# Integrated Stormwater Management, Rules & Regulations

A white paper prepared for the Canadian Water Network research project:
"An Integrated Risk Management Framework for Municipal Water Systems"

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## Prepared for:

Canadian Water Network as part of deliverables for the research project "Development of Integrated Risk Management Framework for Municipal Water Systems (2015)."

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## Partners:

- City of Waterloo
- City of Kitchener
- Town of Oakville
- City of Mississauga
- Region of Peel
- Durham Region
- Town of Orangeville
- City of Surrey
- City of Calgary
- Town of Okotoks
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- Credit Valley Conservation Authority
- Alberta Low Impact Development Partnership
- Allstate Insurance
- Canadian Standards Association
- Institute for Catastrophic Loss Reduction
- Environment Canada
- Ontario Clean Water Agency
- Southern Ontario Water Consortium
- Clean Nova Scotia
- British Columbia Ministry of Transportation and Infrastructure
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- University of British Columbia
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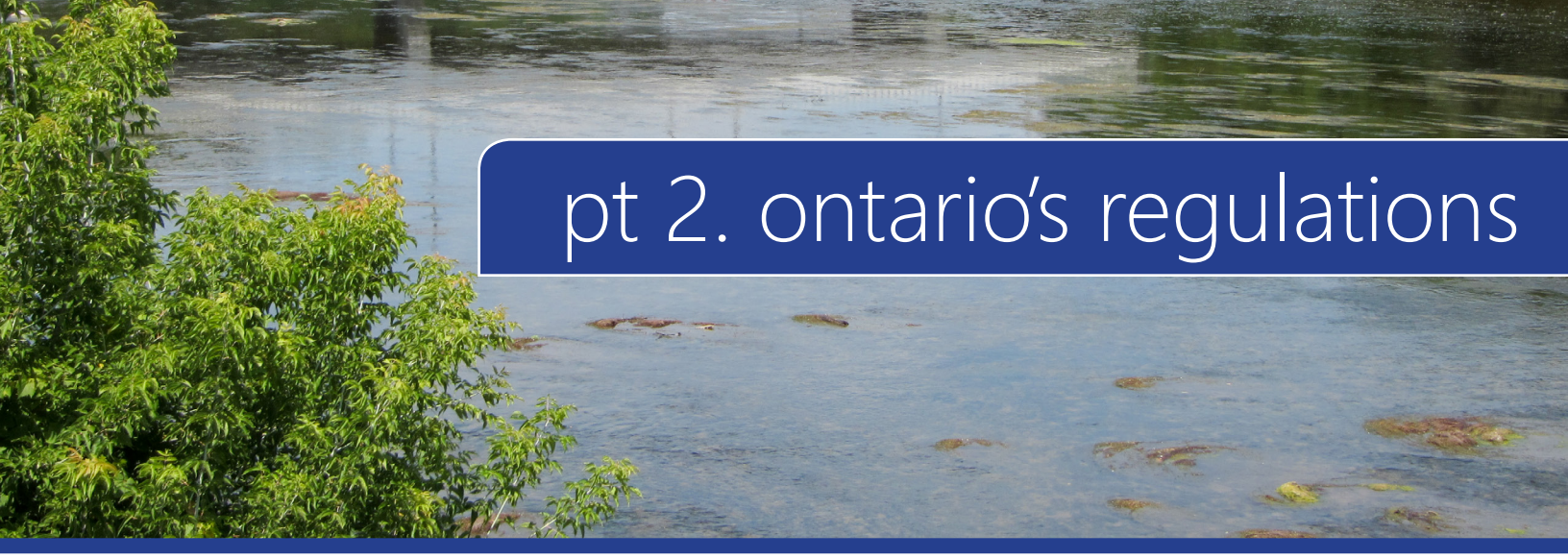
# pt 1. introduction

An important step for understanding how to implement integrated stormwater management is to find cases where stormwater is defined as a resource and where there are regulations to manage stormwater in order to both use it as a resource and prevent its harmful impacts.

This paper examines how municipalities manage stormwater, what are their approaches for using stormwater as resource and what are their regulations in terms of stormwater. We also examine cases where harm is a consequence of lack of stormwater management.

In order to have a better understanding of regulations and protocols concerning stormwater, we need  examine policies and regulations that are in place regarding stormwater in the province of Ontario. We particularly focus on "Ontario provincial policy statement 2014" and other available references such as "Ontario stormwater management planning and design manual" and "Water Pollution Control and Waterworks Regulations".

In the second potion of this paper, we review guidelines form the United States, including Chicago, State of Georgia and California and other places in which they have specific regulations set in place in regards to stormwater management.



# pt 2. ontario's regulations

There are some resources regarding stormwater policies including the provincial policy statement of Ontario (released in 2014), Ontario stormwater planning and design manual (2003) and several other reports provided by other related institutions.

## 2.1 PROVINCIAL POLICY STATEMENT

Within Ontario Provincial Policy Statement, under policy 1.6.6.7, there are some main provisions concerning planning for stormwater management. The policies are based on minimizing the contaminated load, changes in water balance and erosion, property damages, human health and safety risks, maximizing the vegetative and pervious surfaces, stormwater attenuation and re-use and promoting stormwater management best practices and low impact developments [5].

These five provisions are mentioned under planning for stormwater management:

- a) minimize, or, where possible, prevent increases in contaminant loads;
- b) minimize changes in water balance and erosion;
- c) not increase risks to human health and safety and property damage;
- d) maximize the extent and function of vegetative and pervious surfaces; and
- e) promote stormwater management best practices, including stormwater attenuation and re- use, and low impact development"

"Wise use and management of resources" includes:

- h) Ensuring stormwater management practices, minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces.

## 2.2 ONTARIO'S STORMWATER MANAGEMENT PLANNING AND DESIGN MANUAL

Ontario's stormwater manual has a combination of lot level, conveyance and end of pipe management practices to mitigate the negative impacts of stormwater. "Maintaining the hydrologic cycle, protection of water quality, and preventing increased erosion and flooding" are the main purpose of the manual [4]. The strategy of the manual is to control the stormwater on-site (lot level and conveyance control) and manage the stormwater leaving the site (end of pipe control). This manual is provided for individual lot level and conveyance control.

### 2.2.1 Lot levels and conveyance controls

This section contains practices and control methods to increase storage (rooftop storage, parking lot, superpipe and rear yard storage) and infiltration (planting grass, trees and vegetables, making stormwater corridors and directing stormwater to backyard ponds to capture stormwater as much as possible on-site). The purpose is for to reduce stormwater runoff rate during peak hours, which is important to decrease overflows due to stormwater.

### 2.2.2 End of Pipe control

The end of pipe control methods are defined to decrease the impacts of stormwater discharge to waters which come through the stormwater conveyance facilities by treating it. Wetlands, wet ponds, dry ponds and infiltration basins are defined as End of Pipe management facilities.

## 2.3 ENVIRONMENTAL MANAGEMENT AND PROTECTION ACT

In this Act, the only regulation provisions related to stormwater are defined under provision 81(1)(bbb). The provision addresses protecting the environment from harmful effects of stormwater and describes permit requirements for activities related to stormwater.

The 81(1)(bbb) provision states:

- "respecting stormwater and storm water works, including prohibiting any matter or action related to stormwater works and protecting the environment as it is affected by stormwater and requiring the holding of a permit to do any matter or undertake any action related to storm water works and protecting the environment as it is affected by storm water [11]."

The Act also defines the stormwater as "rainwater or water resulting from the melting of snow or ice [11]."

## 2.4 WATER POLLUTION CONTROL AND WATERWORKS REGULATIONS

The water pollution control and waterworks regulations are a set of regulations for water pollution prevention. The storm sewer and stormwater are defined as follows:

- **"Sanitary sewer"** - a system of sewer conduits, sewer drains, sewer mains and sewer pipes in a sewage works that is designed to convey sewage exclusively or principally [11].
- **"Storm sewer"** - a system of conduits, drains, mains and pipes intended to convey storm water exclusively or principally.
- **"Sewage"** - any liquid waste of domestic, commercial or industrial origin containing animal, vegetable or mineral matter in suspension or solution and includes rainwater or storm water that enters any sewage works
- **"Storm water"** - rainwater or water resulting from the melting of snow or ice.

These definitions for stormwater and sewage are the same as those definitions contained within the Environmental Management and Protection Act of 2002. The following are stormwater-related regulations in the "Water Pollution Control and Waterworks Regulations"

- 14 - No permittee shall cause any sanitary sewers and storm sewers to be interconnected in a manner that permits sewage in the sanitary sewer to be discharged through the storm sewer.

Stormwater management is regulated and to permitted by clause 6(1)(d) which states:

- 6(1)The following discharge of contaminants are exempted from Clause 17(a) of the Act:
- (d) Any storm water discharge other than storm water discharge at any industrial operation that has a permit pursuant to clause 17(a) or 17(c) of the Act.
- 17(1) --- (a) all municipal waterworks except, subject to clause (b), municipal wells;
  (b) Municipal wells that are connected to a distribution system; and
  (c) All waterworks, other than municipal waterworks, that have an average flow of potable water, as determined by the department, exceeding 18 cubic metres per 24- hour period, where that determination is based on the three consecutive months having the greatest flow in a year

The act also prohibits the Interconnection of stormwater and sanitary sewers. Section 4(2) discusses discharges prohibitions that may cause an adverse effect [15].

- 4(2): No person shall discharge or allow the discharge of a substance into the environment in an amount, concentration or level or at a rate of release that may cause or is causing an adverse effect unless otherwise expressly authorized pursuant to:
  (a) This Act or the regulations;
  (b) any other Act, Act of the Parliament of Canada or the regulations made pursuant to any other Act or Act of the Parliament of Canada; or
  (c) any approval, permit, license or order issued or made pursuant to:
    (i) this Act or the regulations; or
    (ii) any other Act, Act of the Parliament of Canada or the regulations made pursuant to any other Act or Act of the Parliament of Canada.

# pt 3. federal regulations in the USA

## 3.1 CODE OF FEDERAL REGULATIONS (40 C.F.R 122.26)

The Code of Federal Regulations (CFR) is a set of rules and regulation prepared by executive departments and agencies of federal government of the United States [9]. Title 40 of the code is about Protection of Environmental and under chapter 1 there are Environmental Protection Agency (EPA) regulations.

Section 122.26 of title 40 (part 122 of water programs) presents a detailed program for stormwater discharge NPDES permit requirements. The first part explains the different areas where NPDES permit is required for stormwater discharge. It states that discharges associated with industrial activities, discharges from large and medium municipal separate storm sewer systems and generally discharges which contributes violation of standards for water quality of the United States' waters will need NPDES permit.

Stormwater management regulations are considered as part of United States regulations under NPDES program of water programs of Code of Federal Regulations.

## 3.2 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

The National Pollutant Discharge Elimination System (NPDES) permit program is a regulated permit which is provided to control discharges due to point-source pollutants into the waters in the United States [10]. The NPDES permit will be applied for Industrial, municipal, and other facilities if they discharge directly to surface waters. It was first created under section 402 of Clean Water Act in 1972 to restrict the discharges and dumping of the wastes. It is responsible for the improvement of water quality since 1972 [10]. NPDES improved in 1977 and 1987 during improvement in Clean Water Act. The NPDES permit has been brought under section 122 of the Code of Federal Regulations, EPA Administered Permit Program.

## 3.3 TOTAL MAXIMUM DAILY LOADS (TMDLs)

"A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant [8]". Section 130.7 of title 40 of the Code of Federal Regulations describes TMDLs.

A TMDL contains all point sources (Waste Load Allocations (WLAs)) and non-point sources (Load Allocations (LAs)) pollutants [6]. Under section 303 of CWA (Clean Water Act), States are asked to set a TMDL for pollutants for each water bodies to ensure that they meet the water quality standards [18].

Stormwater forms a part of TMDLs target as it can carry pollutants such as nutrients, pathogens, sediment and metals coming from lands and impervious surfaces into the waters [18]. TMDLs program applies for large and small MS4 systems, construction activities and industrial activities in the United States [18].

Industrial activities are defined as activities related to "manufacturing, processing or raw material storage areas at an industrial plant" (40 CFR 122.26, (b)(14)).

## 3.4 MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4)

Municipal Separate Storm Sewer (MS4) is defined under section 122.26 (Storm water discharges) of Title 40 of Code of Federal Regulation as a conveyance or system of conveyances which are designed to collect or convey stormwater and are not combined.

NPDES permit has authorized different requirements in MS4 permit to combat stormwater related problems such as pollutant discharges, stream erosions, disrupting natural infiltration and feeding of underground water supplies due to developing build environment, impervious surfaces and decreasing vegetations [19].

Based on the EPA's compendium for MS4 permit, 33 states in the United States have developed standards for controlling post construction stormwater discharges, typically by encouraging the use of infiltration, evapotranspiration or harvest practices to control the volume of stormwater [19]. Volume retention provides pollutant load reduction, erosion reduction and "multiple community benefits by treating stormwater as a resource [19]."

**Table 1 - MS4 Permits**

| State | City | Regulations |
|---|---|---|
| Connecticut | Stamford | 2013 Phase I City of Stamford MS4 permit |
| Vermont | | 2012 Vermont general permit |
| New Jersey | | 2009 New Jersey general permit |
| New York | | 2010 New York general permit |
| West Virginia | | 2009 West Virginia general permit |
| Washington DC | | 2011 DC MS4 permit |
| | | 2013 Western Washington Phase II Municipal Stormwater permit |
| | | 2014 Washington State Department of Transportation MS4 permit |
| | Columbia | 2011 District of Columbia Phase I MS4 (DC MS4) permit |
| | Western Washington | 2013 Western Washington general permit |
| Maryland | | State and Federal agencies general permit for small MS4 permit |
| | | Municipalities general permit for small MS4 permit |
| | | Maryland Phase I MS4 permits |
| | Prince George | 2014 Prince George's County MS4 permit |
| | Montgomery | 2010 Montgomery County MS4 permit |
| Delaware | New Castle | 2013 New Castle County MS4 permit |
| Tennessee | | 2010 Tennessee general permit |
| | Chattanooga | 2011 Phase I City of Chattanooga MS4 permit |
| | Nashville | 2012 Phase I City of Nashville |
| Kentucky | Louisville & Jefferson | 2011 Phase I Louisville and Jefferson County MS4 permit |
| Minnesota | | 2013 Minnesota general permit |
| | | Mast List MS4 Permit TMDLs Spreadsheet |
| Wisconsin | | 2014 Wisconsin general permit |
| | Menominee | 2012 Menominee Watershed Permit |
| New Mexico | Albuquerque | 2012 Phase I MS4 permit |
| Montana | | 2009 Montana general permit |
| California | | 2013 California general permit |
| | Los Angeles | 2012 Los Angeles County MS4 permit |
| | | 2012 Los Angeles County system-wide permit |
| | San Francisco | 2009 San Francisco Bay Regional Water Board Municipal permit |
| | San Diego | 2013 San Diego Regional MS4 permit |
| | Orange County | 2009 Orange County MS4 permit |
| Alaska | Anchorage | 2010 Anchorage individual MS4 permit |
| Oregon | Portland | 2011 Phase I Portland MS4 permit |
| Virginia | | 2013 Virginia general permit |
| | Arlington | 2013 Arlington County MS4 permit |
| Pennsylvania | | 2013 Pennsylvania general permit |
| Georgia | | 2012 Georgia general permit |
| Arizona | | 2002 Arizona general permit |
| Arkansas | | 2009 Arkansas general permit |
| Nevada | | 2010 Nevada general permit |

# pt 4. USA: cities and states

## 4.1 THE CITY OF CHICAGO

Chicago is considered to be a leader in the field of stormwater management. It has specific regulations about sewer construction and stormwater management. It is located in the Great Lakes region so it can be a valuable model for policy making for the province of Ontario and other regions of Canada. The Department of water management of the city of Chicago released the newest version of "Regulations for Sewer Construction and Stormwater Management" in March 2014. They have also an ordinance manual for stormwater called "City of Chicago Stormwater Management Ordinance Manual" which was released on March 2014.

The city of Chicago has polices to encourage projects and programs which minimize the negative impacts of stormwater and increases usage of stormwater on-site. Referring to the Chicago's stormwater manual 2014, there are three main provisions in order to mitigate the impacts of new urban development, rate control, volume control and sediment and erosion control. There are specific definitions for each part that determine whether they need to be regulated under the stormwater ordinance manual. In cases where regulations are required, the design requirements are defined as well as are allowable rates and standards. The regulations are both for direct discharge to water bodies and discharge to sewer system. The policy of the city is to encourage and promote programs that:

- Minimize the negative stormwater impacts of new development and redevelopment.
- Protect and conserve land and water resources in conjunction with orderly and responsible property development.
- Prevent pollution of local waters, groundwater, and land.
- Minimize stormwater flows into the combined sewer system by minimizing impervious surfaces, promoting infiltration or discharging to local waters where appropriate.
- Preserve the natural characteristics of stream corridors in order to moderate flood and stormwater impacts, improve water quality, reduce soil erosion, protect aquatic and riparian habitat, provide recreational opportunities, provide aesthetic benefits, and enhance community and economic development.
- Preserve the natural hydrologic and hydraulic functions of watercourses, flood plains, and wetlands.
- Facilitate existing and future intergovernmental agreements for stormwater management.
- Manage stormwater on the site of a Regulated Development to the fullest feasible extent.

Permits are required prior to construction, repair, adjustment, rodding or cleaning of any subsurface structure designed to collect or transport storm and/or sanitary waste water, either on private property, or in the public way. Permits can only be obtained by a licensed drainlayer. A licensed Drainlayer is a person possessing a current Sewer and Drain License issued by the City of Chicago. A license issued by City of Chicago general for business or home repair must be presented at the time of application for a Drainlayer's License.

### 4.1.1 Regulations for Sewer Construction and Stormwater Management

Regulations for Sewer Construction and Stormwater Management released in 2014 contain sewer and stormwater standards, requirements for their management and design parameters. It has discusses illicit connection prohibition. Prohibition of illicit connections is defined to control illicit discharges into storm sewer systems without NPDES permit. There are two separate parts for sewer and stormwater management and design. Stormwater management which is discussed under chapter III is a set of regulations to manage stormwater including rate control, volume control, erosion and sediment control and operation and maintenance requirements. All design requirements, best management practices and standards are provided for rate and volume control. Applicants are able to use existing tables and charts to calculate their maximum allowable release rate and volume, or they can calculate them by submitting their documents for a computerized calculation.

### 4.1.2 City of Chicago Stormwater Management Ordinance Manual

The ordinance explains the need for stormwater management and ways to mitigate its harmful impacts. Construction and development will increase the impermeable areas, reduce the amount of infiltration and cause stormwater runoff. Lack of stormwater management will lead to "increased flooding, combined sewer overflows, degraded water quality, stream channel erosion, hydrologic modifications, and destruction of sensitive habitats and landscapes." [1].
As mentioned in chapter III of the "Regulations for Sewer Construction and Stormwater Management", there are three main provisions to mitigate the impacts of development: Provisions for stormwater management, provisions for sediment and erosion control and Provisions for operations and maintenance [2]. Provisions for stormwater management is divided into two parts: rate control and volume control:

- **Rate control** - rate flow control is required to manage the stormwater leaving the site. To prevent sewer overflows, the rate of stormwater discharge is regulated based on the capacity of the city's sewer system [1]. Rate control will not apply for areas less than 7,500 sqft (like residential units) or directly discharge to waters. Rate control regulations are designed to manage a 100-year storm event. There are regulations for stormwater detention facilities: no more than 400 square feet of impervious surface are allowed without detention. The standards for maximum release rates can be calculated from the provided charts or by submitting documents for a computerized maximum release rate calculation [3].
- **Volume control** - the volume control is to manage the stormwater onsite so a certain amount of stormwater is permitted to leave the site while the rest is planned to be infiltrated or evaporated on the site. The volume control ensures that ground water will be recharged and with the aim of reducing hydrologic modification. Under section 3 (volume control) of the ordinance manual it is mentioned that **"the city encourages developments to treat stormwater as a resource rather than diverting it off site as quickly as possible".**

## 4.2 THE STATE OF CALIFORNIA

The State of California has several regulations for stormwater in construction, industrial and municipal areas. In each part there are definitions of the targeted area, pollution prevention technologies and relevant regulations [14].

The 2013 California general permit, 2012 Los Angeles County MS4 permit, 2009 San Francisco Bay Regional Water Board Municipal Permit and 2013 San Diego Regional MS4 permit are some examples of stormwater management regulations in the state of California.

### 4.2.1 California State Water Resource Control Board

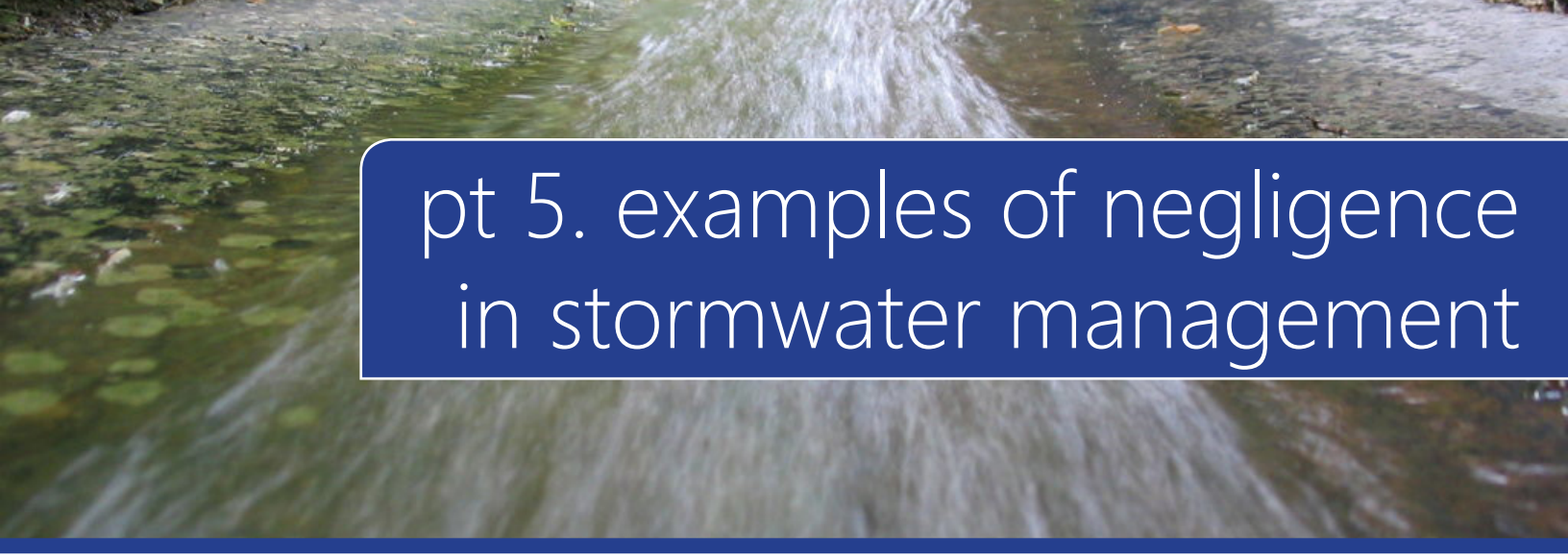
The "California state water resource board" provides a definition of stormwater which divided to "stormwater discharge" and "non-stormwater discharge". The board has defined the "stormwater discharge" as only those discharges originated from participation events while the "non-stormwater discharge" consists of all discharges from an MS4 that do not originate from participation events. The exact definition of the stormwater by the board is based on its definition in Code of Federal Regulations (40 C.F.R. § 122.26(b)(13)) as storm water runoff, snowmelt runoff, and surface runoff and drainage [6].

### 4.2.2 California Code of Regulations (CCR)

The California Code of Regulations contains different areas of legislations and policies like the Code of Federal Regulations. Title 23 of the Code targets water related regulations and including stormwater regulations mentioned in part. 23 CCR § 492.15. This code discusses stormwater management approaches, minimizing runoff, increasing infiltration and improving water and groundwater quality. It encourages implementation of stormwater best management practices which some examples include: (23 CCR § 492.6 Landscape Design Plan [20]).

- (A) Infiltration beds, swales, and basins that allow water to collect and soak into the ground;
- (B) Constructed wetlands and retention ponds that retain water, handle excess flow, and filter pollutants; and
- (C) Pervious or porous surfaces (e.g., permeable pavers or blocks, pervious or porous concrete, etc.) that minimize runoff [20]"

Title 23 (water) of the code has also discussed stormwater management practices to meet TMDLs requirement for each water bodies in all regions of California.



# pt 5. examples of negligence in stormwater management

The following are some examples of cities that suffered negative consequences due to neglecting stormwater management in their water management programs. The number of lawsuits against municipalities is growing (group claims through class actions) [12].

**Table 2 - Financial Consequences of Neglecting Stormwater Management**

| City or Region | Cases | Financial Loss |
|---|---|---|
| City of Stratford [13] | A settlement due to a class action against the city because of flooding in 2002. | $7.7 million |
| City of Thunder Bay [13] | Complaint against the city because of not properly construction, maintenance and operation of stormwater infrastructures | $375 million |
| City of Mississauga [13] | Plaintiffs allege repeated flooding of basement and other surface areas which causes damage | |
| Puget Sound Region [21] | Drainage maintenance and flood control | $1.5 to $4.6 million annually |
| | Improving the water quality of a single watershed due to a single contaminant | $1 million |
| | Treatment costs for storm-water discharge | $400,000 to $7 million |
| | Restoration projects associated with stormwater discharges | $570,000 to as much as $100 million |

# pt 6. human risks and environmental protection

In order to have a better understanding of harmful effects of ignoring stormwater management, it is beneficial to take a look into the costs of stormwater damages. Visitacion et al investigated the cost and benefits of stormwater management for Puget Sound region in the state of Washington [21].

The article divided the impacts of stormwater damages costs into four main categories, "flooding and property damage, water-quality degradation, destruction of estuarine and freshwater habitat, and natural resource losses".

Urbanization causes more impervious areas which can lead to stormwater runoff without appropriate management [22]. Decreasing the amount of infiltration not only disrupts groundwater supply but can also cause more frequent flooding and potential damage to public and private properties [22]. Stormwater can also be a major source of water pollution [22] which has implications for public and wildlife especially for communities who need surface water for their drinking water [23].

Stormwater overflow is an important consequence of inappropriate stormwater management. During heavy rainfalls or snowmelts combined sewer overflows (CSOs) directly discharges untreated human and industrial wastes, toxic materials and debris into the nearest water body [24].

# pt 7. conclusion and recommendations

The purpose of integrated stormwater management is to ensure the health, safety and welfare of citizens, enhance and protect the water quality (City of Monterey Stormwater Ordinance [25]), preventing harmful effects of polluted runoff for the environment, ensuring of groundwater recharge and better use of stormwater as a water resource.

In this paper we described current rules and regulations concerning stormwater management. The United States have rules, permits, ordinances and manuals to ensure an appropriate stormwater management. The City of Chicago and the State of California are two very good examples that implement stormwater management plans in both municipal and state level and define stormwater as a "resource" in order to develop integrated stormwater management.

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