**BASE FLOOD ELEVATION DETERMINATION BF-16-01**

# BASE FLOOD ELEVATION DETERMINATION FOR LOWER REACH OF GATE CREEK NEAR VIDA, LANE COUNTY, OREGON

by Jed T. Roberts[1] and Matt C. Williams[1]
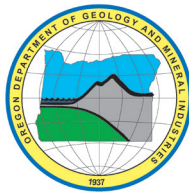
2016

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## DISCLAIMER

The Oregon Department of Geology and Mineral Industries is not liable for any claimed damage from the use of this information. The Federal Emergency Management Agency may, at any time in the future, revise the Base Flood Elevations for this study area. This study and Base Flood Elevation determination does not supersede any existing or future detailed analyses or determination performed by a licensed professional engineer. This analysis and mapping does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size.

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## STUDY BACKGROUND

This study was conducted under a Base Flood Elevation Determination Service agreement dated February 18, 2016, between the Oregon Department of Geology and Mineral Industries (DOGAMI) and AKS Engineering and Forestry, LLC. The purpose of this study was to develop 1% annual chance (100-year) water surface elevations, also known as Base Flood Elevations (BFEs), for the lower reach of Gate Creek in Lane County, Oregon, near the unincorporated community of Vida.

BFEs are determined primarily for administration of the National Flood Insurance Program (NFIP). The Federal Emergency Management Agency (FEMA) oversees the NFIP and issues Flood Insurance Rate Maps (FIRMs) that depict Special Flood Hazard Areas (SFHAs) within which flood insurance for structures is typically required. SFHAs are mapped by *detailed* or *approximate* methods:

- *Detailed analyses* are performed for streams in urban or suburban settings, and SFHAs mapped with this approach are designated as Zone AE, Zone AO, or Zone AH. The analyses incorporate field survey and flood frequency data into a hydraulic model. The resulting BFEs are mapped onto best available topographic data.

- *Approximate analyses* are performed for streams in rural areas, and SFHAs mapped with this approach are designated as Zone A. Unlike detailed analyses, the approximate analysis does not produce BFEs. Instead, this latter method has historically involved engineering judgment of hydraulics and hydrology to map SFHAs onto U.S. Geological Survey (USGS) topographic sheets.

The approximate analysis approach was used to map SFHAs that are shown on the currently effective FIRM for Gate Creek (Figure 1).

DOGAMI has partnered with FEMA through its Cooperating Technical Partner program to improve FIRMs by introducing high-resolution lidar (light detection and ranging) topographic data. As part of this effort DOGAMI has developed a FEMA-approved computer model-based approach to produce BFEs using lidar in areas designated approximate, enabling the Zone A SFHAs to be revised and updated. This same approach was applied for the current study to produce BFEs in an area where FEMA has not yet funded a lidar-based FIRM revision.

**Figure 1.  Zone A Special Flood Hazard Area (FEMA, 1999).**
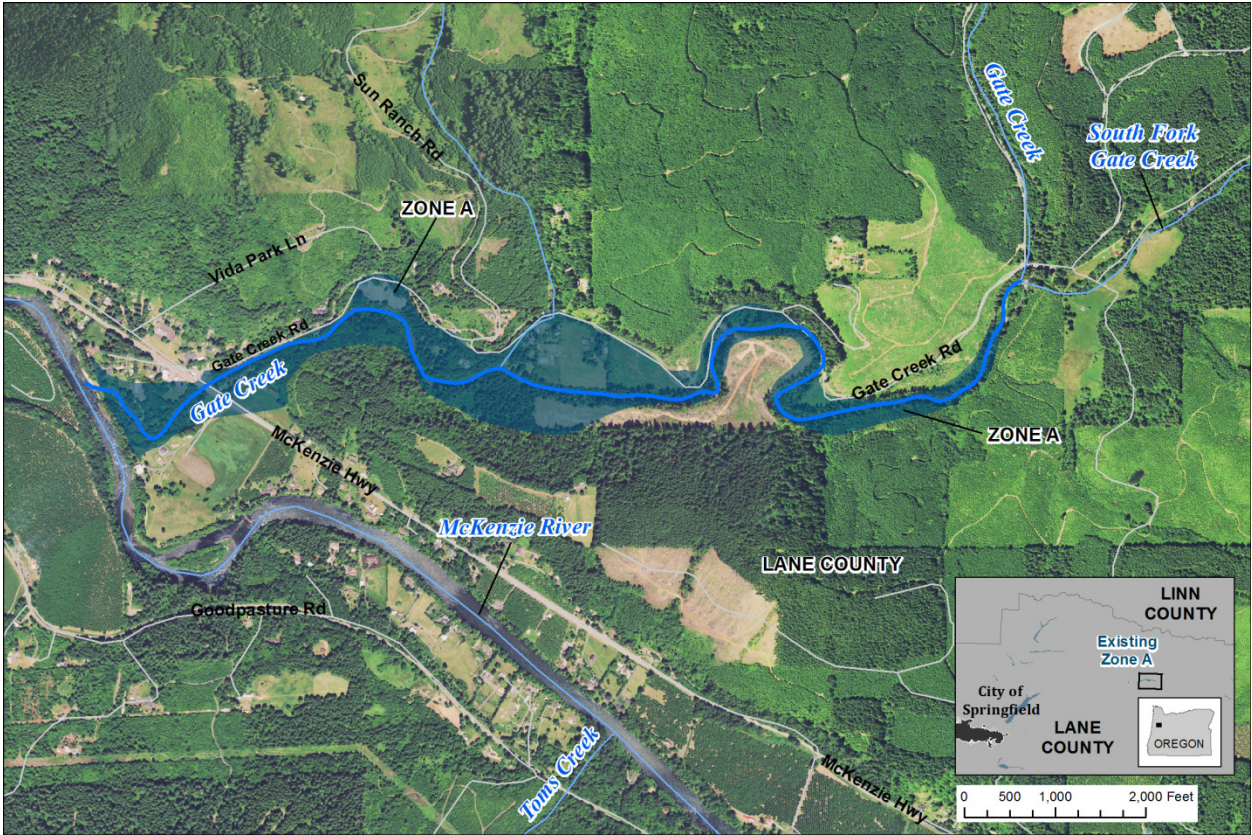
## PHYSICAL SETTING

Gate Creek drains a 48.1-square-mile watershed within the southeastern Willamette River Basin along the western slope of the Cascade Range. It is a tributary to the McKenzie River with the confluence upstream of river mile 41 (Figure 2). The watershed is characterized by steep forested uplands typical of the western Cascade Range. Timber harvests have moderately altered the watershed. Mean annual precipitation in the watershed ranges from approximately 60 to 80 inches per year. Flows do not appear to be regulated by dams or other hydraulic structures.

Gate Creek appears to have been relatively stable in its planform configuration throughout recent history. The channel is moderately confined by bedrock along most of the reach, with valley widths of approximately 500 feet. In the middle of the reach the valley expands to 1,500 feet, where evidence of downcutting is seen in a three-tiered terrace succession, clearly visible from lidar data collected in 2009 (DOGAMI, 2010).

**Figure 2. Location of study reach.**
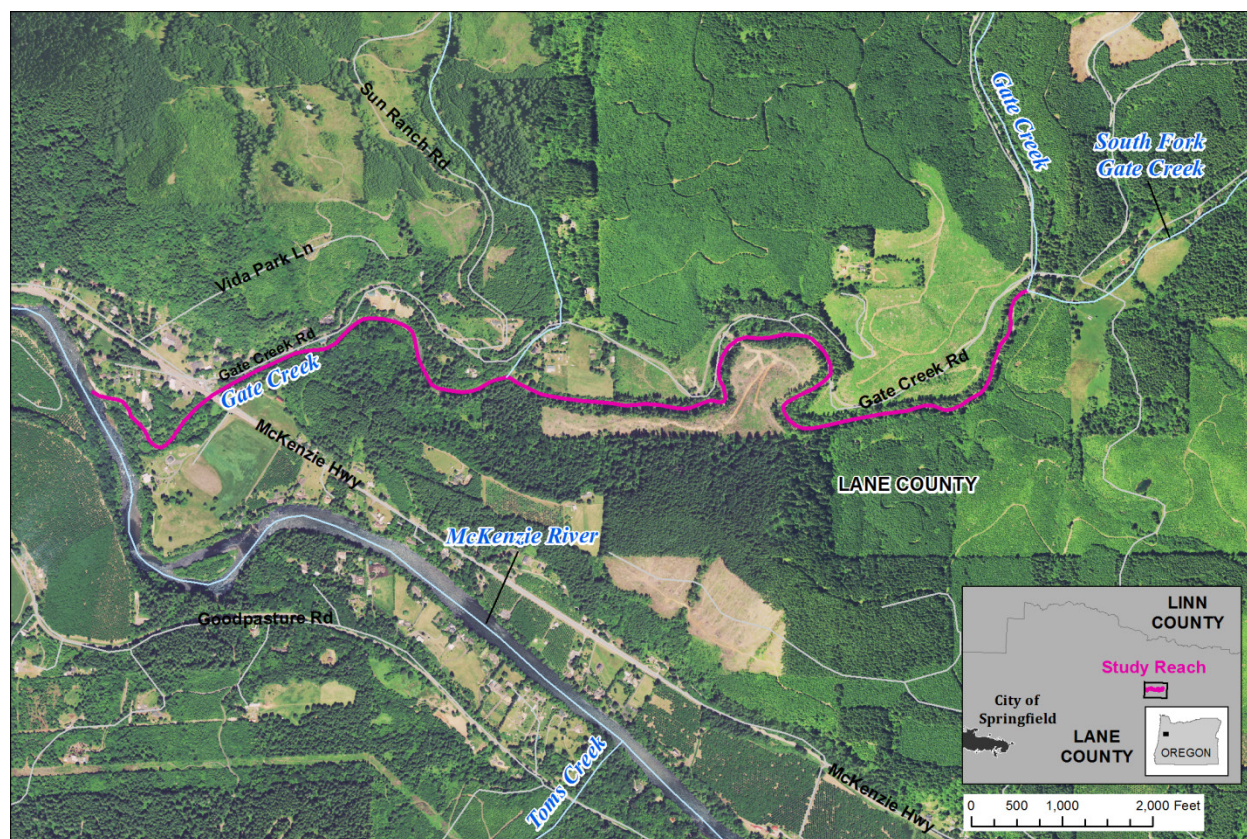
## HYDROLOGIC ANALYSIS METHODS

Two discharge locations were identified for this study. Locations were selected at the downstream terminus of the study reach and upstream based on a minimum drainage area reduction of 1 square mile (Figure 3).

The 100-year peak discharges were calculated using a regional regression equation developed by the Oregon Water Resource Department (OWRD) and the USGS (Cooper, 2005). OWRD and USGS divided western Oregon into three hydrologic regions with separate regression equations. The watershed upstream of the discharge locations fall completely within Region 2B. For these ungaged locations the 100-year peak discharge is given by the equation:

$$Q_{100} = 31.85 \, Area^{0.9114} \, Slope^{0.4501} \, I24\text{-}2^{0.6252}$$

where

$Q_{100}$ = the 100-year (1% annual chance) peak discharge, in cubic feet per second,
*Area* = the drainage area of the watershed, in square miles,
*Slope* = the mean watershed slope, in degrees, and
*I*24-2 = the 2-year (50% annual chance) 24-hour precipitation intensity, in inches.

Basin characteristics were determined using the USGS StreamStats for Oregon web tool (USGS, https://water.usgs.gov/osw/streamstats/, accessed 2015). The resulting 100-year peak discharges are listed in Table 1.
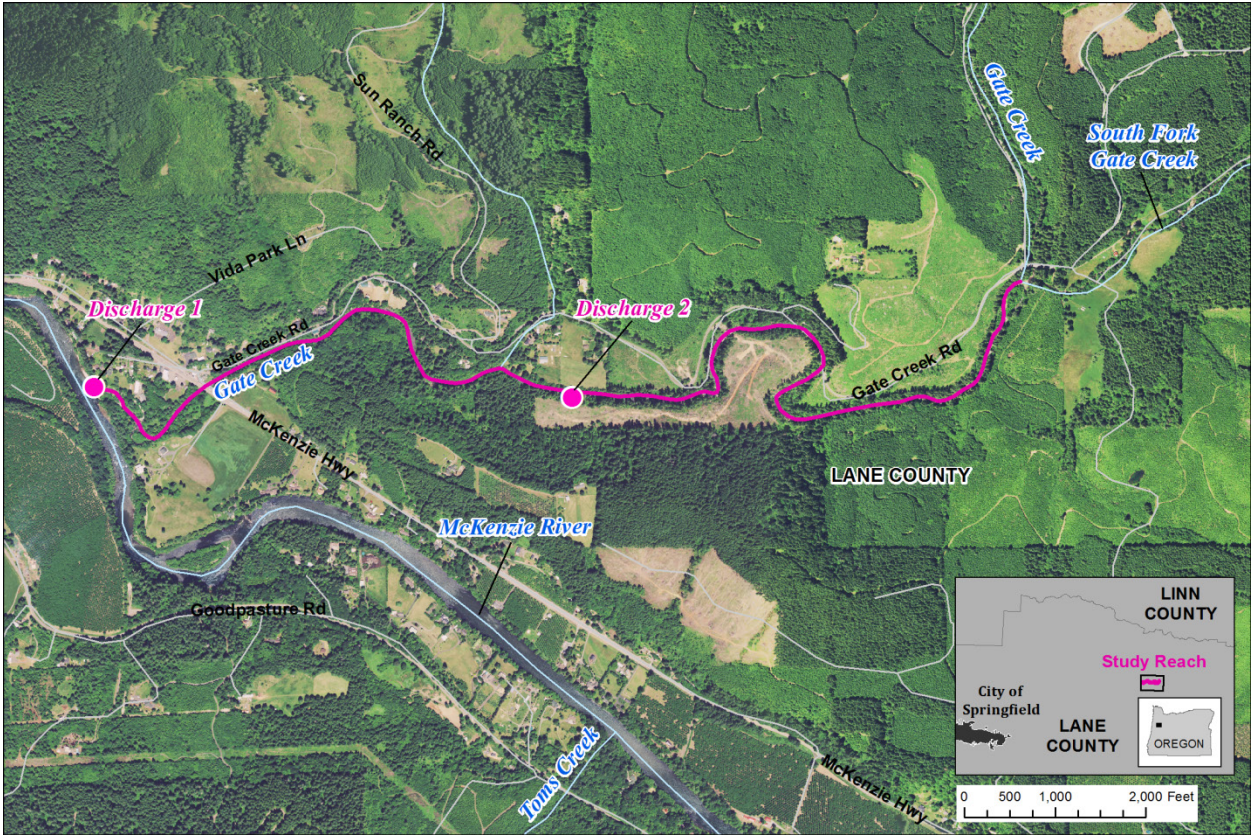
**Figure 3. Discharge locations.**



**Table 1. Summary of 100-year flood discharges.**

| Discharge Location | Drainage Area (sq. mi.) | Mean Watershed Slope (deg.) | 2-year 24-hour Precipitation Intensity (in.) | 100-Year Peak Discharge (cfs) |
|---|---|---|---|---|
| Discharge Location #1 | 48.1 | 21.7 | 2.56 | 7,820 |
| Discharge Location #2 | 46.6 | 22.0 | 2.57 | 7,660 |

## HYDRAULIC ANALYSIS METHODS

To produce simulated water surface elevations of the 100-year peak discharge, a steady flow hydraulic model was developed by using the Hydrologic Engineering Center River Analysis System (HEC-RAS 4.1) produced by the U.S. Army Corps of Engineers (Brunner, 2010). Geometric input data were developed using the Esri ArcGIS® for Desktop Advanced 10.2.2 software package, the Esri 3D Analyst® and Spatial Analyst® extensions, and the HEC-GeoRAS 10.2 add-on produced by USACE (Ackerman, 2011).

Geometric data layers, including stream centerline, flowpaths, bank stations, and cross-sections, were digitized from a hillshade raster derived from a 3-foot resolution lidar digital elevation model (DEM). The lidar DEM was derived from ground classified points with an average density of 0.13 per square foot. The vertical accuracy for the lidar acquisition area is ±0.26 feet on flat surfaces. Lidar acquisition for the study area took place on May 31, 2009 (DOGAMI, 2010).

Twenty-six cross-sections were placed along the study reach, perpendicular to the stream centerline (Figure 4). The downstream reach boundary condition was defined as known water surface elevations from BFEs published by FEMA (1999).

Manning's roughness coefficients were determined for the study area overbank areas using the 2011 National Land Cover Dataset (Jin and others, 2013). Land cover types were assigned a coefficient from land descriptions provided by Chow (1959). Overbank coefficients were found to range from 0.03 to 0.1 throughout the study area. Channel coefficients were determined by inspecting orthoimagery and are fairly consistent, ranging from 0.05 in the upper, more rugged reach, to 0.04 in the lower reach.

**Figure 4. Location of cross-sections used for hydraulic analysis.**
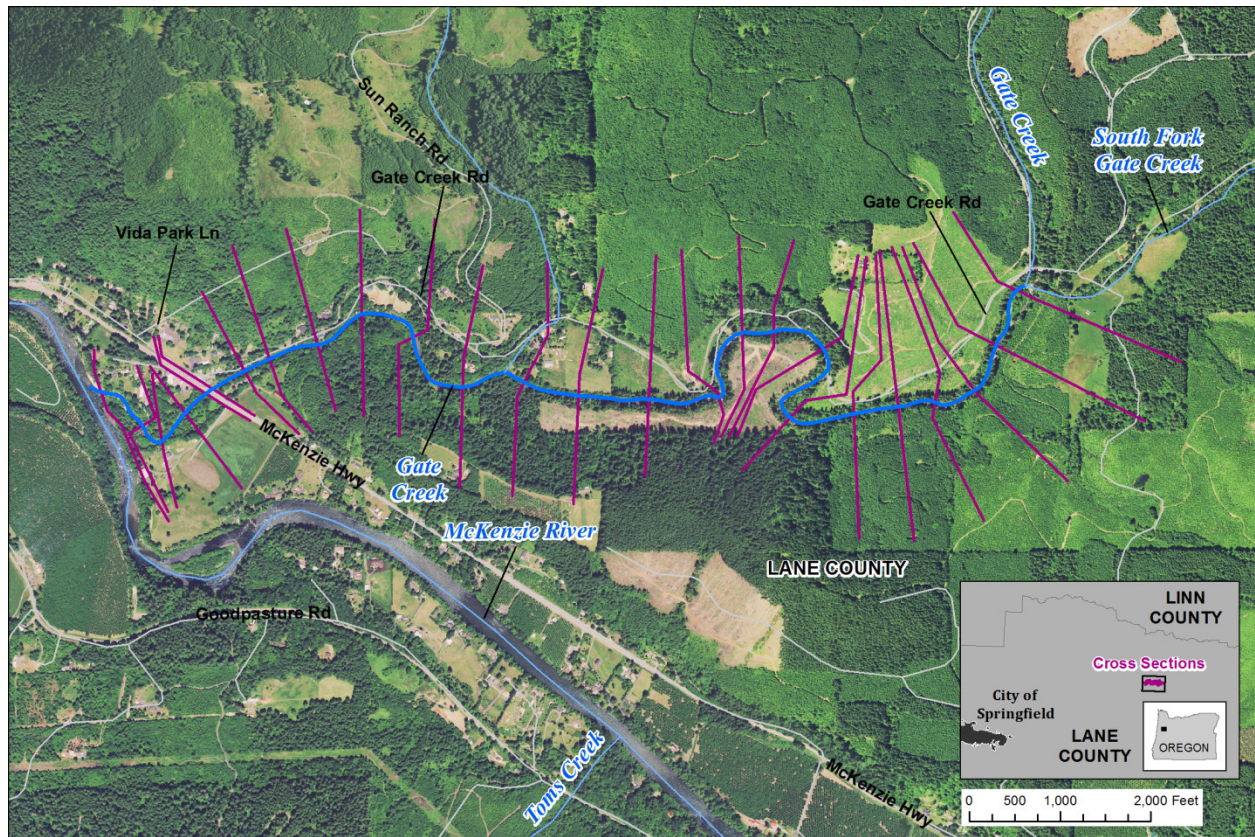


## SUMMARY OF RESULTS

The results of hydraulic modeling show that BFEs range from 767.4 ft (NAVD88) at the downstream terminus of the study reach to 890.2 ft (NAVD88) at the upstream terminus. Table 2 shows BFEs at cross-sections selected approximately every river mile (Appendix A) throughout the study reach.

**Table 2. Summary of 100-Year flood elevations.**

| Reference Cross-Section[1] | Location Description | BFE (ft. NAVD88[2]) |
|---|---|---|
| GC-1 | mouth of Gate Creek | 767.4 |
| GC-2 | 1,200 feet upstream of the McKenzie Highway (State Route 126) bridge | 789.9 |
| GC-3 | 4,200 feet upstream of the McKenzie Highway (State Route 126) bridge | 812.4 |
| GC-4 | 5,500 feet downstream of confluence with South Fork Gate Creek | 845.6 |
| GC-5 | 2,200 feet downstream of confluence with South Fork Gate Creek | 874.0 |
| GC-6 | just downstream of confluence with South Fork Gate Creek | 890.2 |

[1]See Appendix A for map of reference cross-sections.
[2]North American Vertical Datum of 1988.

# REFERENCES

Ackerman, C. T., 2011, HEC-GeoRAS GIS tools for support of HEC-RAS using ArcGIS© user's manual version 4.3.93: Davis, Calif., U.S. Army Corps of Engineers, Hydrologic Engineering Center, CPD-83, 244 p.

Chow, V. T., 1959, Open-channel hydraulics: New York, McGraw-Hill, 680 p.

Brunner, G. W., 2010, HEC-RAS River Analysis System user's manual, version 4.1: Davis, Calif., U.S. Army Corps of Engineers, Hydrologic Engineering Center, CPD-68, 790 p.

Cooper, R. M., 2005, Estimation of peak discharges for rural, unregulated streams in western Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5116, 134 p.

Federal Emergency Management Agency (FEMA), 1999, Flood insurance study for Lane County and incorporated areas: Washington, D.C., 301 p.

Jin, S., Yang, L., Danielson, P., Homer, C., Fry, J., and Xian, G, 2013, A comprehensive change detection method for updating the National Land Cover Database to circa 2011: Remote Sensing of Environment, v. 132, 159–175.

Oregon Department of Geology and Mineral Industries (DOGAMI), 2010, McKenzie River lidar data: Lidar Data Quadrangle Series, LDQ-44122B5-Vida.

## APPENDIX A: MAP OF HYDRAULIC ANALYSIS RESULTS

Attached to this report is a map depicting the hydraulic analysis results of the 100-year peak discharge for the study reach of Gate Creek.
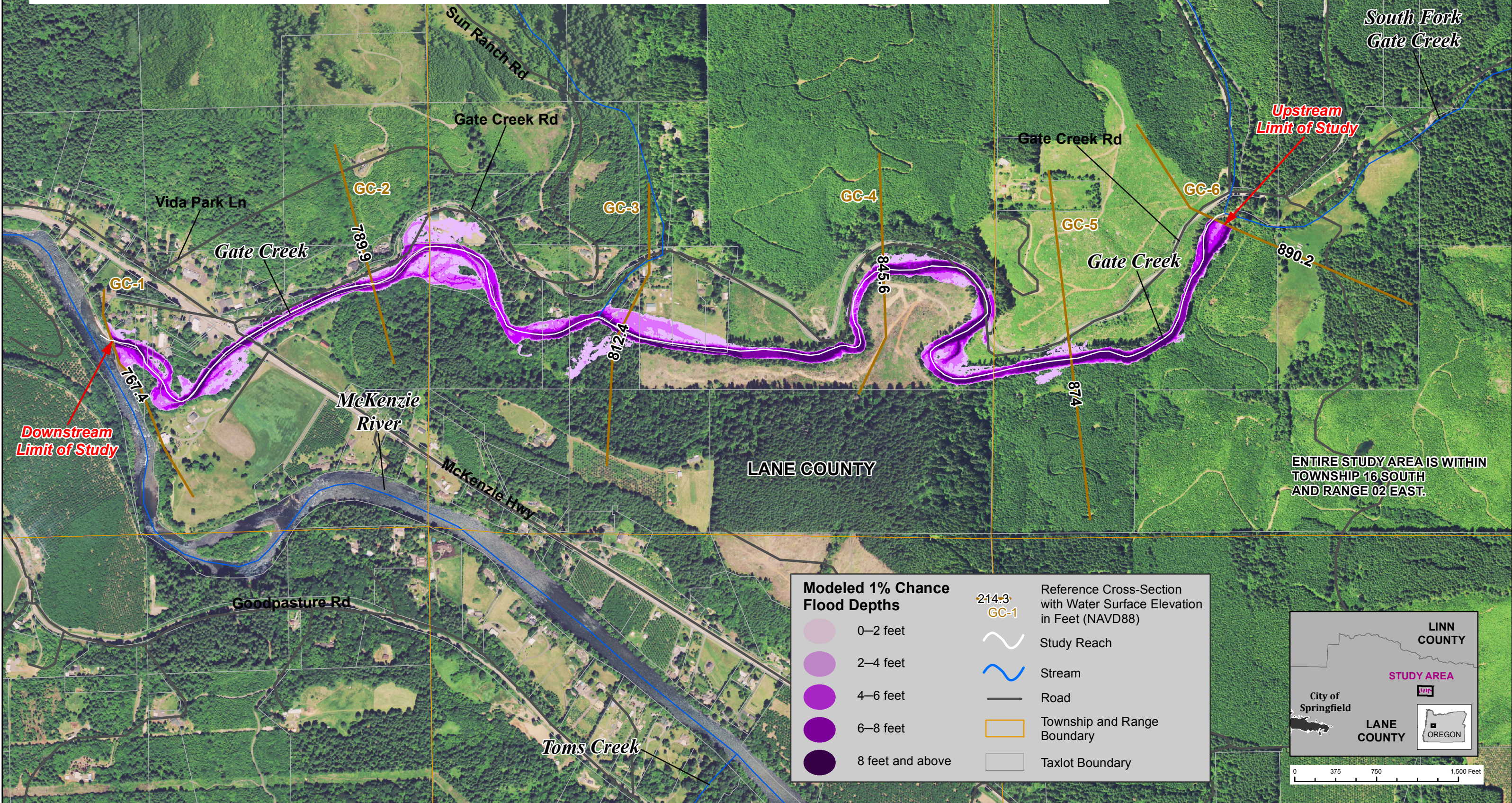
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Brad Avy, Director and State Geologist

BASE FLOOD ELEVATION DETERMINATION REPORT BF-16-01
**Lower Reach of Gate Creek,
Lane County, Oregon**
By Jed T. Roberts and Matt C. Williams
*(See accompanying report.)*

South Fork Gate Creek

Sun Ranch Rd

Gate Creek Rd

Upstream Limit of Study

Gate Creek Rd

GC-6

GC-5

GC-2

GC-3

GC-4

Gate Creek

890.2

Vida Park Ln

Gate Creek

789.9

812.4

845.6

874

GC-1

767.4

Downstream Limit of Study

McKenzie River

McKenzie Hwy

LANE COUNTY

ENTIRE STUDY AREA IS WITHIN
TOWNSHIP 16 SOUTH
AND RANGE 02 EAST.

Goodpasture Rd

Toms Creek

**Modeled 1% Chance Flood Depths**

214.3
GC-1
Reference Cross-Section
with Water Surface Elevation
in Feet (NAVD88)

0—2 feet

2—4 feet

~~~ Study Reach

4—6 feet

~~~ Stream

6—8 feet

—— Road

8 feet and above

Township and Range Boundary

Taxlot Boundary

LINN COUNTY

STUDY AREA

City of Springfield

LANE COUNTY

OREGON

0    375    750    1,500 Feet

## APPENDIX B: HYDRAULIC ANALYSIS DATA PACKAGE

Attached to this report is a data package containing the input and output datasets used to perform this study. The data package includes:

- HEC-RAS 4.1 model (HECRAS folder)
- HEC-GeoRAS 10.2 input geometry data in GIS format (HECGeoRAS_Input_Geometry folder)
    - Cross-sections (XSCutLines)
    - Stream centerlines (River)
    - Flowpaths
    - Bridges
- HEC-GeoRAS 10.1 output data in GIS format (HECGeoRAS_Output folder)
    - 100-year flood zone (FloodZone)
    - Model output 100-year flood zone (bp001)
    - 100-year water surface elevation grid (Gate_100yr_WSEL_ft.tif)
    - 100-year depth grid (Gate_100yr_Depth_ft.tif)
    - Cross-sections with computed 100-year water surface elevations (XSCutlines)
- 3-foot resolution lidar DEM in GIS format (Topography folder)
- Hydrologic data table (GateCreek-Hydrology Sheet.xlsx) and supplementary shapefiles (HydroPoint, Subbasin1, Subbasin2)