Indiana Water Resources Research Center
Annual Technical Report
FY 2002

Introduction

Research Program

Water Quality Management and Improvement in the Urban Setting

Basic Information

Title:	Water Quality Management and Improvement in the Urban Setting
Project Number:	2002IN60B
Start Date:	3/1/2002
End Date:	2/28/2003
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Research Category:	Water Quality
Focus Category:	Surface Water, Nitrate Contamination, Water Quality
Descriptors:	
Principal Investigators:	Ron F. Turco, George Parker, Kim Wilson

Publication

1. Parker G. and V. Poole. Restoring Impaired Wetlands and Other Water, held October 7-9, 2002, in Indianapolis, Indiana..

State: Indiana
Project Number: IN60B
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PIs: R. Turco, Professor, Purdue University; G. Parker Professor Purdue University and K. Wilson, Assistant Professor.

Efforts at the Indiana Water Resources Research Center (IWRRC) over the last year have focused on a revitalization of our in-state programs and the development of efforts in Urban watershed protection. The IWRRC is now co-located with the Environmental Sciences and Engineering Institute (ESEI) on the main campus of Purdue University. The co-location affords both organizations benefits. In the case of IWRRC we are able to use the administrate components of the ESEI to run our programs and projects. This has minimized administrative costs will maximizing the potential for project support. The IWRRC is now returning to supporting project in a more traditional manner and has run a grants competition for this years funding (2003).

At the outset of the project period covered in this report, the IWRRC made an effort to engage the industrial sector by entering into a collaborative effort with a local engineering firm working on wetlands in Dyer, Indiana. This collaboration failed as the economic downturn forced the community of Dyer to forego the wetlands project. We chose to concentrate our wetlands effort on a project area near West Lafayette. This is an ongoing and high visibility set of locations. This breakdown in the arrangement with Dyer also forced us to reconsider the educational component we had proposed. The educational project was shifted to a 750-acre service learning project where students applied Traditional Neighborhood Development (TND) planning and design principles to solving a water problem. Students learn that managing storm water runoff and collection is integral in the design of environmentally sustainable community plans.

On the whole, the IWRRC is returning to a more traditional arrangement of working with faculty and funding small startup projects. This is a shift away from the NIWR based efforts of the past few years. This shift has not been without some problems mostly associated with a loss of visibility on campus and in the state. For example, the university has chosen to not fund a secretarially position with IWRRC (promoting the merger with ESEI). Funds not expended in the year 2002 were held and reallocated in the 2003 or 2004.

Project Reports

Constructed wetlands are utilized in a variety of settings at Purdue University and are an important research tool, particularly in the treatment of non-point source pollution. In addition to the purposes for which they were originally constructed, they provide the framework for numerous multidisciplinary ancillary research opportunities. Two of these constructed wetland projects are the Animal Science Research Facilities Constructed Wetlands and the Kampen Golf Course Constructed Wetlands.

The Animal Science Research Facilities wetland system (ASCW) was completed in 1999 to treat nutrient-rich agricultural runoff from Marshall Ditch, which drains a portion of the Purdue Animal Science Farms. Field tiles discharge water into the headwaters of the ditch from an area of approximately 2000 acres of agricultural and livestock land-use. Water is diverted from the ditch to two settling ponds, routed through the wetland system, and returned to the ditch. The nearby Baker Aquaculture Research Facility provides an additional 30,000 gal/day of low-nutrient water to the ditch, some of which is also routed through the wetlands. Wetland plants were provided by J.F. New and Associates, and portions of the plumbing were designed and installed as part of the Purdue EPICS (Engineering Projects In Community Service) program in Engineering. Since its inception, this project has provided numerous opportunities for individual and class involvement in designing and constructing the wetlands, and evaluating its effects on water quality, habitat, and wildlife. Intensive sampling in 2002 for water quality analysis is being used to evaluate the effectiveness of the ditch and wetlands system in removing excess nutrients.

Re-design of the Kampen Golf Course and the addition of its constructed wetlands was completed in 1998. Prior to reconstruction of the course, untreated storm-water runoff from the surrounding urban and commercial area was directed under the old course through drainage directly to the Celery Bog, a highly valued natural area and park. The main objective of water quality studies at the Kampen Golf Course is to determine how effective the wetlands are in improving the quality of runoff from commercial, residential, and golf course areas before the water exits the course or is re-circulated for irrigation.

The overall goals of water quality studies at the golf course are three-fold:

- Develop the use of golf course constructed wetlands to improve residential runoff.
- Assess the ability of constructed wetlands to protect the adjacent natural wetland environment.
- Evaluate the regeneration of water supplies for golf course use.

Throughout 1999 and 2000, the focus of water sampling was storm-based, following the thought that the highest concentration of potential pollutants is washed from surfaces and appears in the “first flush” of stormwater runoff. Additionally, “first-flush” storm samples from selected events were collected and transported to Heritage Environmental Labs, Inc. in Indianapolis for more detailed chemical analysis. These samples were analyzed for cations, anions, 13 organophosphate pesticides such as the dinitrioaniline preemergence herbicides

(pendimethalin), 27 organochlorine pesticides such as dieldren, 6 chlorinated herbicides like 2,4-D, and other potential contaminants such as nutrients, pesticides, salt, metals, petroleum products, etc,. The focus of water sampling shifted in 2001 to include monitoring of base-flow (non-storm) water quality. Water sampling at the golf course in 2002 focused on obtaining a more detailed seasonal picture of the effectiveness of the wetlands in improving water quality.

Animal Science Research Facilities Constructed Wetlands

Automated sampling equipment was removed from the wetlands in late December, when it became too cold to operate. Grab sampling continued on a bi-weekly schedule throughout the three months of the first quarter of 2002, and on an approximate weekly schedule through mid-August to complete one year of intensive sampling. Automated sampling equipment and a rain gage were re-installed at the wetlands in late April. Installation was later than in previous years due to a late heavy snowfall.

Construction and installation of weir boxes at the outlets from the wetlands was completed (EPICs class project) and flow measurements begun. This has allowed preliminary estimates of evapotranspiration to be calculated. A YSI 660R multiparameter probe was connected to the ditch water splitter box on June 21 to collect continuous measurements of pH, temperature, conductivity, and dissolved oxygen. Diurnal fluctuations in all four parameters are consistently observed, except for brief periods during precipitation events. Initial fluctuations in dissolved oxygen concentration ranged from approximately 12 to 14 mg/l during the day, to 6.5 to 7.5 mg/l at night during the growing season. Dissolved oxygen, conductivity, pH, and temperature readings all respond with decreases in values in response to storm water discharge. Two YSI 660R multiparameter probes were briefly connected to the two outlets of the wetlands at the end of August. In general, dissolved oxygen concentrations were lower than at the ditch splitter box, rarely ranging above 6 mg/L, and fluctuations appeared to be more pronounced for the surface cell outlet. Additionally, dissolved oxygen concentration at the surface cell outlet appears to increase significantly (up to 20 mg/L) in response to large rainfall events (1 event recorded), most likely due to turbulence connected to increased flow at the outlet. Concurrent measurement of the four field parameters (pH, temperature, conductivity, and dissolved oxygen) for the inputs to and the outlets from the wetland systems should be conducted during the next field season.

Analysis of nitrate concentration data from last year's sampling indicates greatest nitrate reductions are in mid to late summer, during the peak growing season and when flow is dominated by discharge from the Aquaculture Center. Although the volume of water discharged from the wetland system is generally insufficient to significantly affect overall downstream water quality, particularly during high flow conditions, the wetlands are effective at reducing nitrate concentrations, even under extreme loading conditions. Analysis of nitrate concentrations from the headwaters tile to downstream of the wetlands discharge indicates that most significant nitrate reduction occurs in the first few hundred feet of the vegetated headwaters channel. The reduction averages 37% in the

first approximately 150 feet (from the tile to the gage site) and averages 66% in the first approximately one mile of stream distance (from the tile to the wetlands input pumps). The average nitrate reduction from the tile to the wetlands input during the peak plant growth period is approximately 90%. Nitrate reductions in the ditch and the wetland system continue through the winter months during plant senescence, though at a reduced scale. Nitrate reductions during plant dormancy highlight the importance of microbial activity in reducing nitrate concentrations. Further work in this aspect of the study would be an important contribution to defining the importance of headwaters (low order) streams in reducing excess nutrients, as well as defining optimal placement of wetland systems in the landscape.

Kampen Golf Course Wetlands

Frequent grab-sampling of golf course sites began in 2001 and continued through early August 2002 to complete one year of intensive sampling. Two additional sets of samples were collected June 25 and November 13, 2002 and transported to Heritage Environmental Labs, Inc. in Indianapolis for more detailed chemical analysis.

Results from samples sent to Heritage Labs for analysis are consistent with previous years' results. Whether from storm or non-storm samplings, no high levels of any of a wide array of potential pollutants, including pesticides, metals, or oil and grease have been detected at the golf course sampling sites. Concerns about accepting urban runoff into the golf course drainage and irrigation system appear to be limited to potential high levels of chloride during the winter months. Low levels of Atrazine (0.23 and 0.46 µg/L) were detected at two sites, the first and second wetland cells, in June 2002, but none was detected in November. The June detections correspond to new sediment inputs to the wetland cell resulting from construction along Lindberg Road and construction of the tunnels.

In general, concentrations of nitrate at the golf course sampling sites are low; close to drinking water standards. Nitrate concentrations are generally highest at the urban input site and decrease through the wetland cell system, with the largest decrease taking place after the first wetland cell. Seasonally, the wetland system continues to reduce nitrate concentrations during plant dormancy, perhaps resulting from microbial activity. The golf course wetlands improve the quality of runoff from the urban area by reducing concentrations of components such as nitrate, chloride, and ammonia. Trap efficiencies continue to improve with time as the wetlands mature, with only TOC (non-storm) and sulfate (dormant season) consistently negative.

Results of aspects of this research project were presented at the *Wetlands 2002 Symposium: Restoring Impaired Wetlands and Other Water*, held October 7-9, 2002, in Indianapolis, Indiana.

Education Project:

The Landscape Architecture Program's third year design studio studies community planning and design. Students designed a 750-acre service learning project where they apply Traditional Neighborhood Development (TND) planning and design principles. Environmental sustainability is the trend in new and infill community design. Students learn that managing storm water runoff and collection is integral in the design of environmentally sustainable community plans.

Students begin the storm water runoff planning and management process of their designs with the small basins. The method for building land use plans begins with definition of the stream system, patterns of runoff, and three hydrologic zones (upland, collection, and conveyance). Each zone is analyzed for soils, slopes, vegetation, and existing land use to determine limitations for development. Steep slopes, runoff collections areas, unstable and poorly drained soils, forested areas in critical runoff zones, and areas prone to flooding and seepage are designated as nonbuildable. The remaining area is developable land, and the bulk usually lies in the upland zone of the basin.

As students apply the TND principles to the layout of roads, buildings, parking and open spaces on the developable land, they also design the storm water management system as an overlay on the entire site. Swales and detention and retention ponds are sized and located to ameliorate safety and health hazards associated with flooding and property damage, stagnation, reduced soil bearing capacity and increase usability of areas through the elimination of unwanted water and to prevent erosion by reducing the rates of flow and volume of runoff. Runoff pollution is identified as a specific area of concern. After flowing over urban surfaces, runoff water is usually laden with grease, oil, organic matter, and other debris. Urban runoff is best treated by filtration and assimilation integrated with a water-flow system. Students learn that the simplest, and most cost effective means for accomplishing this treatment are those used in nature: green plants and microorganisms. Their designs for swales, ponds and wetlands reflect an understanding that urban runoff collected on hard surfaces and introduced into green landscaped swales and wetlands will improve water quality, ecology and sustainability of the site.

Field trips and research provide students with insight into how the design of storm water system plays an important role in shaping development opportunities that affect the life style of future residents and property values of landowners. Developments like Coffee Creek, Indiana; Prairie Crossing, Illinois; and Playa Vista, California were all planned using TND principles with a series of compact, mixed use, pedestrian-oriented neighborhoods, where homes, workplaces, and retail centers are sited sensitively on the land, and the development intends to achieve the goal of economic and ecological sustainability. These precedents show how runoff areas can be shaped into lakes and ponds, prairies, and wetlands that are accessible by miles of trails. Restored plant communities not only provide an aesthetically pleasing vista for the homeowner, they create habitat and healthy ecosystems that attract many species of birds, butterflies and other wildlife. Details such as, plant material selection, placement and composition contribute to both the aesthetic quality of

pond and lake edge and function as living filters removing pollutants and improving water quality.

Final designs are presented to the property owners and local government agencies. Students describe their approaches highlighting specific design solutions and storm water management measures that could be employed to ensure a sustainable development. They discuss conservation measures, such as performance zoning, restoration, conservation easements, and development restrictions as ways to guide and limit development. By the end of the project all participants better understand that from policy and zoning requirements to site planning and design, from wetlands restoration and water quality to a comprehensive open space network, master-planned communities should integrate the natural and built into a seamless whole to become environmentally sustainable.

Information Transfer Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	0	0	0	0
Masters	0	0	0	0	0
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	0	0	0	0	0

Notable Awards and Achievements

Publications from Prior Projects