E-20-E48

Ecological and Environmental Impact of Urban Waterway Sediment Removal: An Assessment and Outreach Project

Introduction

This is a proposed collaborative project among DeKalb County, Georgia, the Warnell School of Forest Resources at The University of Georgia, and the Department of Civil Engineering at the Georgia Institute of Technology. Below is a brief discussion of the situation to be addressed.

Past and present landscape disturbance including agriculture and urbanization has greatly increased the sediment supply to Peachtree Creek and the valley sediment storage. As a result, the channel has aggraded (the channel bottom has risen in elevation), and hydraulic conveyance has been reduced so that flood elevations have risen around the creek. In an effort to deepen the channel and increase hydraulic conveyance, DeKalb County initiated sand dredging at two locations on Peachtree Creek in 1997 under a nationwide permit issued by the U.S. Army Corps of Engineers. The excavated sand is sold as aggregate, and the revenues fund the majority of the operation. In the first year, the two dredges removed 34,000 cubic yards of sand from Peachtree Creek which is approximately equivalent to dredging 1000 linear yards to a depth of two yards.

The permit issued by the Corps of Engineers requires DeKalb County to conduct assessments of the ecological and environmental impacts of this operation. DeKalb County may seek to extend this program to other streams and rivers in the County, but the Corps has indicated it will require demonstration that the existing project is not harming the aquatic environment before it will permit additional dredging operations. For the operation to continue, it is also essential to demonstrate to the public and specific interest groups the results of the project. In fact, the assessment of this operation may set precedents for other similar operations in the state.

Objectives

A team will conduct ecological and environmental assessments, report assessments to DeKalb County Commissioners, and through the Cooperative Extension Service provide a public informational outreach program that include public meetings to present the ecological and environmental impacts of sand dredging at two sites known as the Chambliss-Tucker and K-Mart sites, on Peachtree Creek in DeKalb County. A primary objective of this environmental monitoring and evaluation is to determine and report if the project meets environmental mitigation requirement number four stipulated in the 404 Permit issued by the Corps of Engineers (Environmental Mitigation and Project

Guidelines; Waterway Sediment Removal, DeKalb County, Georgia, dated December 23, 1997). Another objective is to assist DeKalb County and its residents in determining whether the project is compatible with the goals and values of the community.

There are a number of specific questions that will be addressed and reported on in this project. They are as follows:

1. To what depth can sand be excavated in these channels and the channel elevations be dropped?

2. What are the short-term and long-term changes in valley and channel cross-sections?

3. What are the short-term and long-term changes in channel longitudinal profile?

4. What are the responses of the fish and benthic invertebrates to dredging and channel changes?

5. How does dredging affect water quality and beneficial uses downstream?

Previous Assessments

In some geographic areas, in-stream gravel and sand dredging is viewed as deleterious to the aquatic environment because it alters natural sediment transport regimes, possibly destroys fish eggs, disrupts macroinvertebrate production on the channel bottom, increases turbidity at the dredging site and downstream, and stirs up contaminants (metals, nutrients, herbicides, pesticides) possibly bound to the sediment. In urban Atlanta streams and other Georgia Piedmont streams, however, sand dredging may have net positive benefits for the aquatic environment.

Past and present land use activities have severely altered sediment supply and channel conditions in Piedmont streams It is likely (though still not determined) that Piedmont streams featured a cobble and boulder dominated channel form with coarse sands lining the bed between the cobbles and boulders and with occasional gravel patches. Early settlers describe the streams as flowing clear under most flow conditions. Currently, the channel bottoms are sand dominated, turbidity is high for long periods of time after rainfall, there is little microtopography to create cover and resting areas for fish, and macroinvertebrate production is poor and dominated by growth on woody debris. Prior to land disturbance, average flow depth was probably greater and flow hydraulics were more complex so that a greater variety of environments were available to fish and aquatic organisms. The larger interstitial spaces promoted macroinvertebrate production, thus increasing the productivity of the streams at higher trophic levels.

In addition to potentially increasing hydraulic conveyance and reducing flooding, sand dredging in Peachtree Creek and other urban Piedmont streams may promote the restoration of more natural channel conditions. Before dredging, sand buries the channel to a depth of about eight feet, covering boulders and cobbles. During low-flow periods, flow is thinly spread over the relatively even sand deposits. After dredging, the average flow depth is much greater and boulders, around which the water flows, are re-exposed.

The post-dredging condition is more suitable for benthic invertebrate production, foraging by larger fish, and rearing by smaller fish. This condition is potentially more suitable for some types of fish reproduction. As dredging continues over time, and the effects of sediment removal spread downstream, more and more channel will revert to this more natural condition. The principal negative effect of dredging is increased turbidity in the immediate vicinity of the operation and for some distance downstream. Another negative impact is increased slumping of banks downstream initiated when the channel bottom is lowered. Since the existing highly mobile sand deposits are stirred up during high flows, it is unlikely that the dredging operation increases the availability of contaminants associated with the channel substrate. The proposed assessments will evaluate these potential positive and negative impacts both upstream and downstream and propose mitigations for any observed negative impacts.

Assessment and Outreach Procedure

The proposed assessment for the existing Peachtree Creek dredge sites and the subsequent information outreach to the Corps of Engineers, the public and specific interest groups includes the following:

Assessment Tasks Performed by The University of Georgia:

1. Establish monumented cross-sections upstream and downstream to monitor long-term channel changes. Develop a longitudinal profile of the channel.

2. Advise DeKalb County on conducting a longitudinal channel survey, downstream and upstream of the dredging sites, to provide baseline data on channel elevations and allow long-term monitoring of channel response to dredging.

3. Conduct seasonal habitat surveys to characterize aquatic habitat upstream and downstream of dredging areas in summer, fall, winter, and spring. These surveys will include physical channel characteristics, invertebrates, and fish presence and abundance.

4. Compare water quality (turbidity or total suspended solids, nutrients, metals, herbicides, pesticides, and water temperature) upstream and downstream of the dredging sites during low flow periods with an active dredge, low flow periods with an inactive dredge, and during high flows.

5. Assess scour depth in Peachtree Creek upstream of the dredging sites. Scour chains will be installed and monitored to measure scour depth. Assess scour depth (using scour chains) in sand bottomed channels upstream of dredging operations.

6. Construct a sediment budget of the Peachtree Creek basin to quantify sediment input rates, output rates, and valley and channel storage.

7. Monitor turbidity effects of dredging operations.

8. Compare water quality (nutrients, metals, herbicides, pesticides, and water temperature) during low and high flows upstream and downstream.

9. Conduct seasonal habitat surveys: (a) determine channel characteristics upstream and downstream of dredging areas; (b) determine aquatic invertebrates upstream and downstream of dredging areas, and (c) determine fish usage of habitat upstream, within, and downstream of dredging areas.

Assessment Tasks Performed by Georgia Institute of Technology (Sub-contractor)

For a description of tasks to be performed, refer to attached subcontract proposal entitled "Numerical Modeling Tool for Management of Sediment in Urban Waterways." Georgia Tech will develop a numerical modeling tool that can be used to evaluate the impacts of urban developmemt on stream sediment regimes and to predict the consequences of removing excess sediment that has been deposited there as the result of past land disturbance activities.

Assessment Tasks Performed by DeKalb County

1. Conduct the longitudinal channel survey.

2. Conduct backhoe excavation of channel deposits upstream and downstream to determine depths of sediment deposits.

Outreach Tasks Led by The University of Georgia

1. Write three interim reports, and a final report to DeKalb County commissioners describing the investigation and its results. Presentations about the results will accompany the delivery of reports. As with all outreach aspects of this project, this effort will be led by the Extension Specialist through the Cooperative Extension Service

2. Report project results to the Corps of Engineers as to the extent the project meets environmental mitigation requirement number four stipulated in the Corps 404 Permit issued December 23, 1997.

3. Provide educational programs as needed about the project findings to the public at DeKalb County-level Extension education programs.

4. Assist DeKalb County in developing an educational pamphlet on sediment problems in streams and on the purpose and impact of sand dredging.

5. Provide similar educational programming to interest groups seeking further information about the dredging project.

6. Make presentations at other county or regional gatherings where similar dredging projects are being considered.

7. Report to other counties interested in similar projects.

Budget

The budget and budget summary are attached. Subcontract narrative and budget are also attached.

Project Contacts

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E-20-E48 Exhibit B

Numerical Modeling Tool for Management of Sediment in Urban Waterways

A Proposal for a Subcontract

Submitted to

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by

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Introduction

Streambed dredging can alter the balance between sediment supply and sediment transport capacity in a stream with resulting streambed adjustments upstream and downstream of the dredging site. If sediment supply and transport capacity are initially in balance, sand mining can cut off the downstream supply and cause downstream degradation as well as upstream degradation in the form of a head cut (Lagasse et al. 1991). In the case of Peachtree Creek in Dekalb County, Georgia, however, it is likely that a balance does not currently exist due to urbanization of the drainage basin and associated land use changes. In this instance, removal of excess sand supply could be beneficial to the overall sediment regime of the stream and extent of flooding, but it must be well managed and its impacts assessed. This includes determination of the optimum frequency and depth of dredging, the degree of water quality disturbance (turbidity) during dredging activities, the expected changes in channel width and depth and thus flood stages upstream and downstream of the dredged site, and the relative change in sediment and associated contaminant (if any) resuspension during storm events with and without dredging.

Objective

The objective of the proposed work is to develop a numerical modeling tool that can be used to evaluate the impacts of urban development on stream sediment regimes and to predict the consequences of removing excess sediment that has been deposited there as the result of past land-disturbance activities. The potential benefits include reduced flooding, stabilization of the sediment regime of urban streams, and recycling of sand as building materials. Such a modeling tool would also allow the evaluation and mitigation of any adverse impacts such as resuspension of any contaminated sediments. It is proposed that the modeling methodology be developed for Dekalb County, Georgia, but it could then have a much wider impact in the State of Georgia by providing a means for other urban areas to manage similar sediment problems. Such a service would be invaluable for the protection and control of urban water resources in the State of Georgia.

Proposed Methodology

It is proposed that the impact of dredging activities on the stream sediment regime and water quality in an urban stream can best be assessed with a combination of field data collection and numerical modeling. While one-dimensional models such as HEC-RAS (U.S. Army Corps of Engineers, 1997) and HEC-6 (U.S. Army Corps of Engineers, 1977) already exist for evaluation of general long-term aggradation and degradation, they require collection of field data for proper calibration and verification. This includes cross-sectional geometry, bed roughness, sediment size distribution, discharge and sediment load (Gee, 1984).

The numerical model HEC-6 is valuable for assessing long-term, one-dimensional changes in streambed elevation. However, bank erosion may accompany bed elevation changes, and it is not easily assessed by HEC-6, especially if the bank materials include a significant fraction of cohesive sediment. Under these conditions, a two-dimensional (depth-averaged) model is warranted to predict velocities near the banks and the associated rate of bank erosion. Furthermore, it has been shown that bed erosion is not uniform across a sand-bed channel (Skolds and Sturm, 1986). In fact, aggradation and degradation can both occur at different points in the same cross-section. Cohesive sediments provide an additional degree of complexity because of the necessity to predict interparticle forces that can depend on pH, organic matter, and mineralogy, for example (Dennett et al. 1998). Thus, an accurate evaluation of the effects of streambed dredging for a given storm event require a two-dimensional model that is capable of predicting the movement of both cohesive and noncohesive sediment.

The contribution of sediment load due to runoff from an urban watershed into an urban stream needs to be quantified to determine the overall impact of streambed sediment removal on the sediment regime. The contribution of this "wash load" in combination with the "bed-material load" has an effect on the incoming sediment load to the dredged stream reach, and therefore affects the impact of the dredging activities. A watershed and sedimentology model such as SEDCAD (Civil Software Design, 1998) can be used to predict the contribution of wash load to the urban stream for different land-use planning scenarios. It has been used successfully, for example, to predict the sediment production from landfill and urban construction sites (Sturm, 1992).

Scope of Work

The numerical modeling activity would be centered at Georgia Tech and would involve the following tasks:

(1) Computation of water surface profiles using HEC-RAS based on field determination of cross-section data and estimates of channel roughness for a series of frequency-based discharges with calibration by historical data where possible;

(2) Numerical estimates of sediment supply from the watershed using a watershed sediment model such as SEDCAD, which is based on soil type, land use, and storm magnitude and duration, in order to assess effects of land use changes and relative nonpoint source contribution to stream sediment load;

(3) One-dimensional, quasi-steady flow and sediment modeling with HEC-6 to establish long-term aggrading and degrading reaches and resulting changes in stage both with and without dredging;

(4) Unsteady, two-dimensional (2D) or quasi-2D sediment and flow modeling to determine potential local bank erosion for various dredging management scenarios, and the extent of sediment resuspension during storm events with and without dredging.

Some field data collection will be done jointly with UGA including sediment budget data to establish boundary conditions for the numerical sediment model, stream geometry and roughness data, sediment size and fall velocity, and measurement of bed load and suspended sediment discharge as well as bed elevation changes for model calibration and verification.

Expected Products

This work is expected to result in a numerical modeling tool that can be used for managing sediment in urban streams in the State of Georgia. It can be made available to urban communities dealing with the excessive costs of urban flooding and sediment problems. The service provided will result in reduced flood damages and beneficial management of sediment problems caused by past development.

References

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