City of Salinas Development Standards Plan
Low Impact Development Practices for Urban Storm Drainage Management
July 2007

Workshop No. 3
July 12, 2007

Chris Conway, CPSWQ - Kennedy/Jenks Consultants

California Environmental Protection Agency
CENTRAL COAST REGIONAL
WATER QUALITY CONTROL BOARD

Acknowledgements

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- **City of Salinas - Carl Niizawa, P.E., DEE and Denise Estrada**
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Presentation Outline

- Purpose and Objectives of the DSP
- Low Impact Development (LID)
- LID Designs & Practices
- LID Design Considerations
- Source and Structural Treatment Controls
- Model LID Ordinance
- Calculating Pollutant Loads
- Moving Forward with LID!

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Purpose and Objectives of the Salinas DSP

- Effectively reduce the volume, rate, and pollutant loading of urban runoff as required under Central Coast Water Board Order No. R3-2004-0135 (e.g. the NPDES permit)
- Facilitate the implementation of storm water pollution source control and Low Impact Development (LID)
- ***Sustainable Land Management*** and ***Healthy Functioning Watersheds***

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The Process of Developing the Salinas DSP

- Reviewed City Codes and Ordinances for NPDES permit conformance
- Developed a Model LID Ordinance
- Thoroughly researched LID Practices and Design Standards
- Produced a document suitable for application to the entire Central Coast

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Documents Related to the Salinas DSP

- The City of Salinas Standard Specifications, Design Standards and Standard Plans
- The City of Salinas Storm Water Ordinance
- The City of Salinas Zoning Code
- The City of Salinas Grading Ordinance
- The Salinas General Plan
- The City of Salinas Storm Water Management Plan

The Salinas DSP is a Living Document!

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What is Low Impact Development?

- Drainage features and practices that mimic natural hydrologic functions to reduce the rate, volume and pollutant loading of urban runoff to pre-development conditions
- Hydrologically functional site design combined with pollution prevention measures to compensate for land development impacts on hydrology and water quality
- Decentralized storm water micro-management techniques to mimic the original hydrologic regime

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Low Impact Development (LID)

- Based on runoff <u>volume</u> control
- Low Impact Development (LID) =
  - Integrated Management Practices (IMPs)
  - Sustainable Urban Drainage Systems (SUDS)
  - Natural Drainage Systems (NDS)
- LID Practices Restore Pre-development Hydrology and Process Urban Pollutants
  - Interception
  - Infiltration
  - Evapotranspiration
  - Biodegradation
  - Groundwater Recharge

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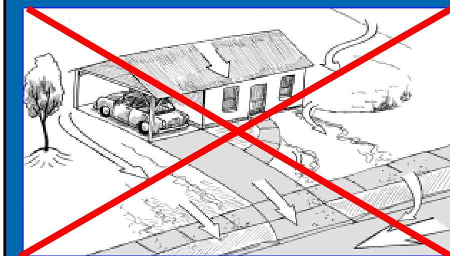
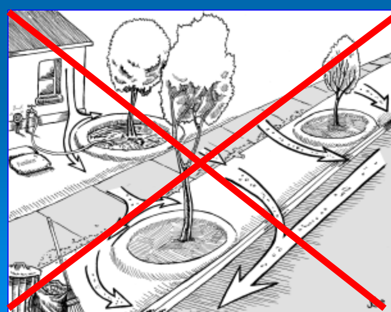
Impervious Surfaces

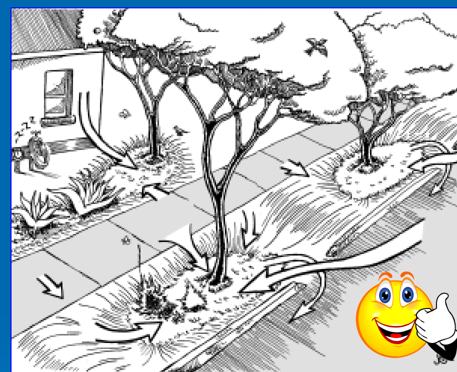
Materials such as concrete, asphalt, roofing, and compacted soil and conventional storm drainage:

- **Indicate intensive land uses that cause pollution**
- **Prevent infiltration of storm water into the ground**
- **Prevent natural processing of pollutants by soils and plants**
- **Provide a surface for accumulation of pollutants**
- **Provide an express route for pollutants to waterways**
- **Increase downstream erosion and flooding**

LID = Rainwater Harvesting







Source: Brad Lancaster

www.harvestingrainwater.com

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Typical LID Practices

- Preserve existing vegetation
- Buffer waterways
- Direct roof runoff to vegetated areas
- Minimize and disconnect impervious surfaces
- Vegetated swales and filter strips
- Bioretention systems with engineered soils and underdrains (where necessary)
- Porous paving systems
- Rainwater catchment systems
- Green roofs
- Storm water ponds and wetlands

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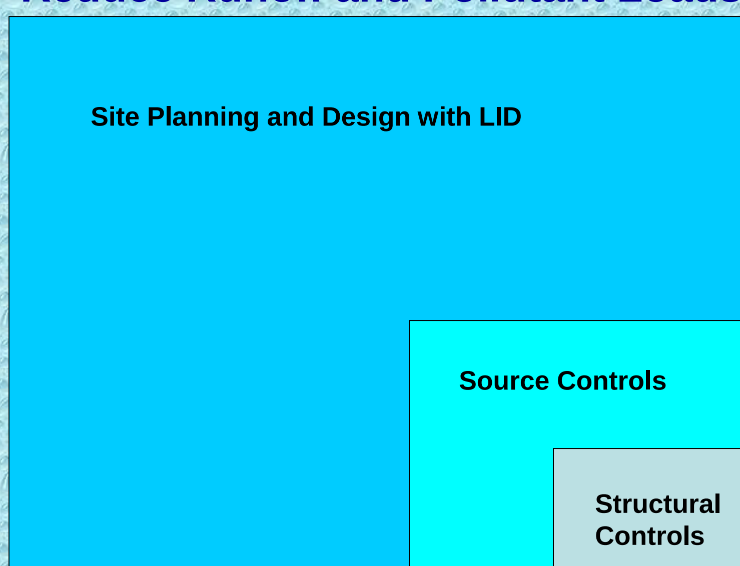
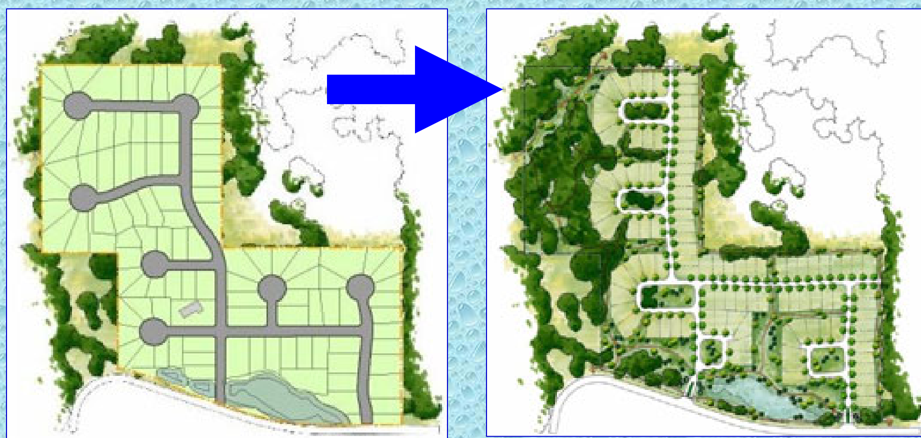
Relative Effectiveness of Methods to Reduce Runoff and Pollutant Loads



Source: Kennedy/Jenks Consultants

LID Site Design



Source: Center for Watershed Protection

Grassy Swales for Parking Lot Runoff

Sources: Kennedy/Jenks Consultants

Swales & buffers incorporated into landscaping

Sources: Kennedy/Jenks Consultants

Runoff directed to vegetated areas

Sources: Kennedy/Jenks Consultants

Bioretention for Parking Lot Runoff

Source: Center for Watershed Protection

Source: Colorado AWARE

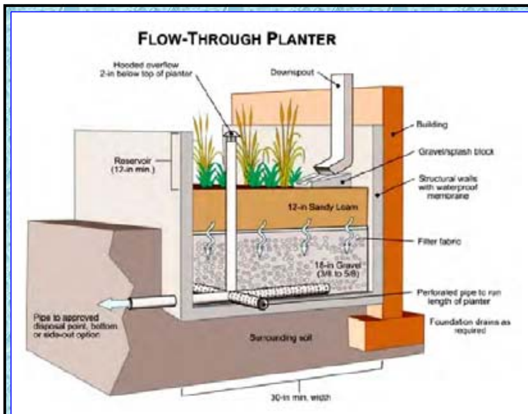
Source: Center for Watershed Protection

Bioretention for Street Runoff

Source: Portland, OR

Source: Filterra™

Source: Kennedy/Jenks Consultants



Bioretention for Roof Runoff

Sources: City of Portland, OR

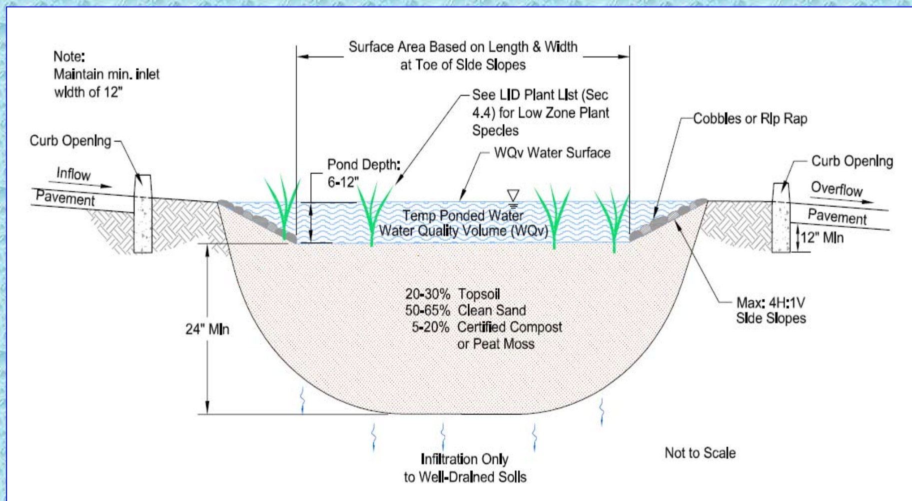
Bioretention Systems

(Landscape Detention, Rain Gardens, Tree Box Filters and Storm Water Planters)

Pollutants	Percent Removal Efficiency
Total Suspended Solids	75 - 90
Total Phosphorus	70 - 80
Total Nitrogen	65 - 80
Total Zinc	75 - 80
Total Lead	75 - 80
Organics	75 - 90
Bacteria	75 - 90

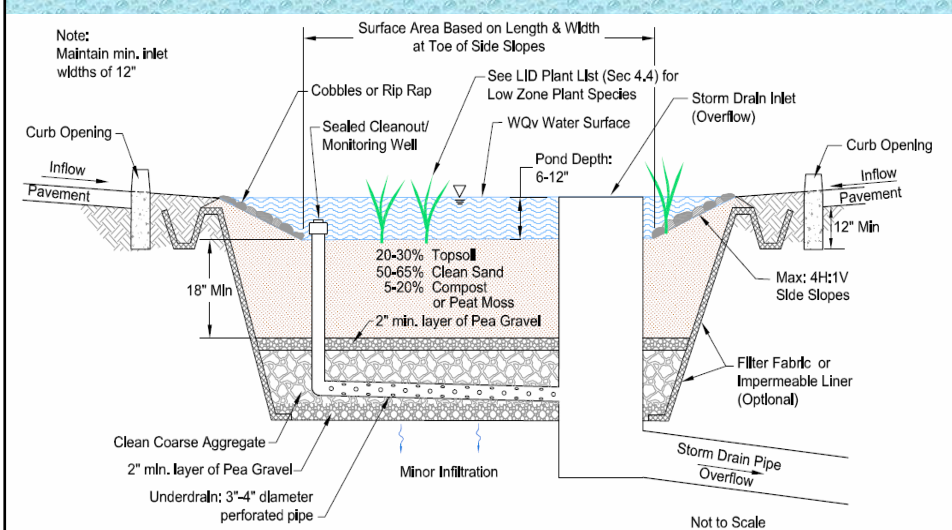
Sources: CASQA, 2003; UDFCD, 1999

Landscape Detention (Bioretention)
In Well Draining soils (0.5 to 2.4 in/hr)



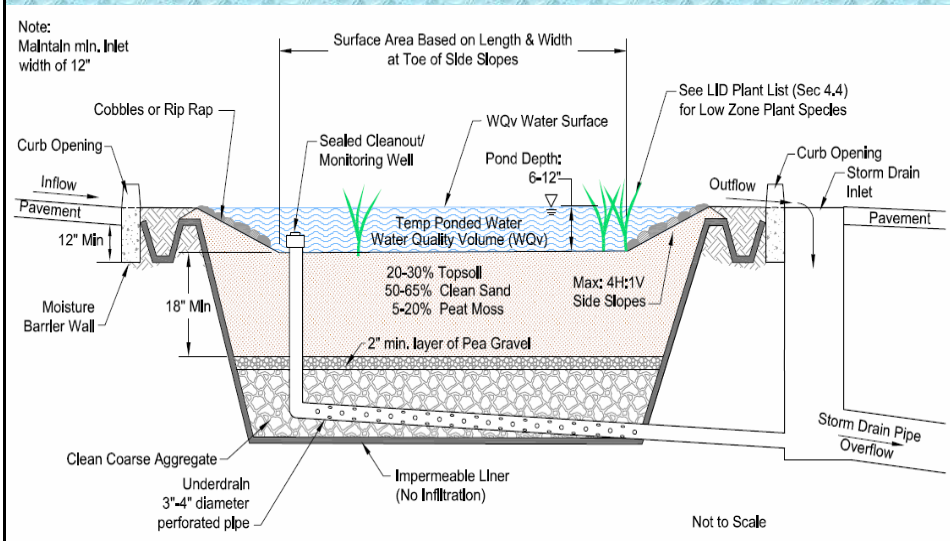
Uses Physical, Chemical & Biological Processes to Reduce Pollutants

Landscape Detention (Bioretention)
With Underdrain System (minor infiltration)



Source: Kennedy/Jenks Consultants

Landscape Detention (Bioretention) With Underdrain System (minor infiltration)



Source: Kennedy/Jenks Consultants

Burnsville Stormwater Retrofit Study
June 2006

Source: City of Burnsville, MN & BARR Engineering

Burnsville residence, Rushmore Avenue

Limestone structure guides water into the garden

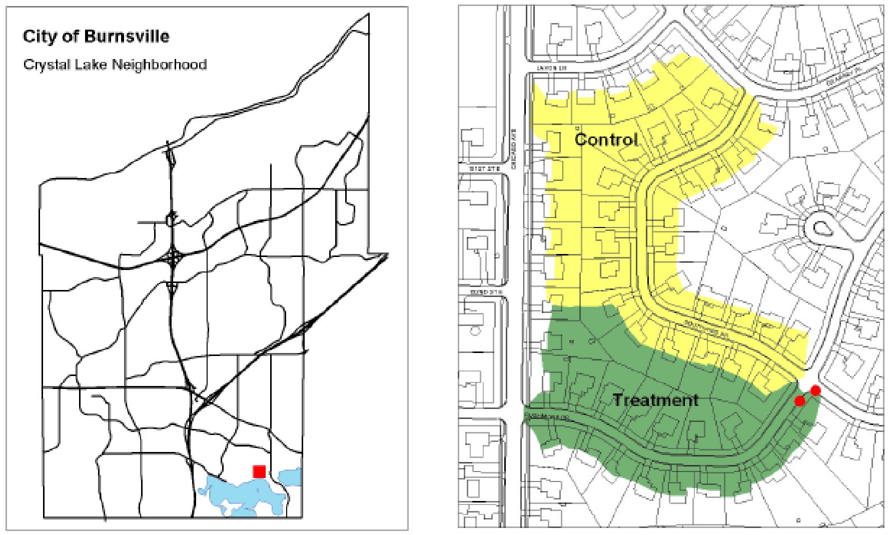
Source: City of Burnsville, MN & BARR Engineering

17 Rain Gardens retrofitted in the ROW of 14 homes in 2003

Figure 2 Treatment Watershed Rainwater Garden Layout

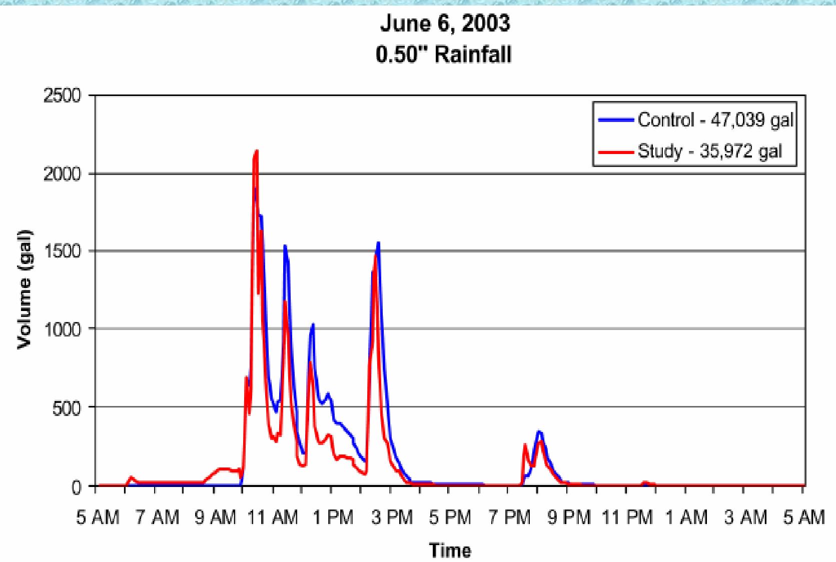
Source: City of Burnsville, MN & BARR Engineering

Figure 1 Paired Watershed Study Area



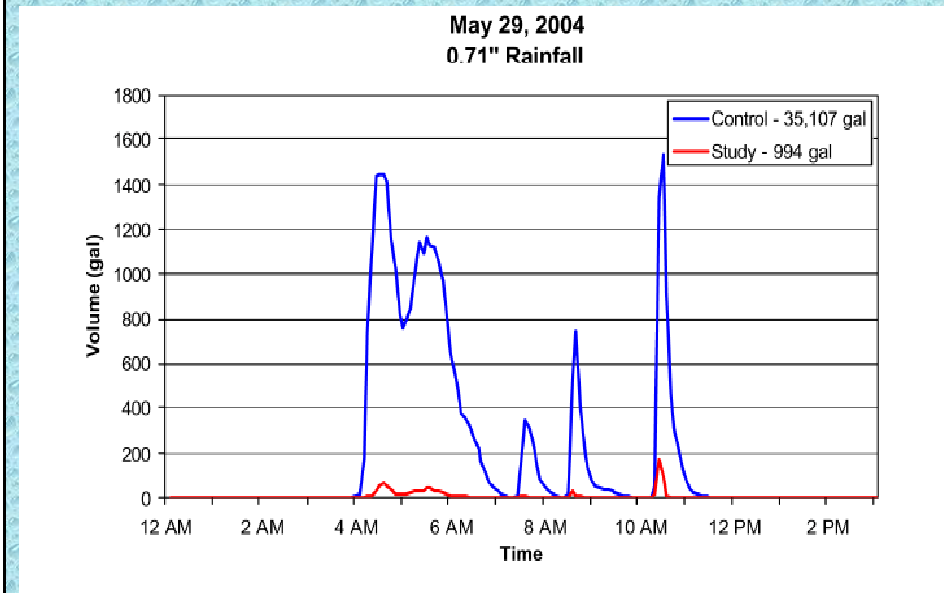
Source: City of Burnsville, MN & BARR Engineering

Pre-Project Hydrographs (e.g. Before Rain Gardens)



Source: City of Burnsville, MN & BARR Engineering

Post-Project Hydrographs (e.g. With Rain Gardens)



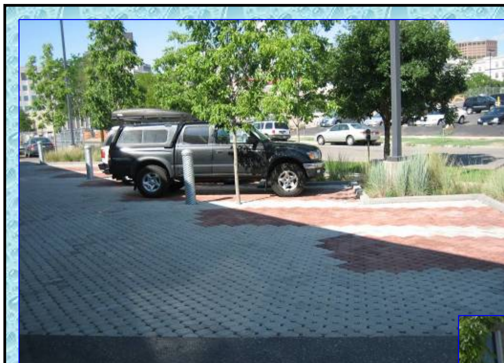
Sources: City of Burnsville, MN & BARR Engineering

Porous Paving Systems

- Porous Pavement Detention
- Open-Celled Block Pavers
- Open-Jointed Block Pavers
- Porous Asphalt
- Porous Concrete
- Porous Turf
- Porous Gravel
- Open-Celled Plastic Grid

Porous Pavements

Open-Jointed Block Pavers



Source: ICPI

Source: Kennedy/Jenks Consultants

Non-porous Pavement / Pervious Concrete

(Denver on 2005-04-11; 14th Ave. & Krameria St. – Two Sites)

Photos by National Ready Mixed Concrete Association

Source: UDFCD, 2005

Cost Savings/Improved Site Utilization

Pervious Concrete Pavement - Provided by NRMCA

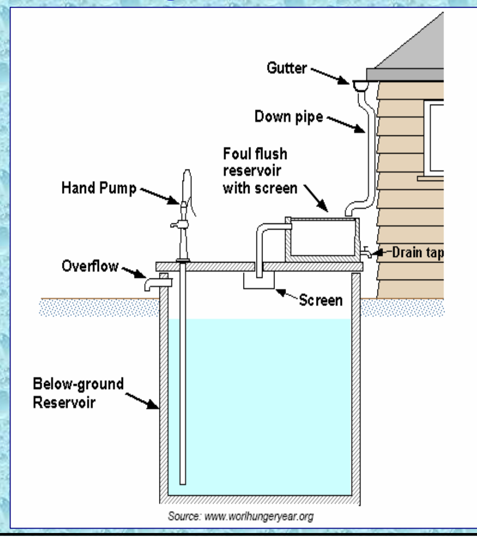
Under Const. – Winter, 2005

- **7 Acre Lot – 12 Acre Site – Westminster, MD**
- **$400,000 Estimated SAVINGS**
  – Underground Drainage *Eliminated*
- **1-1/2 Acre Retention Pond *Eliminated***
  –***reclaimed*** space for facility
- Owner: Shelter Systems, Ltd. (Roof & Floor Truss mfgr)
  - Dwight Hikel, Pres.(www.sheltersystems.com)
- Des.-Build: Conewago Indus. – Hanover, PA
  - ABG Dual Compaction Paver (some sand in mix)

Source: UDFCD, 2005

Rainwater Catchment Systems

Source: Kennedy/Jenks Consultants



Green Roofs

Source: www.infrastructures.com

Sources: Rana Creek

Storm Water Ponds and Wetlands

Sources: Caltrans

Benefits of LID in Salinas

- Runoff Limited to Pre-Development Conditions
- Non-Point Source Pollution Control
- Open Space Preservation
- Waterway Protection
- Water Conservation
- Groundwater Recharge
- Reduced Flooding
- Reduce Water Rights Entitlements
- NPDES Permit Compliance!

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Source Controls
Construction Site BMPs

- Principles of Erosion and Sediment Control
- Planning BMPs for Construction Sites
  - **Harvest & Reuse Topsoil**
- Runoff Control BMPs
- Erosion Control BMPs
- Sediment Control BMPs
- Drainageway Protection BMPs
- General Site and Materials BMPs for Construction Site

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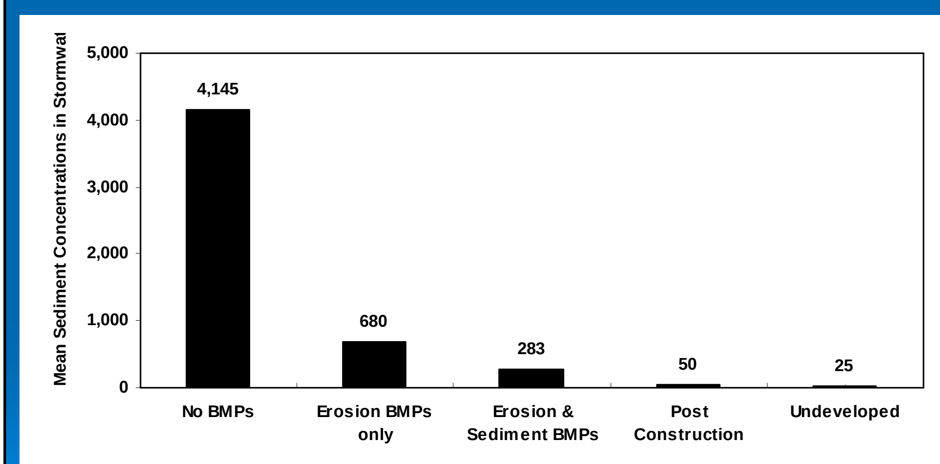
Construction Site BMPs



Source: Schueler and Lugbill, 1990

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Source Controls

- Vehicle Wash Areas
- Waste Handling Areas
- Outdoor Material Storage
- Outdoor Material Loading/Unloading
- Fuel Storage and Fueling Areas
- Outdoor Work, Maintenance, and Wash Areas
- Spill Prevention, Containment, and Cleanup
- Waste Handling and Disposal

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Structural Treatment Controls Public Domain

- Infiltration Trenches
- Infiltration Basins
- Surface Sand Filters
- Underground Sand Filters
- Sedimentation Basins
- Sand Filter Basins
- Oil and Water Separators

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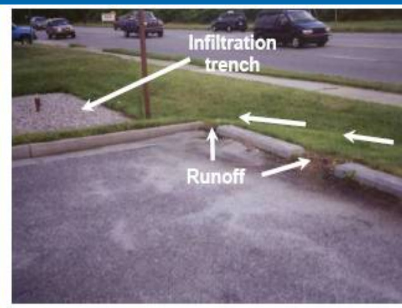
Structural Treatment Controls
Public Domain

Source: California Stormwater BMP Handbooks



Source: Center for Watershed Protection

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Structural Treatment Controls
Manufactured (Proprietary)

- Hydrodynamic Separators
- Wet Vaults
- Modular Wetlands
- Catch basin inserts
- Media Filtration Systems
- Gross Solids Removal Devices

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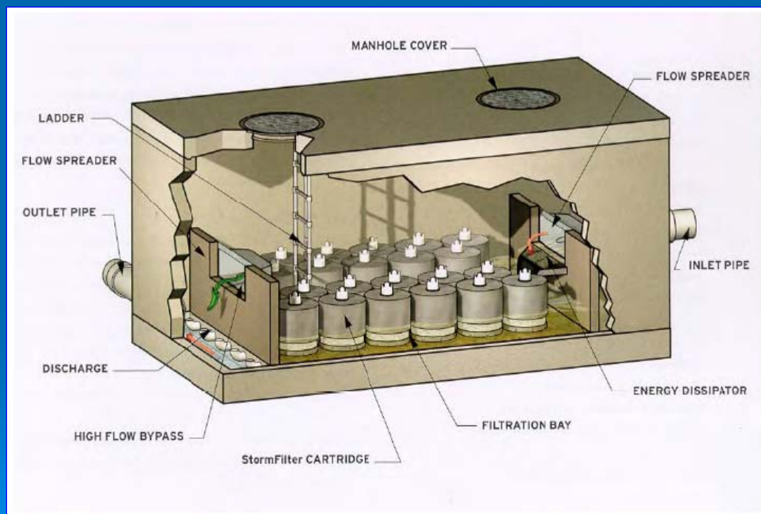
Structural Treatment Controls Manufactured (Proprietary)



Source: Stormwater 360

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National Pollutant Discharge Elimination System (NPDES)

- The Central Coast Regional Water Quality Control Board administers the NPDES program in the Central Coast Region
- The City of Salinas is required to reduce the discharge of pollutants from its storm drainage system to the Maximum Extent Practicable (MEP)
- Implementation of LID = MEP

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NPDES Permit Requirements for New Development

- Minimize impacts on receiving waters from new development and significant redevelopment (5,000 ft^2 or more of new impervious surfaces)
- Require developers to analyze pre- and post-project pollutant loads and peak flow rates and identify BMPs to be implemented
- Review and condition for compliance all priority project categories

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Priority Project Categories

1. Residential subdivisions with 10 or more units
2. Commercial developments that create 100,000 ft^2 or more impervious land area
3. Automotive repair shops (≥ 5,000 ft^2)
4. Restaurants (≥ 5,000 ft^2)
5. Hillside developments (≥ 5,000 ft^2)
6. Parking lots (≥ 5,000 ft^2)
7. Streets, roads, highways, and freeways that create 5 or more acres of pavement
8. Retail gasoline outlets (≥ 5,000 ft^2)

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Numeric Sizing Criteria

1. Volume-based treatment control BMPs shall be designed to infiltrate or treat either:
   a) Volume produced by the 24-hour 85th percentile storm event (based on local rainfall records)
   b) Maximized storm water quality capture volume (WEF/ASCE method, 1998)
   c) 80% of the volume of annual runoff (CASQA method, 2003)

Examples of volume-based treatment control BMPs include extended detention and bioretention basins

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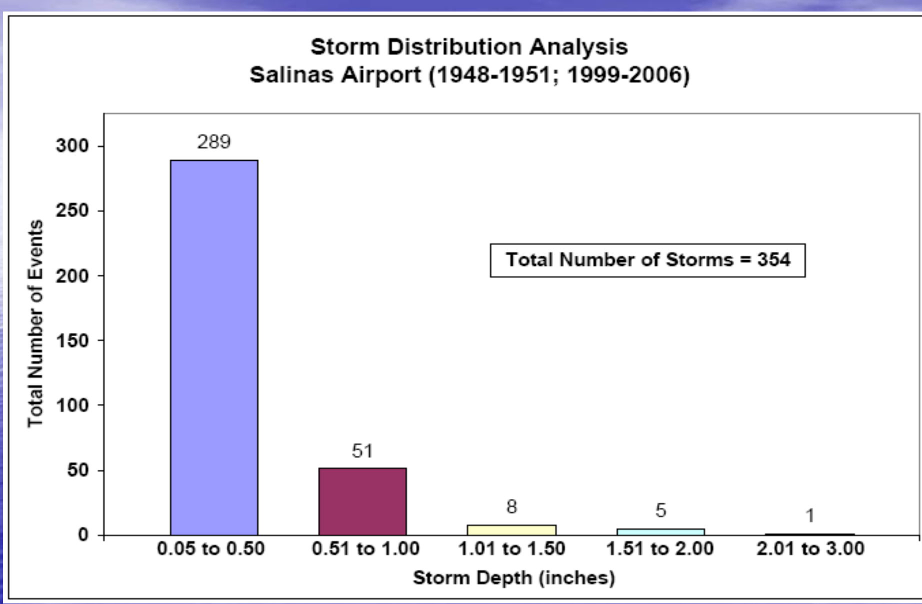
Analysis of Local Precipitation Data



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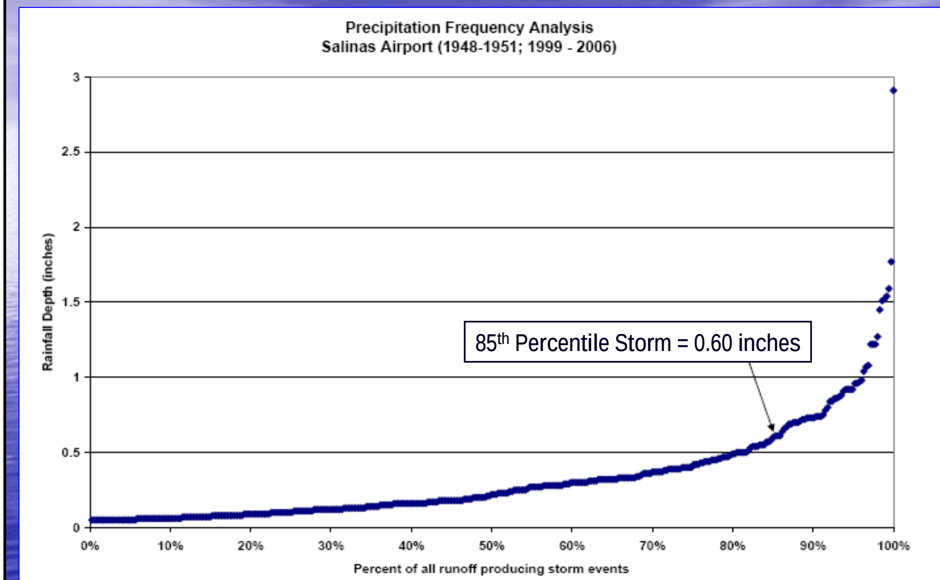

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Numeric Sizing Criteria

2. Flow-based treatment control BMPs shall be designed to infiltrate or treat either:

   Maximum flow rate produced by a rain event equal to two times the 85th percentile hourly rainfall intensity based on local rainfall records (CASQA method, 2003)

   Examples of flow-based treatment control BMPs include vegetated swales and buffer strips

3. An approved equivalent numeric sizing criteria may be used

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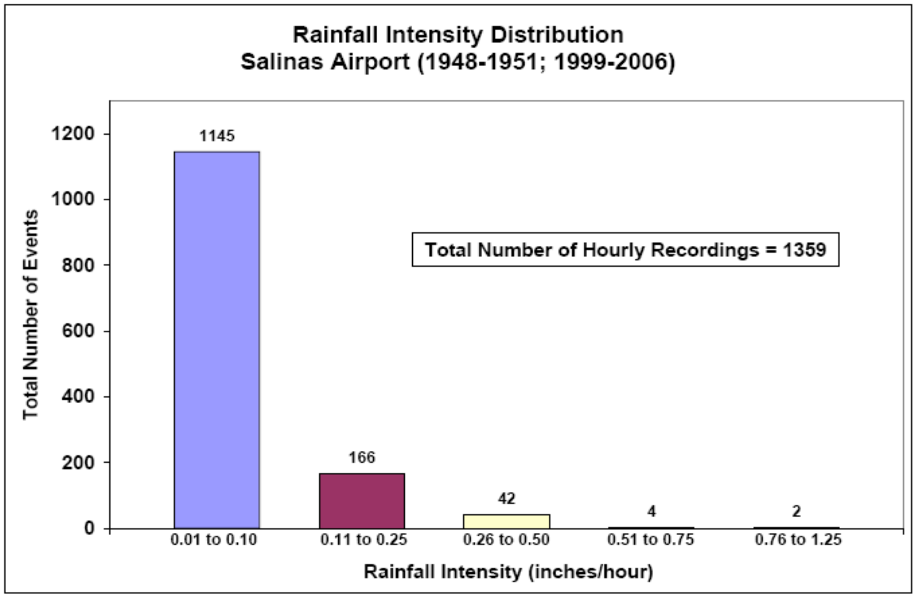
Analysis of Local Precipitation Data



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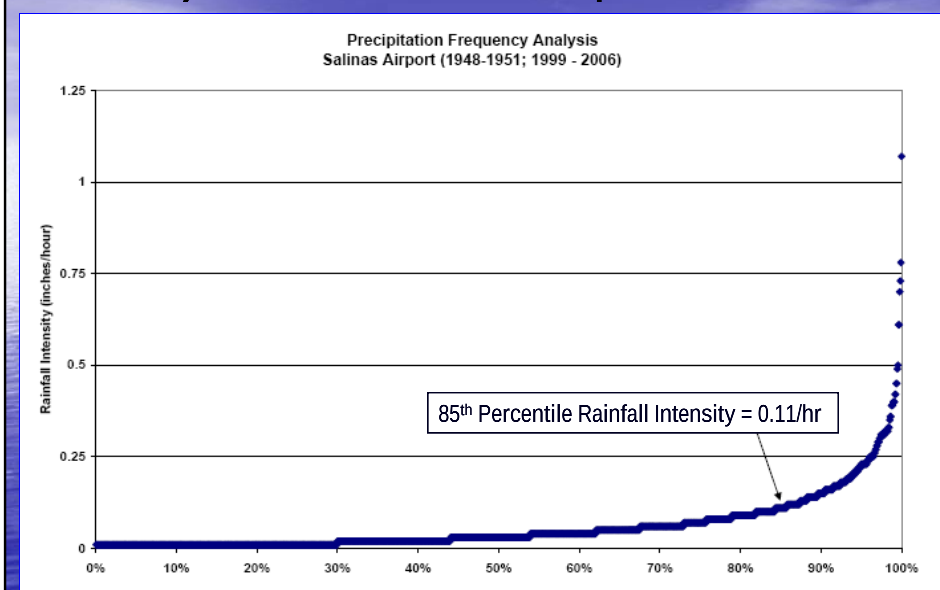

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Infiltration and Groundwater Quality

Restrictions on storm water infiltration devices include the following:

1. Native soil infiltration rates should be between 0.5 to 2.4 in/hr (120 to 25 min/in)
2. $\geq$ 5 to 10 ft Groundwater separation
3. $\geq$ 100 to 150 ft from drinking water wells and septic systems (including abandoned systems)
4. $\geq$ 500 ft from areas of known groundwater contaminatin and underground fuel tanks
5. $\geq$ 100 ft up slope and $\geq$ 20 ft down slope from building and bridge foundations

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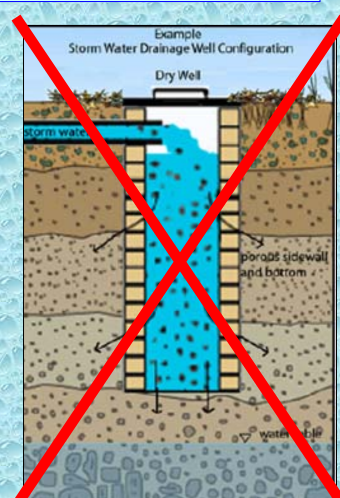
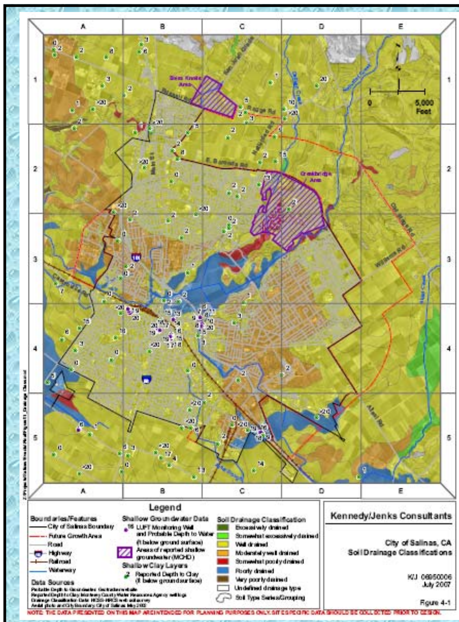
Prevent Groundwater Contamination

Infiltration practices can have unintended consequences for groundwater supplies

- **Use caution with infiltration practices**
- **Class V injection wells**
- **SDWA, UIC & Wellhead Protection**
- **Design infiltration practices per Development Standards Plan**





Salinas Area Shallow Soil and Groundwater Conditions

- Soil Drainage Classifications
- Runoff and Infiltration
- Saturated Hydraulic Conductivity
- Depth to Restrictive Soil Layers
- Available Soil Water Holding Capacity
- Soil Clay Content

For Planning Purposes Only
Need Site Specific Data for Design

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Maintenance Agreement and Transfer

- The City of Salinas shall require verification of maintenance provisions for post-construction treatment control BMPs.
  1. Developer to maintain BMPs until legally transferred to another party; or
  2. Sales or lease agreement includes recipients requirements for maintenance; or
  3. Project conditions or CC&R's for residential developments assign maintenance responsibilities to HOA or other appropriate group; or
  4. Any other legally enforceable agreement

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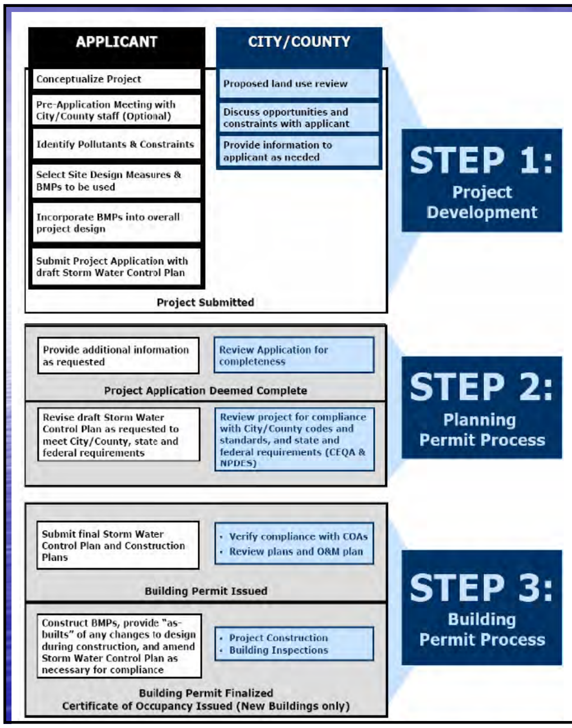

Model Development Review Process

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The Nationwide Urban Runoff Program

- 5-year $30M study (1977–1982)
- Funded by the U.S. EPA
- 28 project locations across the U.S.
- Urban runoff data for residential, commercial and light industrial land uses

Objectives

- Characteristics of pollutants in urban runoff
- Water quality impacts of urban runoff
- Effectiveness of pollutant control measures

NURP Project Locations

Source: NURP, 1983

NURP Primary Pollutants of Concern

TSS – Total Suspended Solids

BOD – Biochemical Oxygen Demand

COD – Chemical Oxygen Demand

TP – Total Phosphorous

SP – Soluble Phosphorous

TKN – Total Kjeldahl Nitrogen

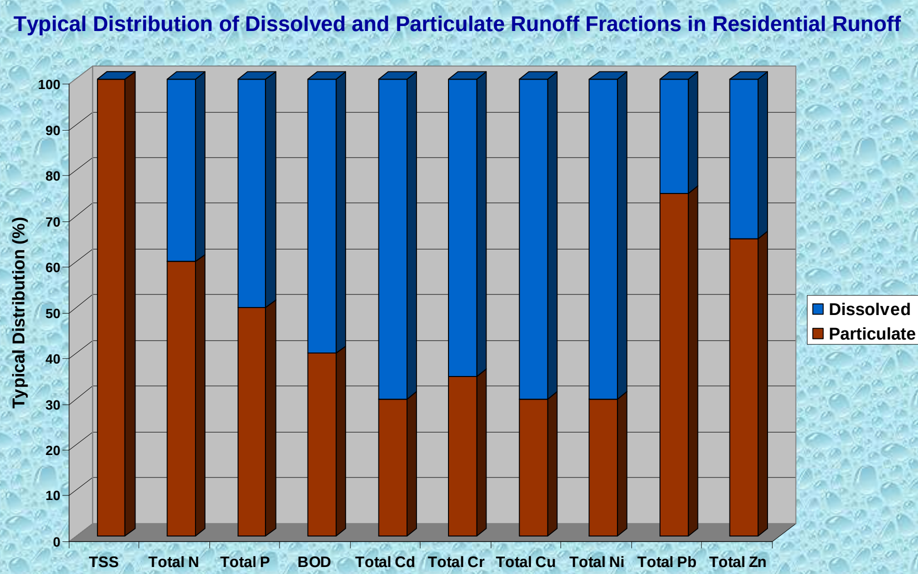
NO_{2+3}-N – Nitrite + Nitrate

Zn – Total Zinc

Pb – Total Lead

Cu – Total Copper

* 20 sites also sampled for "Priority Pollutants"



Source: Harper, H.H. 1988. ***Effects of Stormwater Management Systems on Groundwater Quality. Final Report for Project SM 190, submitted to the Florida Department of Environmental Regulation.***

The Nationwide Urban Runoff Program

Results

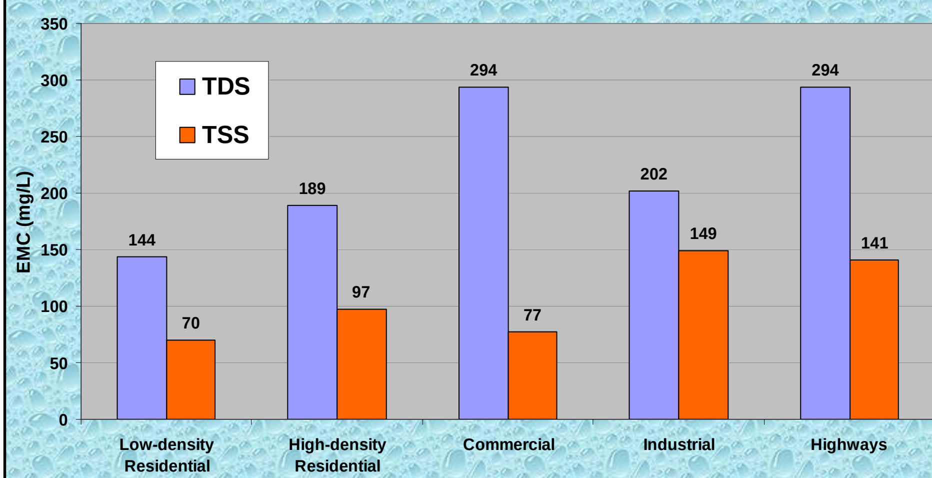
- **Urban runoff contains wide range of pollutants**
- **Majority of pollutant load from the most frequently occurring small storm events**
- **Highest concentration during the "first flush"**
- **Pollutant loadings related to percent of impervious surfaces in a drainage area**
- **Similar land uses yield similar pollutant loads**
- **Pollutant loads generally independent of storm duration, intensity or site location**

The Nationwide Urban Runoff Program

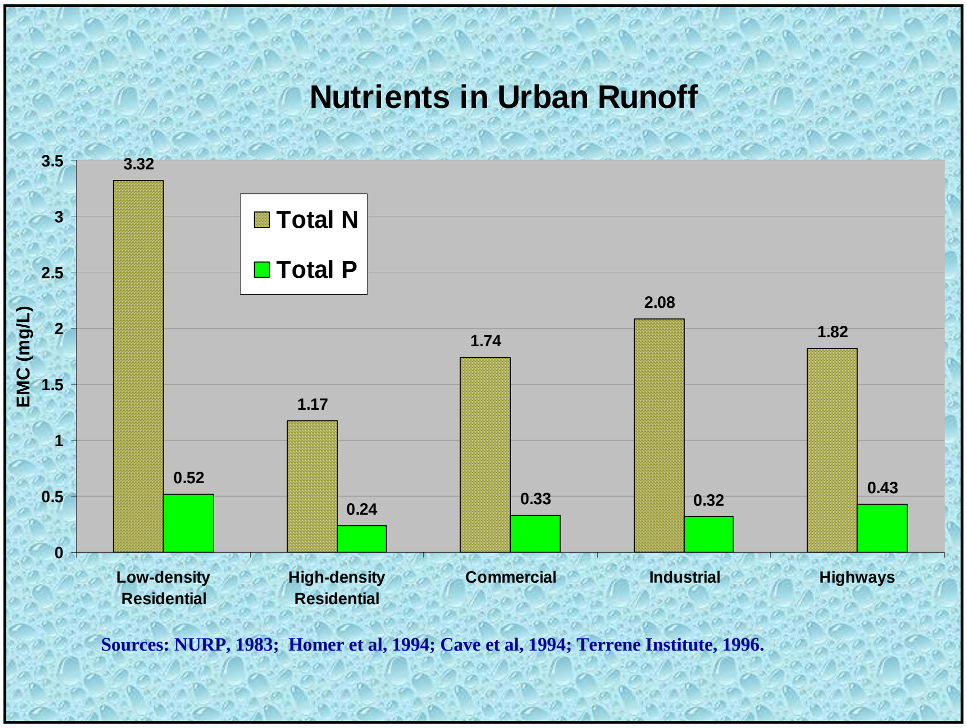
Results (continued)

- **Four major sources of pollution**
  - **Illicit connections and illegal dumping**
  - **Industrial discharges**
  - **Construction site runoff**
  - **Commercial and residential sites**
- **Urban runoff impacting Waters of the U.S.**
- **Provided basis for U.S. EPA regulation of storm water discharges**
- **Produced mean water quality characteristics of urban runoff in the U.S.**

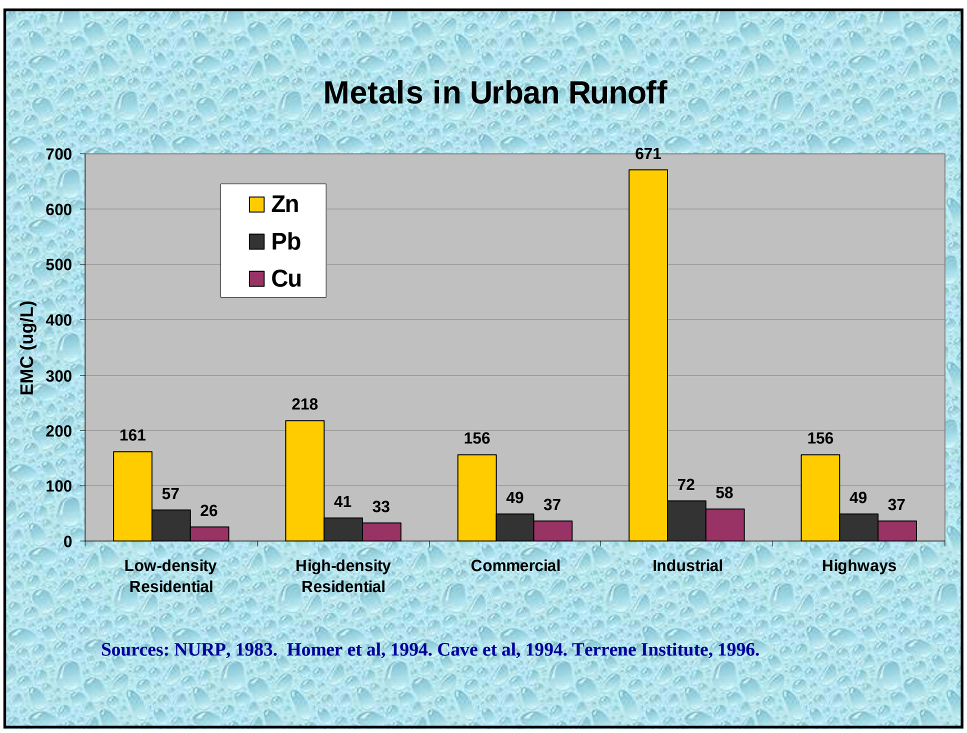
TDS and TSS in Urban Runoff



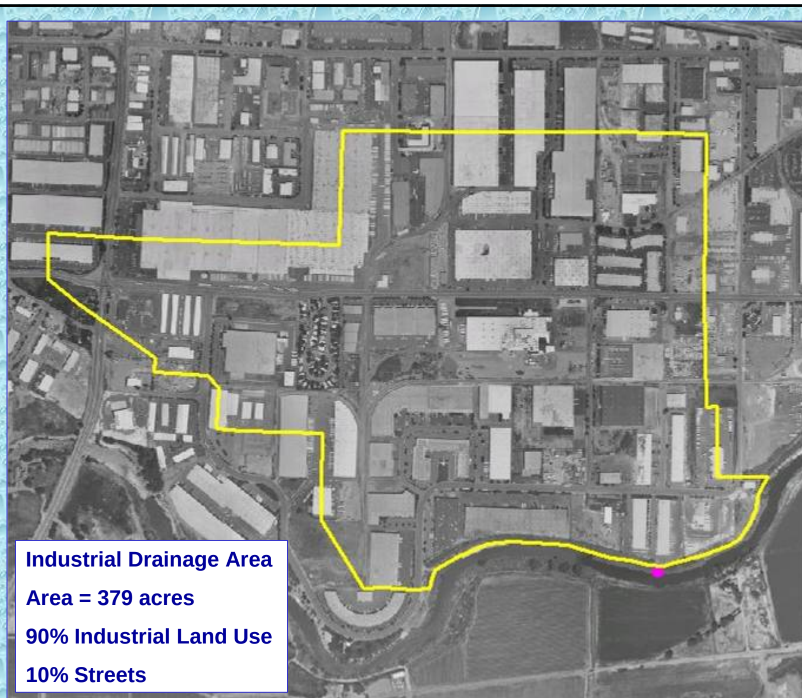
Sources: NURP, 1983; Homer et al, 1994; Cave et al, 1994; Terrene Institute, 1996.



Nutrients in Urban Runoff
EMC (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
Total N
Total P
3.32
0.52
1.17
0.24
1.74
0.33
2.08
0.32
1.82
0.43
Low-density Residential
High-density Residential
Commercial
Industrial
Highways
Sources: NURP, 1983; Homer et al, 1994; Cave et al, 1994; Terrene Institute, 1996.



Metals in Urban Runoff
EMC (ug/L)
700
600
500
400
300
200
100
0
Zn
Pb
Cu
161
57
26
218
41
33
156
49
37
671
72
58
156
49
37
Low-density Residential
High-density Residential
Commercial
Industrial
Highways
Sources: NURP, 1983. Homer et al, 1994. Cave et al, 1994. Terrene Institute, 1996.



Estimating Pollutant Loads

<u>The Simple Method</u>

$L = [(0.9 \times P \times R_v)/12] \times C \times A \times 2.72$

L = pollutant load for pollutant of concern (lbs/yr)

P = average annual rainfall (inches)

R_v = watershed runoff coefficient

> **$R_v = 0.05 + 0.009(I)$**
> **where I = percent imperviousness**

C = average land use pollutant concentration (mg/L)

A = drainage basin area (acres)

Estimating Pollutant Loads

Parameter	Pre-development[1]	Post-development	BMPs Applied[2]
P	7.5 inches	7.5 inches	7.5 inches
I	10%	95%	90%
R_v	0.059	0.905	0.860
C (total N)*	1.92 mg/l	2.08 mg/l	0.41 mg/l
C (total P)*	0.37 mg/l	0.32 mg/l	0.06 mg/l
C (TDS)*	415 mg/l	202 mg/l	40 mg/l
A	379 acres	379 acres	379 acres
L (total N)	66 lbs/yr	1,092 lbs/yr	204 lbs/yr
L (total P)	12 lbs/yr	168 lbs/yr	14 lbs/yr
L (TDS)	14,198 lbs/yr	106,006 lbs/yr	1,392 lbs/yr

*** NURP, 1983; Homer et al, 1994; Cave et al, 1994; Terrene Institute, 1996.**
1 – Agricultural/Pasture pre-developed land use assumed
2 – BMPs assume a 5% reduction in imperviousness and an 80% reduction in pollutant concentrations

Spreadsheet Method

	Total N	Total P	TDS	Zn	Pb	Cu
Low-Density Residential	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Med-Density Residential	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
High-Density Residential	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Commercial	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Industrial	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Highways/ Roads	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Open Space	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Wetlands	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Agriculture	SM Load	SM Load	SM Load	SM Load	SM Load	SM Load
Total Load	**Total N**	**Total P**	**TDS**	**Total Zn**	**Total Pb**	**Total Cu**

Moving Forward with LID!

- ***Provide Additional Technical Resources for LID implementation***
- ***LID Demonstration Projects…***
- ***Conferences, Seminars, Training…***
- ***Public Outreach, Involvement and Education…***
- ***Address the Socioeconomic and Cultural Barriers to LID***
- ***LID Center for the Central Coast***

Kennedy/Jenks Consultants