STORM WATER BEST MANAGEMENT PRACTICES (BMPs) IN SOUTHERN CALIFORNIA

G. Struble[1], T.V. Hromadka II[2]

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Abstract

This study analyzes municipal Best Management Practices (BMPs) for municipalities in five southern California counties; Los Angeles, Orange, Riverside, San Bernardino, and San Diego. Each city, located in the five counties studied, is identified as a coastal, valley, or mountain city. The number of cities that have implemented each BMP are categorized to determine which BMPs are most frequently implemented on a regional basis.

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1 Environmental Studies Graduate Program, California State University, Fullerton, California, USA

2 Principal Engineer, Exponent Failure Analysis Associates, Costa Mesa, California; and Professor of Mathematics and Environmental Studies, Department of Mathematics, California State University, Fullerton, California 92634

1. Introduction

The NPDES (National Pollutant Discharge Elimination System) permitting process, enacted in November 1990, is relatively new. This regulation came about at a time when cities were facing severe cutbacks in their budgets due to a recession that has affected southern California since 1990. This study focuses on analyzing Best Management Practices, or BMPs that cities have implemented since 1990. This study observes the results of dozens of economically challenged cities in meeting the NPDES permitting requirements. The focus of this study, is the area of southern California, including the counties of Los Angeles, San Bernardino, Orange, Riverside, and San Diego.

In this study, BMPs that have already been implemented, or BMPs that are planned by a city in the future are considered. It is assumed that the cities surveyed have each closely examined the costs of implementing their selected BMPs due to recent budget cuts initiated by recessionary times. They have determined what BMPs will be the most efficient for the amount of dollars spent.

The cities that were studied were categorized into coastal, valley, and mountain areas, so that any differences between the three areas could be examined. Cities in the three different areas may implement different BMPs because of different hydrologic responses in their region. For example, a coastal city lies directly along a water body while a valley city is generally a flatter area with fewer water bodies.

Coastal cities include those along the Pacific Coast as well as cities that directly affect storm water quality because of their close proximity to a river or channel draining to the coast. For example, although the city of Bellflower is not along the coast, it lies along the Los Angeles River, which drains into the Pacific Ocean. Valley cities lie in an area that is typically flat and generally not surrounded by water bodies.

BMPs for each city in the five counties studied were obtained from the following sources: a city's yearly report on the NPDES program to the county,

through a county's Drainage Area Management Plan (DAMP), or through a survey sent to a city's Public Works Department.

Once all of the information about each city's BMPs was obtained, the BMPs that each city was implementing or considering were entered onto a spreadsheet data base and statistically analyzed. Not all BMPs were fully implemented; some BMPs were a pilot program, some BMPs were partially implemented, and some BMPs were planned for the future. All of the BMP programs were lumped together in the statistical database.

Once the dates were tabulated, the BMPs were ranked according to the percent of cities that have implemented them. The ranking was done with respect to clusters as opposed to individual ranking. This was done because many BMPs were implemented with the same frequency, therefore making up a cluster.

2. Description of Best Management Practices

Below is a brief description of the Best Management Practices identified in the survey portion of this study, and the identification number linked to each particular BMP.

1. **Street Sweeping**
   Street sweeping can be effective for removing sediment, heavy metals, and nutrients from street surfaces therefore eliminating pollutants from storm water.

2. **Yard Clearing**
   Removing pine needles, leaves, and other materials from yards eliminates potentially large amounts of organics from entry into the storm water runoff system.

3. **Roadway Maintenance**
   A few techniques for roadway maintenance include: appropriate paving techniques, proper chemical/raw material handling procedures, minimizing of impervious surface areas, maintenance of a clean construction site and employee training.

4. **Public Education**

Cities in the five counties have implemented the following public education BMPs:

- educate and demonstrate the proper way to dispose of used motor oil and toxic waste;
- classroom presentations;
- public services staff training;
- video presentations;
- publish information in newsletters and/or newspapers;
- distribute information about NPDES permits on residents, door hangers;
- pollution prevention week;
- TV stations used to educate people about stormwater;
- one day collection season and advertising through PSAs and/or newspaper ads;
- give information about nonpoint source pollution;
- distribute flyers/brochures;
- distribute information about storm water through utility bill inserts.

5. **Household Hazardous Waste**

Hazardous waste collection centers give the public a safe and convenient way to dispose of their household hazardous products avoiding the possibility that they will be disposed of in storm drains.

6. **Used Oil/Oil Filter Collection**

This program educates the public as to the negative impacts of improper disposal of oil and helps to avoid the decision to disposing of hazardous materials improperly.

7. **Storm Drain System Maintenance**

Cleaning out storm drain inlets, catch basins, and lines on a regular or as-needed basis reduces the debris and sediment loads in the drainage system.

8. **Storm Drain Design Standards**

The city of Coronado in San Diego County, has implemented this BMP. All of the city's storm drains terminate on the shoreline of either the San Diego Bay or the Pacific Ocean. The pipe outfalls are highly visible making it easier to monitor the outfall for pollutants.

9. **Stenciling**

Stenciling storm drain systems (inlets, catch basins, channels, and creeks) is a very visible way of discouraging the dumping of improper materials into the storm drain system.

10. **Spill Prevention, Containment and Response.**

A city will use their emergency response section or will contract out to respond to spills resulting from chemicals being transported across streets and highways.

11. **Pesticide Use Enforcement (Pesticide/Fertilizer Management)**

A Pesticide/Fertilizer Management plan is developed to address both acute and toxicity concerns and chronic exposure concerns associated with all insecticides, rodenticides and herbicides.

12. **Code Enforcement**

The purpose of these codes is to prevent illegal discharges into the storm water drainage system.

13. **Inspections**

Inspections for construction, building and business/fire are required to determine compliance with city codes and regulations.

14. **Illicit Connection/Illegal Dumping**

(a) *Illicit Connection*

This BMP prevents the unwarranted physical connections to the storm drain system from overflow cross-connects from sanitary sewers, and floor drains from businesses through regulation, regular inspection, testing, education.

(b) *Illegal Dumping*

Implement measures to detect, correct and enforce against illegal/dumping into storm drains, creeks and streets.

15. **Grading and Erosion Control**

Grading plans are approved through various departments depending on the city, and erosion control for existing developments is monitored by various departments.

16. **Materials Handling, Storage and Recycling**

This BMP is the regulation and control of hazardous materials use, storage, and disposal as a means of preventing these materials from coming into contact with storm water.

17. **New Developments**

(a) *Infiltration Devices*

Infiltration devices capture storm water runoff and allow percolation through the soil column.

(b) *Biofilters*

There are two types of biofilters, swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

18. **Revisions to General Plan**

General plans are a very good place to detail a municipality's goals for storm water pollution control and watershed protection.

19. **Aboveground Tank Spill Controls**

Cities can prevent or reduce the discharge of pollutants to storm water from aboveground storage tanks by installing safeguards against accidental release, installing secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques.

20. **Dry Weather Monitoring**
Storm water monitoring is an effective way of analyzing the pollutants in storm water runoff. Constituents monitored during dry weather conditions include biostimulatory substances (nutrients) which tend to be found in the dissolved form.

21. **Wet Weather Monitoring**
Wet weather monitoring consists of monitoring storm water during rain storms.

22. **Pretreatment inspections of commercial and industrial facilities**
Pretreatment inspections of commercial and industrial facilities are done to inform business owners of BMPs and to assure that all hazardous materials are covered and containment areas are in place.

23. **Drainage Ordinance**
Many cities have municipal codes that contain chapters related to Stormwater Discharge and Collection, Floor Hazard Prevention, and Grading and Erosion Control. These ordinances comprise the enforcement and regulation authority of the city regarding storm water flows and runoff.

24. **Recycling**
In 1989, the California Integrated Waste Management Act was passed in an effort to reduce the amount of trash in landfills. Community programs for collection and recycling of non-hazardous solid wastes are initiated statewide.

25. **Landscape Requirements**
Under this BMP, developments or projects are encouraged to incorporate landscape controls for drainage and runoff.

26. **Wind Born Dust Control**
For cities with dust control problems, this BMP is useful and can be regulated by appropriate departments.

27. **Dechlorination Program**
A city's Water Department cleans water after pipelines have been disinfected.

28. **Site Inspection/Enforcement**
Some variation of a code enforcement team enforces the provisions of a City's Municipal Code. Part of the inspection process includes inspection of proper procedures relative to protecting storm water quality.

29. **Watershed Protection Ordinance**
A Watershed Protection Ordinance is a management measure that can be used to protect storm water quality along with potential land uses within a watershed. The ordinance can be used to determine what types of activities occur in the watershed, where the activities can occur, and what types of storm water control measures are implemented and enforced.

30. **Natural Channels Alternative to Concrete Channels**
Maximum use of natural drainage ways and/or grass-lined channels are to be used when feasible in new development.

31. **Construction Site Inspections**
Cities inspection crews constantly monitor new construction to ensure connections to the sanitary sewer where appropriate. They also monitor to ensure that no illicit connections are made to the storm drain system.

32. **Trash Removal in Lined and Unlined Channels Preceding Rain**
This BMP is effective in curbing the amount of pollutants entering storm water by removing trash and weeds before storms.

33. **Use of Detention/Retention Basins**
These facilities trap sediment in the drainage system and reduce the sediment and heavy metal load in the storm water runoff.

34. **Wetlands Conservation**

Storm water management can be accomplished while protecting wetland areas by utilizing a few practices; flow routing, water level maintenance, inflow/outflow regulations, seasonal application of storm waters, and by routing waters to areas of high soil permeability for maximum infiltration.

35. **Hazardous Materials Management**

Municipalities review and where appropriate implement improvements to hazardous materials practices.

36. **Spill Prevention and Clean Up**

Cities enforce Uniform Building Codes and Uniform Plumbing Codes which address spill prevention and clean up.

37. **Adopt Runoff Ordinance**

A city can use a runoff ordinance as a management measure to protect runoff water quality.

38. **Increase Roadside Trash Receptacle Usage**

Done through the city or county.

39. **Discourage Improper Disposal of Litter, Lawn Clippings, Pet Feces**

Educate the public and business owners as to negative effects from dumping these materials.

40. **Inspect Automobile Uses and Restaurants**

Various departments inspect these establishments for illegal dumping and disposal practices.

41. **Encourage Removal of Dirt, Rubbish, and Debris from Sideways, Alleys**

Educate the public and business owners about the proper way to remove debris.

42. **Encourage Conservation of Water**
Business owners, the public and municipalities are all encouraged to conserve water.

43. **Emergency Response**
This BMP includes a planned response for a hazardous materials emergency.

44. **Hazardous Materials Disposal**
This BMP includes disposing of hazardous materials in a safe manner.

45. **Structural Controls**
Structural Controls include detention/retention basins, infiltration trenches/basins, first flush diversion, porous pavement, oil/grease separators, grass swales, swirl concentrators, and engineering and design modification of existing structures.

46. **Local Ordinances**
Some cities in Orange County have adopted Uniform Fire Code Articles for pollution control, others operate under county codes and policies and some have an Industrial Waste Ordinance specific to controlling hazardous material/waste dumping into surface waters.

47. **Composting**
Composting programs reduce the amount of green waste entering into the drainage system and reduce the amount of pollutants with oxygen demand and levels of coliform in storm water runoff.

3. Ranking Approach

There are three analyses in this study. Coastal and valley cities' BMPs were analyzed separately, and coastal and valley cities' BMPs were analyzed together. Due to sparsity of data, the mountain area (1 city) was not partitioned from the data set.

The following pages show the percentage of all cities in the five counties studied that are implementing BMPs or have a program started. The number of cities that have fully implemented BMPs, partially implemented BMPs, have BMPs in the planning stages or are running a pilot program are divided by the total number of cities in all five counties to give a percentage.

The percentage of BMPs implemented and the ranking of the implemented BMPs are detailed in the following pages. The BMP analysis shows the number of BMPs implemented, partially implemented, in the planning stages and the number of cities running a pilot program divided by the total number of coastal, valley and mountain cities. The BMPs located in a cluster are implemented equally.

In another analysis, the BMPs for all five counties were combined to determine whether there was a significant difference between BMPs being implemented in coastal and valley areas. These results were also ranked with the highest percentage of implemented BMPs ranked highest and the lowest percentage of implemented BMPs listed lowest. There are clusters in these data as well.

Table 1 gives the percentage for coastal, valley, and mountain cities of BMPs that are fully implemented, partially implemented, are in the planning stages, or are running a pilot program. All of the various stages are lumped together to give one percentage.

Table 1. Analysis of BMPs

BMP No.	Coastal	Valley	Mountain
1	0.9347	0.9391	1
2	0.0434	0.1217	0
3	0.0652	0.3565	0
4	0.913	0.826	1
5	0.8913	0.8434	1
6	0.2173	0.2347	0
7	0.9565	0.9043	1
8	0.0869	0.0521	0
9	0.6739	0.5478	0
10	0.0869	0.1478	0
11	0.2826	0.2521	0
12	0.1304	0.1739	1
13	0.1086	0.1565	1
14	0.7391	0.6434	0
15	0.3043	0.3391	1
16	0.1086	0.0521	0
17	0.0869	0.0521	0
18	0.0434	0.0173	0
19	0.0869	0.026	0
20	0.1304	0.1565	0
21	0.1304	0.0782	0
22	0.0217	0.026	0
23	0.1086	0.0695	0
24	0.8478	0.7826	0
25	0.1304	0.0434	0
26	0.0434	0.026	0
27	0.0217	0.0086	0
28	0.1086	0.0608	0
29	0.0652	0.026	0
30	0.0869	0.0347	0
31	0.1304	0.0695	0
32	0.0869	0.0521	0
33	0.0869	0.0434	0
34	0.3043	0.226	0
35	0.1086	0.0608	0
36	0.1304	0.0434	0
37	0.6086	0.4347	0
38	0.6086	0.4173	0
39	0.3695	0.4434	0
40	0.5652	0.4347	0
41	0.5652	0.3565	0
42	0.6304	0.4434	0
43	0.326	0.2173	0
44	0.3043	0.1826	0
45	0.3695	0.1304	0
46	0.326	0.1739	0
47	0.1086	0	0

Table 2. BMP frequency of usage: Total data set

BMP number	Frequency of usage	BMP number	Frequency of usage
1	93.82%	24	79.62%
2	9.87%	25	6.79%
3	27.16%	26	3.08%
4	85.18%	27	1.23%
5	85.80%	28	7.40%
6	22.83%	29	3.70%
7	21.97%	30	4.93%
8	6.17%	31	8.64%
9	58.02%	32	6.17%
10	12.96%	33	5.55%
11	25.92%	34	24.69%
12	16.66%	35	7.40%
13	14.81%	36	6.79%
14	66.66%	37	48.14%
15	33.33%	38	46.91%
16	6.79%	39	41.97%
17	6.17%	40	46.91%
18	2.46%	41	41.35%
19	4.32%	42	49.38%
20	14.81%	43	24.69%
21	9.25%	44	21.60%
22	2.46%	45	19.75%
23	8.02%	46	21.60%
		47	3.08%

4. Ranking of Combined BMPs

In Table 3, BMPs are ranked from high to low percentage of implementation. Those BMPs with bold lettering, and grouped together, are clusters. Clustered BMPs are implemented with equal frequency.

4.1 Statistical Analysis

The frequency of usage for BMPs in coastal and valley areas with a 50% implementation rate and above was found to be similar to the frequency of usage of BMPs for the entire data set. It is therefore determined that, for the five southern California counties studied, there is not a significant difference between BMPs implemented in coastal cities versus valley cities.

Table 4 presents a listing of BMPs with a greater than 50% implementation rate for Coastal, Valley and combined BMPs. The top six recommended BMPs for all categories are included in all three groups.

When every coastal BMP implemented and every combined BMP implemented were compared, there were nine BMPs that had a greater than 5% difference of implementation between the two groups.

There is no particular order to the BMP's listed n Table 5. The (+) marking identifies the group that has the highest percentage of implemented BMPs.

Table 3. BMP ranking: Frequency of usage for total data set

BMP number	Frequency of usage	BMP number	Frequency of usage
1	93.82%	10	12.96%
7	91.97%	2	9.87%
5	85.80%	21	9.25%
4	85.18%	31	8.64%
24	79.62%	23	8.02%
14	66.66%		
9	58.02%	**16**	**6.79%**
42	49.38%	**25**	**6.79%**
37	48.14%		
		28	**7.40%**
38	**46.91%**	**35**	**7.40%**
40	**46.91%**		
		36	6.79%
39	41.97%		
41	41.35%	**8**	**6.17%**
6	22.83%	**17**	**6.17%**
15	33.33%	**32**	**6.17%**
3	27.16%		
11	25.92%	33	5.55%
		30	4.93%
34	**24.69%**	19	4.32%
43	**24.69%**	29	3.70%
44	**21.60%**	**26**	**3.08%**
46	**21.60%**	**47**	**3.08%**
45	19.75%	**18**	**2.46%**
12	16.66%	**22**	**2.46%**
13	**14.81%**	27	1.23%
20	**14.81%**		

Table 4. Most frequently used BMPs

Combined BMPs ranked 50% and above (BMP number)	Coastal BMPs ranked 50% and above (BMP number)	Valley BMPs ranked 50% and above (BMP number)
1	7	1
7	1	7
5	4	5
4	5	4
24	24	24
14	14	14
	9	9
	42	
	37	
	38	
	40	
	41	

Table 5. BMPs with significant difference in usage between total data set and coastal areas

BMP number	Coastal BMPs	Combined coastal and valley BMPs
1	6.52%	27.16%+
43	32.60%+	24.69%
44	30.43%+	21.60%
46	32.60%+	21.60%
45	36.95%+	19.75%
2	4.34%	9.87%+
25	13.04%+	6.79%
36	13.04%+	6.79%
47	10.86%+	3.08%

When every valley BMP implemented and every combined BMP implemented were compared, there were two BMPs (see Table 6) that had a greater than 5% difference of implementation between the two groups. The (+) marking on Table 6 identifies the group that has the highest percentage of implemented BMPs.

Table 6. BMPs with significant difference in usage between total data set and valley areas

BMP number	Coastal BMPs	Combined coastal and valley BMPs
3	35.65%+	27.16%
45	13.04%	19.75%+

5. Conclusions

The BMPs with a 50% and higher implementation rate are listed on Tables 7 and 8.

Because NPDES permits are relatively new, BMPs have been implemented by cities for only a short period of time. To date, there have been little or no studies done on how effective BMPs have been in reducing storm water pollution. Studies should be done in order for cities to have the knowledge that will allow them to implement the BMPs that will be the most beneficial for curbing water pollution. This information would also help cities cut costs since they would not spend money to implement those BMPs that are deemed ineffective.

Table 7. BMPs with highest frequency of usage[a] in coastal areas

BMP no.	BMP description	Implementation rate
7	Storm drain system maintenance	80-100% implementation rate
1	Street sweeping	
4	Public education[b]	
5	Household hazardous waste collection	
24	Recycling	
14	Illicit connection/Illegal dumping	60-75% implementation rate
9	Stenciling	
42	Encourage conservation of water	
37	**Adopt runoff ordinance**	**60.86%**
38	**Increase roadside trash receptacle usage**	**60.86%**
40	**Inspect automobile uses and restaurants**	50-60% implementation rate **56.52%**
41	**Encourage removal of dirt, rubbish and debris from sidewalks, alleys**	**56.52%**

[a] All other implemented BMPs for Coastal areas are below 50%. Refer to ranking sheet on page 000 for detailed ranking order.

[b] Under Public Education BMPs there are twelve (A-L) different public education program that cities implement. Below is the ranking order for the public education programs. The ranking is determined by dividing the total number of coastal cities implementing the particular program by the total number of coastal cities for all five counties that implement the public information BMP. The most popular program is listed first and the least popular is listed last. The bold highlighting indicates that two programs are implemented with the same frequency. Since these programs are implemented by an equal number of cities, one program is not recommended over another.

(J). 23.80% of cities distribute information about nonpoint source pollution.

(E). 21.42% of cities publish information in newsletters and/or newspapers.

(A). 11.90% of cities educate and demonstrate the proper way to dispose of used motor oil and toxic waste.

(K). 9.52% of cities distribute flyers/brochures.

(B). **4.76%** of cities give classroom presentations.

(C). **4.76%** of cities hold public services staff training.

(D). **2.38%** of cities give video presentations.

(G). **2.38%** of cities hold a pollution prevention week.

Table 8. BMPs with highest frequency of usage[a] in valley areas

BMP no.	BMP description	Implementation rate
1	Street sweeping	80-100% implementation rate
7	Storm drain maintenance	
5	Household hazardous waste collection	
4	Public Education[b]	
24	Recycling	50-80% implementation rate
14	Illicit connection/Illegal dumping	
9	Stenciling	

[a] All other implemented BMPs for Valley areas are below 50%. Refer to ranking sheet on page 000 for detailed ranking order.

[b] Under Public Education BMPs there are twelve (A-L) different aspects of implementing this BMP listed. Here they are ranked with the most popular listed first and the least popular listed last. The ranking is determined by dividing the total number of valley cities implementing the particular program by the total number of valley cities for all five counties that implement the public information BMP. The most popular program is listed first and the least popular is listed last. The bold highlighting indicates that two programs are implemented with the same frequency. Since these programs are implemented by an equal number of cities, one program is not recommended over another.

(E). 24.21% of cities publish information in newsletters and/or newspapers.

(J). 20.00% of cities distribute information about nonpoint source pollution.

(K). 17.89% of cities distribute flyers/brochures.

(B). 11.57% of cities give classroom presentations.

(A). 9.47% of cities educate and demonstrate the proper way to dispose of used motor oil and toxic waste.

(H). 6.31% of cities use TV stations to educate about stormwater.

(C). 5.26% of cities hold public services staff training.

(L). 2.10% of cities use utility bill inserts to educate the public.

(G). 1.05% of cities hold a pollution prevent week.

(F). 1.05% of cities distribute information about NPDES on residents doorhangers.

(I). 1.05% of cities hold a one day collection season-advertising with PSA's and newspaper ads.

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