this is a new application and has not been tested for efficiency, however Zeolites have long been proven to be effective in the removal of heavy metals.

11) WHAT ARE THE MAINTENANCE REQUIREMENTS? WHAT IS THE USEFUL LIFE OF THE INSTALLED ADSORBENTS?

As with all products subject to the abuses of nature and individuals, the installed **Fossil Filter™** requires inspection on a regular basis and all foreign objects (leaves, cans, cigarette butts, etc.) be removed. The area around the installations should be swept on a regular basis. The installed **Fossil Rock™** adsorbent should be inspected and replaced if the surface of the granules are more than 50% coated with contaminants and/or the unit has become clogged with silt (see #12). It is recommended that the units be inspected at least three times per year. Inspections should occur once before the beginning and twice during the rainy season.

The useful life of the installed **Fossil Rock™** and heavy Metal Skirt (Silt Basin model only), under normal usage, is estimated to be about six months. Areas with heavy vehicle traffic may require more frequent changes.

12) WILL THE FOSSIL FILTER™ FUNCTION EFFECTIVELY IN AREAS OF HEAVY DEBRIS OR SILT?

Yes, however, in such areas, use of a dual stage filter is recommended. The first (upper) stage filter catches the silt and debris during its filtering life. If it becomes clogged, the water will flow into the second (lower) stage and be filtered. If the product is maintained according to EPA's Best Management Practices (BMP) and the manufacture's recommendations (#11 above), the **Fossil Filter™** will function effectively.

13) ARE THERE KNOWN "ACCEPTED" PRODUCTS CURRENTLY ON THE MARKET THAT FUNCTION AS EFFICIENTLY AS FOSSIL FILTER™ IN THE REMOVAL OF CONTAMINANTS FROM WATER RUNOFF?

Until the creation of **Fossil Filter™**, the Best Available Technology (BAT) was underground large capacity concrete oil/water separators. Compared to **Fossil Filter™** they are less efficient and more expensive to install and maintain. In addition, they are not suitable for post-construction (retrofit) installation.

14) WHAT IS THE COST PER INSTALLATION OF FOSSIL ROCK™ ADSORBENT OR THE HEAVY METAL SKIRT?

One ten pound bag of **Fossil Rock™** contains 1.3 cubic feet of adsorbent and costs $23 while one 24"x24" **Fossil Filter™** contains about .56 cubic feet of adsorbent. So, it would cost approximately $12 to replace the adsorbent in one unit. It would cost $25.00 for one heavy metal skirt.

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15) ONCE REMOVED FROM THE FOSSIL FILTER™, IS THE ADSORBENT CONSIDERED HAZARDOUS MATERIAL? HOW IS IT DISPOSED OF?

Even though Fossil Rock™ is a non-leaching and environmentally friendly substance, once it is exposed to contaminants, is technically becomes "Used Oil Adsorbent Material" with disposal regulations similar to those for oily rags. Classification and disposal regulations may vary from state to state and even from landfill to landfill. Therefore, prior to disposal, maintenance personnel should contact their local regulatory agency to ensure compliance with local and state environmental regulations.

16) ARE FOSSIL FILTER™ INSTALLERS AVAILABLE? ARE MAINTENANCE PLANS AVAILABLE?

Yes, on both counts. Fossil Rock™ is sold through KriStar certified distributors who can provide "Full Circle Service". They can sell, install, maintain the units and dispose of the used adsorbent.

17) WHAT DOES A TYPICAL MAINTENANCE PLAN INCLUDE? COST?

For a normal installation (low silt, debris and contaminant-count problems), most distributor maintenance plans include three inspections with the debris being removed, a general cleanup around the area and a one time replacement of the adsorbent. It will normally cost less than $150.00 for the three visit plan per Fossil Filter™ unit, depending on the number of units, distance to travel and so forth..

18) HOW DO I GET MORE INFORMATION ON FOSSIL FILTER™ AND ITS PROGRAMS?

Contact KriStar's national office in Santa Rosa, California toll free 1-(800)-579-8819.

Sep-12-97 11:36A KriStar Ent. 707-525-0973 P.05

FOSSIL FILTER™
GENERAL SPECIFICATIONS
FOR SILT BASINS™

Scope:

This specification describes a catch basin filtration system that incorporates EPA-approved adsorbents installed in a drainage inlet to collect petroleum-based contaminants while permitting the undisturbed passage of water.

Material Properties:

The trough shall be manufactured from petroleum resistant fiberglass and include an area to retain silt and debris so as not to stop up the drainage system. The filter screens shall be of stainless steel Type 304. The filter media shall be an adsorbent material that contains no hazardous ingredients as defined by the U.S. Environmental Protection Agency (EPA), U.S. Occupational Safety and Health Administration (OSHA), and the World Health Organization (WHO).

Installation:

Installation shall be performed by certified Fossil Filter™ installer. A Fossil Filter™ Installation Record, to be provided upon installation, shall be kept by the end user.

Maintenance and Disposal:

Maintenance services shall be provided by certified Fossil Filter™ maintenance provider. A Fossil Filter™ Maintenance Record, to be provided upon installation, shall be kept on site by the end user.

Disposal of exposed filter media shall be in accordance with local regulatory agency specifications to ensure compliance with all local and state environmental legislation.

Fossil Filter™

SPECIFIER CHART

(Northern California)

Fossil Filter™ MODEL NUMBER	CATCH BASIN MANUFACTURER and MODEL NUMBER					
STANDARD (SINGLE STAGE)	**CHRISTY**	**HANSON**	**HYDRO CONDUIT**	**S. R. CAST**	**TEICHERT**	**WESTERN**
FF - 2424	U21/U23	P24	D22	2K	VF2424	4S
FF - 2430	-	P2430	-	3K	-	5S
FF - 2436	U32	P2436	D23	1L	VH2436	6S
FF - 3030 (see note 3)	-	P30	-	5K	-	7S
FF - 3636 (see note 3)	U52	P36	D33	1M	VS3636	8S
SILT BASIN						
SB - 24 (see note 4)	U21/U23	P24	D22	2K	VF2424	4S
SB - 2436 (see note 4)	U32	P2436	D23	1L	VH2436	6S
SB - 30	-	P30	-	5K	-	7S
ROUND FILTERS						
RF - 24	-	CB24	CB24	SR24	A1024	A1024
RF - 20	-	SBF1975	-	SBF1975	A1075	A1075
CURB INLETS (DUAL STAGE)						
FF - 30CI	-	P2430C	-	2 1/2A	-	2430
FF - 36CI	-	P36C	-	3AC	VJL416	3636
FF - 48CI	U37	P2448C	D24CI/D34CI	4A/4AC	VLL416	3448/3648

NOTES:

1) ABOVE REFERENCED FILTERS ARE MANUFACTURED TO FIT PRECAST CONCRETE DRAINAGE INLETS NOTED.
2) ADDITIONAL STANDARD AND CUSTOM SIZES ARE AVAILABLE.
3) DUAL STAGE FILTERS MAY BE SPECIFIED.
4) FOR LARGER INLETS NOT LISTED, SILT BASIN FILTERS MAY BE INSTALLED SIDE BY SIDE.

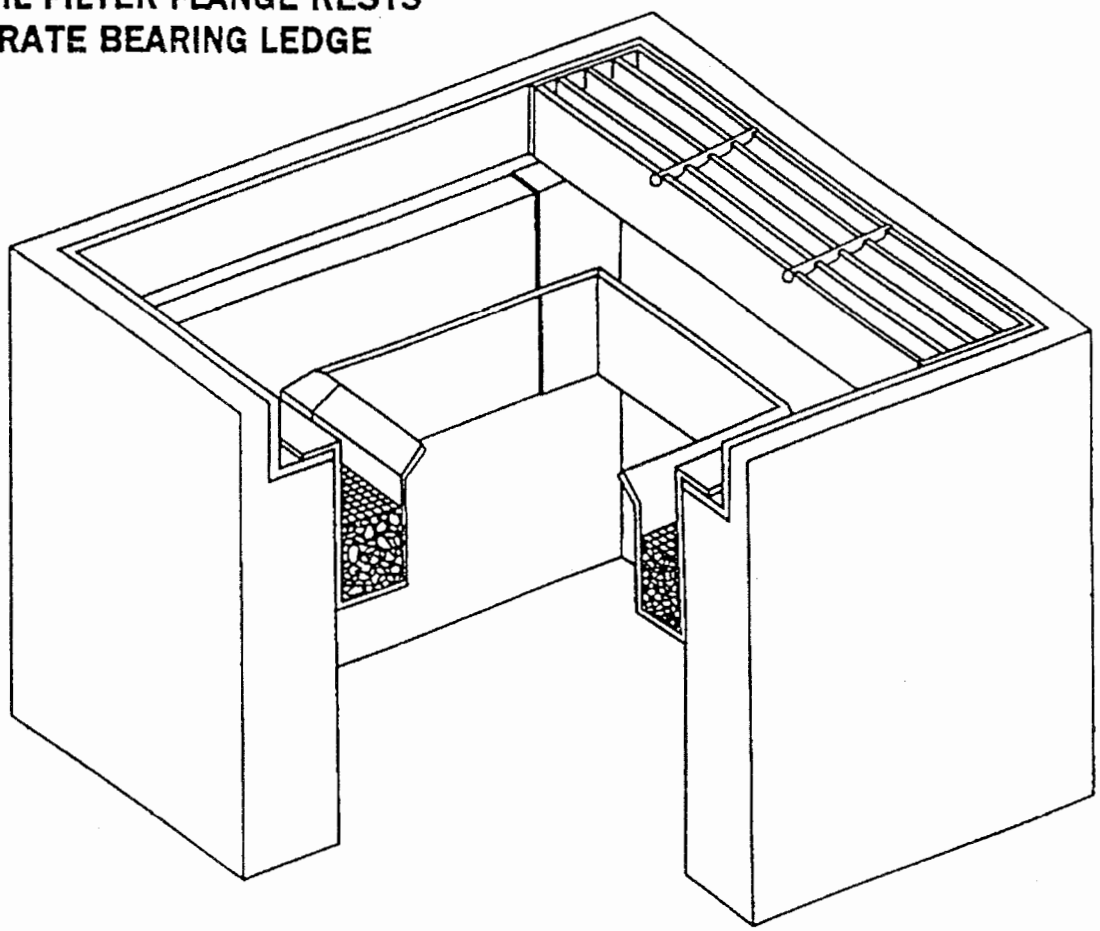
PATENTS PENDING

For additional information contact:
KriStar Enterprises, Inc., at (800) 579-8819 or fax us, (707) 525-0973

FOSSIL FILTER™

STANDARD
GRATE INLET

FOSSIL FILTER FLANGE RESTS ON GRATE BEARING LEDGE



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LIMITED WARRANTY
KRISTAR ENTERPRISES, INC.

TO THE EXTENT PERMITTED BY THE LAW OF YOUR JURISDICTION, THIS LIMITED WARRANTY LIMITS OR EXCLUDES CERTAIN WARRANTIES OR RIGHTS OTHERWISE PROVIDED BY LAW.

KriStar Enterprises, Inc. ("KriStar") hereby warrants its products to be free from defects in material and workmanship for a period of one (1) year from the date of original purchase by the person or entity purchasing KriStar's products directly from KriStar or from KriStar's authorized representatives or re-sellers ("Purchaser"). There are no other warranties or representations with respect to the nature or quality of KriStar's products. Under no circumstances shall KriStar be liable for incidental, consequential, or other or additional damages of any kind or nature whatsoever, including without limitation, shipping and freight charges, installation and/or removal expenses including labor, interest, attorney fees, or other costs, whether such claim is based upon principles or theories of contract, warranty, negligence and/or tort law.

IT IS EXPRESSLY AGREED THAT THIS WARRANTY IS THE EXCLUSIVE AND ONLY WARRANTY TO PASS WITH KRISTAR'S PRODUCTS. AND THAT THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WITHOUT LIMITATION, THOSE OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY.

In the event such disclaimer of implied warranties is held to be unenforceable or otherwise invalid, or if Purchaser or any third party, including without limitation employees, assigns, invitees, agents, contractors, subcontractors, and/or representatives of Purchaser, claim KriStar is liable for negligence arising from the manufacture of its products, or if for any other reason a claim is made that KriStar has not fully satisfied its obligations with respect to its products, KriStar's liability is limited to an amount equal to two (2) times the original purchase price of KriStar's products proven to be defective, exclusive of any applicable taxes. Purchaser hereby agrees to indemnify, defend and hold KriStar harmless in the event any third party brings a claim against KriStar relating to its products.

Any claim for breach of this warranty must be submitted within one year from the date of original purchase and must be in writing, addressed to President, KriStar Enterprises, Inc., 422 Larkfield Center, Suite 271, Santa Rosa, CA 95403. Only a corporate officer (President, Vice President, or Corporate Secretary) of KriStar shall have the authority to modify this warranty, and any such modification must be in writing and signed by the corporate officer, including reference to said officer's title, to be effective.

If a dispute arises out of or relates to this Limited Warranty, or performance or breach thereof, KriStar and Purchaser agree first to try in good faith to resolve the dispute by mediation under the Commercial Mediation Rules published by the American Arbitration Association before resorting to arbitration. Thereafter, any remaining unresolved controversy or claim arising out of or relating to this Limited Warranty, or performance or breach thereof, shall be resolved by binding arbitration in accordance with the Commercial Arbitration Rules published by the American Arbitration Association, and shall be conducted in Santa Rosa, California. The sole Arbitrator shall be a retired or former Judge familiar with commercial and construction matters. Judgment upon the award rendered by the Arbitrator may be entered in the Sonoma County court having jurisdiction thereof.

Purchaser's initials: _____

KriStar Enterprises, Inc. the manufacturer of

FOSSIL FILTER™

is proud to announce:

The New One Piece
"Drop In" *Fossil Filter™*

designed to fit various industry standard precast catch basins

---

★ The new "Drop In" design requires ***NO*** special installation equipment

★ New easy installation allows ***YOUR OWN CREW*** to install

★ For the ease of ordering, simply note the manufacturer and model number of catch basins to be fitted.

☞ *Please refer to the Fossil Filter™ specifier chart* ☜

★ May now be purchased directly from the Manufacturer

For odd sized or shaped inlets
The original *Fossil Filter™*
will continue to be available

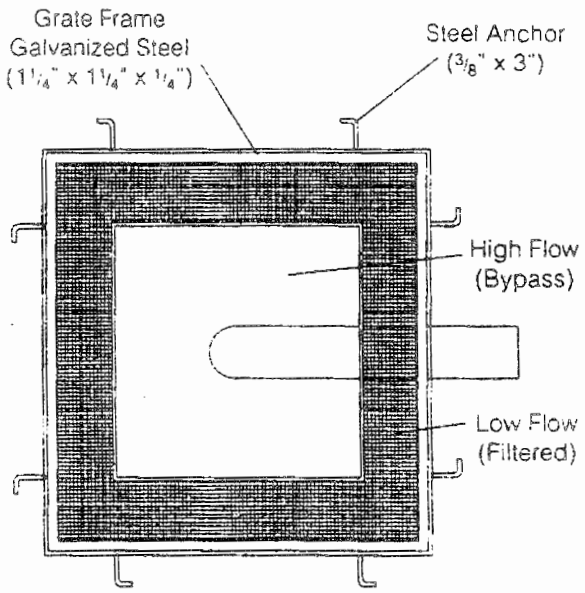
For the installation of *The original Fossil Filter™*
KriStar Enterprises, can recommend a certified installation company in your area .

Call KriStar Enterprises, Inc., (800) 579-8819, for prices and availability

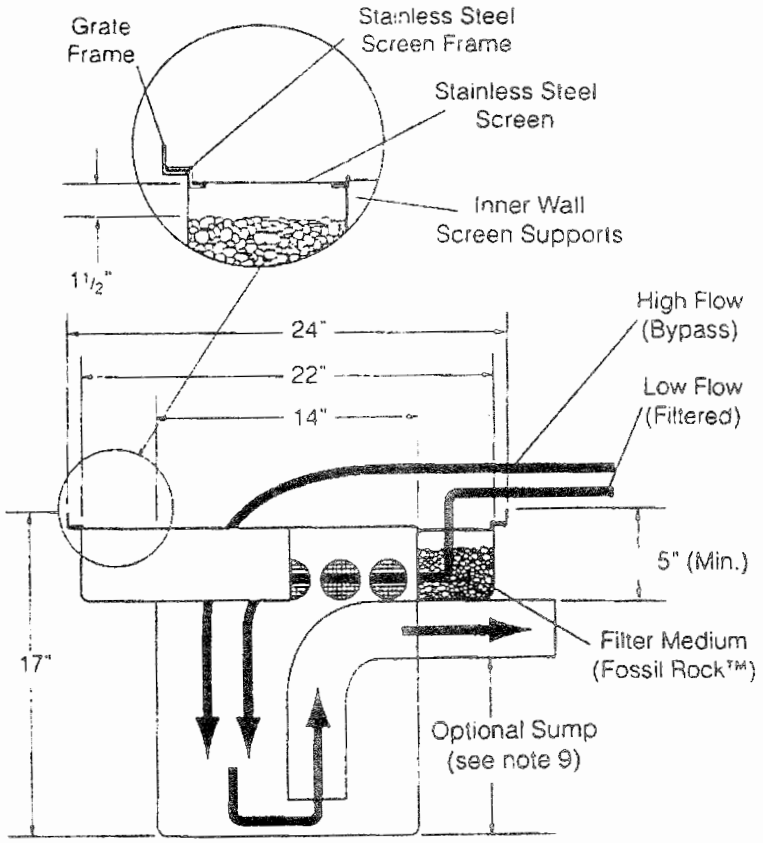
FOSSIL FILTER

FOSSIL FILTER™ CATCH BASIN
(Model FB-24)

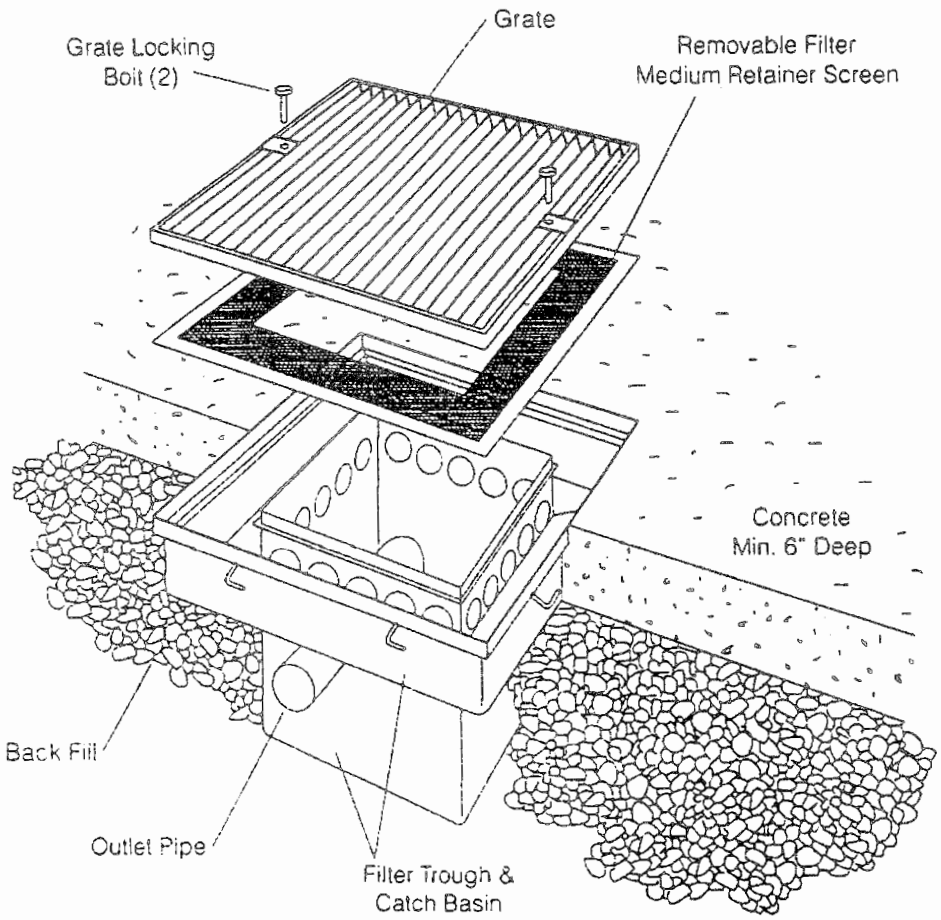
PATENT PENDING



PLAN VIEW
(Shown without grate)



SECTION VIEW
(Catch Basin/Filter Body)



NOTES:

1. Catch Basin/Filter body shall be one piece construction molded from fiberglass which meets or exceeds PS15-69.
2. Grate and frame shall be fabricated steel galvanized in accordance with ASTM A123.
3. Grate shall have maximum spacing of 1/2" between bearing bars in accordance with ADA requirements and shall be secured with locking bolts.
4. Grate shall be designed for H20 wheel loading.
5. Filter screen and screen frame shall be stainless steel (type 304). All screens shall be 8 mesh.
6. Catch Basin may be specified with single or multiple outlet pipes (3, 4, or 6" dia.).
7. Filter medium shall be Fossil Rock™, installed and maintained in accordance with manufacturer recommendations.
8. A minimum cover of 5" is required over outlet pipe(s).
9. Catch Basin may be specified without sump area.

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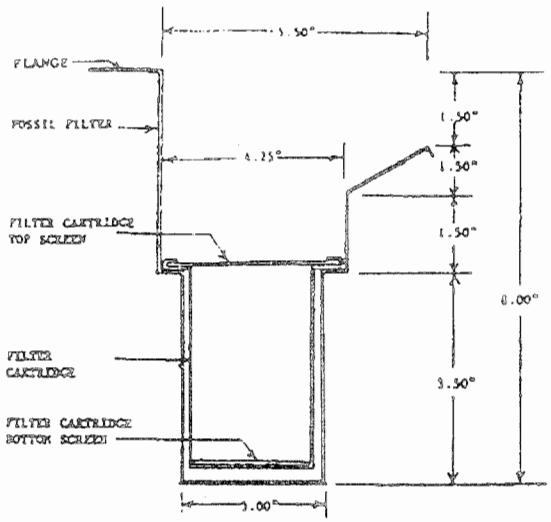
FOSSIL FILTER™

DIMENSION DETAIL



CROSS SECTION OF FOSSIL FILTER™ WITH FLANGE

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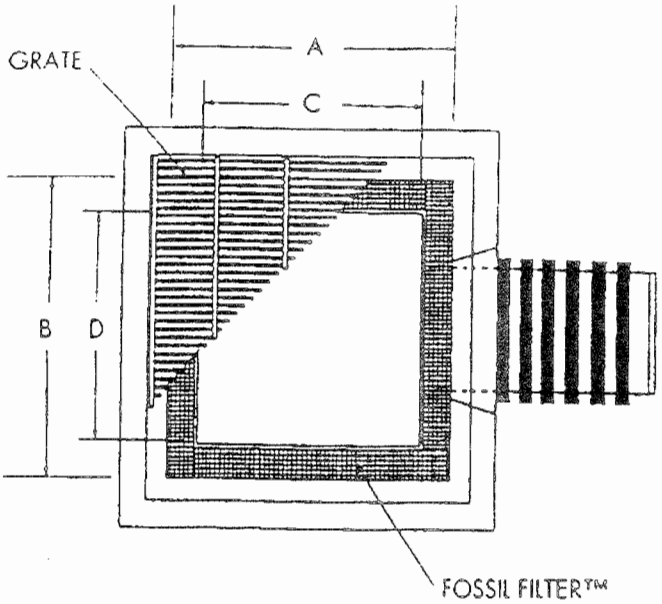
FOSSIL FILTER™

AERIAL VIEW STANDARD GRATE INLET



A & B: INSIDE DIMENSION OF INLET
C & D: FOSSIL FILTER OVERFLOW AREA

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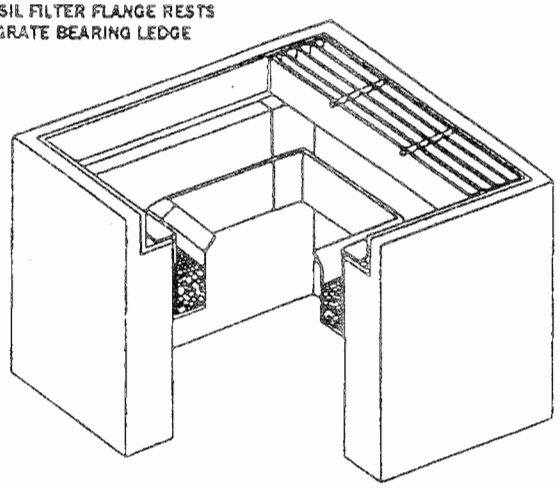
FOSSIL FILTER™

STANDARD GRATE INLET

FOSSIL FILTER FLANGE RESTS ON GRATE BEARING LEDGE



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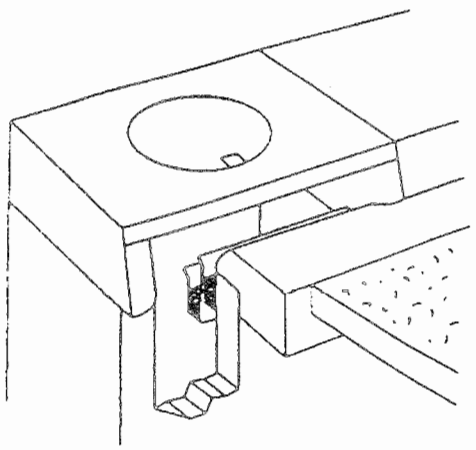
FOSSIL FILTER™

TYPICAL CURB INLET



- DUAL STAGE FILTER SHOWN
- THIS INSTALLATION REQUIRES A FOSSIL FILTER WITHOUT FLANGE ATTACHED TO INSIDE WALL OF INLET WITH CONCRETE ANCHORS (2 MIN.)

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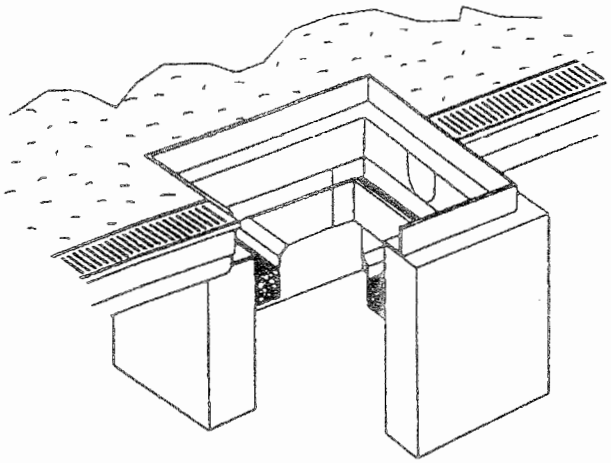
FOSSIL FILTER™

TYPICAL TRENCH DRAIN INLET



THIS INSTALLATION REQUIRES A FOSSIL FILTER WITHOUT THE FLANGE TO ALLOW THE FILTER TO BE LOWERED TO CATCH THE TRENCH DRAIN. ATTACH TO INSIDE WALL WITH CONCRETE ANCHORS.

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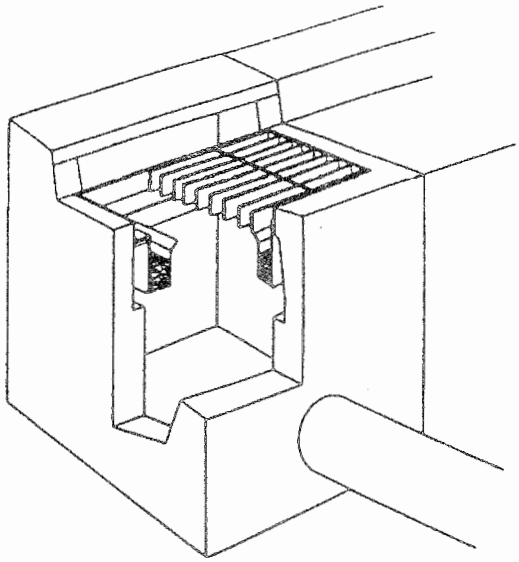
FOSSIL FILTER™

COMBINATION CURB/GUTTER GRATE INLET



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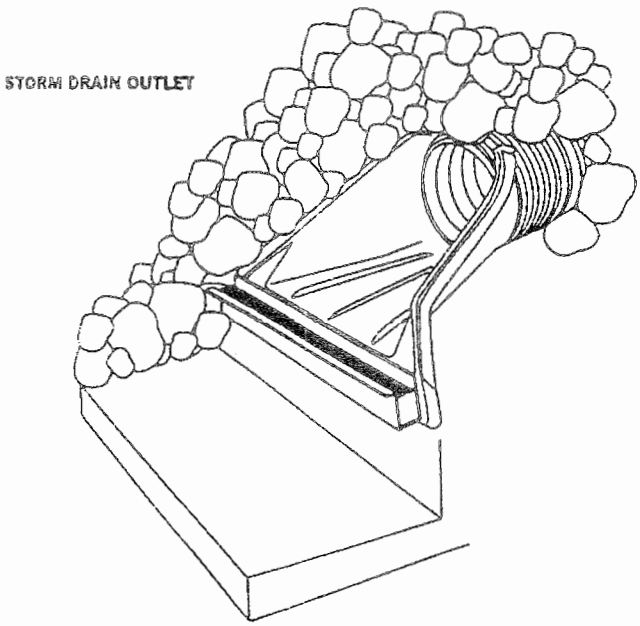
FOSSIL FILTER™

STANDARD FLARED END SECTION



THIS INSTALLATION TO BE USED AS A METHOD OF CATCHING ANY REMAINING POLLUTANTS PRIOR TO FLOWING INTO STREAM.

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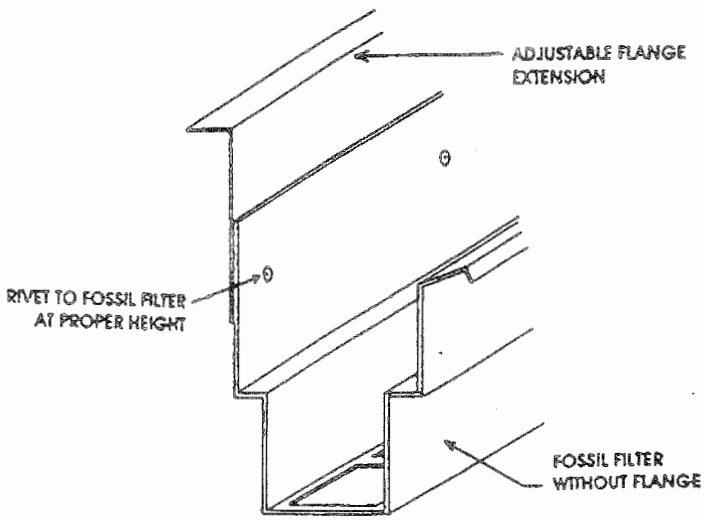
FOSSIL FILTER™

ADJUSTABLE FLANGE EXTENSION



THE ADJUSTABLE FLANGE EXTENSION, WHEN ATTACHED TO THE FOSSIL FILTER WITHOUT FLANGE, INCREASES THE RESTING DEPTH OF THE FOSSIL FILTER WITHIN THE DRAINAGE INLET.

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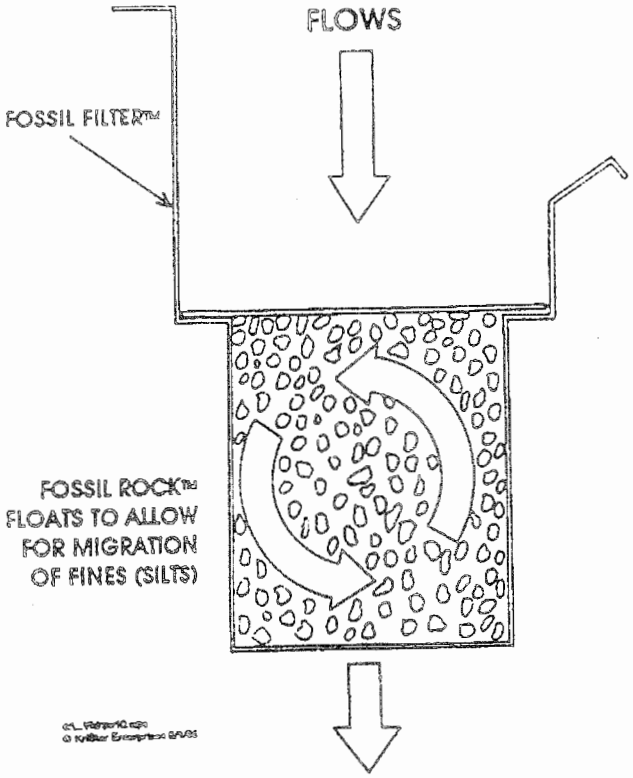
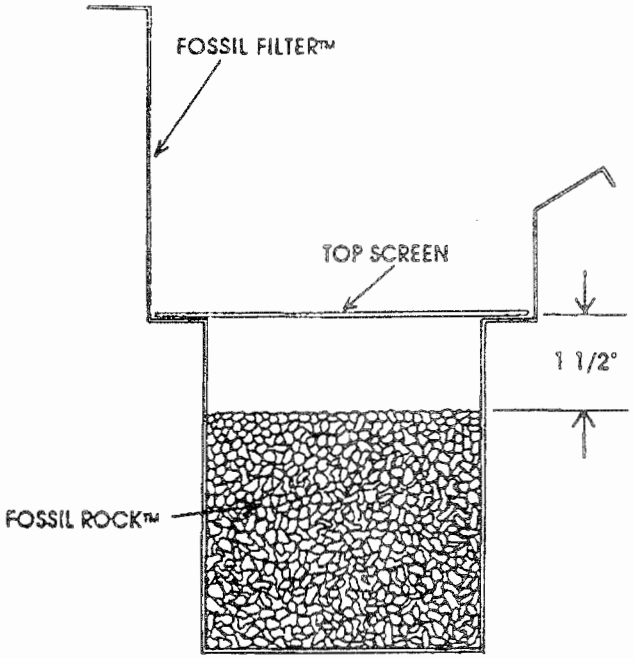
FOSSIL FILTER™ FILTRATION PROCESS DETAIL

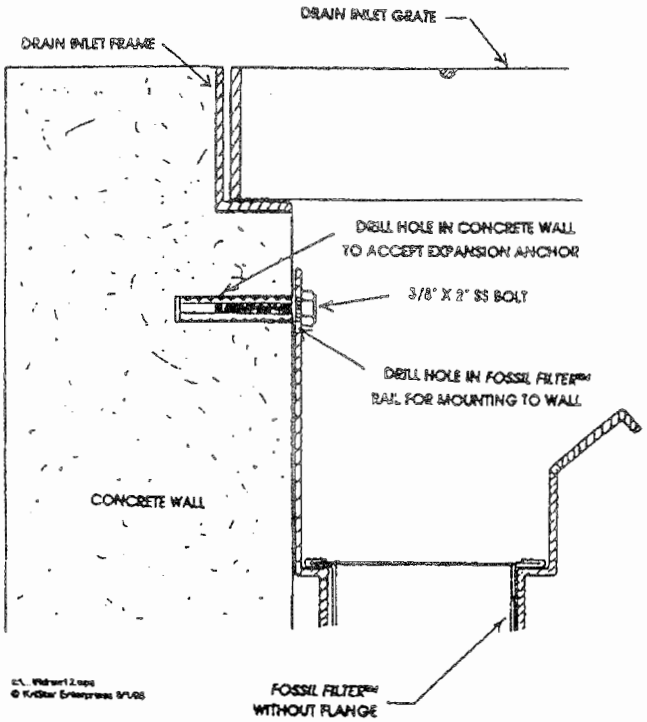


FOSSIL FILTER™ PROPER FILL HEIGHT DETAIL



FOSSIL ROCK™ ABSORBENT MATERIAL SHOULD REST APPROXIMATELY 1 1/2" BELOW TOP SCREEN WHEN PROPERLY FILLED FOR MAXIMUM EFFECTIVENESS. DO NOT OVERFILL.

FOSSIL FILTER™ WALL MOUNTING DETAIL



INSTALLATION GUIDELINES

For Standard and Curb Inlets

STANDARD GRATE INLET

STEP 1: Remove inlet grating.

STEP 2: Set *Fossil Filter™* into drain inlet, resting flange on grate bearing surface.*

* For drain inlet sides without grate bearing surface, pre-fabricated units without flange are available. Follow Step 3 of Curb Opening Inlet for installation instructions.

CURB OPENING INLET

STEP 1: Measure width of curb opening inlet and cut rail section to appropriate length.

STEP 2: Install two rail section end caps (right and left sides) by drilling two 1/8" holes through pre-drilled holes in each end cap and securing with pop-rivets.

STEP 3: Drill three or more holes (depending on inlet size) in the inside wall of the curb opening inlet to accommodate expansion anchors (3/8" x 2" SS bolts). Drill matching holes in *Fossil Filter™* rail section and secure the assembled *Fossil Filter™* trough apparatus to the inside wall with bolts (see attached Wall Mounting Detail).

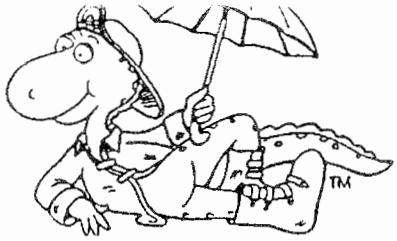
FOSSIL FILTER™ FILTER CARTRIDGE ASSEMBLY

STEP 1: Measure inside dimension of installed Fossil Filtertm trough area and cut filter cartridge to length, allowing 1/4" on each side for end caps.

STEP 2: Cut both top and bottom filter cartridge screens to match length of filter cartridge. Set bottom screen into filter cartridge and secure to bottom using stainless steel wire ties.

STEP 3: Slide top screen into top flange of filter cartridge and install one end cap by drilling two 1/8" holes through pre-drilled holes in the end cap and securing with pop-rivets.

STEP 4: Set the filter cartridge on end and fill the cartridge with *Fossil Rock™* absorbent material through the open end. The absorbent material should rest within 1 1/2" of the top screen when the filter cartridge is horizontal. *Do not overfill.*



MAINTENANCE GUIDELINES

BACKGROUND

When installed in a drainage system (per KriStar instructions and specifications), *Fossil Filter™* is an effective tool in the efforts to reduce pollution of lakes, rivers, streams and oceans caused by contaminants borne in stormwater runoff.

Within the United States, the federal Environmental Protection Agency (EPA) has mandated that states and cities take action to curtail pollution from stormwater runoff. The EPA cites Best Available Technology (BAT) criteria for states and cities to use. *Fossil Filter™* meets that BAT criteria.

NEED FOR AN EFFECTIVE MAINTENANCE PROGRAM

Once installed, the *Fossil Filter™* becomes subject to the provisions of the EPA's Best Management Practices (BMP) dictates. According to the EPA, BMP includes the development of a plan to prevent pollution from stormwater runoff. A natural component of that plan is the establishment of an overall maintenance program. In the absence of an established maintenance program, KriStar Enterprises cannot guarantee the effectiveness of the *Fossil Filter™* .

An effective maintenance program, where *Fossil Filter™* is installed, includes the following key components:

1. **INSTALLATION RECORD**
   At the time of installation, both the installer and owner must complete and sign the *Fossil Filter™* Installation Record (see Example A). The white copy is to remain on file with the owner, the yellow copy must be faxed or mailed to KriStar Enterprises, and the pink copy is to be retained by the installer.

2. **MAINTENANCE RECORD**
   At the time of the installation, the installer and/or owner must complete the top portion of the *Fossil Filter™* Maintenance Record (see Example B). This record is to remain on file with the owner in the owners manual so that he may accurately document the maintenance provided.

   To ensure compliance with EPA mandates, it is the responsibility of the owner to establish, sustain, and record the performance of a regular maintenance program. Again, in the absence of an established maintenance program, KriStar Enterprises cannot guarantee the effectiveness of the *Fossil Filter™* .

3. REGULAR SWEEPING

The surface subject to runoff should be swept regularly during dry periods to remove contaminated dirt, silt, and loose debris.

4. REGULAR INSPECTIONS

The *Fossil Filter*™ filter cartridge should be visually inspected on a regular basis as follows:

a) For areas with a definite rainy season, filter cartridges should be inspected prior to and just after the rainy season.
b) For areas subject to year-round rainfall, filter cartridges should be inspected on a recurring basis, but no less than every six months.
c) For areas with winter snow and summer rain, filter cartridges should be inspected prior to and just after the snow season.

5. CONDUCT OF THE VISUAL INSPECTION

a) The inlet grate is removed and set aside.
b) The installed filter cartridge(s) must be lifted from the trough, one of the end caps removed, and the adsorbent inspected.

As you lift the filter cartridge from the trough and remove an end cap, look for any silt and/or debris resting just under the top screen on top of the adsorbent material. If the adsorbent granules are more than one-half coated with a black substance, the filter cartridge should be refilled with clean adsorbent material (for replacement, see step 8 below). The end cap is then replaced, the filter cartridge set back into the trough, and the inlet grate replaced.

6. REPLACEMENT OF THE INSTALLED ADSORBENT MATERIAL

* *Note: The person replacing the adsorbent material should move away from the inlet so as to avoid spilling the contaminated material into the drainage system.*

The filter cartridge end cap is removed and the contaminated material dumped from the cartridge into a disposal bag or bin. A sufficient amount of clean adsorbent material is then poured into the filter cartridge to a level within 1 1/2" of the top screen when the cartridge is horizontal. *Do not overfill.*

7. DISPOSAL OF THE USED ADSORBENT

Fossil Rock™ is designed to absorb petroleum-based pollutants. Because it has been proven to be a non-leaching product, the used adsorbent material may be taken to a local landfill. However, disposal regulations vary by area. Therefore, we recommend that *Fossil Filter*™ maintenance companies contact their local regulatory agency prior to disposal to ensure compliance with local and state environmental legislation.

8. REPLENISHMENT OF ADSORBENT MATERIAL SUPPLY

A sufficient amount of *Fossil Rock*™ adsorbent material should be kept on hand to replace the amount of installed adsorbent plus an additional amount to be used in case of oil spills. To reorder *Fossil Rock*™ adsorbent material, contact KriStar Enterprises at (800) 579-8819.

At this time, *Fossil Rock*™ adsorbent material is the only tested and approved adsorbent material for use in the *Fossil Filter*™ product. KriStar Enterprises cannot verify a similar level of effectiveness with the use of other adsorbents.

If you have any questions about the *Fossil Filter*™ product or the *Fossil Rock*™ adsorbent material, please call KriStar Enterprises at (800) 579-8819, or the *Fossil Filter*™ Representative in your area.

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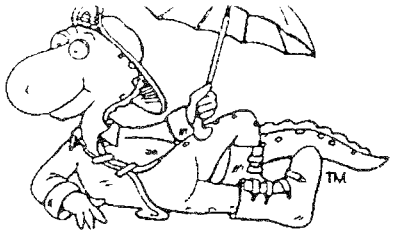
1/24/97



FOSSIL FILTER™
GENERAL SPECIFICATIONS
FOR STANDARD UNITS

Scope:

This specification describes a catch basin filtration system that incorporates EPA-approved adsorbents installed in a drainage inlet to collect petroleum-based contaminants while permitting the undisturbed passage of water.

Material Properties:

The trough and filter cartridge shall be manufactured from 16 gauge, galvanized sheet metal. The filter media shall be an adsorbent material that contains no hazardous ingredients as defined by the U.S. Environmental Protection Agency (EPA), U.S. Occupational Safety and Health Administration (OSHA), and the World Health Organization (WHO).

Installation:

Installation shall be performed by certified Fossil Filter™ installer. A Fossil Filter™ Installation Record, to be provided upon installation, shall be kept by the end user.

Maintenance and Disposal:

Maintenance services shall be provided by certified Fossil Filter™ maintenance provider. A Fossil Filter™ Maintenance Record, to be provided upon installation, shall be kept on site by the end user.

Disposal of filter media shall be in accordance with local regulatory agency specifications to ensure compliance with all local and state environmental legislation.

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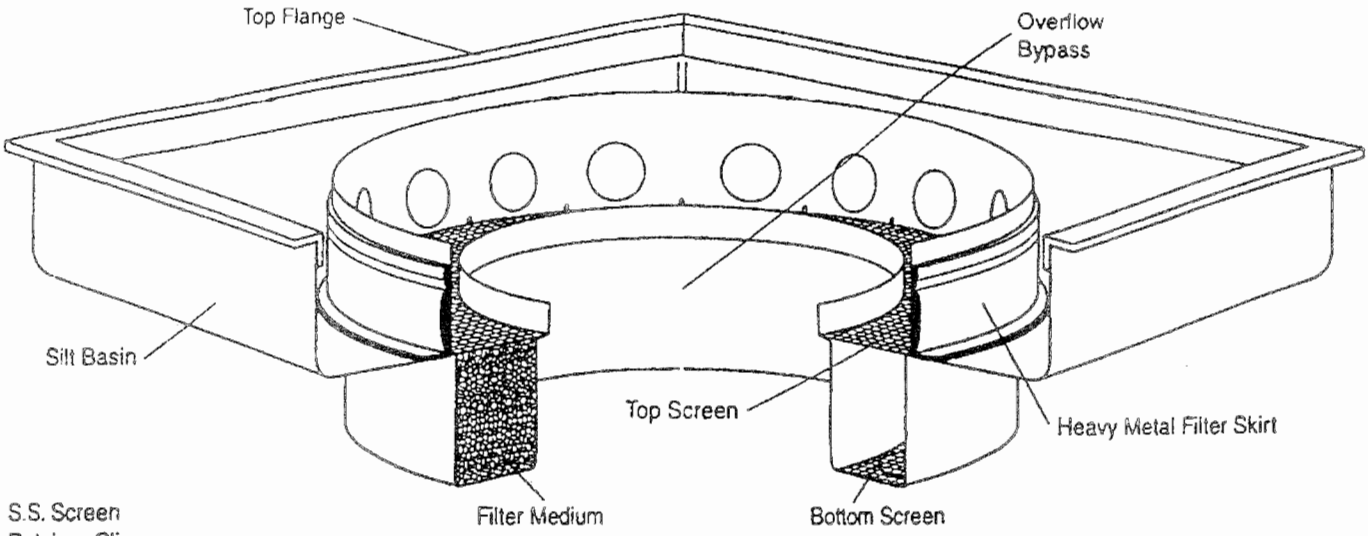

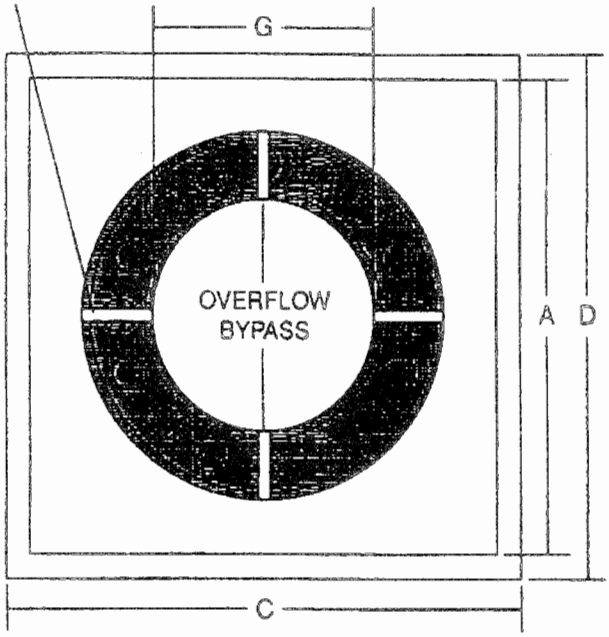

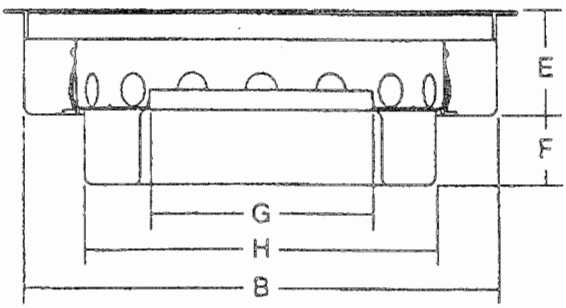

NOTES:

1. Filter body shall be of fiberglass manufactured to meet or exceed PS 15-69.
2. Top Flange shall be galvanized steel (16 gauge) cut or trimmed as required to fit below the grate of drainage inlet.
3. Top and bottom screens and screen retainer clips shall be stainless steel (Type 304).
4. Heavy metal filter skirt material shall be treated to retain heavy metals.
5. For manufacturer warranty purposes:
   a. Filter medium shall be ***Fossil Rock***.
   b. ***Fossil Filter™*** shall be installed by manufacturer-certified installer.
   c. Refer to Manufacturer's recommendations for maintenance program.

DIMENSION CHART

MODEL NO	A	B	C	D	E	F	G	H
SB-24	22"	22"	26"	26"	6"	4"	11"	20"
SB-30	29"	29"	32"	32"	6"	4"	13"	23"
SB-2436	22"	35"	26"	38"	6"	4"	11"	20"

MODEL SB-24: For 24"x24" I.D. Drop Inlet
MODEL SB-30: For 30"x30" I.D. Drop Inlet
MODEL SB-2436: For 24"x36" I.D. Drop Inlet

NOTE: Top Flanges that enable this product to be installed in larger and/or nonstandard drainage inlets are available.

FOSSIL FILTER™ WITH SILT BASIN

KriStar Enterprises, Inc., Santa Rosa, CA (800) 579-8819

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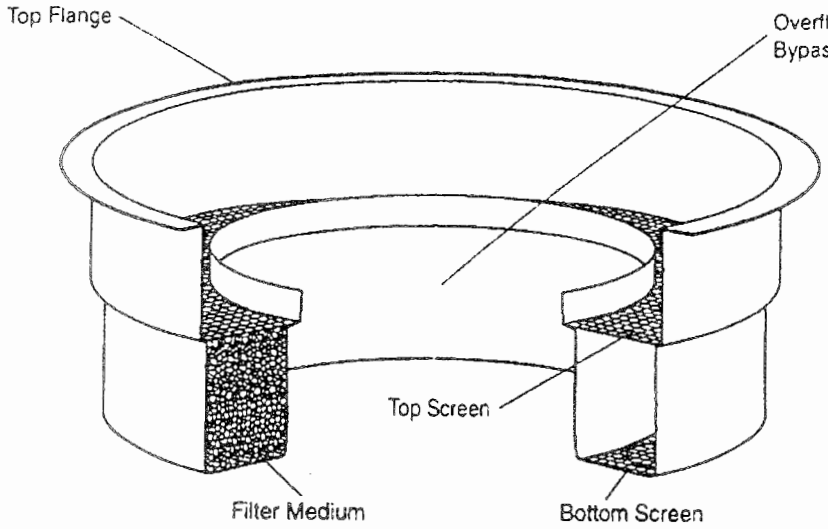

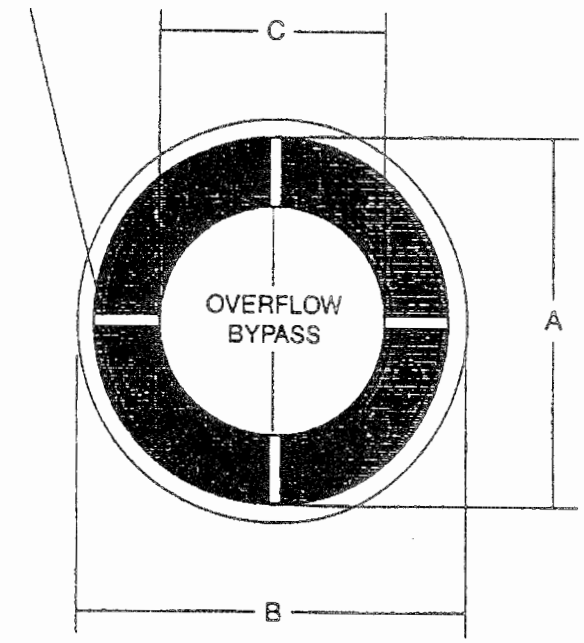

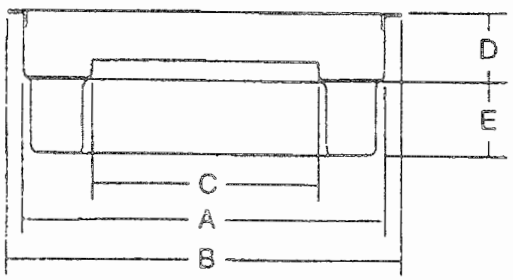

NOTES:

1. Filter body shall be of fiberglass manufactured to meet or exceed PS 15-69.
2. Top Flange shall be galvanized steel (16 gauge) cut or trimmed as required to fit below the grate of drainage inlet.
3. Top and bottom screens and screen retainer clips shall be stainless steel (Type 304).
4. For manufacturer warranty purposes:
   a. Filter medium shall be *Fossil Rock*.
   b. *Fossil Filter*™ shall be installed by manufacturer-certified installer.
   c. Refer to Manufacturer's recommendations for maintenance program.

DIMENSION CHART

MODEL NO	A	B	C	D	E
RF20	20"	23"	11"	6"	4"
RF24	23"	25"	13"	6"	4"

NOTE: Top Flanges that enable this product to be installed in larger and/or nonstandard drainage inlets are available.

FOSSIL FILTER™ ROUND

KriStar Enterprises, Inc., Santa Rosa, CA (800) 579-8819

PATENT PENDING

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T List of Manufacturers Contacts for Storm Water Treatment Devices Per Joanne McLaughlin

Return-Path: <mail@lava.net>
X-Sender: dashiell@pop.lava.net
Date: Tue, 27 Jan 1998 08:14:59 -1000
To: dashiell@lava.net
From: Joanne McLaughlin <joannemc@tec.nh.us> (by way of "Eugene P. Dashiell" <mail@lava.net>)
Subject: Responses to my inquiry

On Thursday, January 22, 1998 I wrote:

I am looking for objective, third-party data that compares the sediment and oil removal rates from stormwater runoff for conventional catch basins vs. the new technologies that are available (elg., Vortex).=20

A local environmental planner tells me that there are some local municipal engineers who are not convinced by manufacturers' data that the new systems are more effective than conventional systems (e.g., catch basins with sumps, or two-chamber catch basins where sediments drop out in the first and there is an oil sock to collect oils in the second chamber).

Does this kind of data exist and where? Also, what other convincing information is available other than that re-entrainment and resuspension of sediments will occur in conventional systems with each successive storm?

The following is a summary of responses. Thanks to all for your help.

Joanne McLaughlin
NH Coastal Program

From: Wayne Jenkins <wjenkins@dg100.mde.state.md.us>
Joanne,

Here in Maryland we are dealing with many of the same issues that you bring up here. One person who is fairly knowledgeable about these packaged BMPs is Stu Comstock who is an engineer in my dept, the Maryland Dept of the Env. Call him at 410-631-3578 and he may be able to help.

From: Michael Barrett <mbarett@mail.utexas.edu>

The City of Austin has collected data on convention catch basins with sumps and traps and found essentially no pollutant removal. For details call Roger Glick 512-499-2096. Don't know of any objective monitoring proprietary devices. =20

Michael Barrett, PhD, P.E. Phone 512-471-0935
Center for Research in Water Resources Fax 512-471-0072
PRC Building 119
The University of Texas at Austin
Austin, TX 78712

From: Eric Winkler <winkler@ecs.umass.edu>

The Massachusetts Strategic Environtechnology Partnership is currently developing verification reports for several technologies in the category you are interested in. I personally have performed two evaluations, (StormTreat and StormCeptor) and am in process on Vortechnics and HIL Downstream

Defender. You can get a hold of these reviews through the Massachusetts Executive Office of Environmental Affairs (Paul Richard 617-727-9800 Ext= 449).

Eric Winkler, Ph.D.
Strategic Environtechnology Partnership
University of Massachusetts at Amherst
413-545-2853

From: Andrew J. Reese <ajreese@oees.com

The city of Seattle did a study on catch basin inserts - contact them for= infor

Andy Reese=20
Ogden Environmental

>From Ed Molash <MOLASHE@wsdot.wa.gov>

This is premature, but WSDOT will monitor stormceptor and vortechs over the next 2 years to evaluate removal efficiencies for a variety of constituents, including TPH. We also have doubts about product vendor's data. We'll release our data after we analyze a stattisticdally significant number of samples. General info on WSDOT's experimental BMP and stormwater monitoring plan can be found within our NPDES stormwater management plan, which can be located and downloaded at:
http://www.wsdot.wa.gov/eesc/evvironmental/WSManuals.htm

Ed Molash
WSDOT - Water Quality Engineer
360-705-7507

From: Gordon England <gengland@mindspring.com>

We have been experimenting with various devices, booms, etc. for several years and have several conclusions. Booms or pads of oil absorbant material do grab hydrocarbons. If they stay wet in inlets a heavy bacteria grows on them reducing their effectiveness..In dry inlets they tend to get covered with dirt which also hurts them. We tried to send them to labs for analysis but they are also made of hydrocarbons and the labs could not tell us much. =20
More importantly, we concluded that for most land uses the oil loadings were very minimal and it was not cost effective to remove small amounts of hydrocarbons. When hydrocarbons reach the rivers they evaporate and oxidize fairly rapidly so these pollutants are very low on our priority list. Of course in industrial or commercial uses with automotive repairs or parking lots you will find concentrated loadings meriting BMP's.
Oil water separators will work but they cannot take large flows do to their separator plates. And they are expensive. The best product we have found are fiberglass inlet inserts that trap oils effectively. They are only a few hundred $ and drop into existing inlets. These are made by Suntree Isles in Cape Caneveral, Florida-407-639-0444. =20

Good luck
Gordon England
Brevard County

Stormwater Utility

From: Mark and Diane <dmdbmdb@carlsbadnm.com>
After completing a study of structural best management practices for a site which precluded the use of any land intensive solution, I found that only five out of nine of the BMP's evaluated had third party evaluation of pollutant removal efficiencies. Some are exhaustive and others are marginal. They are Bioretention, CSF=AB, Fossil Filter TM, StormCeptor=AB,= and
StormTreatTM. The contacts for the technologies evaluated in the report are listed below.

BaySaver TM =09
BaySaver, Inc.
1010 Deer Hollow Drive, Suite 111 Mark Hausner
Mt. Airy, MD 21771 (301) 829-6119

Bioretention =09
Biohabitats Incorporated
15 West Aylesbury Road J. Keith Bowers
Timonium, MD 21093 (301) 337-3659

CSF=AB =09
Storm water Management
2035 N.E. Columbia Blvd. Felon Wilson, P.E.
Portland, OR 97211 1-800-548-4667

Downstream Defender TM =09
H.I.L. Technologies
94 Hutchins Drive John Bolata
Portland, ME 04102 1-800-848-2706

Enviro-Drain=AB Filters=09
Enviro-Drain
13226 97th Avenue, NE, C208 Jim Hutter
Kirkland, WA 98034. 206-820-1953

Fossil Filter TM =09
KriStar Enterprises, Inc.
422 Larkfield Center, Suite 271 Doug Allard
Santa Rosa, CA 95403 1-800 579-8819

Stormceptor=AB =09
Stormceptor Corporation
600 Jefferson Plaza
Suite 304 Vincent Berg, P.E.
Rockville, MD 20852 1-800-762-4703

StormTreat Systems TM =09
StormTreat Systems, Inc.
90 Route 6A, Sextant hill Unit 1 Mark Nelson
Sandwich, MA 02563 (508) 833-1033

Vortechs TM =09
Vortechnics, Inc.
41 Evergreen Dr. Francis Tighe

Portland, ME 04103 (207) 878-3662

Regarding your search on conventional systems, caution should be exercised on the ability of these systems to retain pollutants during significant storm events. Many of the new technologies incorporate strategies to avoid resuspension. The contacts above may offer a starting point for research on conventional systems, but it is best to sample other sources as well. Try EPA's web site. I have found it useful on a variety of subjects.

Good luck on your search,

Mark Bremer, P.E.
Civil Engineer
National Park Service
Carlsbad, NM

Peace,

Mark

U Aquashield
Stormwater Filters
for Street Storm Drain Catch Basins
Manufacturers Literature

REMEDIAL SOLUTIONS, INC. Phone: (423) 870-8888 • Fax: (423) 870-1005 • Toll Free: (888) 344-9044
One Northgate Park • Suite 406 • Chattanooga, Tennessee 37415

February 13, 1998

Eugene P. Dashiell
Environmental Plans and Assessments
1314 South King Street
Suite 951
Honolulu, Hawaii 96814

Dear Mr. Dashiell:

Thank you for your inquiry about the AquaShield™ Filtration System. Enclosed is a Qualification Statement for the technology which provides detailed information about the three models that Remedial Solutions, Inc. (RemSol) offers to meet site specific needs.

The AquaShield™ technology complies with the seven guiding principles for an Environmentally Preferable Product according to Executive Order 12873, Section 503 and Section 6002 of the Resource Conservation and Recovery Act for buying recycled products. The AquaShield™ is made from recycled materials and uses a filter media composed of 100% recovered materials that would otherwise be placed in a landfill.

RemSol is pleased to offer the AquaShield™ technology as an affordable means of pollution prevention for stormwater and wastewater discharges. The performance is backed by our limited warranty that is included in our service agreement. It is accepted as a Best Management Practice (BMP) by the city of Chattanooga which is recognized by the Center of Excellence, Environmental Best Manufacturing Practices Program as a leader in environmental compliance for nonpoint source pollution prevention and stormwater management.

I will contact you soon to answer any additional questions you may have about the AquaShield™. In the meantime, I have included order forms for your information and use. The surface drain model form includes subsurface measurements that are important considerations for properly sizing your unit. The convergence flow model form also identifies critical information RemSol needs to meet your site specific needs. The mobile unit is sized and priced according to the anticipated maximum flow requirements on a case by case basis.

Again, thank you for your interest in the AquaShield™ Filtration system. I look forward to speaking with you soon.

Sincerely,

J. Kelly Williamson

J. Kelly Williamson
President

AquaShield™ Filtration System Technology

QUALIFICATION STATEMENT

The AquaShield™ Filtration System technology is a highly effective means of pollution prevention for Nonpoint Source Pollution (NSP). The systems protect the waters of the Community and State by removing pollutants from stormwater runoff and wastewater discharges. Contaminated water enters the system and the contaminants of concern are extracted in a unique multi-stage filter process using a patented media made of 100% recovered materials. The AquaShield™ Filtration Systems have proven to be up to 100% effective in the removal of contaminants through independent testing by a certified laboratory.

Remedial Solutions, Inc. (RemSol) developed, manufactures, sells and services the AquaShield™ Filtration Systems. The purpose of the systems is to provide the users an economical and effective means of pollution prevention for compliance with NSP, stormwater and wastewater discharge requirements. AquaShield™ Filtration System technology is approved as a "Best Management Practice" (BMP) when the systems are properly maintained.

This Statement provides information demonstrating that the AquaShield™ complies with the seven guiding principles for an Environmentally Preferable Product according to Executive Order 12873, Section 503 and section 6002 of the Resource Conservation and Recovery Act.

A patent is pending on the AquaShield™ technology which offers three models to meet variable site-specific conditions. The first model, as shown on our company brochure, is adaptable to most any size or shape of existing or new surface drainage opening and is simple to install. This model is excellent for compliance with stormwater and wastewater discharge requirements and is easy to service. The second model is designed for heavy flow conditions at the convergence of several surface inlets. This model is also simple to maintain and requires some light construction for installation. The third model is a mobile treatment unit that can filter large volumes of water from excavation sites, secondary containment dikes, emergency response conditions and remote areas.

General Operation Description

The process by which the AquaShield™ Filtration Systems operate is simple. There are no moving parts in any of the three models. The units are typically constructed of stainless steel to withstand harsh conditions and provide long term service. A routine maintenance program is established for each unit based on the volume or load of the contaminants of concern, the frequency of releases of contaminants at the facility or location, and the nature of the surface being drained or the area where the water is being removed.

Each of the three models operate basically in the same manner. A simplified process flow diagram is included with this document as Figure 1. The flow of the incoming wastewater begins the process of the filtration. The wastewater flows by gravity (or can be pumped into the mobile unit) into the primary sediment removal stage to capture and extract unwanted debris and suspended solids. The wastewater then moves through a series of filters composed of a patented media made of 100% reclaimed materials. The filter media is hydrophobic and captures the contaminants of concern while allowing the water to continue to pass through the filtration process. The filter media is licensed as an oil spill cleanup agent (OSCA) by the California State Water Resources Control Board. Typically, there are at least two of these filter stages in the surface drainage opening model (SD-100) while the heavy duty convergence flow model (CF-200) has several filter stages. A polishing filter stage is normally used prior to discharge of the treated water. Sampling ports are included to ensure regulatory compliance and that the efficiency of the system is maintained.

Typically, the highest concentrations of contaminants are present in the initial flow of stormwater runoff and wastewater discharges. For example, during a qualified stormwater sampling event, samples of the discharge water are obtained during the first hour of the rainfall event. Special emphasis is given to the "first flush" of runoff water in the sampling procedures because of the increased amount of pollutants at that time. As the rainfall event continues, the concentrations of contaminants

often decrease for nonpoint sources.

The filter media does not allow the captured contaminants to be released once absorbed into the material. This is a unique quality of the AquaShield™ Filtration Systems which allows superior performance in extreme conditions. The technology involves the treatment by filtration and recycling of water and aqueous wastes including but not limited to the following:

> wastewater, stormwater, free-phased organics, petroleum spills, nonpoint source discharge water, vehicle washdown waste water, wastewater from secondary containment dikes, excavation and construction sites, underground storage tank removals, emergency response conditions, remote wash down areas, and captured water at stream crossings for timber cutting sites.

Descriptions of the AquaShield™ for surface drainage openings and for heavy duty convergence flow conditions are provided below. These systems are compatible as fixed treatment technology of the wastestreams identified above. A description of the mobile treatment model is included in a separate document.

AquaShield™ Filtration System: SD-100

The AquaShield™ for surface drain catch basins (SD-100) is made of stainless steel because of its superior ability to withstand harsh conditions that are encountered where various chemicals could degrade other possible construction materials. Our system is compatible with most any size or shape catch basin to allow ease of use in variable site conditions. The SD-100 can be installed in surface openings of stormwater dry wells or leaching pools designed as detention basins. An adaptor directs the water entering the catch basin into the filtration system without restricting the normal surface flow. The filter stages can be added or removed from the system depending on the specific needs of the site and the size of the basin. A sampling tray is included with most systems for compliance purposes. A standard stormwater or surface water sampling device can be used to obtain representative samples after

filtration has occurred.

The cost for a typical SD-100 system and a one year supply of filter media is shown below. This example is designed for maximum flow through a normal 2 ft. x 2 ft. storm drain and can remove up to 16 gallons of petroleum hydrocarbons before changing filters.

CONSTRUCTION	FILTRATION	PRICE	QUANTITY	AMOUNT
Stainless steel (#304)	3-stage	$1,550.00	1	$1,550.00
MAINTENANCE	FREQUENCY			
#1 filter	Bi-Monthly	$45.00/ea	6	$270.00
#2 filter	Quarterly	$45.00/ea	4	$180.00
#3 (polishing) filter	Semi-annual	$20.00/ea	2	$40.00
Sample Tray	N/A	N/C	1	N/C

The filter replacement schedule is highly dependent on factors such as the volume of the contaminants of concern, the frequency of spills at a facility, and the physical nature of the surface being drained. This typical system assumes that the potential for contamination is low to moderate as might be encountered in a frequently used parking lot.

To compare to past practices, the AquaShield™ system priced above costs 81% less than a system that requires higher installation costs and maintenance. For example, a typical 1,000 gallon oil water separator equipped with an electronic alarm system will cost more than $8,224.00 plus the installation, plumbing and electrical costs. Also, this size oil water separator will generally accommodate a 100 gpm flow rate and requires routine removal of the accumulated oil and sediments by a waste oil company at an additional charge. Furthermore, an oil water separator can release the accumulated contaminants as a result of unexpected large volumes of water flowing through the system if proper maintenance has not occurred. The AquaShield™ priced above is designed to manage approximately 280 gpm through an existing catch basin and has proven

that it does not release the extracted contaminants even in severe circumstances when the filters need replacing.

AquaShield™ Filtration System: CF-200

The heavy duty convergence flow model (CF-200) operates in a manner as provided in the general description above. The AquaShield™ CF-200 is capable of accommodating the flow from several surface drains connected to a single discharge point. The CF-200 is installed down stream of the convergence of the surface drains and connects to the existing drain piping. Installation is as simple as for a normal pre-cast concrete catch basin structure with a manway opening at the surface.

The AquaShield™ CF-200 provides an increased filtering capacity during normal flow for greater contaminant removal. Multiple filter stages and channels control the flow pattern of water to maximize the treatment. The CF-200 is equipped with overflow areas to allow continued water travel and not cause flooding or backup on the surface during periods of prolonged and increased drainage. The filter stages and sediment retention are easily serviced from the ground level.

The average cost for a typical 6 ft. x 6 ft. unit is $8,500.00 plus installation and maintenance. Because of the increased filtering capacity and large sediment retention, the normal maintenance is approximately $980.00 per year where the pollution load is low to moderate. This typical AquaShield™ CF-200 model can remove more than 60 gallons of petroleum hydrocarbons and retain approximately .40yd^3 of sediment.

ANALYTICAL DATA AND OTHER INFORMATION

An independent test of the AquaShield™ system has been conducted by a certified laboratory to demonstrate the effectiveness of the system under intense field conditions. The reports from Analytical Industrial Research Laboratories, Inc. in Chattanooga, Tennessee are included with this document. Three sets of data have been produced during the course of the test. The test location is a convenience store and truck stop facility along Interstate 24 approaching Chattanooga. The AquaShield™ is in a typical catch basin near the diesel fueling island which collects stormwater runoff and the wash down water from the surrounding 13,000 ft^2 area. Details of the testing procedures and site specific information are included in the laboratory's performance test report.

The first set of laboratory data, sample date September 4, 1997, shows the analytical results for normal stormwater discharge parameters in milligrams per liter for the "incoming water" and the "outgoing water" from the AquaShield™. The first set of data from September 4, 1997, shows a significant reductions in the levels of TSS (75.5%), Oil & Grease (98.1%), Barium (88.6%), Chromium (95.+%), and Lead (85.2%). There is also a notable reduction in BOD (85.1%) and COD (21.1%) levels with only minor changes in pH, Air and Water temperature. The levels of Ammonia (as N) and TKN were reduced 76.6% and 81.1%, respectively.

The second sampling event on October 3, 1997 followed approximately nine inches of rainfall in September and two surface spills which totalled more than 20 gallons of diesel fuel (in addition to the normal activities at a truck stop). The filters were not replaced before the second test samples were taken. As in the first test, there are significant reductions in the levels of Oil & Grease (97.9%) and Chromium (95+%). There is also notable reductions in BOD (57.5%), COD (62.3%), Ammonia (77.4%), TKN (80.9%), Barium (64.4%) and TSS (16.2%). Air temperature, Water temperature and pH remained constant during the testing event. It is clear that the removal of the pollutants continues even in severe circumstances when the filters need replacing.

The third set of test data on October 13, 1997 shows lower concentrations of contaminants for the incoming water and continued removal of pollution after the AquaShield™ Filtration System. The unit was serviced and new filter media installed before this sampling event. There was no rainfall recorded between October 3 and 13, 1997. As before, there are reductions in the levels of Oil & Grease (49.2%) and TSS (76.0%). There is also significant reductions in BOD (56.8%), COD (63.5%), Ammonia (75.0%), TKN (80.0%), Barium (55.0%) and Lead (44.3%). Air temperature, Water temperature and pH remained relatively constant during the testing event. There continues to be a reduction of all incoming contaminants in conditions when pollution loads are low to moderate.

Results of a toxicity characteristic leaching procedure (TCLP) analysis are also provided in the laboratory section. The results indicate non-detectable concentrations of metals and volatile organic compounds (VOCs) from a saturated (used) filter. This tCLP information will be useful in selecting the treatment/disposal alternatives.

V Stormceptor Stormwater Filters for Street Storm Drain Catch Basins Manufacturers Literature

Fall '96 Volume 1, #2

FRIENDS OF FOUR MILE RUN

Thinking Globally and Acting Locally "Spotlight on Alexandria" Issue

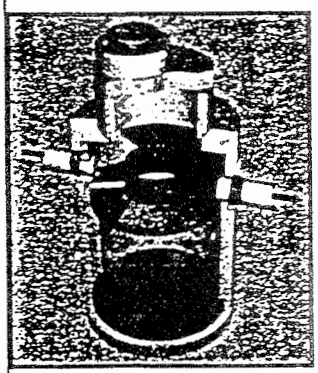
Urban Pollution Vanquished in new Alexandria Development

Three New Technologies Debut in Four Mile Run

by Don Waye

A new generation of devices for cleaning up urban runoff is making its debut in the Four Mile Run watershed. These devices are the latest in an evolving technology known as "Best Management Practices," or BMPs, developed to clean up non-point source pollution. The Stormceptor®, a sand filter, and two bio-retention stands are the three new types of BMPs being installed at the "Highpointe at Stonegate" development in Alexandria. The BMP devices will clean up many of the pollutants likely to wash off the 147-townhouse development and parking lot before they have a chance to pollute Four Mile Run.

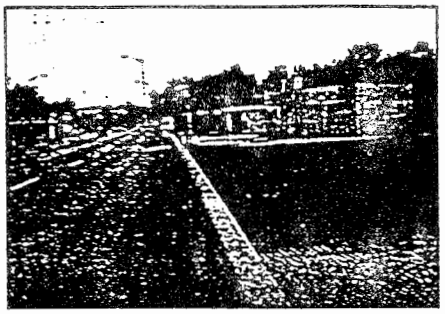
Non-point source pollution is the insidious and pervasive subset of pollution sent to our waterways that is not attributable to industrial discharge pipes or municipal sewage outfalls. It typically works like this: during dry days, pollutants associated with human activities (including pets dependent on human care!) accumulate on land surfaces. During rainy days, these pollutants get washed off down nearby storm drains and into our local streams, polluting not only Four Mile Run, but also the Potomac River and the Chesapeake Bay. Walt Kelly's "Pogo" best summed up the problem of non-point source (NPS) pollution inadvertently whenever he proclaimed. "We have met the enemy and he is us!"



Stormceptors

Hailing from Canada (and now U.S. made, as well), these small devices are ideal for installing in new or existing storm drains immediately downslope of loading docks, gas stations, and other heavily industrialized sites. The Stormceptor is the patented trade name for a next-generation oil-grit separator.

- Continued on Page 2. See *BMPs*.



Is revitalization finally coming to blighted Arlandria?

Arlandria Blight May Give Way to Renewal

FRIENDS to Have Input

Friends of Four Mile Run has been invited to participate in an ad hoc committee to develop a vision for a re-vitalized Alexandria starting this October. Friends of Four Mile Run member Lee Regan, who lives in Alexandria, will be the "Friends" rep for this group. Lee works for the U.S. Geological Survey and has had a long-term interest in protecting and restoring Four Mile Run. In 1992 and 1993, Lee gave up one Saturday morning a month for a year to be a volunteer water quality stream monitor for NVPDC Four Mile Run program. Look for a status report or two from Lee in upcoming newsletters. ◆

INSIDE

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6	Lawn Care & The Case Against Turf
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BMPs, from Page 1 ·

Unlike the oil-grit separators of the 1980s which were widely used in suburban Maryland and D.C., these seem to avoid the related problems of pollutant re-suspension and frequent, expensive maintenance.

Stormceptors debuted in the U.S. last year (most notably in Maryland), and several have been approved on an experimental basis in Northern Vir-ginia. At least two will be installed in Alexandria by year-end 1996, including the one at Highpointe. Their performance for removing pollutants will be monitored to help local governments decide whether or not Stormceptors should be widely used in Northern Virginia.

Anecdotal reports from early installations are very promising. Recently, there was a 250 gallon oil spill from a tanker truck at the Peace Bridge border crossing between New York and Ontario. When an emergency clean-up crew arrived on the scene, they feared they were too late to catch the spill before it fouled local waterways. The response crew ran fire hoses to flush out whatever remained of the spilled fuel from the storm drains for diversion into a make-shift containment area, but no fuel was found. The crew searched downstream for evidence of the spill, but still failed to find even a trace. Eventually, a crew member popped open a manhole, and discovered a Stormceptor inside. The Stormceptor had intercepted the entire spill and stored it safely off-line in its containment tank, despite that section of storm drain having been flushed with fire hoses.

The Stormceptor had intercepted the entire spill and stored it safely off-line...

As a result of this incident all new Stormceptors come with specially marked manhole covers for easy identification.

The company that sells Stormceptors, Stormceptor Corporation, believes that within a few years, insurance premiums for gas stations and certain other industries at high risk for generating hazardous spills will drop. They note precedents in other devices effective at reducing liability risk, and believe that it's just a matter of time until premiums are lowered, as the device gains wider acceptance. If this happens, Stormceptors would likely become the first BMP type to not only pay for itself, but actually save the site owner money over the long term.

Bio-retention

Created in Prince George's County, Maryland, this new type of BMP is an update of the infiltration trench, an early BMP type that has been around since the 1970s.

The idea behind both the infiltration trench and the bio-retention stand is to divert stormwater

- Continued on Page 3. See *BMPs*.

How Three "Next Generation" BMPs Stack Up: Cost, Application, & Performance:

	Stormceptor	Bio-retention	Sand Filter
Installation Cost	Low to moderate	Low to high (depends on soil type)	High
Maintenance Cost	Low	Usually low	High
Applicability	Anywhere urban or suburban	Limited by soils	urban sites with rolling terrain
Phosphorus Removal Efficiency	Good 35 - 50%	Very good 45 - 70%	Good 35 - 70%
Nitrogen Removal	Poor	Fair	Good, only if designed for this goal
Oil & Grease Removal	Excellent (~99%)	Not recommended	Some (varies)
Sediment Removal	Very good	Very good	Not recommended
Heat Pollution Removal	None	Very good	Good

BMPs, from Page 2

runoff to an area of groundwater recharge. The infiltration trench encourages recharge (diversion to groundwater) by providing a properly sized and carefully designed gravel pit at the downslope end of a developed site.

During the 1980s, research showed that these facilities required less maintenance and provided improved pollutant removal efficiencies when combined with 10 to 20 foot vegetated buffer strips. The bio-retention stand goes this idea one better — placing the vegetated buffer strip on top of the infiltration trench. In fact, plantings are carefully selected to nurture the ideal micro-environment for maximizing pollutant removal from stormwater runoff.

One criticism of the infiltration trench is that few nutrients are truly removed from the environment. Critics argued that most pollutants were merely diverted from the surface water to the groundwater. With bio-retention, nutrient uptake from the plantings effectively removes much of the phosphorus and even some nitrogen from the system. And, nearly all of the heat pollution that typifies parking lot runoff is removed.

Bio-retention is cheap, effective, and versatile. Its only serious drawback is its unsuitability for areas underlain with slow-draining, clay-dominant soils. Because bio-retention is only appropriate for sandy and loamy soils, it is a poor choice for most of the Four Mile Run watershed. Continued research is needed to see if soil re-conditioning can reasonably extend the utility of this promising new BMP.

Sand Filters

First used in Austin, Texas, then modified for use in Delaware and Washington, DC, sand filter BMPs are now becoming commonplace in Alexandria, where several varieties exist.

The design most commonly employed in Washington, DC is a compartmentalized underground vault. Storm runoff, usually from parking lots enters a baffled chamber designed to capture trash, heavy sediments, and floating pollutants, including some oil and grease. Water velocity and energy is also slowed here, allowing for controlled flow to enter into the second chamber. This partition contains a carefully designed sand filter, often with separate layers of aggregate, sand, filter fabric, and sometimes peat. A perforated underdrain (pipe) allows the cleaned water to leave the system.

Sand filters are promising technology that can deliver impressive pollutant removal rates. On the down side, they are expensive to build and maintain, and require a minimum of three feet of head (vertical distance between the inlet and the outlet); additionally, some may clog prematurely. ◆

Yucky Stuff We Found in the Stream

by Don Waye

On June 8, a team from FRIENDS participated in the annual clean-up of Four Mile Run sponsored by Arlington County Parks. Here's what we removed from the stream:

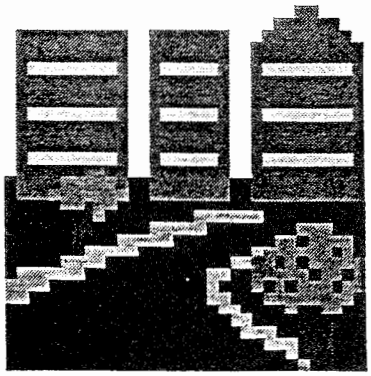
- a car battery
- a transmission
- a tailpipe
- several car tires
- hubcaps
- a roof gutter
- a bike frame
- a big steel plate (the kind that temporarily covers highway repairs
- numerous plastic grocery bags
- countless fast-food cups, wrappers, and containers
- lotsa other stuff that doesn't belong in streams. ◆

Enter our Logo Contest!

Submit your entry for the Friends of Four Mile Run logo and win a free three-year membership ($75.00 value). Three runners-up will receive one-year memberships. All entries will become the property of Friends of Four Mile Run. Deadline: December 31, 1996.

Submissions should be sent to:

FRIENDS OF FOUR MILE RUN
9918 Wood Wren Ct.
Fairfax, VA 22032-4018



WHY YOU SHOULD BE CHOOSING **STORM*CEPTOR*** AS YOUR URBAN WATER QUALITY DEVICE

Design Flexibility - Storm*ceptor* can be used in situations where no other device will work. Examples are very shallow installations (2.0 surface to invert) and very deep installations (30 feet). No loss in storage capacity or treatment rate when larger storm drains are used, unlike other local separators.

Structural Integrity - Storm*ceptor* is designed to withstand H-20 loading for shallow and deep installations. Unlike other local separators that use thin wall design, which limits use and requires careful and precise backfilling, the Storm*ceptor* is designed for rugged installation abuse.

Cost/Ease of Maintenance - Most separators require maintenance 3 to 6 times a year and physical entry into confined space is required. Storm*ceptor* generally will require maintenance only once per year and confined space entry is not required. Cost of maintenance is about a 1/3 to an 1/8 of other separator devices.

Compatibility with Existing & New Storm Drains - Storm*ceptor* can be used on existing torm drains and new storm drain lines. Storm*ceptor* nearly eliminates the need to impact existing infrastructure features.

Time/ Ease of Installation per Acre Treated - Storm*ceptor* can be installed in a hour and operational in two or three hours.

Oil Removal Performance, Long Term - Storm*ceptor* has documented test results to demonstrate its reliability to remove high percentages (+95%) of free oil and grease. No need to replace expensive absorbent pillows as required in other separators.

TSS Removal Performance, Long Term - Storm*ceptor* has documented test results to demonstrate its reliability to remove high percentages (80%) of sediment and solids (TSS).

Guarantee - Storm*ceptor* is backed by one of the largest concrete company's (CSR) in the world. Our local competitor publishes a "Disclaimer" statement, which says they provide, "**no *warranties, expressed or implied, for merchantability of fitness for any particular purpose or application.***"

Cost - Storm*ceptor* is the least costly to plan, design, secure approvals, construct, operate and maintain and the most reliable urban water quality device available.

Storm*ceptor* - THE SOLUTION TO URBAN POLLUTION
Your Best Chose For Urban Water Quality Control

W Timari
Pavement Grease & Oil
Waterless Cleaner
Honolulu, David Buck
Distributor/Manufacturers Literature

TIMARI
Trading Company Ltd.

January 2, 1997

Eugene P. Dashiell, AICP
Project Coordinator
Steering Committee Chairman
1314 South King St., Suite 951
Honolulu, HI 96814

Dear Eugene,

First of all, I would like to thank you for supplying us with a copy of your Management & Implementation Plan for the Ala Wai Canal Watershed Water Quality Improvement Project. It seems to be a very comprehensive compilation of the problems that exist regarding the canal.

It was a pleasure speaking on the phone with you and I apologize that it took me awhile to get this information off, but I have honestly been somewhat sidetracked during the Holiday Season (I'm sure you understand). However, in this packet, I have enclosed some information on our NEWFACE & KLEEN GREEN products. In addition, I have enclosed some references and testimonials of some of the places that have either bought our products or that we have cleaned. My colleague Loch Eggers passed on the same information to Clyde Morita.

Hopefully, we can work with one another to make 1998 a monumental year and reverse/clean up some of the problems that plague the Ala Wai Canal Watershed area. If you have any questions, feel free to call me at 523-0008.

Sincerely,

David Buck

Pier 23 / P.O. Box 1358 / Honolulu, Hawaii 96807 / Telephone: 808-523-0008 / FAX: 808-534-0216

NEWFACE

Spills and Liquid Waste Conversion

Grease and Oil - Chemical - Water - Paint - Ink Pigment -
Vomit - Blood - Urine

NEWFACE ABSORBENT is an inert, non-toxic, natural, non-flammabl rock, and is produced as the end product of mining and processing. It ha the unique capacity to absorb 85% - 90% of its volume in liquids. Thi high ratio of absorption ability to weight gives NEWFACE ABSORBEN a superior advantage over products that weigh more and absorb less. (absorbs approximately 4 times more than kitty litter clay based products)

NEWFACE ABSORBENT meets or exceeds all state and federa environmental standards to allow industry to comply with Proposition 65 with legally required disposal of hazardous spills and clean up NEWFACE ABSORBENT if used as directed in toxic clean up will avoi fines, penalties and prosecution as environmental protection is stepped up

NEWFACE ABSORBENT is reusable in many applications. It is able t capture liquids of any density, such as water, chemicals, grease, or pain In its powder form it can be swept up along with existing solids, i.e. broken glass, food solids, etc.

NEWFACE ABSORBENT uses the least amount of product to absor spills. It eliminates slippery substances from work areas, and eliminate the need for solvents because it leaves the spill site totally dry. It als eliminates the problem of washing grease and oil down storm drains o sumps because it solidifies the waste for normal disposal.

ECONOMICAL, EFFECTIVE,
ESSENTIAL FOR EPA/OSHA
COMPLIANCE

Non-Toxic
Non-Flammable
Non-Reactive

TIMARI TRADING COMPANY
PIER 23/P.O. BOX 1358
HONOLULU, HI 96807
(808) 523-0008

TAKE THE STAIN OUT WITH NEWFACE

NEW

NEW

21ST CENTURY WAY TO KEEP YOUR CONCRETE LOOKING LIKE NEW!

NEWFACE when used on concrete and asphalt surfaces will extract the oil leaked by vehicles and give your concrete a brand new appearance by leaving a protective coating that looks like new concrete and that will keep new oil deposits from penetrating into your concrete.

NEWFACE removes fresh and built-up, dried out, oil stains on asphalt and concrete in a matter of seconds leaving a clean, non-tracking surface behind.

NEWFACE is made of 100% inert materials, contains no chemicals is safe for your employees, works on any type of liquid spill and is non-flammable.

NEWFACE has a patented process in its manufacturing making it the only product of its kind in the world.

Please Call TIMARI TRADING COMPANY. at (800) 523-0008 to arrange for a representative to give you a demonstration that will enlighten your thinking on how to clean concrete and asphalt surfaces. Step into the 21st century with a new revolutionary product.

MATERIAL SAFETY DATA SHEET
No.: 1 Rev. 1
Date Prepared:3/1/94

I. PRODUCT IDENTIFICATION
OSHA APPROVED FLOOR SWEEP

Trade Name(s): NEWFACE ABSORBENT

Generic Name: NEW FACE, Lava Rock CAS #: None
Chemical Name: Amorphous siliceous mineral silicate Formula: Silicates of variable composition

Manufacturer: NEW FACE Inc.
2026 N. Chico Avenue # B
So. El Monte, CA. 91733 Telephone: (818) 401-3770

Supplier: Same as above

II. PRODUCT INGREDIENTS

INGREDIENT NAME	CAS #	%	PERMISSIBLE EXPOSURE LIMIT
Expanded Lava Rock	None		5mg/m$_3$, TWA
	14808-60-7	100	Respirable Dust re: OSHA PEL

Crystalline Silica Quartz content in expanded NEWFACE dust (<45 microns) is below XRD detection limit of 0.0%
Cristobalite - ND 14464-46-1

PEL CALCULATION BASED ON LESS THAN .1% CRYSTALLINE SILICA

III. PHYSICAL DATA

Appearance and Odor: White aggregate or powder, odorless
Boiling Point: N/A Evaporation Rate: N/A
Vapor Pressure: N/A Specific Gravity (water = 1): 2.3
Water Solubility (%): Slight Melting Point: N/A
Vapor Density (Air = 1): N/A % Volatility by Volume: N/A

IV. FIRE AND EXPLOSION DATA

Flash Point (Method): Nonflammable NFPA Flammable/Combustible Liquid Classification: N/A
Flammable Limits: N/A Auto-Ignition Temperature: N/A
Extinguishing Media: N/A Special Fire-Fighting Procedures: None
Unusual Fire or Explosion Hazards: None

V. HEALTH HAZARDS A. Summary / Risks

SUMMARY: This NEW FACE product contains a small quantity of crystalline silica quartz (Less than 0.1% and in the product dust [<45 microns], the content is below XRD detection limit of 0.07%. See Section II). OSHA considers NEWFACE to be a nuisance dust and concludes NEWFACE is nontoxic.

NEWFACE has not been listed as a carcinogen by the National Toxicology Program or OSHA.

Medical Conditions Which May Be Aggravated: Preexisting upper respiratory and lung disease (such as bronchitis, emphysema, asthma or others).

Target Organ(s): Lungs Primary Entry Route(s): Inhalation

Acute Health Effect: Transitory upper respiratory irritant.

Chronic Health Effects: Inhalation of high levels of any nuisance dust over long periods of time may overload lung clearance mechanism and make lungs more vulnerable to respiratory disease and affect lung capacity.

V. HEALTH HAZARDS B. Signs/Symptoms of Overexposure

Inhalation: Coughing, irritation of nose and throat; congestion may occur upon overexposure.
Skin Contact: N/A
Skin Absorption: N/A
Ingestion: Not Hazardous. Generally regarded safe by the FDA.
Eyes: Temporary irritation and/or inflammation.

V. HEALTH HAZARDS C. First Aid/ Emergency Procedures

Inhalation: Remove from dusty area; drink water to clear throat; blow nose to evacuate dust.
Skin Contact: N/A
Skin Absorption: N/A
Ingestion: N/A
Eyes: Do not rub eyes. Flush eyes with copious amounts of water to remove any dust particles. Consult a physician if irritation persists.

VI. REACTIVITY DATA

Stability: Material is stable. Hazardous polymerization will not occur.
Chemical Incompatibilities: Hydrofluoric acid
Conditions to Avoid: None in designed use. Avoid contact with hydrofluoric acid.
Hazardous Decomposition Products: Reacts with hydrofluoric acid to form toxic silicon tetrafluoride gas.

VII. SPILL OR LEAK PROCEDURES

Prodedures for Spill/Leak: Vacuum, clean, or sweep.
Waste Management: Not considered as hazardous waste by RCRA (40 CFR Part 261). Place waste and spillage in closed containers. Dispose in approved landfill. RQ-N/A.

VIII. SPECIAL PROTECTION INFORMATION

Goggles: "Normally not required." May use safety eyewear to protect from dusts.
Gloves: "Normally not required." May use gloves to protect overly sensitive skin.
Respirator: Is not necessary. Preexisting upper respiratory conditions may use dust mask to protect lungs from dust inhalation
Special Consideration for Repair/maintenance of Contaminated Equipment: Insure proper respiratory protection.

IX. SPECIAL PRECAUTIONS

Storage Segregation Hazardous Classes: N/A

*** ALWAYS SEGREGATE MATERIALS BY MAJOR HAZARD CLASS ***

Special Handling/Storage: Store in a dry place. Repair all broken bags immediately. Avoid creating dust. Maintain good housekeeping practice.

Other: Comply with all Federal, State and Local regulations.

Submitted By Patrick J. Murphy Title: President

As of the date of preparation of this document, the foregoing information is believed to be accurate and is provided in good faith to comply with applicable Federal and State law(s). However, no warranty or representation with respect to such information is intended or given.

Material Safety Data Sheet

Prepared: 8/ 8/92
STEWART HOLYK

Chemtrec ---------- 1-800-535-5053
UCI Poison Control - (714) 634-5988

Section I General Information

duct

Range: 0=Minimal 4=Severe

606 KLEEN GREEN

HEALTH 1 | FIRE 0 | REACT 0

Chemical Family
ALAKLI CLEANER/DEGREASER

DOT Classification
CLEANING COMPOUND,NOI,LIQUID

facturer
LD CHEMICAL
N. CHICO AVE.
EL MONTE, CA 91733
3) 442-0079

Special: PLEASE WEAR PROTECTIVE GEAR WHEN HANDLING ANY CHEMICAL

Section II Hazardous Ingredients

nical	CAS Number	Percent By Volume	Exposure Limits In Air ACGIH(TLV)	OSHA(PEL)
ol Monobutyl Ether	111-76-2	7.0 %	25 ppm	25 ppm

Section III Health Hazard Data

Effects Of Overexposure

Skin: Contact of this product upon the skin can cause slight irritation. There is also possibility of defatting of the skin due to the removal of the skins natural oils.

Eyes: Contact of this product upon the eyes can cause slight irritation of the eyes and eyelids.

lation: Fumes from this product are generally considered non-toxic, But can cause slight irritation of the nose, nasal passages, and lungs.

gestion: When concentrated solutions of this product are swallowed, It can cause slight irritation to the mouth, esophagus, and stomach.

First Aid Procedures

Skin: Flush exposed area with lukewarm water.

Eyes: Flush eyes with cool water for 15 minutes. Consult physician if irritation persists

lation: Fumes from this product are generally considered harmless.

gestion: Do not induce vomiting. Have patient drink large amounts of milk or water and consult physician immediately.

Carcinogens

FED/OSHA: NTP: IARC: CAL/OSHA:

Section IV Spill, Leak, and Disposal Procedures

Spill Control

l Spill: Flush area with water to an industrial sewer line.

ge Spill: Contain spill with dikes of absorbant materials such as clay, sand, or vermiculate. This material is not considered Hazardous and may be disposed of as non-hazardous refuse.

Waste Disposal

All hazardous materials must be solidified and disposed of in an EPA approved class one facility. When disposing of chemicals, contact local, state, and federal environmental agencies to fully understand the necessary regulations governing the disposal of chemical wastes.

Section V Fire and Explosion Hazards

h Point: 0 Method: Average

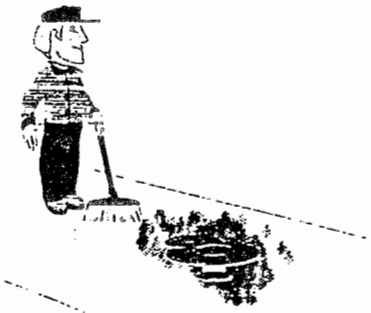
mable Limits In Air: Lower: N/A Upper: N/A

Extinguishing Materials: WATER, SAND, CO2, DRY FOAM, HALON

ial Fire Fighting Procedures: THIS PRODUCT WILL NOT BURN OR SUPPORT COMBUSTION.

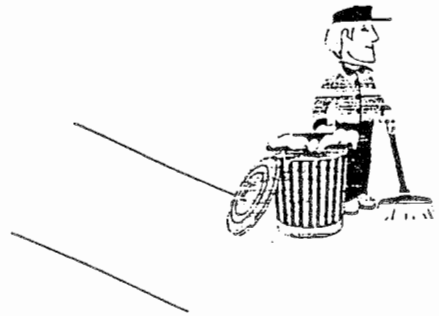
NEWFACE ABSORBENT DEEP CLEANING INSTRUCTIONS FOR CONCRETE AND ASPHALT

1. APPLY KLEEN GREEN DEGREASER TO OIL SPOT AT A MIXTURE OF 5 TO 1 WITH WATER FOR CONCRETE AND 20 TO 1 FOR ASPHALT.

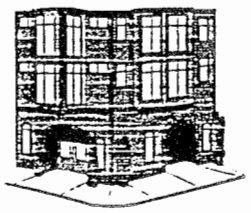


2. SCRUB KLEEN GREEN INTO OIL SPOT WITH A STRONG BRISTLED BROOM TURNING OLD SOLIDIFIED OIL BACK INTO A LIQUID NEWFACE CAN EXTRACT.

3. AFTER OIL HAS BEEN LIQUEFIED APPLY GENEROUS AMOUNT OF NEWFACE ABSORBENT TO AREA AND WORK ABSORBENT INTO THE CONCRETE BY SWEEPING IT INTO SPILL WITH YOUR BROOM. SWEEP UP EXCESS ABSORBENT PUT IN CAN OR BUCKET AND REUSE ON YOUR NEXT AREA.



4. THE RESULTS ARE A CLEAN PARKIN SPACE THAT LOOKS LIKE NEW! AS WEL A THIN PROTECTIVE COATING O ABSORBENT IS DOWN IN THE POURS O YOUR CONCRETE READY TO ABSORB OI FROM THE NEXT LEAKY CAR. ASPHAL SURFACES CAN BE RINSED WITH HOSE.



NEW FACE Incorporated

The 21st Century way to clean your parking area!

Tel. (818) 401-3770 FAX (818) 442-0230

2026 North Chico Ave., So. El Monte, CA. 91733

Technical Bulletin

KLEEN GREEN

NO. 606
ALL PURPOSE CLEANING COMPOUND

DESCRIPTION: Kleen Green was developed to do a cleaning job on any type of oil or grease. It is a liquid concentrateed alkali, light green to yellow in color. It is a very fast cleaner. It may be used in hot or cold water.

METHOD OF USE: Kleen Green may be used at a concentration of 1 to 30 parts water, depending on the amount of soil you are cleaning. It may be used as a wax stripper at full concentration. It may be used for cleaning machinery, by spraying at a concentration of 4 to 1. Then wipe off with a wet rag. For cleaning concrete floors use at 4 to 15 to 1 concentration. For asphalt parking spaces use at 20 to 30 to 1 concentration. For washing walls mix with 5 to 10 parts water. It is excellent for cleaning aluminum parts, as it carries carbon soot found in most oils. It will clean white wall tires and plastic seat covers.

SAFETY FACTOR: Kleen Green is non-toxic, non-flammable and non-corrosive. It is ordorless, and will not injure workers. It may be disposed of by dumping in the sewer. It will bleach painted surfaces if used at full concentration.

PACKED: 55 GALLON DRUM
5 GALLON PAIL
4 GALLON CASE

TIMARI TRADING COMPANY LTD.

NEW FACE PRICE LIST AS OF 7/1/1997

PRODUCT	CONTAINER	QUANTITY	PRICE
NEWFACE ABSORBENT	INDUSTRIAL SIZE BOX	1-3 BOXES	$44.95/EAC
NEWFACE ABSORBENT	INDUSTRIAL SIZE BOX	4-11 BOXES	$39.95/EAC
NEWFACE ABSORBENT	INDUSTRIAL SIZE BOX	12-49 BOXES	$35.95/EAC
NEWFACE ABSORBENT	INDUSTRIAL SIZE BOX	50 + BOXES	$32.95/EAC
KLEEN GREEN A.P.C.	1 GALLON	1	$24.95/GALLO
KLEEN GREEN A.P.C.	4 GALLON CASE	4	$23.95/GALLO
KLEEN GREEN A.P.C.	5 GALLON BUCKET	1	$19.95/GALLO
KLEEN GREEN A.P.C.	5 GALLON BUCKET	4+	$17.95/GALLO
KLEEN GREEN A.P.C.	55 GALLON DRUM	1	$15.95/GALLO
CONCRETE BROOM	14 INCH HEAD	1	$21.95/EAC
NEWFACE SPRAYER	2.5 GAL. PUMP SPRAYER	1	$59.95/EAC

FOR ADDITIONAL INFORMATION ON TIMARI TRADING COMPANY PRODUCTS CAL
523-0008

Outer Islands 1 (800) 914-9015

Chaney, Brooks
& COMPANY
DIVERSIFIED REAL ESTATE SERVICES
COMMERCIAL DIVISION

ASSET MANAGEMENT
PROPERTY MANAGEMENT
SALES & LEASING
REAL ESTATE CONSULTING

Management/Corporate
606 Coral Street, Second Floor
Honolulu, Hawaii 96813
phone (808) 544-9509
fax (808) 544-1863

Sales and Leasing/Corporate
606 Coral Street, First Floor
Honolulu, Hawaii 96813
phone (808) 528-0039
fax (808) 544-9574

Downtown
Grosvenor Center
733 Bishop St., Suite 2500
Honolulu, Hawaii 96813
phone (808) 537-6132
fax (808) 533-2047

Accounting
606 Coral Street, P.O. Box 212
Honolulu, Hawaii 96810
phone (808) 544-1600
fax (808) 544-1632

Kauai
4370 Kukui Grove Street, Suite 211
Lihue, Hawaii 96766
phone (808) 246-0634
fax (808) 246-9463

Koilua-Kona
78-6831 Ali Drive, Suite K-14,
Koilua-Kona, Hawaii 96740
phone (808) 322-3777
fax (808) 322-3900

January 3, 1997

Mr. Mark Buck
Timari Trading Company Ltd.
P.O. Box 1358
Honolulu, Hawaii 96807

Dear Mr. Buck,

Thank you for a job well done here at the First Insurance Building. I was concerned when the cleaning of the parking structure had to be scheduled for completion in one weekend. As you know the parking structure here has not been done in quite a while and the lighting level that exists made the job even more difficult. What a pleasure it was to come in on Monday to find the project completed. It was also a pleasure to inspect the work and discover there was no need for your crew to return to complete a punchlist. Your companies desire *and* ability to do quality work is evident. Also the products used by your crew did an excellent job of lifting the stains in the parking stalls.
Once again thank you for delivering the results you committed to along the timeline we required.

Sincerely,

Chaney Brooks And Company

Michael Lafferty
Chief Engineer
First Insurance Building

First Hawaiian Bank

P.O. Box 1959, Honolulu, Hawaii 96805-1959

January 9,1997
Mr. Mark Buck
Timari Trading Company
P.O. Box 1358
Honolulu, Hawaii 96807

Dear Mark,

We are very pleased with the results of your cleaning of First Hawaiian Banks parking structure. As you are well aware; Our facility has 400 concrete surface parking stalls on multiple levels and (3) stairwells, covering 117,265 square feet.
Your company was chosen because of your competitive price and your cleaning product Absorbit/Kleen Green. I was looking for an alternative to the standard steam cleaning methods that will only wash off the top layers of oil and grease but don't get down deep. Also of great concern was not having the removed oil and grease washed down the drains and into the ocean.
Your cleaning method, products and diligent personnel cleaned our dirty, sooty, greasy surfaces so that they were like fresh poured concrete once again, but yet left the painted stall markings unaffected.
You and all your personnel showed us at First Hawaiian Bank that Tamari Trading Company has the ability to plan, coordinate and execute a complex cleaning project despite terrible weather, interference from other contractors and incoming/outgoing vehicles.

Mahalo,

Ralph O. Mench
Chief Engineer
First Hawaiian Bank-
Kamehameha Industrial Center

Unusual Fire & Explosion Hazards: NONE

Note: Under normal conditions hazardous polymerization will not occur.

Section VI Physical Data

Boiling Point: 212
Specific Gravity (water = 1): 1.06
Vapor Pressure: N/A
Percentage Of Volatiles:
Vapor Density: N/A
Evaporation Rate (water = 1): 1.03
Ph (concentrate): 13.2
Ph (1% solution): 13.2
Solubility In Water: THIS PRODUCT IS 100% SOLUBLE IN WATER.
Appearance and Odor: CLEAR GREENISH/YELLOW LQIUID WITH A BLAND ODOR.

Section VII Special Protection Information

Respiratory Protection: NONE
Protective Gloves: NONE
Eye Protection: When handling this product and there is the possibility of splashing it is recommended that proper protection of the eyes be worn.
Other Equipment: NONE

Section VIII Special Precautions

* Chemicals can be hazardous if not respected. The use of proper equipment and procedures for handling chemicals are not only of benefit for their obvious uses, but can reduce the possibility of serious injury and time loss accidents.
* Keep this material away from high heat and observe proper housekeeping procedures.
* DO NOT mix chemcials unless instructed by qualified personnel.

Note: This data is furnished gratuitously independent of sale of the product and only for your investigation and independent verification While data is believed to be correct, SHIELD CHEMICAL shall in no event be responsible for damages whatsoever, directly or indirectly, resulting from the publication or use of or reliance upon data contained herein. No warranty, either implied or expressed, of merchantability of fitness or of any nature with respect to the product or to the data is made herein. You are urged to obtain data sheets for all SHIELD CHEMICAL materials you buy, process, use, or distribute, and are encouraged to advise anyone working with or exposed to such materials of the information contained herein.

Sources:
1) Dangerous Properties of Industrial Material; Sax , 6th Ed
2) Hand of Toxic and Hazardous Chemicals and Carcinogens; Sittig, 2nd ed
3) Condensed Chemical Dictionary ; Hawley , Tenth Edtion
4) TLV's and Biological Exposure Indices for 1985-86 ; ACGIH, 2nd print
5) Director's List of Hazardous Substances ; State of Cal, 1st printing
6) Title 29 CFR parts 1900 to 1910, Revised as of July 1, 1984
7) Documentation of TLV's and BEI's ; ACGIH , Fifth Edtion
8) Guidelines for the selection of Chemical Protective Clothing ; ACGIH , 2nd printing
9) Emergency Response Guidebook ; Depatment of Transportation , 1984 ed