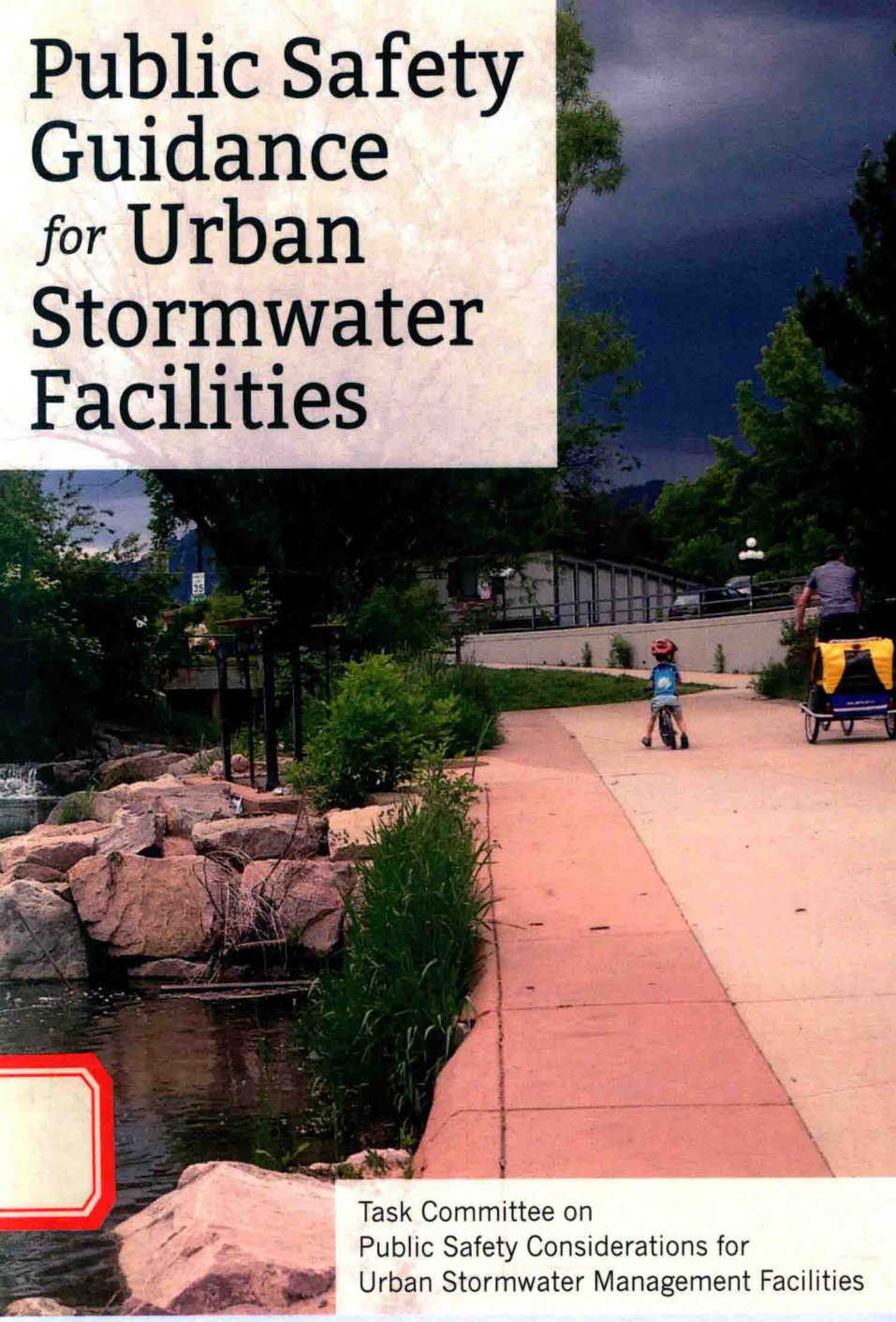
Public Safety Guidance *for* Urban Stormwater Facilities



Task Committee on
Public Safety Considerations for
Urban Stormwater Management Facilities

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Public Safety Guidance for Urban Stormwater Facilities

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Sponsored by

The Urban Water Resources Research Council
of the Environmental and Water Resources Institute
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Preface

The purpose of this document is to provide guidance for protecting public safety at urban stormwater management facilities, such as ponds, channels, water quality control measures (also widely referred to as best management practices, or BMPs) and low-impact development (LID) features, to engineers, landscape architects, land planners and other stormwater professionals. This guidance applies to the planning, design and operation/maintenance (including inspections) of such facilities. This guidance is conceptual and provides general observations and recommendations.

Unless site-specific circumstances clearly indicate otherwise, stormwater professionals should assume that members of the public will visit and interact with stormwater facilities in urban areas. People like to be around water, to be involved with it and to become stewards of it. Surveys have shown that properties adjacent to attractive, well-maintained water bodies hold a premium value. The hazards posed to the public by such facilities should be anticipated, discussed with relevant public and private parties, evaluated and mitigated as appropriate. Public education on the purpose of stormwater facilities and their potential dangers (including mitigation) is essential.

The cosponsors of this document recognize that it is impractical, if not impossible, to provide zero risk at stormwater management facilities. As with any other type of public works infrastructure, there are inherent risks associated with conveying, storing, treating and otherwise managing stormwater, and there are practical constraints related to budgets, appearance, access and other factors that preclude complete public protection. Also to be considered is that there are inherent risks associated with natural water bodies. However, failure to consider public safety is not consistent with the standard of care that professional engineers, landscape architects, planners and other stormwater and public works professionals are entrusted to uphold. Similarly, regular inspection and maintenance are essential to ensure that stormwater management facilities function safely and perform as designed. The American Society of Civil Engineers/Environmental & Water Resources Institute/Urban Water Resources Research Council (ASCE/EWRI/ UWRRC), the National Association of Flood & Stormwater Management Agencies (NAFSMA), the American Public Works Association (APWA), the Water Environment Federation (WEF), the American Water Resources Association (AWRA), the American Planning Association (APA) and the American Society of Landscape Architects (ASLA) recommend that protecting public safety should be a key objective when planning, designing, inspecting, operating and maintaining urban stormwater management facilities.

Contents

Chapter 1
Purpose and Overall Perspective

The purpose of this document is to provide guidance for protecting public safety at urban stormwater management facilities, such as ponds, channels, water quality control measures (best management practices, or BMPs) and low-impact development (LID) features, to engineers, landscape architects, land planners and other stormwater and public works professionals. This guidance applies to the planning, design and operation/maintenance (including inspections) of such facilities. This guidance is conceptual and provides general observations and recommendations.

The cosponsors of this document represent a broad coalition of public and private sector engineers, planners, landscape architects, regulators, public works staff and others who regularly practice in the areas of urban stormwater management, flood control and water quality protection. The cosponsors have previously published literature that provides suggestions for enhancing public safety. Representative excerpts are provided in Appendix A. Many general engineering, planning and landscape architecture references discuss public safety; examples are found in Appendix B. Appendix C contains photographs of both safe and unsafe stormwater facilities, while Appendix D contains example conceptual design drawings related to public safety.

As shown in Figures 1 and 2, potential hazards to the public can be apparent (such as overly steep side slopes, lack of escape route and maintenance access and high-velocity discharges onto a steep drop into a detention basin), but hazards can also be far more subtle. By contrast, Figure 3 provides an example of a facility that was designed with safety in mind; this stormwater retention pond has safety provisions, including mild, well-vegetated side slopes and a gentle drop-off below the water level, and it has trails safe for public use, receives regular maintenance, and is attractive, which promotes regular public use and thus improves safety and contributes to economic, environmental and community benefits.

This guidance addresses a wide range of safety issues and considerations. Safety considerations are site specific in nature and should be evaluated on a case-by-case basis.

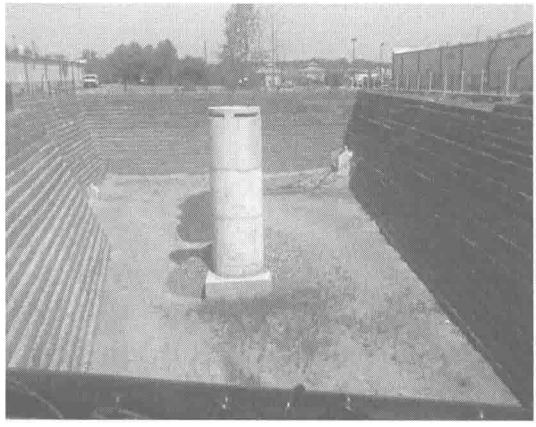

Figure 1. Dry Detention Basin with Safety Concerns Due to Steep Side Slopes and No Egress or Escape Route

Source: James Lenhart, P.E., D.WRE; reproduced with permission.

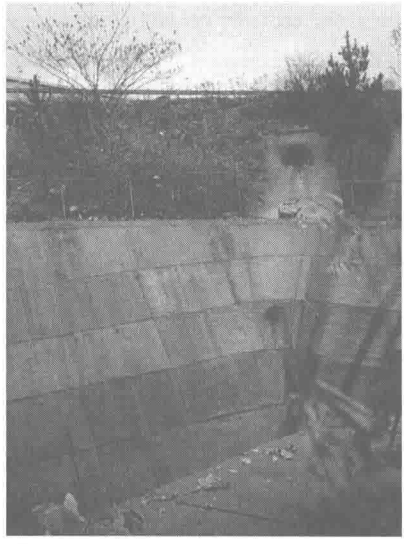

Figure 2. Dry Detention Basin, Culvert and Rundown with Safety Concerns Due to Steep Side Slopes and No Egress or Escape Route

Source: Robert Pitt, Ph.D., P.E., BCEE, D. WRE; reproduced with permission.

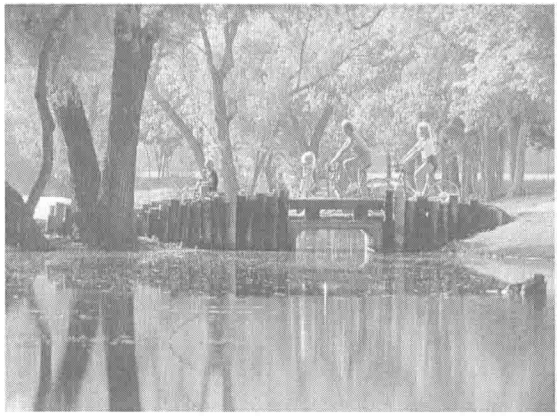

Figure 3. Stormwater Retention Pond with Safety Features

Source: Jonathan E. Jones, P.E., D.WRE; reproduced with permission.

Chapter 2
Background and Scope of Guidance

2.1 Representative Facilities Addressed

Representative urban stormwater management facilities that this guidance document addresses include:

- Open channels and waterways, including both manmade and modified natural channels.
- Structures within or immediately adjacent to open channels, such as grade control/drop structures, low-head dams, weirs, low water crossings, trails and pedestrian bridges.
- Closed conduits such as storm drains, culverts, long underground pipes, inverted siphons and related facilities such as inlets, outlets and energy dissipaters.
- Impoundments with a permanent water surface (commonly called "retention ponds" or "wet ponds") and without a permanent water surface (commonly called "detention basins" or "dry ponds") and features such as dam embankments, spillways, inlet and outlet structures, energy dissipaters, surrounding slopes, forebays, micropools, railings, debris barriers (trash racks) and related facilities.
- Other water quality control measures (BMPs) such as wetlands, infiltration basins, swales, filter strips and techniques collectively referred to as "low impact development" (LID), such as rain gardens and bioretention facilities.
- Public trails and bridges adjacent to channels, ponds and other features.

2.2 Scope of Guidance

This guidance applies both to larger, regional facilities that typically serve multiple properties and to small onsite facilities that serve individual properties. The focus is on post-construction facilities of all types, including best management practices (rather than construction BMPs), and on separate storm sewer systems (rather than combined sewer systems) although some recommendations are transferable. Many of the design guidelines primarily apply to new or reconstructed (retrofitted) facilities; however, many recommendations also apply to existing facilities.

The authors of this document have generally not provided hard and fast design criteria, such as keeping the product of depth and velocity less than a prescribed factor. Such a quantity could have unintended consequences, such as discouraging the use of open channels with the many associated benefits that such facilities often provide to communities. Instead, the cosponsors urge that safety considerations be evaluated on a site-specific basis.

Public safety risks associated with structural or geologic/geotechnical failures are not addressed in detail herein, nor are requirements related to flood control facilities such as levees and large dams (small earthen embankments are discussed in Section 4.7). Urban stormwater runoff often has pollutants that can adversely affect public health, such as bacteria, viruses and trash (diapers, hypodermic needles, hazardous material containers, etc.), and this aspect of safety is only briefly reviewed.

Facilities may involve safety risks extending beyond those inherently associated with stormwater and associated control structures or practices. For example, additional safety risks may arise from facility placement in locations that are secluded (due to lack of visibility) or otherwise attractive to criminal elements. Numerous physical risks may be inherently associated with any facilities, arising from sharp edges, confined spaces, soft or unreliable footing, slippery surfaces, uneven ground, abrasive or hard surfaces, and so on. Such risks are not addressed in detail in this document.

This document is intended for use by those with professional competencies sufficient to enable its proper interpretation and application within the current state of professional practice regarding stormwater facilities. It is not intended to be useful to, or used by, those without such qualifications.

Contributors to this guidance document from the American Planning Association and American Society of Landscape Architects emphasize that many of the public safety measures described herein are consistent with good urban design and can promote the following objectives (Hopper 2006):

- Enhancing the local economy
- Connecting the community physically and socially
- Providing a diversity of options and experiences
- Creating an equitable, comfortable and welcoming environment
- Retaining the character of the community and creating a sense of place
- Making the community sustainable, enduring and resilient
- Making the community safe and suited to the needs of everyone, including disabled and elderly people
- Making the community walkable and bikeable
- Providing for custodianship, management and maintenance over time
- Preserving historic facilities

Legal considerations are not discussed in detail, although there are references to this topic (including "attractive nuisances"), especially in Appendices A and B. Legal/liability issues vary significantly from locality to locality. Litigation is, by definition, case specific, and dependent on facts unique to the incident in question. Stormwater facility owners, planners/designers and those charged with inspection and maintenance should be cognizant of potential liability if their actions are found to not

meet a reasonable standard of care and should utilize risk management practices (anticipating risks and managing them).

2.3 Examples of Safety Hazards

Examples of potential causes of failures, accidents and threats to public safety (and in some cases to maintenance workers) include the following. This list is not complete, but it attempts to illustrate the range of issues that may be encountered.

- Pond and channel side slopes that are overly steep and prevent reasonable access and egress (escape), and which are hazardous for maintenance staff who may be using heavy equipment such as lawn mowers.
- Ponds that lack safety benches and which have underwater slopes that "drop off" rapidly.
- Inadequate or inappropriate use of fencing and railings, or poor maintenance that compromises their function.
- High-velocity and rapidly rising flow in channels that are publicly accessible and that include bicycling and walking trails in close proximity. Static and dynamic forces that can act upon a person in a stormwater facility can be overwhelming and are generally not recognized by the public. Appendix B contains guidance on how to calculate such forces, as do various other references cited herein.
- Low water crossings along roadways, usually in rural areas. When these crossings are inundated with flood flows, flow can readily move a car and possibly undermine the roadway, posing great danger to the vehicle's occupants.
- Localized flooding or standing water or ice, which interferes with foot, bicycle or vehicle traffic.
- Flowing water across grassy areas (causing erosion and rilling) where pedestrian traffic can reasonably be anticipated.
- Water accumulation/ponding due to poor hydraulic design of storm drainage facilities at roadway underpasses, low water crossings and other "sag" locations.
- Unprotected culvert and pond inlets and pond outlet structures (lacking trash racks), including long conduits, particularly where pipe inlets are inundated frequently and for prolonged periods.
- Roadside ditches with high, steep banks and inadequate guardrails, signage and/or lighting.
- Below grade roadway conduits that double as pedestrian access and that are subject to inundation.

- Low head dams, weirs and grade control structures that have unsafe hydraulic conditions (and that create "keepers" [reverse rollers] from which escape can be very difficult).
- Standing water (for more than 3 days) that is conducive to mosquitoes and the diseases they transmit. Mosquito infestations can be aggravated by trash that accumulates.
- Ponds or channels that have synthetic or clay liners that either are not covered with a material that enables solid footing or become covered with algae and silt and are slippery.
- Inverted siphons in irrigation or drainage canals that receive runoff and that are not properly signed, roped off, etc., and that lack safety racks.
- Facility inflow and outflow pipes that are directly across from and in close proximity to each other, creating a zone of high forces.
- Structural or geotechnical problems at detention/retention pond dams or at highway culverts that can cause embankment failure.

Table 1 provides representative news headlines pertaining to safety incidents at urban stormwater management facilities. Although news coverage of episodes such as those referred to in Table 1 increases public awareness of the hazards of stormwater facilities, this heightened awareness is usually limited to the local area and short-lived; in general, the public does not have a proper appreciation for the hazards posed by these facilities and by natural water bodies.

Table 1
Representative News Headlines
Regarding Public Safety Incidents at Stormwater Facilities
and Urban Waterways

Headline	Source and Date
Third Victim Found Dead as Flood Warnings Remain in Sodden San Antonio	NBC News. May 28, 2013
Crews Recover Teen's Body from Big Sioux River	KOTA News (Sioux Falls, South Dakota) March 15, 2013
Five-year-old Renton Girl Nearly Drowns in Detention Pond; Is Fence the Answer?	pnwlocalnews.com (Renton, Washington) June 28, 2012
A Harrowing Journey	*Stormwater Magazine* Editorial June 26, 2012
Missing Leesburg Man Drowns in Drainage Pond	*Loudoun* (Virginia) *Times.com* May 22, 2012
2 Walnut Creek Teens Drowned in Treacherous Stream	*San Francisco Chronicle* February 23, 2011
Lawrenceville Mother Pleads for Help before Drowning in Her Car	*Atlanta Journal Constitution* September 23, 2009
Vigilance Only Line of Defense at Retention Ponds	*Columbus Dispatch* May 10, 2007
Suction in Texas Decorative Pool Apparently Pulled Four to Bottom	*USA Today* June 18, 2004
Boy Found in Retention Pond Dies	TheDenverChannel.com May 13, 2003
Drowning Sparks Protest of Pond	*St. Petersburg Times* June 17, 2001
City Worker Dies after Being Sucked into Drain	*New York Times* March 3, 2001
Teen Friends Drown in Culvert, Storm Runoff Trapped Boys under Water	*Cincinnati Enquirer* September 25, 2000
Denver firefighter dies in flood after saving trapped woman	*Deseret News* August 18, 2000
Tragedy of Girl Drowned in Drain Pipe	*The Oxford* (England) *Mai* May 4, 1998
Parents Pray Son's Death a Message	*The Cincinnati Post* August 21, 1997
Body of Boy Found in Drainage Ditch, Raging Waters Fill Area Culverts during Storm	*Colorado Springs Gazette* August 6, 1997
Man Drowns after Being Swept over Dam	*Springfield* (MO) *News-Leader* (undated)

Chapter 3
Recommendations for Integrating Public Safety into Stormwater Facility Planning, Design, Operation and Maintenance

3.1 Factors Affecting Approach to Public Safety Protection

Circumstances involving public safety are site-specific in nature and depend on factors such as:

- What level (or levels) of risk will a particular structure pose?
- Does the proposed design envision areas where access is encouraged (such as wading zones), discouraged (where fencing or other measures might be employed) or prohibited (such as inlets to siphons)?
- Is access to the site controlled or not?
- Land use setting. Is regular public access and use of the facility likely because it is in a residential neighborhood or near a school, trail, playground, park or library?
- New facilities vs. retrofitting vs. simply maintaining existing facilities.
- Local standards, criteria, recommendations and design guidelines in literature (see Appendices A and B for examples of safety recommendations from the engineering, planning and landscape architecture literature).
- State or federal laws and regulations that may apply directly or indirectly, such as the Americans with Disabilities Act (ADA) or regulations promulgated by state/federal highway departments and agencies.
- Public comment during planning, design and after the facility is in operation. Public works departments can learn of safety issues from public comments.
- Intent of original designer—is facility being operated and maintained in accordance with original design drawings and associated documentation, including goals and objectives?
- History of public interaction with existing facilities; for example, are children known to play in an existing channel or pond that is being modified? Have accidents occurred at the location of interest?
- Topographic, geologic and hydrologic characteristics (including rainfall characteristics) of tributary drainage area.
- Legal considerations, including local legal precedents that may be pertinent.
- Capital and operation and maintenance costs, and available funding (and funding constraints).

When planning, designing, inspecting and operating/maintaining stormwater facilities, site-specific factors of this kind should be carefully considered and accounted for. In addition, the close interdependency among public safety practices, including emergency access, frequency of inspections/maintenance and facility appearance should be recognized. In general, safe facilities are regularly inspected and maintained and are visually appealing (or at least are not eyesores). By contrast, facilities that fall into disrepair and are unsightly often pose public safety concerns. The photographs in Appendix C provide examples of this.

3.2 Practices for Protecting Public Safety at Urban Stormwater Management Facilities

Experience has shown that a wide variety of general practices can be adopted to reduce public safety risks at urban stormwater facilities. Examples are provided in Table 2; however, this table is not intended as a checklist for all projects. The use of the listed items needs to be considered in light of local conditions, the intent of the facility, its design features and multiple other factors, as not all items on the list are appropriate for all facilities. Section 3.3 provides guidelines for specific kinds of facilities, such as ponds and channels. Specific issues such as mosquito management and appropriate use of fencing are addressed in Section 4. Appendix C provides photographs related to public safety, while Appendix D provides conceptual design drawings for various facilities.

In general, land planners, landscape architects and engineers are encouraged to plan and design attractive, multiple purpose facilities that appeal to the public and are regularly used. Facilities of this kind are generally well maintained, regularly observed, viewed as amenities and less likely to be vandalized, all of which promote public safety.