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CASE STUDIES

1. Floodway Building Prohibitions | Case Study #1

King County Department of Development and Environmental Services, Washington

December, 2007

Background

In 1990, in addition to prohibiting development in floodplains, King County added a new restriction called the "Zero-Rise Floodway". Prior to 1990, King County used the FEMA "One-Foot-Rise Floodway" standard, which allowed development in the "Floodway Fringe" as long as the 100-year floodway water level is not elevated more than one foot. The Zero-Rise Standard reduces flooding by prohibiting "Flood Fringe" development that would cause a perceptible rise in the floodway. The prohibition on development in the FEMA Floodway still applies and the floodway is enlarged to include almost the entire floodplain.

Metrics and Benchmarks

- Metric: Allowable rise in “Flood Fringe”.
- Baseline: New development must not increase the water surface elevation of the base flood level more than one foot. The lowest floor of new construction must be elevated to at least two feet above the base flood level. Floodway encroachments are prohibited unless it can be demonstrated that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the 25-year and base flood discharge.
- Benchmark: Decrease the number of building permits issued that are located in the “flood fringe” by 100%.

Strategies

- Prohibit “flood fringe” development.
- Increase floodway to encompass nearly the entire floodplain.

1. Floodway Building Prohibitions | Case Study #2

City of Houston, Texas

October, 2006

Background

Since 1968, Houston has prohibited construction in the floodway. In 1985, the City of Houston changed the law to allow exemptions. More than 20 years after the exemptions were allowed, engineers show that the cumulative effect of allowing individual building exceptions contributed to flooding.

After numerous public meetings and hearings in 2006, City Council voted unanimously to close the loophole and not allow construction on unimproved property located in the floodways. The City does, through the issuance of building permits, allow existing businesses and homes in the floodway to add on a room, be improved, remodeled, renovated, or even increase a structure's square footage. If a home or business is damaged or destroyed by fire, storms, or other acts of God, citizens can repair or rebuild it and increase the footprint of the previous structure provided it meets current building codes.

The City's recent work to reduce flooding has resulted in real-world savings for Houston property owners through upgrades in the National Flood Insurance Program's Community Rating System. These upgrades have saved homeowners millions of dollars in lower flood insurance premiums. $250 million in drainage improvements have been invested and there are plans to invest a similar amount over the next 5-year Capital Improvement Plan cycle from Fiscal Year 2009 through Fiscal Year 2013 with no new fees. Also, Council enacted new ordinances prohibiting the placement of construction fill into the floodway, requiring an increase in the diameter of new drainpipes, and strengthening development regulations for new subdivisions.

Metrics and Benchmarks

- Metric: Percentage of structures located in the 100-year floodplain.
- Baseline: Number of structures in the FEMA 100-year floodplain = 560; Number of structures in the floodway = 315
- Benchmark: Decrease percentage of new development in the floodplain and floodway by 100% in the next three years.
- Metric: National Flood Insurance Program's Community Rating System
- Baseline: Class 6 CRS Rating
- Benchmark: Class 4 CRS rating

Strategies

- Prohibit construction in the floodway.

2. Opens Space Conservation | Case Study #1

Flood Control District

Maricopa County, Arizona

Background

Maricopa County's floodplains are used by the public in a variety of forms. The Indian Bend Wash in Scottsdale is a nationally recognized example of a natural drainage channel expanded to include a wide, greenbelt floodplain. The greenbelt offers dry weather recreational amenities such as golf courses, multi-use paths and ball fields while providing increased floodwater conveyance capabilities in wet weather. The floodplains of the county's five major river systems are especially important. Besides their natural floodwater control properties, they provide wildlife habitat, and groundwater filtering and recharge. A floodplain is a fragile environment and can lose its ability to function properly by natural changes or human alteration. Restoration efforts such as the District's El Rio vegetation control research project on the Gila River can bring a floodplain back to its original state. Non-structural management activities, such as the regulation of development in floodplains maintain the hydrologic function of floodplains, which naturally control flood waters.

Metrics and Benchmarks

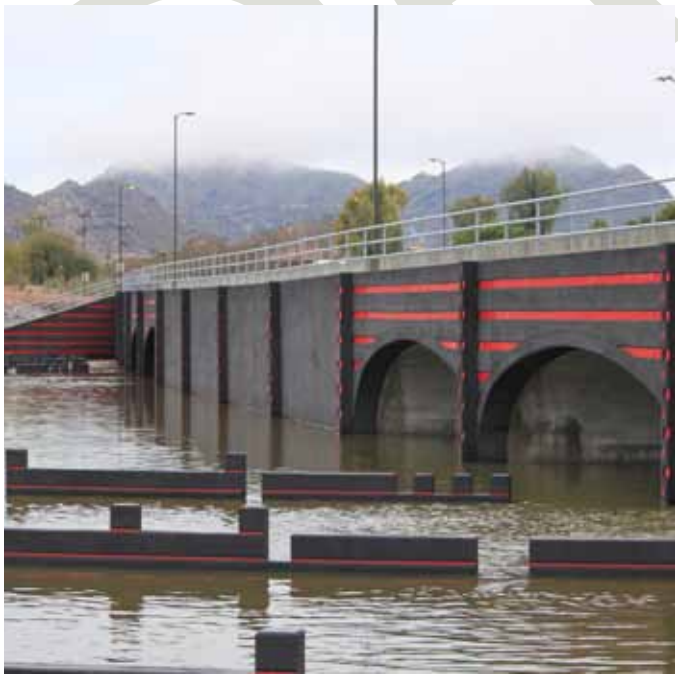
- Metric: Percentage of Open Space park land which also functions as conservation easement.

- Baseline: The recommended level of service for Open Space park land is 10 to 15 acres per 1,000 residents. The year 2015 need with 77,726 projected residents is 777-1,166 acres and the 2020 need with 99,200 projected residents is 992-1,488 acres. New Braunfels has three existing Open Space parks including portions of Cypress Bend park, Solms Park and Fischer Park. It is recommended that New Braunfels acquire an additional 119 acres to meet the targeted Regional Park standard and an additional 419 acres of linear park corridors should be added to meet the 2020 target level of service.

- Benchmark: Acquire the acreage necessary to of Open Space, Regional and Linear park land to meet the recommended year 2020 level of service in 8 years.

Strategies

- Natural drainage channel includes recreation uses while increasing floodwater conveyance.



2. Opens Space Conservation | Case Study #2

Miner's Ravine - 26 Acre Flood Control Property

Roseville, California

Background

Placer Land Trust permanently preserved 26 acres on Miner's Ravine at Sierra College Road in the Roseville Placer County Flood Control and Water Conservation District.

The easement permanently protects the Miner's Ravine site and guarantees the site will always be used for flood control, wetland habitat and public recreation.

The Miner's Ravine flood control project is designed to take the pressure off of the stream channel during periods of high flooding. Roseville and other downstream communities will benefit from increased flood protection. Earthen berm walls channel up to 160 acre feet of flood waters into the basin, where it is held until the peak flows are over.

The flood control project was deemed necessary due to the continued development in Placer County. More development means more concrete and pavement, faster-moving waterways, and less permeable soil to disperse flood waters. Consequently, development mitigation fees funded most of the Miner's Ravine project, with agency grants supplementing the project.

Flood control isn't the only benefit of the Miner's Ravine project. When the basin isn't holding back flood waters, it will function as a natural wetlands and scenic open space. Placer Land Trust and others are helping to restore natural vegetation and function to the stream, making it more attractive for spawning salmon. The Trust's easement also protects the property as a place for public recreation. The property contains a small parking lot with a paved bicycle trail hooking up with the 27-mile Roseville Bikeway. Interpretive signs on the property give visitors an understanding of how flood control and land conservation can work together.

Metrics and Benchmarks

- Metric: Length of trail and number of interpretive signs in dual-functioning flood control open spaces.
- Baseline: 76.9 acres
- Benchmark: In conjunction with open space acquisition for flood control, the addition of interpretive signage along trails.

Strategies

- Permanently protected site guarantees the site will always be used for flood control, wetland habitat and public recreation.

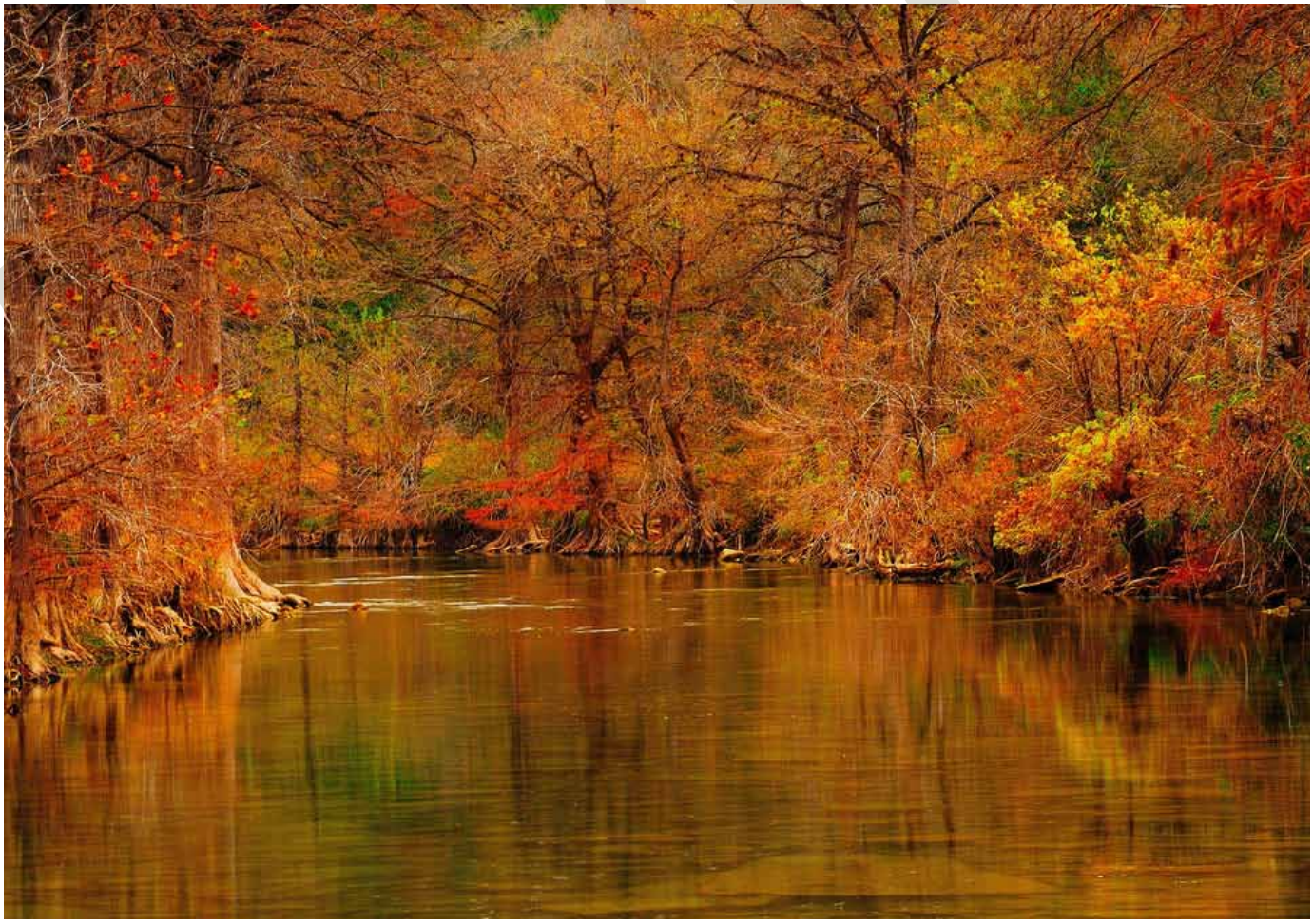
2. Opens Space Conservation | Case Study #3

Regional Habitat Conservation Plan

Hays County, Texas

Background

The conservation program of the Regional Habitat Conservation Plan (RHCP) is based on a phased conservation banking approach with a goal of assembling between 10,000 and 15,000 acres of preserve land over the 30-year duration of the RHCP. The RHCP will help the County serve the needs of its growing population and will promote responsible economic development, good public infrastructure, and open space preservation, including habitat protection for endangered species.



Metrics and Benchmarks

- Metric: Number of endangered species within Comal County.
- Baseline: 31 species, including amphibians, birds, crustaceans, fish, insects and mammals.
- Benchmark: Increase presence of species on Comal County endangered species list by 15% within three years and 5% each year thereafter.

Strategies

- Assemble 10-15,000 acres of preserve land over 30 years though a phased conservation banking approach.

3. Flood Hazard Mitigation | Case Study #1

Flood Hazard Mitigation Plan

State of South Carolina

Background.
South Carolina has 4,000 square miles of floodplain putting 150,000 households in danger of flooding. Some of these areas have recently experienced some of nation's worst flooding in years.

Scenic waterways have led to increased development, which has affected the floodplain and downstream jurisdictions. A committee defined the vision by calling for reserving undeveloped floodplains as natural areas or for low intensity development. Urbanized areas would be protected from flood damage in accordance with comprehensive local mitigation plans, which includes the following:

- Prevention measures (planning, zoning, building codes)
- Property protection (acquisition, building elevation, floodproofing and insurance)
- Natural resource protection (preserve or restore natural areas and natural functions of floodplains, wetlands)
- Emergency service (early warning, response, recovery)
- Structural projects (dams, levees, channels, dunes)
- Public information activities (inform property owners and visitors about hazards)

Metrics and Benchmarks.

- Metric: Number of properties that are damaged by future floods.
- Baseline: 180 publicly and privately-owned properties were damaged in the 2010 flood.
- Benchmark: Decrease the number of properties that are damaged by future floods by 30%.

Strategies

- Include prevention measures, property and natural resource actions, emergency service, reduction of rist to structures and critical facilities and public information activities in Flood Hazard Mitigation Plans.

3. Flood Hazard Mitigation | Case Study #2

Flood Control District Hazard Mitigation Plan

King County, Washington

Background.
The King County Flood Control District Hazard Mitigation Plan aims to reduce risks to county-wide structures and critical facilities from flood related hazards. By establishing this plan, the district will be in a position to better leverage local funds with federal grants.

The Plan Goals are to:

- Protect life and property.
- Support emergency services.
- Promote public awareness.
- Encourage the development and implementation of long-term, cost-effective and environmentally sound flood risk reduction projects.
- Leverage partnering opportunities.

Metrics and Benchmarks.

- Metric: Acquisition of flood damaged structures along the Guadalupe River.

- Baseline: The Federal Emergency Management Agency's Hazard Mitigation Grant Program (HMGP) provided New Braunfels with funds for a buyout program for flood-damaged properties following the Flood of 2002.

- Benchmark: Find funds to implement a buyout program for structures damaged in the 2010 floods. Reduce the number of damaged structures by 45% in the next three years.

Strategies

- Include prevention measures, property and natural resource actions, emergency service, reduction of risk to structures and critical facilities and public information activities in Flood Hazard Mitigation Plans.

4. Stream and River Restoration | Case Study #1

Adopt-A-Stream

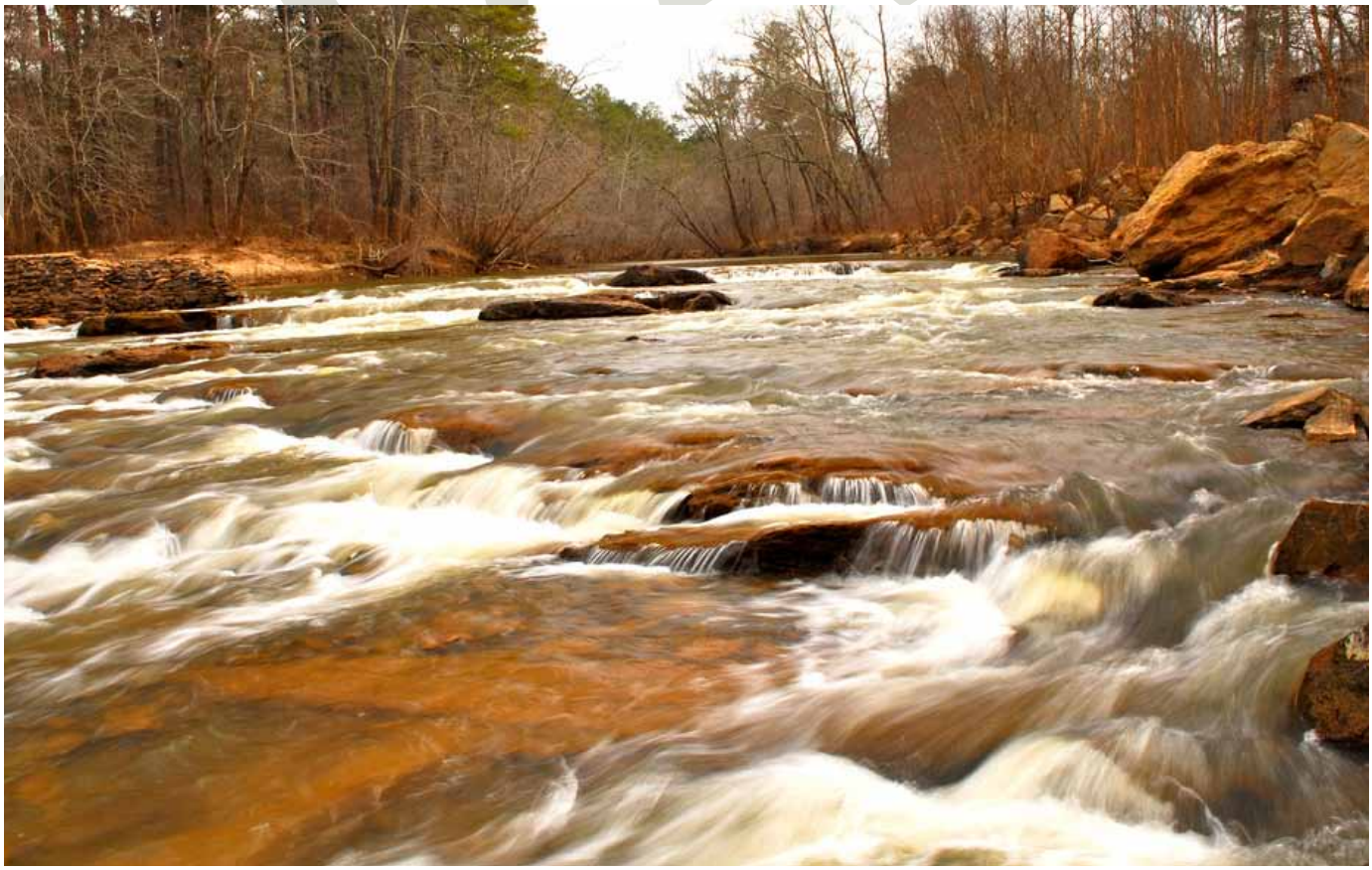
Georgia

Background.

Georgia Adopt-A-Stream (AAS) is housed in the Non-Point Source Program in the Water Protection Branch of the Georgia Environmental Protection Division. The program is funded by a Section 319(h) Grant. The goals of Georgia Adopt-A-Stream are to:

- Increase public awareness of the State's non-point source pollution and water quality issues.
- Provide citizens with the tools and training to evaluate and protect their local waterways.
- Encourage partnerships between citizens and their local government.
- Collect quality baseline water quality data.

To accomplish these goals, Georgia Adopt-A-Stream encourages individuals and communities to monitor and/or improve sections of streams, wetlands, lakes or estuaries. Manuals, training, and technical support are provided through Georgia EPD, Adopt-A-Stream Regional Training Centers and more than 50 established Community/Watershed Adopt-A-Stream organizers. The Adopt-A-Stream and Wetland Regional Training Centers are located at State Universities in Columbus, Milledgeville, Americus, and Savannah. These centers play a key role in providing training, technical support and organizational support to citizens throughout Georgia.



http://www.pc.gc.ca/lhn-nhs/qc/canallachine/index.aspx

Metrics and Benchmarks.

- Metric: Number of miles of stream and/or river that is adopted by a volunteer group.
- Baseline: New Braunfels is affiliated with the Geronimo and Alligator Creeks Watershed Partnership. Currently, they have water quality monitoring sites along Geronimo Creek, and underway with a Watershed Protection Plan.
- Benchmark: Increase the quantity of adopted New Braunfels' streams and rivers by 10% every year.

Strategies

- Increase public awareness of the State's non-point source pollution and water quality issues.
- Provide citizens with the tools and training to evaluate and protect their local waterways.
- Encourage partnerships between citizens and their local government.
- Collect quality baseline water quality data.

www.familyvacationcritic.com

http://www.pc.gc.ca/lhn-nhs/qc/canallachine/index.aspx

www.travel.nytimes.com

www.SiteBits.com

4. Stream and River Restoration | Case Study #2

Muddy River Restoration Project

Boston, Massachusetts

Background

Since the fall of 1996, the Muddy River flooded three times, causing damage to residents, businesses institutions and the public transit system in Boston and Brookline. The flooding has brought urgency to the need to restore the river as a step in implementing the Emerald Necklace Master Plan of landscape and historic resource treatments that seek to undo the effects of erosion, storm damage and neglect over the years.

The objective of flood control is to remove restrictions in the river so that the flooding during major storms does not damage adjacent properties or the subway. These restrictions include the build-up of sediments in the riverbed, the filling of the river accompanied by extending culverts and the growth of invasive vegetation.

Flood control strategies will address the three problems that restrict the capacity of the river:

- The built-up sediment will be dredged to restore the original depth and width of the river;
- A combination of “daylighting” and the installation of larger culverts (pipes) will occur in areas where the river has been filled;
- Invasive vegetation will be completely removed and the historic shoreline restored.

Metrics and Benchmarks

- Metric: Mileage of stabilized stream banks.
- Baseline: Total miles of river or creek bank within the city = 35; Total miles of river or creek bank within the watershed = 496 miles.
- Benchmark: Increase the amount of stabilized stream banks within the city and watershed by 10% each year.

Strategies

- Remove built-up sediment to restore original dimensions of river.
- Daylight and install large culverts.
- Remove invasive vegetation.

4. Stream and River Restoration | Case Study #3

Stream Buffer Ordinance

Buford, Georgia

Background

As part of Buford's MS4 permitting process, Buford created an ordinance that protects naturally vegetated riparian buffers and provides a multitude of water quality benefits including, but not limited to:

- Infiltration of stormwater runoff prior to reaching the stream.
- Reduction of the velocity of stormwater runoff to stream.
- Treatment of stormwater quality through the filtering effects and uptake of the riparian fauna.
- Stream bank stabilization.
- Shading of the stream.

The City of Buford mandates preservation of riparian buffers through enforcement of a 50-foot undisturbed buffer with an additional 25-foot impervious surface buffer along perennial and intermittent streams, as required by the District.

Metrics and Benchmarks

- Metric: Number of insurance claims filed due to structural loss due to erosion or flooding damage.
- Baseline: The City of New Braunfels allows for streambank stabilization as an alternative to dedicating the erosion hazard setback zone. Streambank erosion hazard setbacks may extend beyond the limits of the regulatory floodplain.
- Benchmark: Decrease number of cases filed by 10% in the first year.

Strategies

- Streambank stabilization and buffer for stormwater treatments and reduction of encroachments.

5. Litter Control | Case Study #1

Stormwater Ordinance

Monterey, California

Background

The City of Monterey was part of a Model Urban Runoff Program designed to be used by small municipalities under 100,000 in population. The Model Program includes a “Stormwater Discharge Management Ordinance” which provides the legal authority required to regulate illicit discharges.

Metrics and Benchmarks

- Metric: Gallons of litter that is cleaned from streams and rivers annually.
- Baseline: 2010 - 518,987 gallons; 2009 - 390,281 gallons; 2008 - 203,700 gallons; 2007 - 199,138 gallons.
- Benchmark: Reduce litter tonnage by 40% in the first year, and by an additional 15% each year thereafter.

Strategies

- Stormwater Discharge Management Ordinance provides legal authority to regulate illicit discharges.

5. Litter Control | Case Study #2

Municipal Litter Control

Wichita Falls, Texas

Background

In order to gain a MS4 permit, one of Wichita Fall's goals regarding General Facility Housekeeping is to prevent the discharge of trash, debris and other pollutants from municipal facilities into local waterways and to maintain safe and healthy work places.

Each facility and equipment operator is responsible for taking steps to protect the stormwater and environment as part of their daily duties.

Metrics and Benchmarks

- Metric: Gallons of litter that is cleaned from streams and rivers annually.
- Baseline: 2010 - 518,987 gallons; 2009 - 390,281 gallons; 2008 - 203,700 gallons; 2007 - 199,138 gallons.
- Benchmark: Reduce litter tonnage by 40% in the first year, and by an additional 15% each year thereafter.

Strategies

- Require loads to be covered with a tarp during transfer to waste station and landfill.
- Provide annual operator awareness training.

6. Construction Control Measures | Case Study #1

A Comprehensive Erosion Control Permit Program

Douglas County, Colorado

Background.
Under state law, Colorado may accept only Storm Water Pollution Prevention Plans (SWPPPs) developed by state-registered engineers or by qualified designers under the direct supervision of professional engineers.

Before a SWPPP is developed, the applicant and the applicant's engineer are encouraged to conduct a pre-submittal meeting with Douglas County staff. During the meeting, all parties discuss Douglas County's requirements, which helps accelerate the plan review and approval process.

The Program employs three full-time grading, erosion and sediment control inspectors, six engineering inspectors, seven review engineers, a development review manager, environmental, drainage and stormwater management engineers, water quality technician, agreements technician, permits and inspections manager, and Director of Engineering Services. To satisfy the Program's rigorous specifications, staff members conduct several types of inspections.

The CSRC staff has seen significant reductions in review and plan-approval times. Many plans are now approved on their first submission. Staff members have also seen an increase in the comprehensiveness and effectiveness of submitted Program plans. And finally, staff members have seen violations drop significantly, a trend they attribute to the new Grading, Erosion and Sediment Control (GESC) manual and the longevity of the program.

Metrics and Benchmarks.

- Metric: Number of pre-SWPPP submittal meetings.
- Baseline: 0
- Benchmark: Reduction of plan-approval time by 2 weeks.

Strategies

- Pre-submittal meetings are encouraged prior to Storm Water Pollution Prevention Plans (SWPPP).
- Site inspections throughout the construction process.

6. Construction Control Measures | Case Study #2

Outcome-based Erosion Control Program

Eugene, Oregon

Background.

Eugene, Oregon, uses an outcome-based approach to erosion prevention and sediment control that promotes flexibility by considering site-specific conditions and cost-effectiveness. Eugene implemented the Erosion Prevention and Construction Site Management program in February 1997. The program requires all construction activity in the city, regardless of size, to meet minimum standards to protect water quality. A permit must be obtained for construction activity disturbing 1 acre or more. The program is funded through permit fees, enforcement and stormwater utility funds.

Eugene's program requires that all construction projects meet a very specific set of outcomes during construction and implement mandatory best management practices (BMPs) during the wet-weather season to the maximum extent practicable (MEP). Projects that are 1 acre or larger or are larger than 500 square feet and are in a "sensitive area" are required to obtain a permit, but all construction is required to meet the required outcomes to the MEP.

Compliance with the outcomes is assessed through inspections. The public plays a part in ensuring compliance by reporting sites that might be out of compliance. Follow-up inspections are conducted to ensure compliance. All permitted activity is required to have one initial inspection before any ground disturbance. Follow-up routine inspections are conducted monthly for most residential construction. Commercial construction receives at least one inspection per month but is often monitored weekly. All other construction activities not required to obtain permits are inspected as needed or during routine building inspections. Inspections are conducted until final stabilization is in place. Routine inspections are documented, and sites not in compliance are reinspected to ensure compliance. The program has three full-time erosion prevention specialists and one supervisor.

Metrics and Benchmarks.

- Metric: Percentage of construction site inspections and follow-up visits
- Baseline: 0
- Benchmark: Increase the number of inspections and follow-up visits for new construction projects to at least one inspection and one follow-up visit for each project.

Strategies

- Outcome-based erosion control program.

Cooperative Erosion Control Enforcement and Compliance

Charlotte, North Carolina

Background.

The City of Charlotte and the County of Mecklenburg (CharMeck) have collaborated to develop an effective erosion and sediment control enforcement program that employs frequent inspections, Notices of Violation, and fines, as well as an appeal process to effectively and fairly require compliance. Inspections are conducted approximately once every 2 weeks, and fines of up to $3,000 per day are possible. The program is also working to evaluate the effectiveness of the erosion control program by monitoring streams to assess reductions in total suspended solids.

The City of Charlotte's and Mecklenburg County's Land Development and Water Quality programs work cooperatively to ensure compliance with the erosion control ordinance. The city has eight erosion control inspectors and seven plan review engineers working on erosion control issues. The county has three plan review engineers and five erosion control inspectors.

The City of Charlotte's Land Development staff performs engineering reviews for land development activities inside the city and its extra-territorial jurisdiction (ETJ), including the review of erosion and sediment control plans. The city and county share the appeals board and collaborate to ensure that ordinances are identical.

The goal of the program is to achieve a 25 percent reduction in total suspended solids loads in streams with established in-stream storm water monitoring sites. For streams where no sites have been established, the goal is to prevent turbidity levels from increasing more than 25 percent downstream of the construction site. If it is determined that turbidity levels have increased more than 25 percent, the city increases its inspections. Data are maintained in an inspector logbook, and a report is provided at the end of each quarter. These reports are then provided to staff during Water Quality meetings at the beginning of each quarter. Based on the reports, action plans are developed to enhance measures, such as inspection and enforcement activities, to achieve water quality goals.

Several streams have shown a reduction in sediment levels since the program began in 1999. Additional monitoring is needed to establish long-term trends.

Metrics and Benchmarks.

- Metric: Erosion and sedimentation control plan.
- Baseline: New Braunfels requires a soil erosion and sediment control plan submittal for commercial permits.
- Benchmark: The plan must conform to the erosion and sedimentation requirements of the TCEQ stormwater permit for construction. In addition to statewide requirements, plan must also follow Edwards Aquifer Protection Program requirements when in the Edwards Aquifer.

Strategies

- All construction activity, regardless of size, must meet minimum standards.
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- Inspections that do not meet standards can be fined up to $3,000 per day.

7. Retrofit Existing Stormwater Facilities | Case Study #1

Private Stormwater Facility Maintenance and Inspection

Seattle, Washington

Background.

The City of Seattle regularly inspects all privately owned stormwater detention, treatment and conveyance systems in the city. Under the Seattle Municipal Code (Chapter 22.800), owners of private drainage systems are responsible for maintaining the systems to ensure that they continue to function over the long term.

Property owners are notified with a letter in advance of the inspection and are welcome to accompany the inspector. The facility is inspected for high sediment levels, missing or broken components, and drainage issues. Within two weeks of the inspection, a letter is sent to the property owner with a report detailing any problems and explaining how the facility needs to be maintained or repaired. The city also provides a list of drainage contractors and information on best management practices (BMPs) for stormwater drainage systems. In addition, the city provides checklists for how to inspect and maintain many different types of facilities on its Web site.

Site re-inspections occur 60 days after the follow-up letter and report. If compliance is not achieved during that time, a Notice of Violation, which may result in a $300 fine for each day the violation continues, may be issued. The city also coordinates with the property owner to inspect after a drainage contractor has completed any work and before the contractor has been paid to ensure that the job was performed adequately.

The city performs between 200 and 500 inspections per year, depending on priorities and staff constraints. There are approximately 3,000 records in the current database; however, the city does not inspect single-family residences, which account for about 500 sites. Each year 50 to 100 new sites are added to the database.

Metrics and Benchmarks.

- Metric: Database of inspected sites.
- Baseline: None. TBD.
- Benchmark: Begin a database and increase the number of inspected sites by 50 each year.

Strategies

- The city regularly inspects all privately-owned stormwater detention, treatment and conveyance systems.
- Property owners are responsible for maintaining drainage systems to ensure long-term functionality.

7. Retrofit Existing Stormwater Facilities | Case Study #2

Stormwater Facility Retrofit Techniques

Montgomery County, Maryland

Background.
Retrofitting existing stormwater management ponds and facilities helps the County capture and treat additional volumes of rainfall runoff generated by impervious urban areas of the watershed.

Depending on the time of original construction and the regulatory standards in place at that time, older ponds were often designed to handle rainfall runoff for shorter storm events and smaller volumes of runoff than present-day ponds.

Some of the strategies that the County has used are as follows:

- Increase volume of the pond.
- Modify the outflow.
- Use bypass weirs/structures.
- Add wetlands or a permanent pool.
- Increase time of travel.
- Dredge.

Metrics and Benchmarks.

- Metric: Database of inspected sites.
- Baseline: None. TBD.
- Benchmark: Begin a database and increase the number of inspected sites by 50 each year.

Strategies

- Consistently update database of stormwater facilities.
- Construct bypass weirs, add wetlands or retention and dredge to capture and treat additional volumes of rainfall runoff.

8. Building Runoff Capture | Case Study #1

T.R.E.E.S. Reduces Runoff (Trans-Agency Resources for Environmental and Economic Sustainability)

Los Angeles, California

Background.

T.R.E.E.S. uses an innovative, inexpensive and integrated approach to address pollution and flooding. They developed a set of Best Management Practices (BMPs) for industrial sites, commercial buildings, schools and single family homes that create a "blueprint for ecologically, socially and economically sustainable Los Angeles". The following BMPs are the most applicable and cost-effective:

- Strategic planting.
- Other tree planting.
- Tree maintenance.
- Mulching.
- Cistern installation.
- Dry well installation.
- Greywater system installation.
- Pavement removal.

The T.R.E.E.S. Project began in 1997 with a design charrette that included city planners, landscape architects, engineers, urban foresters, and public agency staff. The goal of the charrette was to identify and design retrofit opportunities for Los Angeles that cost-effectively reduce the environmental effects of urbanization.

Most of the BMPs are relatively inexpensive, and several are within the ability of the average homeowner to install. With widespread application of the technology, a do-it-yourself design, and mass production, the cost is expected to be an achievable 50-cents per gallon.

Metrics and Benchmarks.

- Metric: Number of cisterns or rain barrels rebates that are distributed yearly.

- Baseline: New Braunfels Utilities (a separate entity from the City) had five approved rebates from August 1, 2010 to July 31, 2011. So far for 2011, there have been three approved rebates. The rebates are for residential only and equal $0.50 per gallon of water storage installed.

- Benchmark: Increase the number of cisterns or rain barrels that are distributed yearly by 10% each year.

Strategies

- Install greywater systems, dry wells and cisterns.
- Strategically plant and maintain vegetation near impervious areas to help in cleaning stormwater runoff.

8. Building Runoff Capture | Case Study #2

Willamette Stormwater Control Program

Portland, Oregon

Background

Faced with severe pollution in the Willamette River, poor watershed health, and loss of habitat for endangered salmon, Portland decided to develop the Clean River Plan. The plan is a comprehensive approach to improve water quality in urban streams that promotes low impact development (LID) strategies among property owners and developers.

The Clean River Plan offers solutions to eliminate combined sewer overflows (CSOs) and local basement flooding, including techniques for controlling urban runoff from commercial, industrial, and institutional properties.

The Clean River Plan uses a variety of strategies for removing stormwater from sewers and restoring beneficial natural processes. These strategies are intended to help downsize or displace single-purpose infrastructure such as large pipes, expanded treatment plants and pump stations.

To jump start participation in one facet of the program, Portland's Bureau of Environmental Services initiated the Willamette Stormwater Control Program, providing technical and financial assistance for a limited number of pilot projects that control stormwater runoff. These projects are to focus on strategies such as:

- Disconnecting roof downspouts and directing runoff to vegetated swales, planters, or other landscape features.
- Removing or replacing pavement with porous materials that allow stormwater to soak into the ground.
- Re-grading some paved areas so they drain into new or existing landscaping.
- Installing roof gardens that reduce stormwater flow into the sewers and also improve air quality.

Metrics and Benchmarks

- Metric: Pervious pavement coverage.
- Baseline: New Braunfels does not currently regulate paving material.
- Benchmark: Increase the amount of pervious material that is used on new construction by 15% the first year and 10% each additional year.

Strategies

- Re-grade paved areas so they drain into new or existing landscaping.
- Install roof gardens that reduce stormwater flow into sewers.
- Direct roof runoff to swales and planters.
- Remove or replace impervious pavement with pervious materials.

8. Building Runoff Capture | Case Study #3

Zero Impact Development Ordinance

Lacey, Washington

Background.
Lacey adopted a Zero Impact Development Ordinance in August of 1999 - the direct result of a conference called "Salmon in the City." The ordinance is still in early stages of implementation and to date, no developers have taken advantage of it.

The primary goal of the Zero Impact Development Ordinance is to retain the hydrologic functions of forests after a site is developed such that there is near "zero effective impervious surface." The ordinance works by providing developers with the opportunity to demonstrate zero effective impervious surfaces and to use watershed-sensitive urban residential design and development techniques. The ordinance makes LID a legal alternative to conventional site design. However, actions are voluntary and to date, no other incentives exist to encourage zero impact developments in Lacey.

The Lacey ordinance is designed to protect receiving waters and aquatic resources. It established criteria that a development project must meet in order to qualify for deviations from certain current development standards.

The Lacey ordinance criteria have since become known as the 60/0 standard. In other words, at least 60 percent forest must remain after development and impervious surface must be made "ineffective" or established as zero effective impervious surface area (also known as the "zero impact" standard). Developers can make impervious surfaces ineffective by disconnecting them from conventional drainage infrastructure and installing LID integrated management practice to capture and treat runoff. The ordinance also requires monitoring and evaluation designed to measure the performance of steps taken to ensure zero impact.

Metrics and Benchmarks.

- Metric: Number of projects that implement LID techniques in new construction.
- Baseline: TBD.
- Benchmark: Increase the number of projects that implement LID techniques in new construction by 20% the first year and 10% in subsequent years.

Strategies

- The Zero Impact Development Ordinance provides developers with the opportunity to demonstrate zero effective impervious surfaces. It requires developers to maintain a site's original hydrologic function after development.
- Low Impact Development is a legal alternative to conventional site design.

9. Impervious Coverage Reductions | Case Study #1

Edwards Aquifer Recharge Zone Building Limitations

Austin, Texas

Background

The City of Austin protects water quality through the Land Development Code (LDC), which governs zoning, subdivision and the site planning process. The City's watershed protection ordinances are codified, particularly in those sections of the LDC that address subdivision and site plan.

Projects that require subdivision or site plan approvals must comply with the City of Austin's watershed ordinances. These ordinances have evolved over time to:

- Reflect the current understanding of water quality and stormwater hydrology.
- Cover all 45 watersheds within the City's planning area, either wholly or in part.

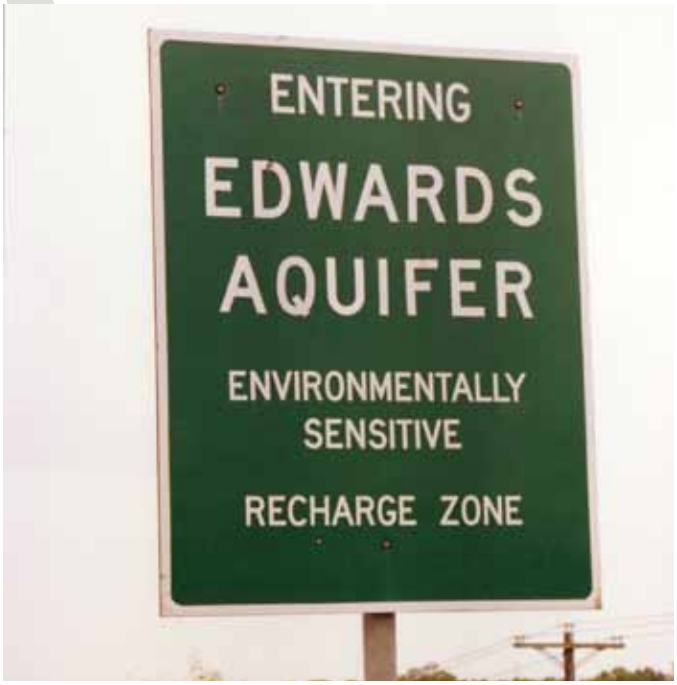
The City of Austin has adopted fewer than ten watershed ordinances since 1980, these include: Lake Austin, Lake Austin Peninsula, Barton Creek, Williamson Creek, Lower Watersheds, Comprehensive, Interim, Composite and Save Our Springs. The ordinances discuss impervious cover, density, transfer of impervious cover or development rights, stormwater treatment and detention requirements, construction site management and stream setbacks or buffer zones.

Metrics and Benchmarks

- Metric: Reduce impervious surface area per parcel.
- Baseline: Average impervious cover per parcel within City Limits = 26%.
- Benchmark: Achieve average impervious cover per parcel within City Limits = 20% within five years.
- Metric: Have a ratio of impervious surface per person below the average of other cities at a similar density to New Braunfels.
- Baseline: Pervious surface/person in the City Limits = .037 acres. People/acres in the City Limits = 2.6.
- Benchmark: Increase average pervious cover per person within City Limits to .25 acres within five years.

Strategies

- The Edwards Aquifer Recharge Zone Building Limitations limits impervious cover and density in the Edwards Aquifer Recharge Zone. Developers may transfer impervious cover or development rights. The Limitations also specify stormwater treatments and construction management, require detention and stream bank setbacks or buffer zones.



9. Impervious Coverage Reductions | Case Study #2

Stormwater Low Impact Development Practices in the High Point Redevelopment Project

Seattle, Washington

Background.

The High Point redevelopment project incorporates stormwater LID drainage practices. The High Point area was a low-income housing development that is now being redeveloped as a mixed-income housing development. This project redefines the stormwater management design approach to be used for infrastructure and site development. The collaboration for this project produced an unprecedented effort between the Seattle Housing Authority, Seattle Public Utilities, and other City agencies. As a result of this innovative design approach, a traditional low-income housing development was enhanced by a more livable green space.

To achieve the drainage goals, each block was identified as having an "Allowable Percent Impervious Surface Overage". During the review of each individual project, a "Permit Submittal Chart for Drainage Requirements" is filled out and checked to ensure an applicant did not exceed a predetermined allowable percentage of impervious surface. Once the project was permitted, the actual "total percent of impervious coverage" for a given block is entered into the City GIS system. This will be used to prevent any future redevelopment from exceeding previously permitted impervious surface thresholds.

The plan also calls for minimizing some street widths from 32 to 25 feet to reduce impervious areas and add to the traditional urban character of the neighborhood. To help reduce stormwater run-off, porous concrete pavement was used on two City street sections, half of the public sidewalks, and for parking and access on many of the private properties.

Metrics and Benchmarks.

- Metric: Database of total percent of impervious coverage.
- Baseline: None. To Be Verified.
- Benchmark: Add 50 cases per year to the database.
- Metric: Reduced street widths.
- Baseline: Residential collectors are to be designed at 27-37' wide (varies with parking option).
- Benchmark: Number of new or redeveloped streets that have a reduced street width standard.

Strategies

- Neighborhood blocks have allowable percentage of impervious surface overage.
- Reduce street widths.
- Maintain a future redevelopment threshold database.

Enlisting Citizens to Monitor Water Quality

Monroe County, New York

Background

The Monroe County Stormwater Coalition has several public volunteer programs that complement its monitoring activities, including a citizen stream monitoring program and a stormwater outfall adoption pilot program. The Stormwater Coalition's limited resources help in monitoring large water bodies, while the volunteer monitoring program helps to fill in the gaps and foster local water body stewardship. Groups of citizens have adopted and monitored more than 100 miles of streams. They have also planted riparian corridors along their adopted stream segments. One full-time staff member coordinates the citizen monitoring activities.

The Stormwater Coalition coordinates 50 volunteer teams of 3 to 5 citizens, who adopt a 1/2 mile segment of stream for 2 years. Most of the teams consist of family members, groups of friends, coworkers, or neighbors. Children and young adults are also encouraged to participate. Teams choose their adopted stream segments, which should be accessed through public lands or a team member's property. Several teams have been granted permission by landowners to access stream segments even though the landowners are not team members.

In preparation for monitoring, each team is asked to contact its local government to explain the program, describe what the team members will do over the next 2 years, and ask for support. Next, a representative from each team is required to attend a 2- to 3-hour training session that covers the team's responsibilities and safety issues. Each team is also given a participant's manual. The Stormwater Coalition also offers an intermediate-level training session for teams that want to improve their skills in benthic macroinvertebrate identification.

Metrics and Benchmarks

- Metric: Number of city-sponsored groups that monitor local water body quality.

- Baseline: The Guadalupe-Blanco River Authority currently has three monitoring sites in New Braunfels that provide monthly data.

- Benchmark: Increase the number of city-sponsored water quality monitoring groups to 5 the first year and add an additional group each year in subsequent years.
- Metric: Levels of e. coli in streams and rivers with established in-stream stormwater monitoring sites.

- Baseline: In 2010, Dry Comal Creek e. coli levels were between 70-750 CFU/100mL and Comal River e. coli levels were between 120-210 CFU/100mL.

- Benchmark: Reduce the e. coli levels in the Comal River and Dry Comal Creek to healthy levels (less than 125 CFU/100mL) within the first year and maintain this level in following years.

Strategies

- Enlist citizens to monitor water quality, and vegetate riparian corridors.
- Establish a stormwater outfall adoption pilot program.

Volunteer Adopt-A-Pond Maintenance Program

Hillsborough County, Florida

Background

Through the Adopt-A-Pond program, Hillsborough County, Florida, uses volunteers to inspect and maintain regional stormwater management facilities. The program is also used as a way to educate residents about non-point source pollution, wildlife and native plants. Effective design and regular maintenance of stormwater management facilities is necessary to allow the facilities to operate properly and remove pollutants. Hillsborough County Adopt-A-Pond improves the appearance, water quality and habitat of neighborhood stormwater ponds. The program's goals are to work with citizen volunteers to reduce neighborhood pollution, increase pond habitat, reduce litter, mark storm drains, increase citizen awareness of stormwater impacts and improve pond treatment functions. Citizens become involved in the program through county staff referrals and public outreach.

The education and communication portion of the program produces the Adopt-A-Pond website, pamphlet, information booklet and quarterly newsletter. Participants receive an Adopt-A-Pond Notebook, aquatic plant identification material, a neighborhood sign, waders, aquatic plants for planting, a Pond Management Plan Workbook and county staff support. They can attend neighborhood meetings, Pond Walks and an annual pond seminar and can receive annual awards. The county also provides an online mapping tool to allow participating groups to locate their pond and post pictures of their completed work.

To get started in the program, interested citizens form a pond group to adopt a pond in their neighborhood. Once the group is formed, the members sign an Adopt-A-Pond Agreement and promise to maintain the facility for three years. The group also agrees to abide by the criteria outlined in the program's policies and procedures. At the end of the three years, they can renew their agreement. Each group receives one free vegetation removal provided by the county and $600 worth of native plants during the initial stages of the project. At the end of a 6-month review period, the group can request up to $300 worth of additional plants. Groups that fulfill all requirements for the program are also eligible to continue to receive up to $200 worth of plants per year.

Metrics and Benchmarks

- Metric: Percentage of "adopted" ponds or other water body that are regularly inspected by volunteer citizens.
- Baseline: 0
- Benchmark: Achieve 15% adoption of New Braunfels ponds in the first year and an additional 10% each year for the next five years.

Strategies

- Volunteer Adopt-a-Pond Maintenance Program reduces pollution and litter while increasing citizen awareness of stormwater impacts.

Project Watershed

Central New York

Background

Project Watershed is an Izaak Walton League of America environmental education and community outreach program that engages central New York high school, middle school and college students, and adult volunteers, in monitoring water quality and conserving local streams.

The program:

- Engages middle and high school students in hands-on, real-world science using streams as living classrooms.
- Educates teachers, students and adults about water quality, watershed ecology, pollution, and stream monitoring.
- Collects scientifically valid data for schools, the public, and government agencies responsible for water quality.
- Instills a commitment to sensible stewardship of water resources among participants.
- Reports pollution problems.
- Conserves streams.

Metrics and Benchmarks

- Metric: Percentage of schools in New Braunfels that participate in a water monitoring program.
- Baseline: 0
- Benchmark: Increase the number of city-sponsored water quality monitoring schools to 15% the first year and add an additional 5% in subsequent years.

Strategies

- Engagement of local schools teaches children about stormwater impacts and water quality which at the same time benefits the city by allowing for the collection of scientifically-valid data for water quality monitoring.

11. Detention Basin | Case Study #1

Multi-use Detention Facility

Arlington Heights, Chicago, Illinois

Background

Arlington Heights, located to the northwest of Chicago, is an example of a community that works with the local government to develop stormwater facilities that serve dual purposes. Developers in Arlington Heights were required to provide on-site stormwater detention. They often turned these detention basins over to the community, which made agreements with the park district to maintain these areas as park or open space.

But in the past these areas did not receive any design directions from the park district and often turned into a wasted space and a maintenance problem. Now the park district has an agreement with the community that they will only take over and maintain stormwater detention facilities that have a recreational use. Since then several recreational facilities like golf course, ball diamonds, tennis courts, ice skating rinks, sledding hills and nature areas have been incorporated into detention ponds.

In addition to providing flood control and aesthetic enhancement, the Arlington Lakes Golf Course uses its detention lakes for irrigation purposes. The facility also provides year-round use by offering the course as a cross-country ski trail in the winter.

Metrics and Benchmarks

- Metric: Percentage of Open Space park land which also functions as conservation easement.

- Baseline: The recommended level of service for Open Space park land is 10 to 15 acres per 1,000 residents. The year 2015 need with 77,726 projected residents is 777-1,166 acres and the 2020 need with 99,200 projected residents is 992-1,488 acres. New Braunfels has three existing Open Space parks including portions of Cypress Bend park, Solms Park and Fischer Park. It is recommended that New Braunfels acquire an additional 119 acres to meet the targeted Regional Park standard and an additional 419 acres of linear park corridors should be added to meet the 2020 target level of service.

- Benchmark: Acquire the acreage necessary to of Open Space, Regional and Linear park land to meet the recommended year 2020 level of service in 8 years.

Strategies

- Detain stormwater on-site, which is then maintained as park or open space by the Parks Department. The Parks Department has an agreement with the community that the stormwater detention facility will only be maintained if it has a recreational use.
- Land can be used for golf courses, sports fields, tennis courts and nature areas.

11. Detention Basin | Case Study #2

Arroyo Chico Drainage Basin

Tucson, Arizona

Background

Pima County Regional Flood Control District and the City of Tucson in cooperation with the U.S. Army Corps of Engineers (ACOE) have jointly undertaken a multi-phase flood control, environmental restoration and recreation project called the Tucson Drainage Area/Arroyo Chico Multi-Use Project. The project area encompasses approximately six miles of the Arroyo Chico Wash.

The Arroyo Chico and its tributaries drain an area of 11.4 square miles located in central and downtown Tucson. These ephemeral watercourses drain a watershed which is fully developed and contains a mix of residential, commercial and industrial areas.

Because of the increased runoff due to urbanization of the contributing watersheds, the capacities of the open channel/culvert sections are generally inadequate to convey the peak flows caused by intense thunderstorm events, resulting in frequent and severe flooding of residential, commercial and industrial areas along the entire length of the arroyo. Flood damages to both private properties and public infrastructure are estimated by the ACOE at $2.7 million (1998 prices) annually.

The construction of the Phase 2B Park Avenue Detention Basin Complex provides the opportunity for environmental restoration of degraded riparian ecosystem, preservation of acceptable existing native habitats, and recreational improvements for the neighboring communities. The City of Tucson Citizens Advisory Committee (CAC) provided 18 points that were adopted in April 1998 by the Mayor and Council for the development of the Park Avenue Basins. These recommendations have been used as guidelines for the design of the Park Avenue Basins by the ACOE. Final construction plans and specifications were completed in March 2005.

Metrics and Benchmarks

- Metric: Restoration of degraded landscapes turned into parks that benefit the public while providing flood control and ecosystem preservation.
- Baseline: TBD
- Benchmark: Prioritize the acquisition of parkland properties that need rehabilitation.

Strategies

- Detention basins used as recreational areas provide opportunities for environmental restoration of degraded riparian ecosystems while improving neighboring communities.

Innovative Stormwater Management Standards and Mitigations

Arlington County, Virginia

Background

Arlington County is an ultra-urban county in the metropolitan Washington, DC, area. There are 7,323 people per square mile in the county, and much of the development is infill or redevelopment. Many of the water quality impacts are caused by existing development, infill and redevelopment.

The county has developed a set of pollutant removal requirements for development sites dependent on the amount of existing and proposed impervious cover, as well as whether there are any stormwater quality BMPs on-site. The ordinance requires on-site treatment for impervious surfaces with which vehicles come into contact (e.g., parking areas, roadways, loading areas). If treatment of such areas does not meet the full pollutant removal requirements for the site, the developer is given several innovative compliance options: additional on-site treatment for the developing area, on-site treatment for off-site areas or a monetary contribution to the county's Watershed Management Fund.

Developers may contribute $2.50 per impervious square foot of impact area (determined through the county's stormwater calculation worksheet) to the Fund in-lieu of constructing on-site BMPs. The contribution rate may be updated and is to reflect the cost of providing on-site treatment, including the design, building, and maintenance of structures. According to the CBPO, the fund is used to reduce non-point source pollution and improve stream quality and habitat through programs which provide BMP retrofits, stabilize or restore stream valleys and steams, educate the residents of the county on methods of reducing non-point source pollution runoff, promote public awareness of the importance of stormwater quality, supplement county programs which provide water quality protection, provide demonstration projects or provide water quality monitoring or analysis.

Metrics and Benchmarks

- Metric: Initialization of fee in-lieu program for impervious coverage impact.

- Baseline: New Braunfels provides incentives regarding the drainage facility criteria. A fee may be utilized in place of a detention or retention system. Collected fees will be used to construct public flood control improvements.

- Benchmark: Expansion of the current to include impervious coverage fee and participation increase in proportion to growth of New Braunfels.

Strategies

- Require development site pollutant removal based on the amount of existing and proposed impervious cover. Compliance options include additional on-site or off-site treatment or monetary contribution to the Watershed Management Fund.

12. Implementation Mechanisms | Case Study #2

Clean River Rewards Incentive and Discount Program

Portland, Oregon

Background

Property owners who manage stormwater on site and/or on the public right of way that serves their property are eligible for discounts at 35% of the stormwater charge for on-site and 65% of the stormwater charge for public right-of-way. For residential properties, the discount is based on managing stormwater runoff from the roof areas only. The discount for commercial properties is based on managing stormwater runoff from both roof and paved areas. To maintain the discount, the utility account must remain active, stormwater facilities must be properly maintained and operated and the city must be granted access to the property for limited inspections of stormwater facilities. Partial credits are available on a sliding scale for properties that manage any portion of stormwater on-site, including partial credits for tree coverage and a credit for residential properties that have less than 1,000 square feet of total impervious area.

Metrics and Benchmarks

- Metric: Stormwater fee discount.

- Baseline: New Braunfels approved stormwater utility fees in July 2011. This fee would potentially raise $2.3 million per year to fund drainage work in New Braunfels. The fee would amount to $4.60 per month for a 2,000-3,000 square foot home. Smaller homes would receive a $3.00 fee and larger homes could pay up to $6.60. Commercial properties would pay approximately $4.60 per month.

- Benchmark: Establish tiered system of stormwater utility fee discounts for on-site stormwater management. Increase participation in the discount program by 15% in the first year.

Strategy

- The Clean River Rewards Incentive and Discount Program allows property owners who manage stormwater on-site or on the public right of way to be eligible for discounts at 35% of the stormwater charge for on-site and 65% for the public right of way.

12. Implementation Mechanisms | Case Study #3

Stormwater Fee Discounts

Centennial, Colorado

Background

Stormwater fees for all improved land are based on the ratio of Impervious Area (IA), which is the "footprint" of all surfaces on a parcel from which water would run off (for example, roof, walkway, driveway, patio, parking lot and so on). The annual stormwater fee charged to a property owner is based on the impact the property will have on the storm drainage system. The fee is billed on the Arapahoe County Tax Statement that is sent in January.

Payment is due similarly to the payment schedule of property tax payments. The IA is determined by aerial photography, which is taken annually and used with County records and Geographical Information System (GIS). From the information gathered for each parcel, the IA is identified and measured. The IA measurement is then used according to the fee rates, thus the higher the ratio, the higher the rate.

Metrics and Benchmarks

- Metric: Impervious Area coverage.
- Baseline: Average impervious cover per parcel within City Limits = 26%.
- Benchmark: Reduce average impervious cover per parcel within City Limits to 20% in the first three years.

Strategy

- An annual stormwater fee for improved lands is based on impervious area and is charged to the property owner based on the impact that the property will have on the drainage system.