

King County Flood Plan Update Issue Paper: Gravel Removal and Sediment Management

Topic: Gravel removal and sediment management for flood risk reduction purposes.

Statement of Issue:

Sediment accumulation in river channels can increase flood hazard and flood risk in King County. The 2006 King County Flood Hazard Management Plan (Flood Plan) established a comprehensive sediment management program, which can include gravel removal (dredging), to reduce the flood risk. This issue paper describes implementation of the sediment management program in specific King County rivers since 2006 and also identifies recent actions at the countywide or regional scale regarding sediment management. One such recent countywide action warrants a minor revision in this Flood Plan update. Other than this one revision, it is proposed that the existing King County sediment management program be continued as it is in the 2006 Flood Plan.

Background:

Gravel Removal and the King County Sediment Management Program in the 2006 Flood Plan

The Flood Plan recognizes gravel removal as a potential flood risk reduction strategy that can be considered on a case-by-case basis, as long as its flood risk reduction effectiveness, potential impacts and priority relative to other projects also are considered. Flood Plan Policy RCM-3 on Gravel Removal states that “King County should remove gravel from rivers and streams for flood hazard management purposes” only when a set of six conditions can be met. Policy RCM-3 is consistent with state and federal policies and regulations. No revisions to Policy RCM-3 are proposed.

The King County sediment management program, described in Flood Plan Section 4.3.1 and depicted in Figure 4-6, identifies two main program components: channel monitoring and sediment management actions. Channel monitoring includes the periodic survey of in-channel sediment levels to document trends in sediment accumulation. Channel monitoring also includes hydraulic modeling of flood water surface elevations in response to changes in sediment levels. In these monitoring analyses, persistent increases in sediment levels along with corresponding increases in modeled flood water surface elevations typically indicate that flood hazard has increased due to sedimentation. Channel monitoring results are used to inform decisions on sediment management actions; they also would be required for permit applications on any gravel removal project.

Channel monitoring is conducted in King County on eight river segments: the South Fork Snoqualmie and the Middle Fork Snoqualmie Rivers (both near North Bend), Snoqualmie River along Fall City, Snoqualmie River along Carnation, Lower Tolt River, Lower Raging River, Lower Cedar River (where the City of Renton conducts the monitoring) and the Lower White River (where King County cooperates with City of Auburn in collection of survey data).

The sediment management actions part of the program applies to these same monitored river channels and includes evaluation of the channel monitoring data relative to an identified flood risk reduction objective. If that objective is not being met and it can be demonstrated that there is an increased flood risk that is attributable to sediment accumulation, then potential sediment management action alternatives can be considered, including:

- Short term: gravel removal; install temporary flood barrier
- Long term: elevate, or purchase and remove at-risk structures; set back levee(s)

The primary criteria that are used to evaluate potential sediment management alternatives are based on the three main goals of the Flood Plan (Section 1.2):

1. Reduce risks from flood and channel migration hazards.
2. Avoid or minimize the environmental impacts of flood hazard management.
3. Reduce the long-term costs of flood hazard management.

The intent is that such criteria, or others based on these same goals, be used to select a preferred sediment management or flood risk reduction project. Examples that illustrate the use of such criteria to evaluate and select preferred alternatives in implementation of the King County sediment management program are described below.

Implementation of the King County Sediment Management Program in King County Rivers:

South Fork Snoqualmie River Gravel Removal Study and Levee Improvement Project:

The South Fork Snoqualmie River decreases in channel gradient within a leveed river segment along the City of North Bend; ongoing sedimentation is a flood hazard concern in this area. Flooding in 1990 was followed by gravel removal in 1991 and 1994. Channel monitoring results since the 1990s identified areas and rates of sedimentation and associated increases in flood water surface elevations, and determined that an identified flood reduction objective was not being met along part of the South Fork Snoqualmie. The South Fork Snoqualmie River gravel removal study, completed in 2011, evaluated three gravel removal scenarios for flood hazard reduction effectiveness, potential adverse impacts and planning-level cost estimates using criteria based on the three main Flood Plan goals listed above. Study findings indicated that two of the gravel removal scenarios would result in moderate decreases in flood hazard that could persist for about a decade at one critical location where overtopping has occurred in the past. Potential adverse impacts (to salmonid habitat, levee stability, or downstream flooding) were characterized generally, and planning-level costs were estimated at \$1.5M to \$3.6M, depending on the gravel removal scenario.

Another notable finding of this study was that gravel removal would be ineffective in decreasing flood hazard in the area affected by Bendigo Blvd Bridge backwater conditions. This finding corroborates the results of an earlier hydraulic study and suggests that the most effective approach to decreasing the flood hazards at this particular location would be a capital project to modify the Bendigo Blvd Bridge, e.g., by widening its opening.

The South Fork Snoqualmie River gravel removal study identified one scenario that would be most appropriate if it is decided that gravel removal is going to be pursued as a project on this river. Because no other flood risk reduction/sediment management alternatives have been

evaluated yet, no recommendations were made in that study. Instead, findings from the South Fork Snoqualmie River gravel removal study are being used in the South Fork Snoqualmie River Levee Improvement study, now in progress, which is evaluating a set of flood risk reduction alternatives such as levee setback, home elevations, property acquisitions, levee reconstruction and elevation as well as gravel removal. A preferred alternative, or combination of alternatives, will be selected based on the results of the South Fork Snoqualmie River Levee Improvement study using selection criteria that will be similarly based on the three main Flood Plan goals.

City of Pacific Flood Risk Reduction Options (Lower White River):

The Lower White River along the Cities of Auburn, Pacific and Sumner is located at the downstream end of a sediment-rich basin in an area of natural deposition. Also, in-channel sediment accumulation probably is accelerated due to the channelization and confinement in the early 1900s of a previously dispersed network of distributary channels. The historical response to aggradation since channelization typically was persistent and widespread dredging. Channel monitoring data indicate that ongoing aggradation has occurred since cessation of channel dredging in the late-1980s, and hydraulic studies show associated decreases in channel conveyance capacity to a point where the identified flood reduction objective is no longer being met. Sediment accumulation in the Lower White River channel exacerbated overbank flooding in January 2009 within the City of Pacific. In response, a number of actions have been or are being implemented over different time scales.

Because of the direct connection between channel sedimentation and the 2009 flood damages, and the high likelihood that such flooding and damage would be repeated, a short-term flood protection measure was rapidly deployed. In October 2010, King County installed (and continues to maintain) more than 4,000 lineal feet of HESCO © structures, with supporting pumps, as a temporary flood barrier along the area of January 2009 flooding. Even as an urgent short-term action, this flood barrier was evaluated for its flood reduction effectiveness (by hydraulic modeling), for potential impacts (as part of permit requirements) and for cost effectiveness (relative to potentially repeated flood damages).

In addition, King County purchased and removed 11 at-risk residential structures and purchased a 7-acre undeveloped riverside parcel within the area of January 2009 flooding. This project was implemented relatively quickly, with completion in 2011, even though acquisition and removal projects have longer-term flood risk reduction benefits. Because such acquisition projects so consistently have been demonstrated to be a preferred and effective long-term flood risk reduction strategy and due to the urgency of the situation, a standard evaluation of potential alternatives against selection criteria was not conducted. However, this project is consistent with Lower White River Flood Hazard Management Objectives and Strategies identified in Section 5.10.10 of the Flood Plan (to acquire properties and follow up with levee modification to reconnect the river to its floodplain) and with the provisions and objectives of the sediment management program.

For longer-term flood risk reduction on the river reach scale, King County is preparing detailed project design for the Countyline levee setback and floodplain reconnection project along the left (east) riverbank. This project was proposed with equal purposes of habitat restoration and flood risk reduction, and was conceptualized well before the recently more direct effect of

sedimentation on flood hazards became evident. Its alternatives analysis used evaluation criteria based on the three main Flood Plan goals, but did not explicitly consider gravel removal as a project alternative due mainly to its broader purpose of floodplain reconnection. However, a recent US Geological Survey (USGS) study documents decreased channel flood capacity below an identified flood objective and evaluates sediment management options for this same river reach. It found that a levee setback project would be much more effective than gravel removal in reducing flood hazards, which is considered sufficient substantiation that a levee setback is the appropriate preferred project alternative in this river reach. A more detailed and updated evaluation of gravel removal will be included as part of the advanced design and review process for the project. A planning-level cost estimate for the Countyline levee setback and floodplain reconnection project is \$9M.

Even as short-term and longer-term flood risk reduction/sediment management projects are considered, designed and implemented, the channel monitoring portion of the program continues on the Lower White River, with periodic resurvey of channel topography. In addition, King County is cooperating with the USGS to better understand Lower White River sedimentation through two new efforts: a basin-scale analysis of sediment production, transport and deposition, the findings of which will inform long-term sediment management efforts and the design of capital projects in the Lower White River; the installation of four additional river stage gages to monitor flood flow levels in greater detail through this part of Lower White River.

Cedar River Gravel Removal Project:

In 1912, the Lower Cedar River was redirected to its present course into Lake Washington via 1.4 miles of constructed channel. Because of its very low gradient, the constructed channel experiences sediment deposition and the sediment deposition results in a corresponding reduction in channel flood capacity. Consequently, the constructed channel has been dredged periodically to reestablish flood capacity, most recently in 1998. Dredging of the lower 1.25 miles of the Cedar River is identified in the 2006 Flood Plan as the Cedar River Gravel Removal Project, which is proposed for implementation in the near future.

In 1998, the US Army Corps of Engineers implemented the Cedar River 205 Flood Control Project with the City of Renton as the local sponsor. That project included dredging and construction of levees and floodwalls along the lower 1.25 miles of the constructed channel. Its stated objective was to reduce flood damages within the Renton area of the Cedar River in a cost effective manner and with minimal impacts to fish and wildlife habitat, with the intent to provide protection against the 100-year flood. Analysis and design of the 1998 project, including preparation of an EIS, evaluated a set of project alternatives against several criteria in the categories of flood damage reduction effectiveness, cost effectiveness, environmental quality, regional development and other social effects. Potential project alternatives included modification to Chester Morse Dam operations, a setback levee upstream of Renton, channel widening within Renton, a sediment trap, floodwall and levees, channel dredging and others. A combination of constructed levee/floodwalls, modification to a bridge near the river mouth, channel dredging and other features was identified as the preferred alternative.

The Army Corps required future maintenance dredging as part of the 205 Project to maintain its flood protection benefits. Also, because this 205 Project is federally certified, the required

maintenance dredging was accredited in the federal flood hazard mapping of this portion of the Cedar River. Annual channel monitoring by the City of Renton demonstrates that ongoing deposition in the constructed channel is decreasing flood capacity below the identified flood protection objective and therefore maintenance dredging is needed. This maintenance dredging would be implemented as a part of the King County Flood District's 6-year Capital Improvement Project list, with the City of Renton as local sponsor. Implementation of dredging is targeted to commence in 2013, subject to obtaining all required permits. A planning-level cost estimate for the total Cedar River dredging project is \$5.7M.

Other factors affecting the Cedar River project also provide context. The Lower Cedar River in this project area is a constructed channel that was redirected from its original location. It now flows through densely developed areas of municipal and industrial infrastructure that includes downtown Renton, the Renton Municipal Airport and the Renton Boeing Plant. These areas have regional economic significance and maintenance dredging is intended to avoid extensive flood damage to these areas. Also, available information indicates that the planning and permit process for a project such as the proposed Cedar River dredging can require extensive time and effort to ensure appropriate project implementation and mitigation of impacts. Compensatory mitigation measures will be required to offset project impacts, including adverse effects on regulated wetlands or salmonid habitat of species listed under the Endangered Species Act.

These projects on three river segments on the South Fork Snoqualmie, Lower White and Lower Cedar Rivers, demonstrate how the King County sediment management program is being implemented through all of its intended components. In each river segment, a flood reduction objective has been identified, channel monitoring results are compared to that objective, and, if appropriate, flood risk reduction/sediment management alternatives are identified, analyzed and evaluated against criteria that are based on the three main Flood Plan goals. Application of this alternatives analysis and evaluation process has resulted in selection of different preferred alternatives in two of the river segments: channel dredging on the Lower Cedar River and a levee setback project on the Lower White River. The selection of a preferred alternative(s) is yet to be determined on the South Fork Snoqualmie River.

On five other river segments, the channel monitoring component of the sediment management program is being implemented: the Lower Raging and Lower Tolt Rivers, the Snoqualmie River along Fall City and Carnation, and the Middle Fork Snoqualmie River. This channel monitoring information will be used to analyze the effectiveness of gravel removal in these river reaches, as appropriate. Consideration of flood risk reduction/sediment management alternatives are yet to be conducted in these five segments. Evaluation of gravel removal along with other potential project alternatives against the evaluation criteria similarly based on the three main Flood Plan goals would occur as part of basin-scale capital project planning efforts by King County.

Recent Countywide or Regional Actions Regarding Sediment Management:

Terminology:

Use of the term "gravel removal" in King County Code (KCC) has been questioned. The proposed remedy is to replace it with the term "dredging", whose definition in the Washington Administrative Code is consistent with the provisions intended by "gravel removal" in the

current KCC and 2006 Flood Plan. This correction in the term has no effect on the associated development standards specified in the KCC.

Draft 2012 Pierce County Flood Plan:

King County staff recently reviewed and commented on the Draft Pierce County Flood Plan with regard to gravel removal and sediment management, as part of ongoing coordination between Pierce County and King County on flooding issues. The Draft Pierce County Flood Plan also proposes two gravel removal pilot projects on the Puyallup River, the progress of which King County staff will follow for its informative value.

Sediment Management Group:

A Sediment Management Issues Group (SMIG) was formed by the Washington Association for Floodplain Management (WAFM; now part of the Northwest Regional Floodplain Management Association; NORFMA). The SMIG is composed of scientists, engineers, agency staff and other practitioners who meet regularly to share information on sediment management evaluations and projects particular to this region. King County staff attends the meetings and participates in a sub-committee that is preparing a searchable library of articles and documents relevant to sediment management.

Summary statements:

Projects on three river segments demonstrate the implementation of all components of the King County sediment management program. Implementation of the channel monitoring component of the program continues in five river segments, with analysis and evaluation of gravel removal and other project alternatives yet to be conducted. Evidence from these examples, plus feedback from other agencies indicate that the King County sediment management program is appropriate in its approach, scope and provisions because it includes documentation of existing conditions, evaluation of a range of potential action alternatives, and consideration of potential impacts and long-term costs in selecting a sediment management (or flood risk reduction) action.

One specific, proposed revision is that terminology be revised in the Flood Plan update and in King County Code so that the term “gravel removal” is replaced with the term “dredging”.

Other than the one revision to terminology, King County proposes to continue to implement the existing sediment management program as described in Flood Plan Section 4.3.1, with minor edits to update it. Gravel removal for flood risk reduction purposes will continue to be considered on a case-by-case basis, along with other potential sediment management/flood risk reduction actions.