Impact of Watershed Development for the Fall River Watershed
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Soil Science Society of America 69th Annual Meeting Salt Lake, Utah 2005

Introduction
A watershed-planning meeting was held at the Greenwood County USDA Service Center, Kansas on Thursday, October 3, 2002. The purpose of the meeting was to address concerns that various regulatory agencies had with the Fall River Watershed District’s request to revise the districts 404 permit.

These agencies requested additional water quality data on the five-paired watersheds, comparing controlled and non-controlled watersheds. This data was collected on a frequent basis related to the seasonal hydrology of the watershed. Samples were analyzed for turbidity, total suspended solids, dissolved oxygen, fecal bacterial, and total phosphorus. This data compares the environmental quality of water from these paired watersheds. This report presents the results of the paired watershed water quality monitoring and analysis for five paired watersheds distributed throughout the watershed and five main branch locations in the Fall River Watershed District #21 during 2003-04.

Objective
The U. S. Environmental Protection Agency (EPA) has prescribed monitoring designs for use in watershed projects funded under section 319 of the Clean Water Act (USEPA, 1991b). The objective in promoting these designs has been to document changes in water quality that can be related to the implementation of nonpoint source control measures in selected watersheds. The designs recommended by EPA are paired-watershed and upstream-downstream designs. Monitoring before implementation is usually required to detect trends or show causality (Coffey and Smolen, 1990). In 1995, the Kansas Natural Resource Council and the Sierra Club filed a complaint against the EPA, compelling it to enforce Section 303(d) of the Clean Water Act by establishing total maximum daily loads (TMDLs) for Kansas’s waters that did not meet quality standards for their designated uses. The Kansas Department of Health and Environment (KDHE) collected data for the Fall River Watershed from 1990 through 2000. The designated uses of water in the Fall River Watershed include aquatic life support, primary contact recreation, domestic water supply, food procurement, ground water recharge, industrial water supply, irrigation and livestock watering. KDHE (2002) used the 1998 303(d) impairments to set two trfus for the Fall River Watershed, fecal coliform bacteria and low dissolved oxygen.

This study will use the paired-watershed design to examine the water quality related to sub-watersheds that are controlled by watershed dams compared to watersheds that are drained without control. In selecting watershed pairs, the watersheds should be as similar as possible in size, shape, aspect, slope, elevation, soil type, climate, and vegetative cover (Striffler, 1965). It is important to use small watersheds when performing paired-watershed studies since they are more easily managed and more likely to be uniform (Striffler, 1965). EPA recommends that paired watersheds be no larger than 5,000 acres (USEPA, 1991b).

Methods

Stream Flow (Ward and Elliot, 1995)
Flow in a stream is a function of many factors including precipitation, surface runoff, interflow, the cross sectional geometry and bed slope of the channel, the bed and side slope roughness; meandering, obstructions, and changes in shape; hydraulic control structures and impoundments; and sediment transport and channel stability. Generally, flow in streams and impoundments is classified as open-channel flow because the surface of the flow is open to the atmosphere. Stream flow can be classified several ways. For example, it can be turbulent in steep rocky areas or following severe storm events. Typically, stream flow is tranquil and is considered to be a steady uniform flow. The calculated stream flows for this study assume this condition where the stream depth does not change during the flow measurement and the same depth at every section along the stream.

The stream flow is:

\[ q = v \cdot a \]  
(1)

where: q = stream flow (ft³/sec), v = average stream velocity (ft/sec), and a = cross-sectional area of flow (ft²).

Total Annual Sediment Load
Controlled vs Non-Controlled

For uniform flow in a stream, the average stream velocity, v, can be estimated by Manning's equation:

\[ v = \frac{1.486 \cdot R^{2/3}}{S^{1/2}} \]  
(2)

where: v = average stream velocity (ft/sec), n = Manning's roughness coefficient of the stream channel, R = hydraulic radius (a/p, p = wetted perimeter), and S = channel bed slope (ft/ft).

Flow measurement and sample collection for this study was made at road crossings at bridges or culverts using Stevens and BISCO stage recorders. The cross sectional area and hydraulic parameters needed to estimate stream flow through these structures were measured.

Turbidity parameter
The turbidity measurements in this study will be made in the field with a MicroTIPI Field Portable Turbidity Turbidimeter purchases from HF Scientific, Ft. Myers, Florida. This turbidimeter has a calibrated measurement range of 0.01-110 NTU. This machine is compliant to ISO 7027: Water Quality - Determination of Turbidity (Nephelometric Method).

Dissolved Oxygen Parameter
The dissolved oxygen measurements in this study will be made in the field with an Ox 3400 Field Portable DO meter purchases from WTW Measurement Systems, Ft. Myers, Florida. This dissolved oxygen probe has a calibrated measurement range of 0 to 20 mg/l. The current Kansas standard for dissolved oxygen is 5 mg/l.

Results

Paired Watershed Flow

Figure 1. Paired watershed headwaters % fall river watershed.

Paired Watershed Rainfall

Figure 2. Contour map showing paired watersheds and main branch monitoring locations during 2003.

Controlled Watersheds have the Following Features:
1. Controlled watersheds tend to have lower peak flows and the flow is sustained for longer periods during dry weather.
2. Turbidity and total suspended solid concentrations are lower in streams below controlled watersheds.
3. Sediment and total phosphorus concentrations and loading are lower in streams below controlled watersheds.
4. Bacterial populations and loading are lower in streams below controlled watersheds.

The ponds and lakes upstream of these controls act as a sink that captures contaminants that are stored in the sediments of the lake or degraded by time in the lake water. If the landuse practices above these lakes is maintained in an environmentally proper way the lakes will continue to be a management practice protecting and conserving the water resources that flow into them.