King County's SciFYI

King County
Department of Natural Resources and Parks
Water and Land Resources Division

A digest of current natural science issues in King County

January 2010

Preliminary Assessment for January 2009 Flood Magnitudes for King County Watersheds

By Jeff Burkey and Kyle Comanor, P.E.

King County's Science and Technical Support Section, along with the River and Floodplain Management Section, have completed a preliminary Assessment of the 2009 January flood events. The technical assessment focus was to characterize the January 2009 storm event for rivers with flow gaging locations wholly or partially in King County. The rivers included in the assessment were the White, Green, Cedar, Sammamish, Snoqualmie, Tolt and Skykomish rivers, and Issaquah Creek. Similar assessments will be implemented following future flood events.

Flood Event Summary

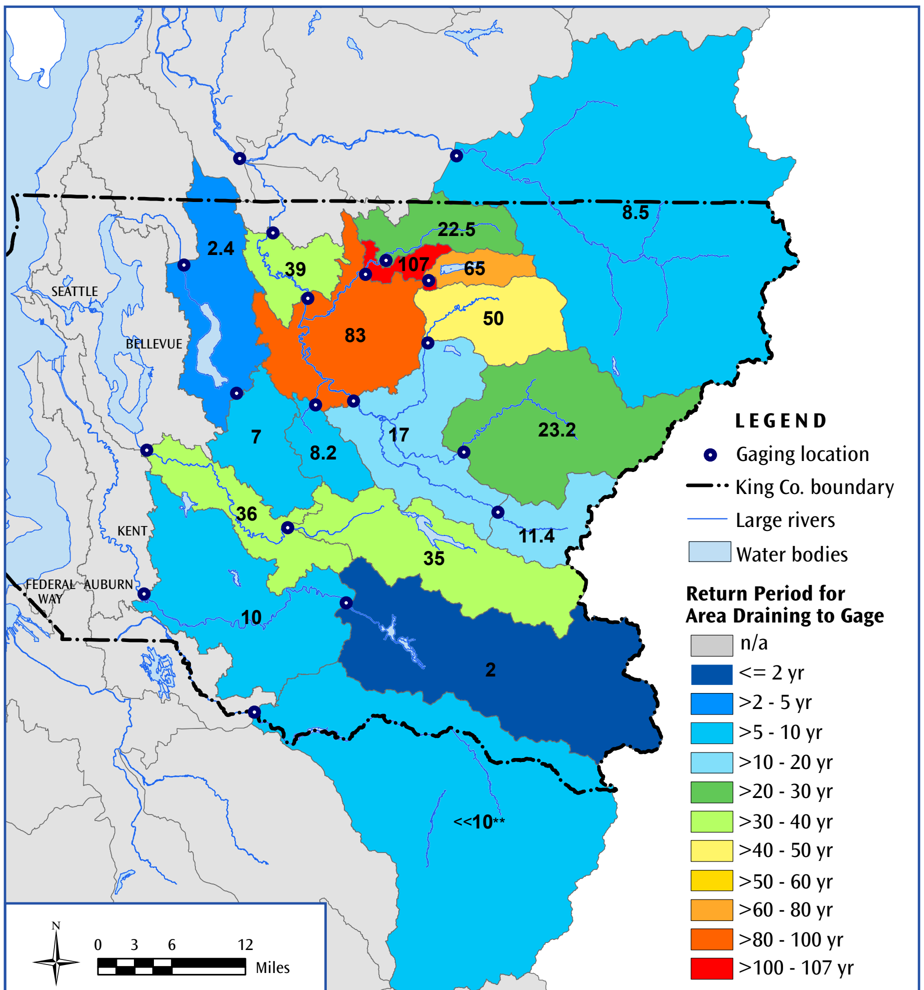
Flood frequency return periods are another way of estimating probabilities of a given size of a flood event to occur. For example, a 100-year flood event is defined as there is a one in 100 chance (1 percent) that a flood of that magnitude or greater can occur in any given year. Thus, a 100-year flood event can occur more frequently than once every 100 years, but on average, over a very long period of time, a flood of that magnitude will occur once every 100 years. (See map on front page.)

During the January 2009 event, all rivers and streams that have a designated flood stage or flood phase were either multiple feet above flood stage and/or at Phase III or greater. The Green and White rivers and Issaquah Creek rose to Phase III flooding, while the Snoqualmie, Tolt and Cedar rivers surpassed the threshold for Phase IV flooding. Flooding in the lower Tolt river for January 2009, was estimated to be larger than a 100-year flood event.

Some of the most-severe flooding in January 2009 occurred in the Tolt and Snoqualmie river basins, where peak flow rates were either the highest or second-highest events on record. Based on available historical data from the U.S. Geological Survey (USGS), this translated into flood frequency estimates ranging from 50-year to 107-year return periods for the events of record, and 22-year to 65-year return periods for the gage stations with the January 2009 storm as the second-highest event.

The Cedar River also experienced flow rates high enough to become the second-largest event on record at Renton which was estimated to be a 36-year return period. The rest of the evaluated gage stations were well below 20-year return period estimates with all but two below 10-year estimates. Despite the varied nature of the flooding, all but four gages had floods within the top five of recorded events.

The full technical report will be online by mid first quarter of 2010. If you have any questions feel free to contact Jeff Burkey via e-mail jeff.burkey@kingcounty.gov



SUMMARY OF PROVISIONAL FLOOD FREQUENCY ESTIMATES*
Shown as Gage Drainage Areas for January 7-9, 2009 Event

Climate Change Impacts on River Flooding: State-of-the-Science and Evidence of Local Impacts

By Curtis DeGasperi

A report under development summarizes current scientific evidence for climate change related trends in river flooding and evaluates historical King County river flow data to identify flow trends. Specifically, trends related to magnitude, duration, frequency, and timing of high river flow. Part of the overall work program includes evaluation of river flow hydrologic simulation results (using output at the same gaging locations) for potential future trends using downscaled global climate model runs.

The chart on the next page illustrates preliminary results of three different climate model scenarios for the same reach of the Snoqualmie River. The model runs forecast return interval flows for years 2000, 2025, 2050 and 2075.

This report will provide an assessment of potential changes in future river flows in response to climate change. The implications for flood management in King County will be more fully discussed based on the review of the scientific evidence for climate-related changes in river flooding, historical trend analysis results, and predicted future river conditions.

Background

Flooding is arguably the most costly natural hazard in King County. Since 1978, King County has had the most flood insurance claims and the greatest number of repetitive flood loss properties of any county in the State of Washington (Washington State Hazard Mitigation Plan, November 2007).

Growing flood damage costs are primarily due to the intersection of naturally powerful and dynamic river floodplain interactions, and the concentration and continuing encroachment of people and their infrastructure in floodplains. However, there is mounting evidence that stream-flow has generally been increasing in the United States since the 1940s, although the Pacific Northwest was noted as having a number of stream-flow decreases, particularly in the lowest flow percentiles.

Preliminary Findings

Findings to-date indicate what seems to be some seasonality to these stream-flow trends, with the flow increases detected mostly in October and November. This appears to be consistent with observed seasonality in increases in precipitation in the U.S.

Because King County is in the path of warm, moist air flow coming from the Pacific Ocean bumping up against the windward side of the Cascade Mountains and other areas along the Pacific Coast, this area experiences some of the highest relative flow magnitudes in the conterminous United States and Alaska.

Generally, the magnitude of King County floods depends on a number of factors including:

- Intensity and duration of rainfall;
- Antecedent soil moisture conditions;
- Basin area and elevations; and
- Snow pack presence, location and depth.

Some of the largest recorded floods in the Pacific Northwest, including the floods of 1964 and 1996, were cased by substantial rain-on-snow events, which most significantly affect larger drainage basins on the order of 100 to 100,000 square miles.

Preliminary analyses suggest an increase in the magnitude, duration, frequency and timing of extreme precipitation and river flow. This appears to be the result of some combination of decadal variation in precipitation and climate change-related upward shifts in temperature and snow accumulation and melt.

It should be noted that the detection of these trends is difficult; not only because of the relative infrequent nature of extreme events and the limited number of stations and record lengths evaluated, but difficult because of changes in land cover that have occurred over the period of analysis, which is primarily forest harvest and re-growth.

Flood Management and Associated Preliminary Finding

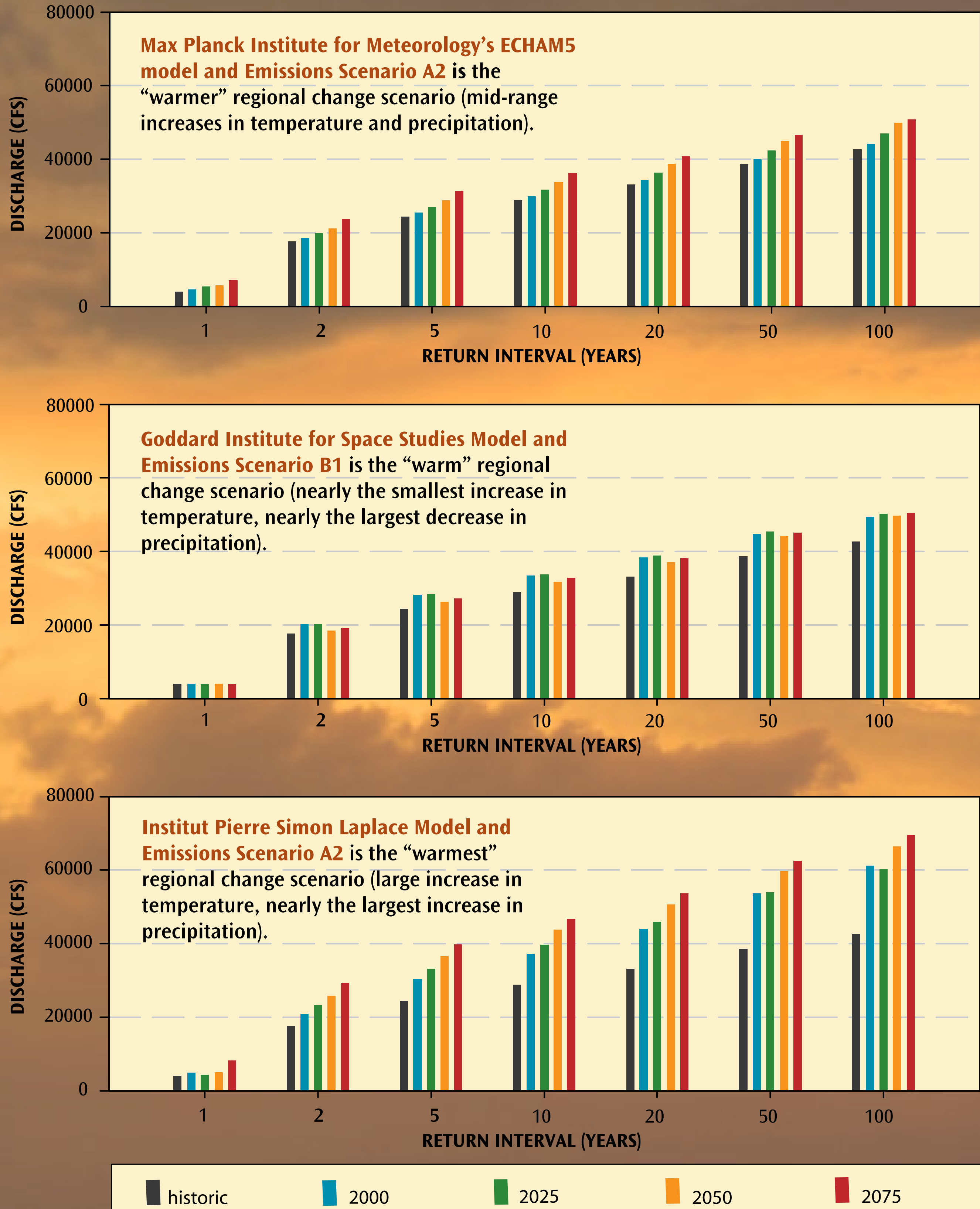
Historically, flood management has been based on the use of historical data to estimate flood return probabilities of specific magnitudes e.g. 50-year, 100-year flood returns. However, trends in observed data and modeling of potential future conditions suggest that this approach (based on the assumption of stationarity*) is no longer valid. It should be noted that there is no other approach to this type of analysis that has reached the level of what might be considered a consistent standard practice that would be suitable for a nationwide flood management program such as the Federal Emergency Management Agency (FEMA).

The issue of stationarity and the potential of a future hydrologic regime with ever-greater frequency and magnitude of high flows suggest that a more integrated water management approach would be beneficial (Green, 2004; Meyer et al., 2009).

For those who would like to be notified when the final report becomes available, please contact Curtis DeGasperi at Curtis.DeGasperi@kingcounty.gov

*A stationary time series is one whose statistical properties such as mean and variance are constant over time. Standard flood frequency analysis assumes that annual maximum flow series are stationary. However, land cover change, hydrologic modification via dams and flood plain alteration, and climate change bring the assumption of stationarity into question (Milly et al. 2008).

Projected return interval flows for Snoqualmie River near Snoqualmie (USGS 12144500) based on output using downscaled climate predictions from three Global Climate Model Scenarios representing current and future periods centered on years 2000, 2025, 2050, 2075.



2009 Year 1 Post-Construction Monitoring of the Stuck River Drive Revetment Repair, White River

By Ray Timm and Sarah McCarthy

Photo 1. *An eroded portion of the Stuck River revetment taken from the White River looking upstream just above the R Street Bridge. Photo: Ray Timm.*

Map 1 & Photo 2. Regional/Vicinity map with approximate location of Stuck River Revetment Repair Project, topographic bed survey (light blue line), 7.5 miles above the confluence with the Puyallup River. Note, the bridge in the photo is R Street. Inset shows approximate location of project in the drainage.

A facility inspection following the November 2006 flood revealed damage to the Stuck River Drive Revetment which is located upstream of the R Street Bridge on the White River in Auburn, Washington. The revetment is a flood protection facility made primarily of rock riprap designed to protect the river bank from erosion. The revetment was severely eroded and undercut, requiring repair (Photo 1). The revetment repair, which was completed in 2008, was intended to protect nearby infrastructure while improving aquatic habitat diversity and cover in this segment of the White River.

Project Site

The project site is on the left bank of the White River in the City of Auburn. The site is within a broad floodplain area about 7.5 miles upstream of the White River's confluence with the Puyallup River (Map 1, Photo 2). The left bank in this location is hardened continuously for about 2.5 miles upstream from the project site, and flow velocities along the left bank and throughout this reach can be high for fish during flood events. Because the site is in a reach that is largely confined by flood protection facilities, there is very little low velocity habitat or refuge for juvenile fish. The White River also carries a high sediment load.

The White River and its tributaries serve as essential spawning, rearing and migration habitat for chinook, pink, chum, sockeye and coho salmon, as well as winter and summer steelhead, resident rainbow, bull, and cutthroat trout. Currently, chinook, steelhead, and bull trout are listed as threatened under the Endangered Species Act. King County's flood facility repairs strive to improve habitat conditions for salmon by increasing habitat complexity and vegetation along the river bank.

Monitoring Methods

Monitoring of the repair site is intended to document progress toward meeting the following project objectives:

1. Repair the revetment and lay back (flatten) bank slopes where possible.
2. Improve habitat complexity along the facility (sedimentation and scour pools).
3. Improve the quality of the river bank by increasing the amount of native vegetation on the bank and hanging over the channel.

Monitoring activities include photographic documentation of the site, bed material characterization, and assessment of plant survival. Post-construction monitoring was initiated in 2009 (Year 1), and included photography, measurements of bed elevation along the facility, and observations of bed material characteristics. In addition, a post-flood facility damage assessment was conducted immediately following a large flood event in January 2009. During this flood event, the river flow exceeded 12,000 cubic feet per second and corresponded to slightly less than a 10-year discharge event. Vegetation survival (and any necessary plant maintenance) will be conducted in years 3 and 5.

Year 1 Results

The introduction of large roughness elements along the bank was expected to create local scour and sediment deposition around placed boulders and large wood. Instead, it appears that because the large wood and boulders were all placed in a relatively continuous configuration, the water velocity was decreased along the entire facility, causing sediment deposition but no scour near the toe of the facility (Figure 1). Formal sediment particle size measurements were not conducted, but from visual inspection, the mean particle size appeared to be much finer than that observed prior to construction. In fact, much of the placed rock was buried under sand along the margin of the bank following the January 2009 flood.

The bank was indeed protected from damage during the January 2009 flood. Post-flood inspections revealed an intact facility with no signs of erosion. In addition, visual inspections close to the peak of the storm discovered slower-moving water around the large wood and boulders, contrasted by swift-moving water in the center of the channel (photo 3). A small amount of flood-borne wood floating downstream was recruited to the revetment repair, but did not cause any damage to the facility or anchored large wood.

The monitoring revealed two main results:

- First, the revetment was successfully repaired and the bank was protected from damage during the 2009 high flow event that was comparable to the 2006 flow discharge that caused the flood damage to the facility. Therefore, the first project objective was met.

Photo 3. Stuck River Revetment Repair site during 12,200 cfs event, Jan. 9, 2009. Notice the difference in water velocities between the large wood and the bank, and channelward of the wood. Photo: Terry Butler.

- Second, it appears that slower water velocities and/or high sediment loads in the White River caused sedimentation along the toe of the facility. Habitat complexity was increased initially through the placement of large wood and boulders, but may have been slightly reduced by the sediment deposition.

Conclusion and Next Steps

These findings show the utility of installing large roughness elements in the river channel as velocity-dampening bank protection. Bed characteristics along facilities may have the potential to change quickly due to the high sediment load in the White River.

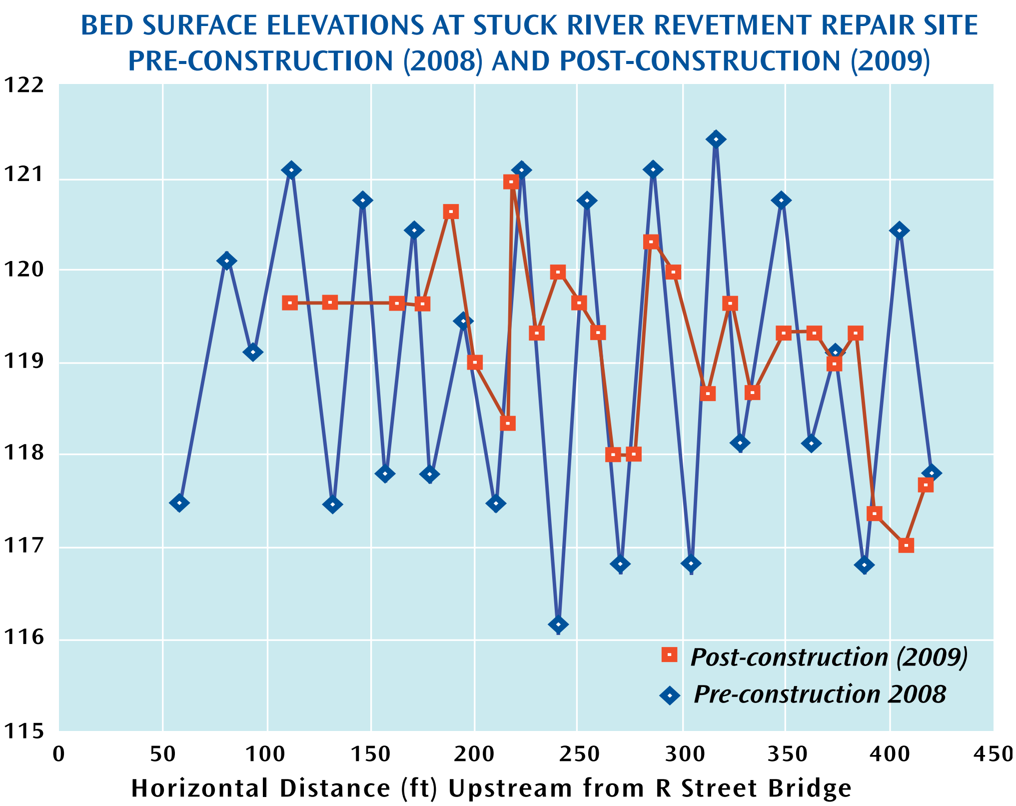


Figure 1.

The large wood and boulders installed at the toe of the facility were intended to provide rearing habitat and low velocity flood refuge for fish. Visual surveys when juvenile fish are likely to be present and velocity measurements during a high flow event would be useful for documenting project effectiveness. As the installed vegetation matures, we expect the overhanging cover to further benefit fish by providing shade and invertebrate prey sources. Continued monitoring is recommended to determine the long-term effectiveness of the project in terms of flood protection, habitat function, and cost effectiveness.

For additional information on this report, contact Ray Timm, ray.timm@kingcounty.gov. For project design information, contact Deborah Scheibner, Project Engineer, Deborah.Scheibner@kingcounty.gov

Focus on Flooding

Many homes, businesses and farms are in harm's way if the Green River experiences serious flooding.

Residents, businesses and farms below the Howard Hanson Dam in the Green River Valley should prepare now for a higher risk of flooding.

The higher risk is due to water seeping more rapidly through an earthen bank next to the dam after record high water last winter. Until the U.S. Army Corps of Engineers can make repairs, it must limit the amount of flood water it stores behind the dam.

If heavy and prolonged rain occurs this flood season (roughly October through March), many homes and businesses in the valley that don't typically see flood water—including parts of Auburn, Kent, Renton, South Seattle and Tukwila—could be flooded.

Evacuations in some communities are possible. Key transportation routes and transit service could be disrupted, and power outages and sewer back-ups are possible even outside the immediate flood zone.

Prepare now to help keep your family and property safe when the rains come.

How to prepare for a flood

1. **Sign up to receive automated flood alerts for the Green River and other King County rivers at** www.kingcounty.gov/flood.
2. **Make an emergency plan** and assemble an emergency kit.
3. **Buy flood insurance now;** it takes 30 days for a policy to take effect. Review your current policy; a standard insurance policy will not cover flood damage. Contact your insurance agent or visit www.floodsmart.gov.
4. **Purchase an inexpensive AM radio** or NOAA weather radio with batteries in case of power outages for urgent news, day and night.
5. **Monitor area news** media for information if severe weather is predicted.
6. **Listen for alerts about evacuation routes** or visit www.kingcounty.gov/floodplans for the latest evacuation route information.
7. **Monitor local road conditions** and obey closure signs.
8. **Take medications and supplies with you,** for those with medical needs.
9. **Be ready to relocate animals and livestock** out of harm's way.
10. **Minimize flood damage:**
    - Store valuables and electronics higher on the ground floor, on the second story or in your attic.
    - Store chemicals above possible flood levels; recycle or dispose of them at the Wastemobile at the Auburn Supermall.
    - Learn how to use sandbags and locate where you can buy or get them ahead of time if needed for flood fighting.
    - Move vehicles and equipment to high ground before flood waters rise.
    - Keep storm drains free of leaves and other debris.
    - Know who to call and how to protect yourself if flooding leads to sewer overflows into homes and businesses.

Howard Hanson Dam Fact Sheet
www.nws.usace.army.mil/
(Click on Howard Hanson Dam Pool Restriction)

Green River Valley Flood Safety
www.kingcounty.gov/floodplans

Flood planning and response resources

- **American Red Cross serving King and Kitsap counties**
  206-323-2345 or 360-377-3761
  www.seattleredcross.org

- **Flood warning/watch information**
  King County Flood Warning Center
  206-296-4535 or 800-768-7932
  Staffed 24 hours during a flood to answer questions and provide information.

- **King County Flood Warning information line**
  206-296-8200 or 800-945-9263
  Recorded flood phase information for area rivers.

- **King County Flood Warning System**
  www.kingcounty.gov/flood
  Real-time flood gage data and flood phase information.

- **Regional Public Information Network**
  www.rpin.org
  Sign up to receive updates on flooding and other emergencies.

- **National Weather Service Forecast Office**
  www.wrh.noaa.gov/sew/
  Find out if heavy rain is forecast, and if the Green River is under a flood watch.

- **Social media**
  twitter.com/kcalerts
  Sign up to receive updated flood information via real-time "tweets."

- **How to prepare for a flood**
  www.kingcounty.gov/floodplans

- **National Flood Insurance Program**
  888-379-9531
  www.floodsmart.gov

- **Emergency sandbag information**
  (open during flooding)
  206-296-4535 or 800-945-9263

- **3 Days 3 Ways**
  www.3days3ways.org

- **Take Winter By Storm**
  www.takewinterbystorm.org

- **Sewage overflows**
  www.kingcounty.gov/SewageSpills

- **Metro Transit disruptions**
  www.kingcounty.gov/metro

- **King County Road 24/7 Helpline**
  206-296-8100 or 1-800 KC ROADS

- **King County Road Alert**
  www.kingcounty.gov/roadalert

- **Hazardous Waste Disposal (house or business)**
  206-296-4692
  www.govlink.org/hazwaste

City flood information

- **City of Auburn**
  http://www.auburnwa.gov/Emergency/disaster/Green_River_and_Howard_Hanson_Dam_Information.asp

- **City of Kent**
  http://www.ci.kent.wa.us/emergencymanagement/index.aspx?id=2636

- **City of Renton**
  http://rentonwa.gov/government/default.aspx?id=26157

- **City of Tukwila**
  http://www.ci.tukwila.wa.us/headlines/flood/AreYouReadyforaFlood.pdf

- **King County Employee Information**
  http://www.kingcounty.gov/employees/HumanResources/Flood.aspx

Happy water year 2010!

By Jeff Burkey

Here is a quick summary of the past 2009 King County water year using National Weather Service SeaTac gage; October 1, 2008 thru September 30, 2009.

Total for the year is **33.98 inches**.

Half of our precipitation for the year fell on **19 days**.

There were **149 days** (41 percent of the year) of measurable precipitation; days with traces of precipitation are not counted.

The largest one-day total, Jan. 7, 2009, and the two-day total was **3.51 inches** for the same storm.

The second-largest one-day total was **2.15 inches**, Nov. 6, 2008, with a two-day total of **3.14 inches** for Nov. 6 & 7, 2008.

The longest run of consecutive days of no measurable precipitation was **29 days**—May 20–June 17.

The second-longest run of consecutive days of no measurable precipitation was **27 days—July 14–August 9.**

For the summer months of June through August, precipitation fell on **14 days** totaling **1.40 inches**; only **0.06 inches** over **two days** fell in July.

There were **50 days** with 0.25 inches or more precipitation.

About King County's Sci FYI

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Send questions, comments and future story ideas to:
Kate O'Laughlin - kate.olaughlin@kingcounty.gov, 206-296-8363 or
Jim Simmonds - jim.simmonds@kingcounty.gov, 206-296-1986

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