Chapter 1

A Stream Protection Strategy

Introduction

Urban streams are arguably the most extensively degraded and disturbed aquatic system in North America. Research over the last two decades has revealed that urban development has a profound impact on the hydrology, morphology, water quality and biodiversity of urban streams (Table 1). The quality of an urban stream depends on the interaction of many different physical and biological processes, each of which is strongly influenced by the degree of impervious cover present in its contributing watershed (Fig. 1).

Urban stream degradation is a classic example of the difficulty in addressing long–term environmental change at the local level. Development is a gradual process that spans decades and occurs over a wide region of the landscape. It is, however, composed of hundreds of individual development projects completed over a much shorter time–span, which transform just a few acres at a time. Consequently, the true scope of stream degradation may not be fully manifested at the watershed scale for many years. The challenge for local planners is that they must review and mitigate the impact of each individual development proposal over the long term within a watershed context.

When viewed from the air, headwater streams dominate the landscape (Fig. 2). Their scale, proximity, and vulnerability to changes in land use make them an excellent choice for local water resources management. Indeed, the preferred geographic unit for local planning is the subwatershed, which drains a small network of individual streams.

The stream protection strategy outlined in this chapter attempts to provide a coherent framework for effective environmental regulation at the local level throughout the development process. The approach focuses on the comprehensive protection of headwater stream quality throughout the entire development cycle, utilizing an integrated review process.

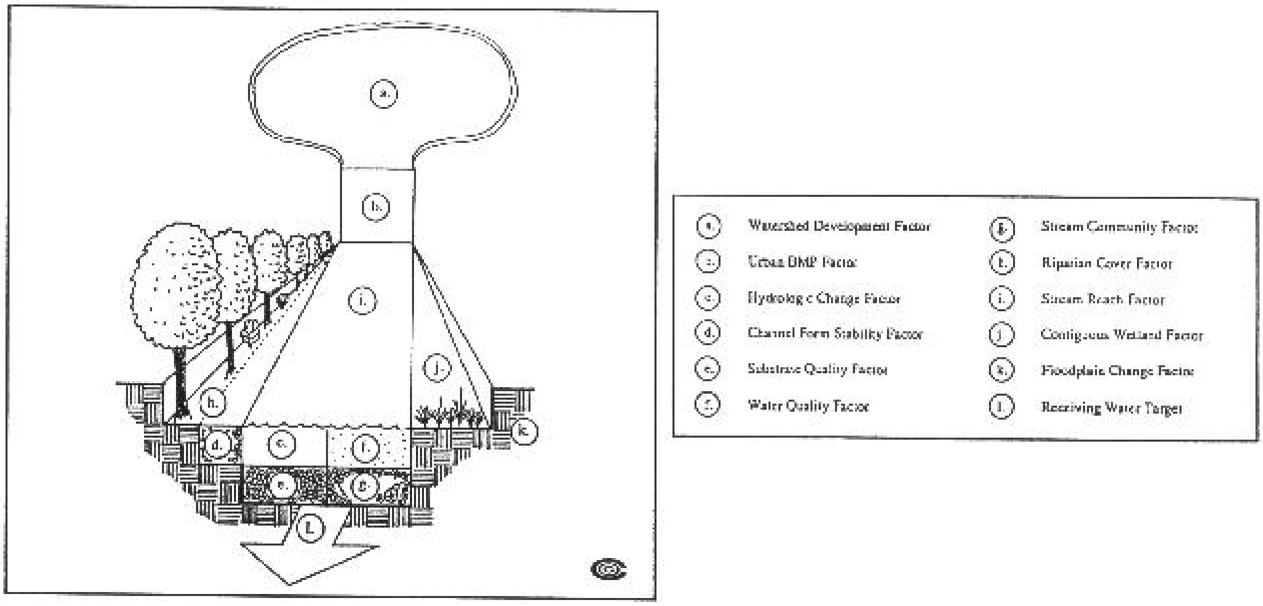
Seven Elements of an Effective Stream Protection Strategy

Communities have tried to deal with the complex range of impacts on streams by adopting an equally complex series of regulations and criteria to govern the development process. However, these measures have often been less effective than anticipated. A major reason for this failure has been the tendency to regulate a single impact at only one stage of development. Until recently, few communities have tried to craft a comprehensive stream protection strategy over the entire development cycle, from watershed–based zoning to its ultimate realization in the construction of individual development projects.

TABLE 1: SUMMARY OF IMPACTS ASSOCIATED WITH URBAN STREAMS

Changes in stream hydrology	**Changes in stream morphology**
Increased magnitude/frequency of severe floods Increased frequency of erosive bankfull and sub–bankfull floods Reduced groundwater recharge Higher flow velocities during storm events	Channel widening and downcutting Streambank erosion Channel scour Shifting bars of coarse sediments Imbedding of stream substrate Loss of pool/riffle structure Stream enclosure or channelization
Changes in stream water quality	**Changes in stream ecology**
Sediment pulse during construction Nutrient loads promote stream and lake algal growth Bacterial contamination during dry and wet weather Higher loads of organic matter Higher concentrations of metals, hydrocarbons, and priority pollutants Stream warming Trash and debris jams	Shift from external production to internal production. Reduced diversity of aquatic insects Reduced diversity of fish Creation of barriers to fish migration Degradation of wetlands, riparian zones and springs Decline in amphibian populations

FIGURE 1: KEY PROCESSES THAT CONTRIBUTE TO URBAN STREAM QUALITY



A stream is more than the water flowing between the banks. Many physical and biological factors interact to produce stream quality.

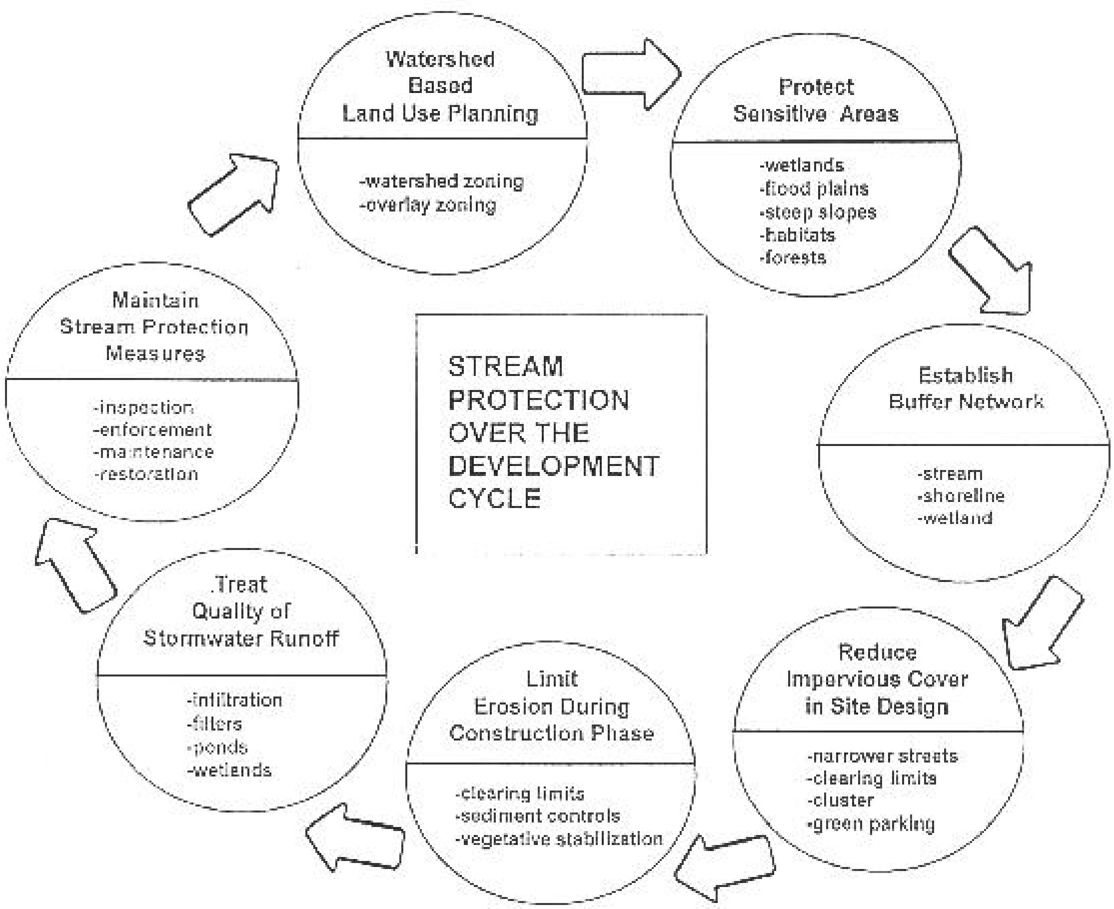
FIGURE 2: HEADWATER STREAMS IN THE URBAN LANDSCAPE

One such approach is described below. The local stream protection strategy has seven primary components that roughly correspond to normal stages of the development cycle (Fig. 3).

1. Watershed-based zoning

The future quality of an urban stream is fundamentally determined by the broad land use decisions made by a community. It is

FIGURE 3: THE STREAM PROTECTION STRATEGY AND THE LOCAL DEVELOPMENT CYCLE



The seven elements of an effective local stream protection strategy roughly follow each stage of the development cycle - from zoning, planning, site design, construction, stabilization, and final occupancy.

therefore essential that the impact of future development on streams be seriously assessed during the zoning or master planning process. The most appropriate planning unit for this assessment is the watershed or subwatershed. On the basis of the forecasted level of impervious cover, it is possible to devise effective and achievable strategies for stream protection (Chapter 3).

2. Protect sensitive areas from development

The second component of a local stream protection strategy involves the adoption and enforcement of ordinances that prevent development from occurring in key natural areas, such as streams, wetlands, floodplains, steep slopes, mature forests, critical habitat areas and shorelines. The ordinance describes how these sensitive areas will be delineated at each site and outlines how they are to be protected during the site planning, construction and post–construction stages. Some guidance on effective performance criteria to protect sensitive areas can also be found in Schueler (1994).

3. Establish stream buffer network

To fully protect urban streams, it is necessary to establish a wide forested buffer adjacent to the stream channel. The buffer network can be regarded as the right–of–way for a stream, and is an integral element of the stream itself. A forested buffer provides shade, woody debris, leaf litter, streambank protection, pollutant removal, and a multitude of other functions and services to the stream. Given its key importance, extensive guidance is provided later in this manual on how stream buffers are designed and enforced (Chapter 5).

4. Modify subdivision code to reduce creation of impervious cover

A key objective in any site plan is to reduce the impervious cover created by the development. Less impervious cover translates into less stormwater runoff and lower pollutant loadings. Planners and landscape architects can utilize a wide range of site planning tools to minimize impervious cover. Some of these tools are summarized in Table 2. In many cases, full utilization of these tools is limited by outdated local zoning regulations or inflexible subdivision codes.

Indeed, existing subdivision codes often result in the creation of needless impervious cover, in the form of wide streets, expansive parking lots, and large–lot subdivisions. Much of this guide is devoted to exploring the potential for narrower streets, green parking lots and clustered subdivisions.

5. Limit the disturbance and erosion of soils during construction

Perhaps the single most destructive stage in the entire development process occurs when vegetation is cleared and the site is graded to achieve a more buildable landscape. The potential impacts to a stream are particularly severe at this stage: trees and topsoil are removed, soils are exposed to erosion, steep slopes are cut, natural topography and drainage are altered, and sensitive areas are often disturbed (Corish 1995).

TABLE 2: STRATEGIES TO MINIMIZE IMPERVIOUS AREA AT THE SITE LEVEL (ADAPTED FROM WELLS 1994, SCHUELER 1994, PZC, INC. 1992)

1. Reduce residential road widths	13. Vertical parking structures
2. Shorter road lengths	14. Require open space/green space
3. Cul-de-sac donuts	15. Require buffers
4. Disconnect roof leaders	16. Swales rather than curb/gutters
5. Cluster development	17. Encourage runon to pervious surfaces
6. Angled parking	18. Commercial open space landscaping
7. Smaller parking stalls	19. Sidewalks on one side of street
8. Reduced parking ratios for some land uses	20. Reduce setbacks and frontage
9. Shared parking and driveways	21. Flexible minimum lot sizes
10. Shorter residential driveways	22. "Hourglass" streets
11. Reduced cul-de-sac radii	23. T or V shaped turnarounds
12. Taller buildings (with higher FAR ratios)	24. Permeable spillover parking areas

Thus, the fifth component of an effective stream protection strategy is reduction of the massive sediment pulse that inevitably occurs during the construction stage, through a combination of clearing restrictions, erosion prevention and sediment controls. Traditionally, many communities have focused on enforcing erosion and sediment control plans at construction sites, primarily through structural practices and temporary seeding (Goldman et al. 1986). The value of non–structural practices for erosion control, such as clearing restrictions, construction sequencing, footprinting, and forest conservation, is increasingly being recognized (Corish 1995, Horner et al. 1994).

6. Treat the quantity and quality of stormwater runoff

The sixth component of the stream protection strategy involves the installation of urban stormwater BMPs to treat the quality and quantity of runoff generated by impervious surfaces. Stormwater BMPs include ponds, wetlands, filters and infiltration systems that are designed to replicate predevelopment stream hydrology and water quality. While many recent advances have been made in stormwater BMP design, most can only partially mitigate the impacts of development on streams (Horner et al. 1994; Schueler et al. 1991). Stormwater BMPs are a simple structural solution to a complex problem and cannot be expected to compensate for a lack of watershed planning, poor site design, or the absence of a stream buffer network. Indeed, a poorly designed or located stormwater BMP can create as many environmental problems as it was intended to solve. Lastly, stormwater BMPs requires an ongoing commitment to maintenance to keep the performance and longevity. Many communities have failed to recognize the long–term cost burden of stormwater maintenance.

7. Maintain stream protection infrastructure

The last element of a local stream protection strategy involves a concerted effort to inspect, maintain and restore the stream protection "infrastructure" (i.e., the structural and non–structural measures indicated in Steps 1 to 6). This can involve the maintenance of stormwater BMPs, enforcement of buffers, or restoration of streams. This stage is often the weakest element of a local stream protection strategy. It is also one of the most important, as the stream protection infrastructure must continue to function properly over many decades to achieve the desired level of stream protection.

Two other steps are also essential to maintain stream quality after a watershed is developed. The first involves public outreach efforts to educate residents on how they can prevent pollution in the watershed (through reduced fertilizer/pesticide use, disposal of household hazardous wastes, etc.). The second step involves periodic monitoring of stream quality to provide feedback to watershed managers and the public on how well the stream protection strategy is achieving its objectives.

Advantages of the Stream Protection Strategy

Many communities have discovered that the stream protection strategy is a better alternative than conventional development regulations. Perhaps its greatest merit is that it is **resource–driven**. Its primary objective is very clear—the quality of urban streams and their associated resource components is to be maintained or enhanced. The stream protection objective is tangible, measurable and understandable to all the participants in the local development review process.

The strategy is directly linked to the local development review process by making stream protection a priority during all stages of the development process—from the conception of how the landscape is to be altered, through the planning, design and construction of individual projects, to the maintenance of the stream infrastructure after it is completed. Each step of the development process only proceeds when it can be reliably determined that the impacts of the development on the stream are minimal. As such, the strategy sets high performance criteria that explicitly recognize how difficult it is to maintain the quality of headwater streams in the face of development pressure.

A third benefit of the strategy is that it typically requires an interdisciplinary approach during development review. Each development proposal must be assessed in terms of all of its short– and long–term impacts to the stream. Thus, plan reviewers must be skilled in many disciplines in order to craft a development plan that produces minimal change to the hydrology, morphology, water quality, habitat structure and biodiversity of the stream.

The last advantage of the strategy is that it presents a clear and practical **management** approach towards local development. When administered properly, the strategy can greatly streamline the local review process, reduce administrative burdens on local government, and be fully responsive to the needs of the development community for clear direction, timely review and cost reduction.

The Stream as the Primary Focus of Protection

Why are streams such a primary focus for protection? As noted earlier, headwater streams integrate all aspects of the environment. When a watershed is transformed, the first impacts are often seen in the headwater stream. Beyond their intrinsic value as a sensitive environmental indicator, headwater streams are a very useful unit for local environmental management for a number of reasons.

1. Many communities have found that stream protection is a very clear, easily understood and well supported local resource goal.

The public intuitively understands the goal of stream protection. Quite simply, there is a stream in everyone's backyard. Once educated about their backyard streams, most residents place a high value on them. This can translate into the popular support needed to develop and maintain funding for stream protection.

2. Headwater streams exist on the same general scale as development.

A headwater stream is seldom located more than a quarter mile away from a development site. Consequently, it is possible to directly link stream protection goal with the impacts generated by an individual development project. By contrast, it is much more difficult to relate impacts from individual development sites to broader regional water quality resources, such as a large lake, river or estuary.

3. Headwater stream protection also provides reliable insurance that downstream water resource objectives can generally be achieved.

Streams are the "narrowest door" in the water system. If a community cannot protect the quality of its headwater streams, it cannot reasonably expect to maintain the quality of downstream lakes, rivers or estuaries. Over time, the cumulative impact from hundreds of individual development sites will slowly degrade water quality at the regional scale. If headwater streams are properly protected, a community can be more confident that downstream water quality can be maintained.

The Role of Site Planning in Stream Protection

At first glance, many communities may feel that implementation of the stream protection strategy is a rather daunting challenge. In an era of fiscal austerity, some communities may reasonably question whether they possess enough financial, staff and political resources to successfully carry it off. While the stream protection strategy does require a strong local commitment, it is primarily a management approach to better organize *existing* staff resources and programs around a common objective. The stream protection strategy also recognizes that many existing local development regulations actually work against the goal of stream protection. Therefore, the strategy is *not* intended to produce more rules and regulations to govern development. Rather, it seeks to reform and simplify existing ones, and substitute flexible performance criteria in the place of rigid and uniform standards.

Thus, the first step in implementing the stream protection strategy usually involves a critical analysis of existing subdivision codes and related development criteria. Nearly every community in America has a subdivision code that regulates the density and geometry of development, specifies road widths, parking and drainage requirements, and defines resource protection areas. In many communities, subdivision codes routinely exceed several hundred pages. Often known as the "cookbook," these lengthy codes contain a series of restrictive and uniform standards that govern all aspects of development, and trigger a complex site planning process. These requirements virtually tie the hands of the architects, landscape architect or engineers involved in design and site planning for new developments. While the exact standards often vary, most subdivision codes contain some kind of rigid standard within each zoning category that mandate:

- equal sized or shaped lots
- minimum lot sizes
- frontage requirements
- fixed setbacks for front, back and side yards
- road widths and needed right of ways
- road turnarounds
- sidewalks and pedestrian access
- residential and commercial parking space requirements
- prohibition of common or shared facilities, such as driveways and septic systems
- curb/gutters and storm drains
- stormwater quantity or quality practices
- grading to promote positive drainage

Subdivision codes have evolved to their present level of complexity over the last few decades in response to an increasingly diverse list of community concerns. Chief among these has been the need to accommodate the automobile, reduce liability, and provide emergency access. Other concerns include the need to respect privacy, reduce noise, allow for pedestrian movement and prevent drainage problems. The underlying objective has been to standardize development practices so as to create more consistent subdivisions, to meet the goals of protecting public safety, enhancing community amenities and preserving local property values.

It is not always clear, however, how well these complex codes are actually meeting these elusive community goals. It is abundantly clear that numerous aspects of subdivision code do not support better stream protection, insofar as they create needless impervious cover or fail to provide the right of way needed to adequately protect the stream. Relatively simple code modifications often make economic and environmental sense.

Communities are encouraged to reevaluate their existing development criteria in the 12 areas listed above in the checklist. In addition, each Chapter provides further guidance on how the stream protection strategy can be implemented through better site planning, within the context of existing codes and criteria.

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