Effective Field Techniques and Watershed Modeling for Characterizing Mercury Loading to Surface Water

Black Butte Mine Superfund Site, Lane County, Oregon

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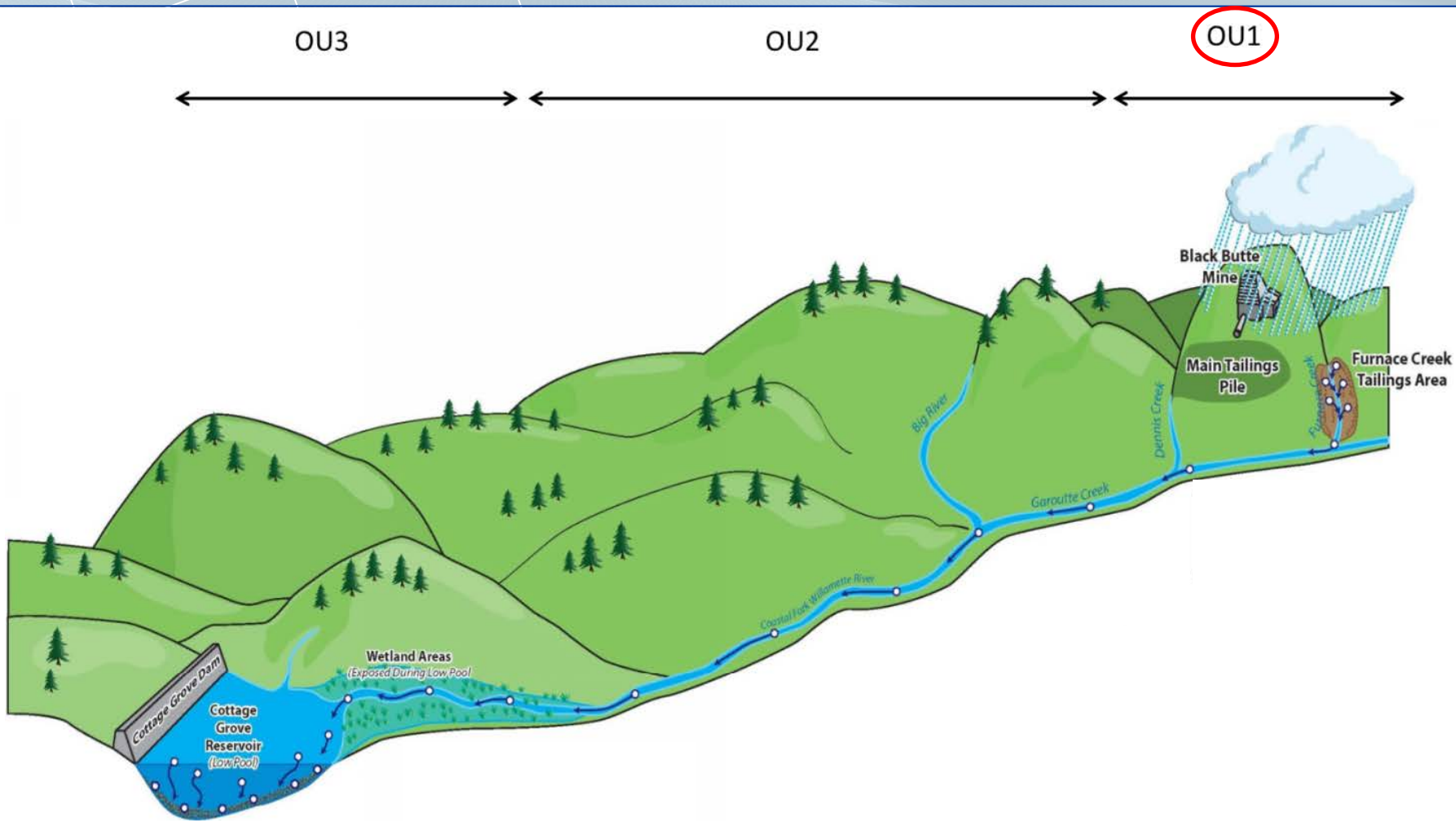
CDM Smith®

Preliminary Conceptual Site Model



Modified from Optimization Review Report (USEPA July 2012)

Technical Approach to Characterize Mercury Loading to the Watershed

- **Identify streams receiving mine impacted water discharge**

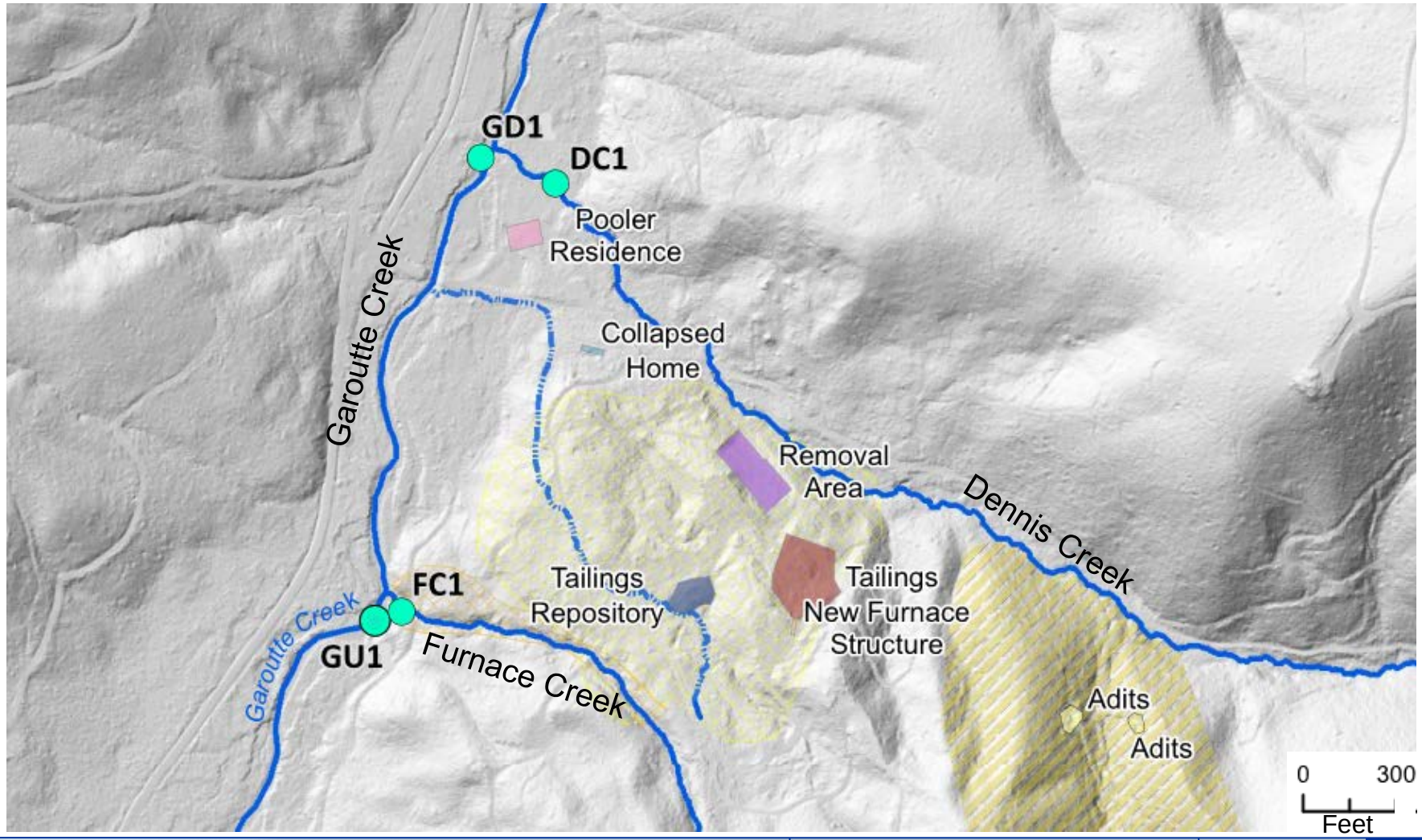
- **Estimate mercury loading to each stream:**
  - Quantify stream discharge throughout the year
  - Quantify mercury concentrations throughout the year

- **Watershed model:**
  - Construct watershed model using site specific data
  - Calibrate model to stream discharge and mercury concentration data
  - Utilize the model to evaluate remedial alternatives

Presentation Outline

- **Field methods to determine:**
  - Water level (stage)
  - Stream Discharge
  - Mercury concentration in surface water and precipitation
- **Preliminary mercury loading results**
- **Construction and initial calibration of the watershed model**

Garoutte, Furnace, and Dennis Creek Surface Water Monitoring Stations



STAGE AND STREAM DISCHARGE MEASUREMENTS

Water Level Monitoring

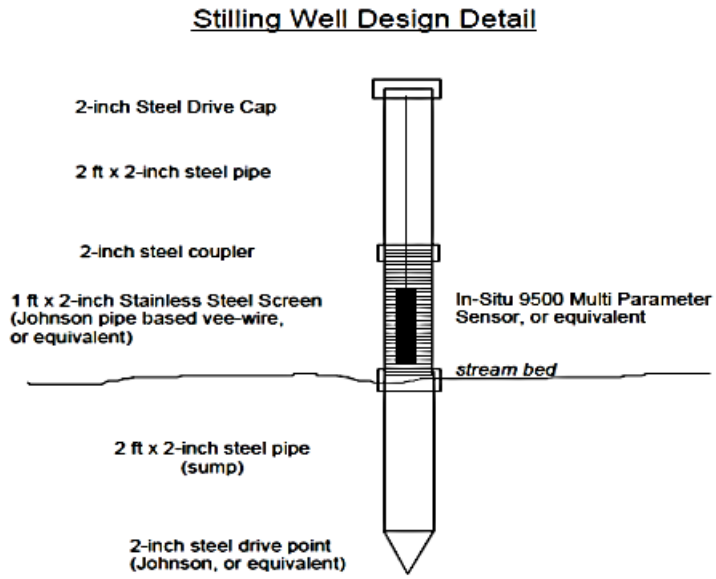
- **Staff Gauge – manual water level measurements**
- **Stilling Wells – continuous monitoring with pressure transducers**

Automated Water Level and Water Quality Instrumentation

Objectives – Track water level and water quality year round

Stilling Wells

- Hand-driven well points
- Johnson Vee-wire screen, SS
- Screened 12-inches above stream bed



Instrumentation

- Troll 9500 – Level, turb., temp., conduct., pH
- AquaTroll 200 – Level, temp., conductivity
- 15-minute data logging intervals

Stream Discharge Estimates

Technical Approach

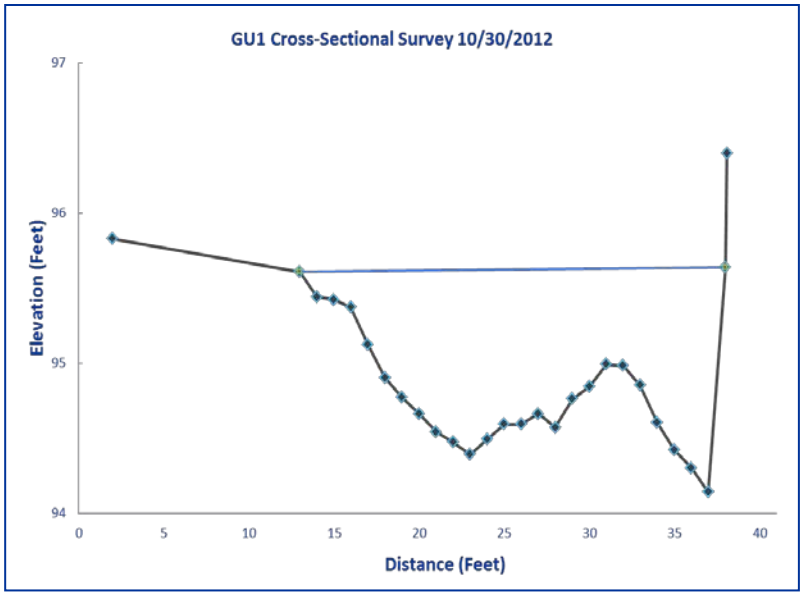
- Collect stream discharge measurements at a range of water levels
- Establish a rating curve relating stream discharge to water level
- Use rating curve to estimate stream discharge at any given water level

Stream Discharge Measurement Methods

1. Longitudinal stream profile surveys
2. Cross-sectional stream velocity measurements
3. V-notch weir
4. Direct measurement

2 – Cross-Section Stream Velocity Surveys

- Swoffer gauge
- Depth and velocity measured along cross-section
- Stream discharge calculated from depth, velocity, and interval length

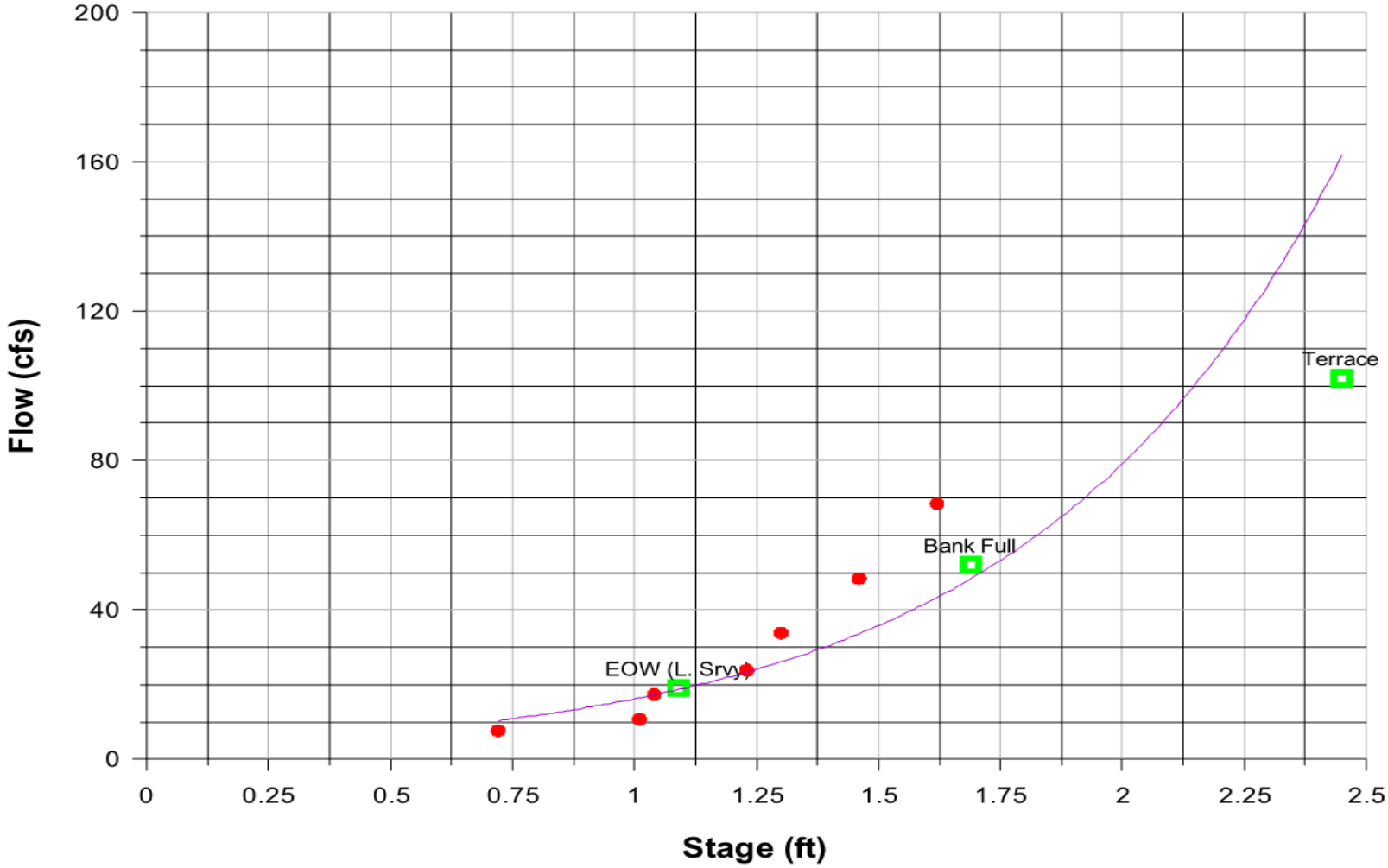


Other Discharge Measurement Methods

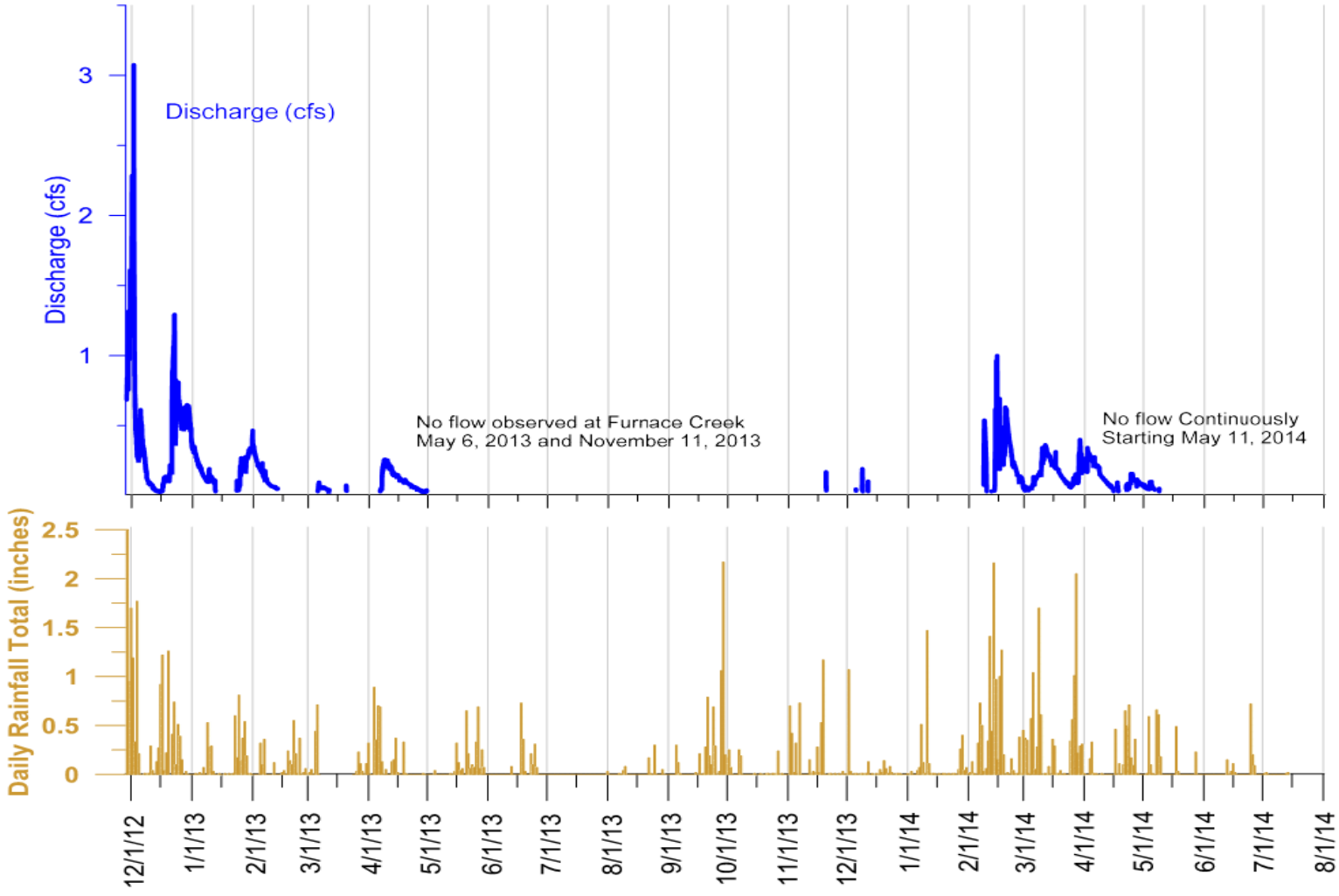
3 - V-notch Weir

4 - Direct Discharge Measurement

Rating Curve for GD1
Stream Discharge vs Water Level



Stream Discharge at FC1



SURFACE WATER SAMPLING

Surface Water Quality Sampling

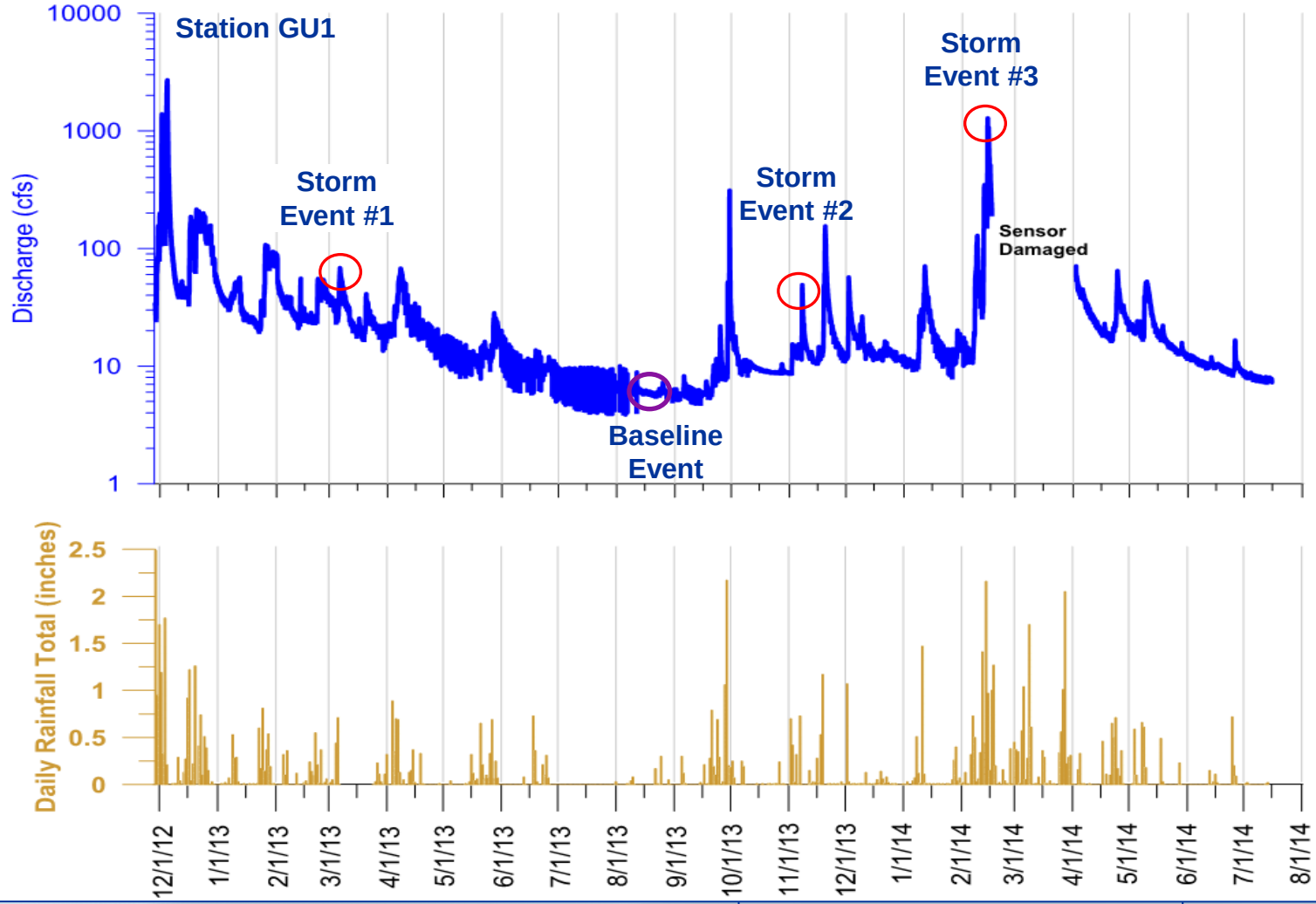
Objective

- Determine mercury concentrations over wide range of discharge rates

Surface Water Sampling Events

- Samples collected at GU1, GD1, FC1, and DC1
- One sampling event during low-discharge in dry season
- Three storm events of different intensity and antecedent conditions

Surface Water Sampling Events



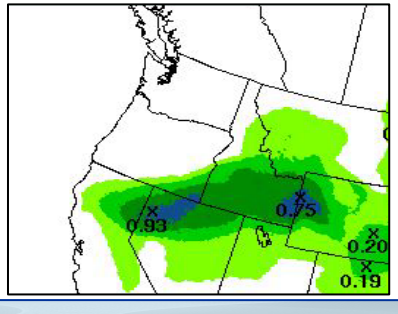
Storm Event Surface Water Sampling

Sampling Approach

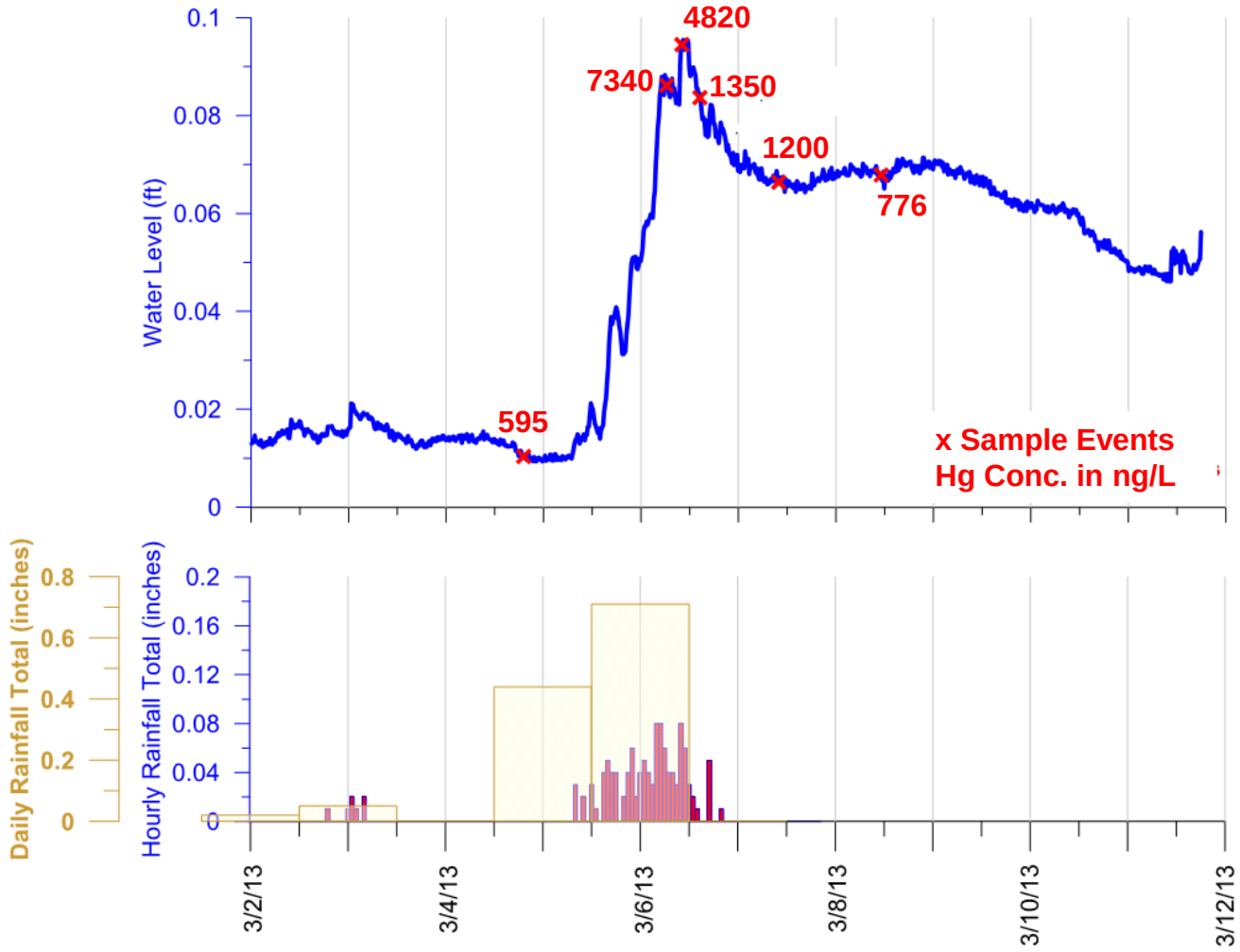
- Collect 6 samples throughout the storm event for a total of 10 parameters(10 sample bottles) at each of the 4 stations (240 bottles per storm event)
- Monitor and sample precipitation throughout the storm event
- Clean-Hands protocol and low-level mercury analysis

Logistical Challenges

- Storm event tracking and predictions
- Mobilize a trained field crew of 5
- Transport of samples and equipment to remote stations



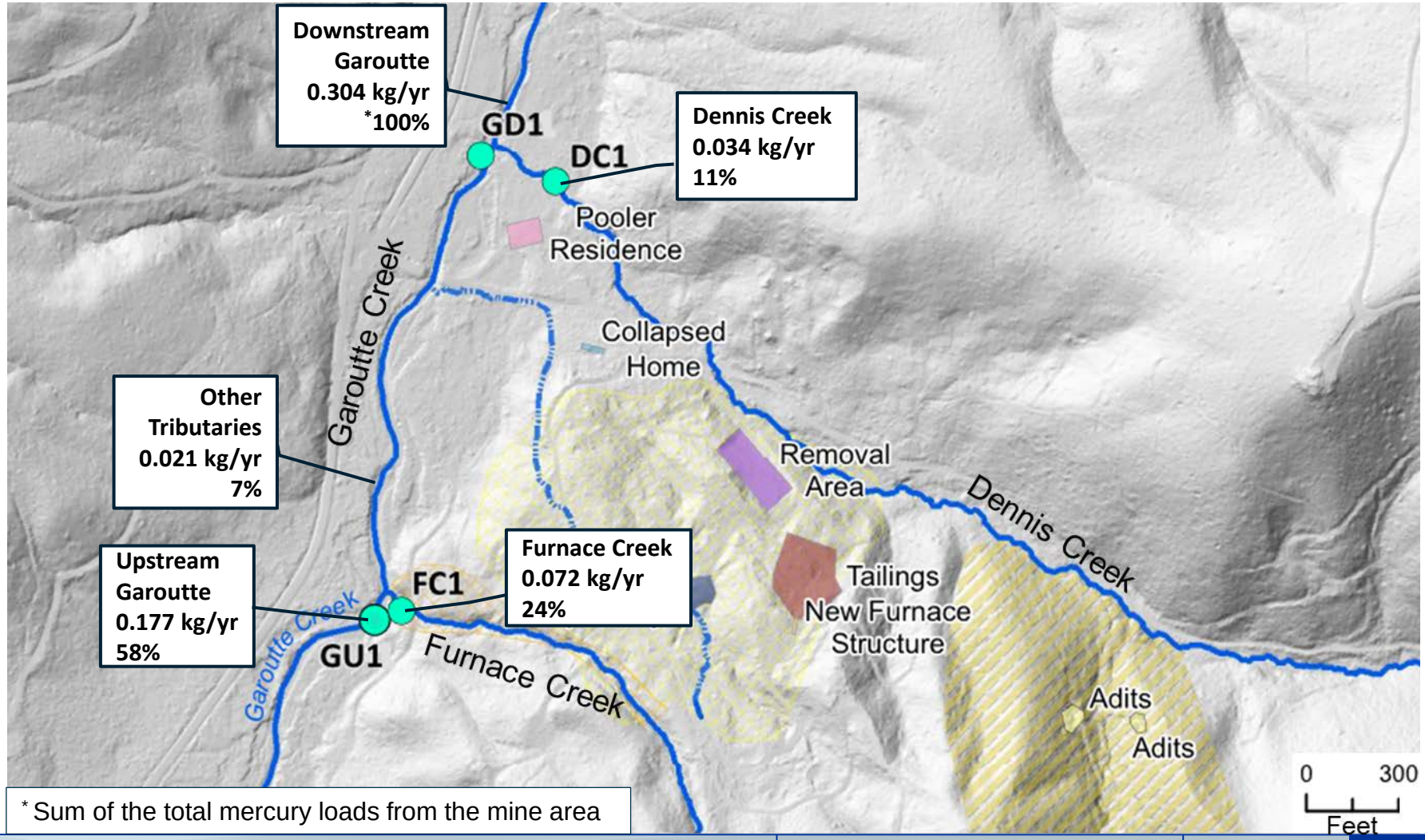
Storm Event #1 Sample Collection at Furnace Creek – FC1



Black Butte Mine Weather Station and Precipitation Sampler

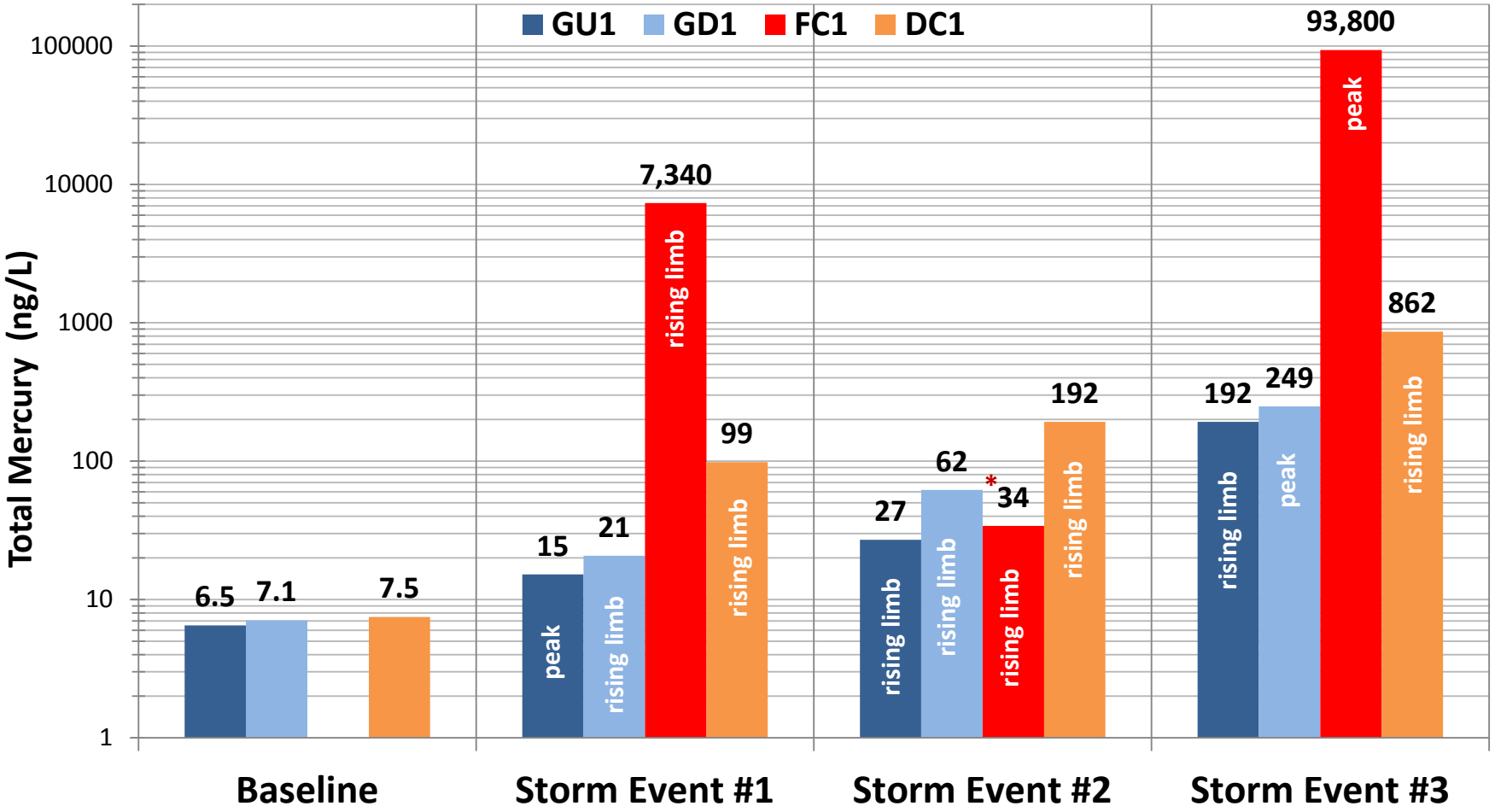
PRELIMINARY RESULTS

Estimated Annual Mercury Loads and Percent of Total Load in Downstream Garoutte Creek



* Sum of the total mercury loads from the mine area

Maximum Mercury Concentration Observed During Storm Events



* Bank seepage sample, not representative of surface water

WATERSHED MODEL

Black Butte Mine Watershed Model

Objectives:

- Develop a model to evaluate mercury loading downstream of Black Butte Mine
- Use the model to evaluate remedial alternatives

Modeling Approach:

- Develop the model using site specific data
- Calibrate the model based on measured stream discharge and concentration data
- Update the model as new data is collected

Watershed Model Information

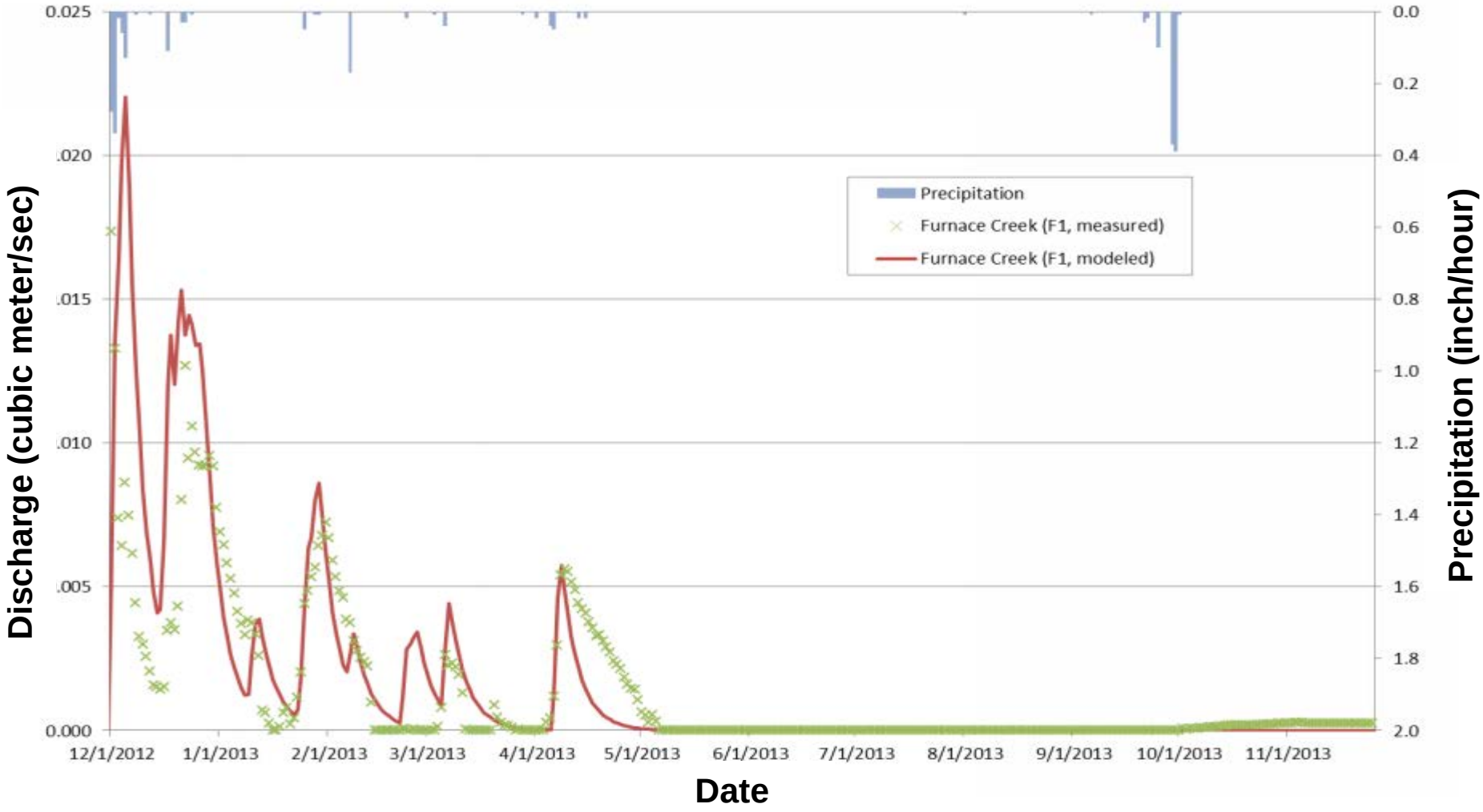
Model Type:

- Watershed Analysis Risk Management Framework Stream Water Quality Model (WARMF model)

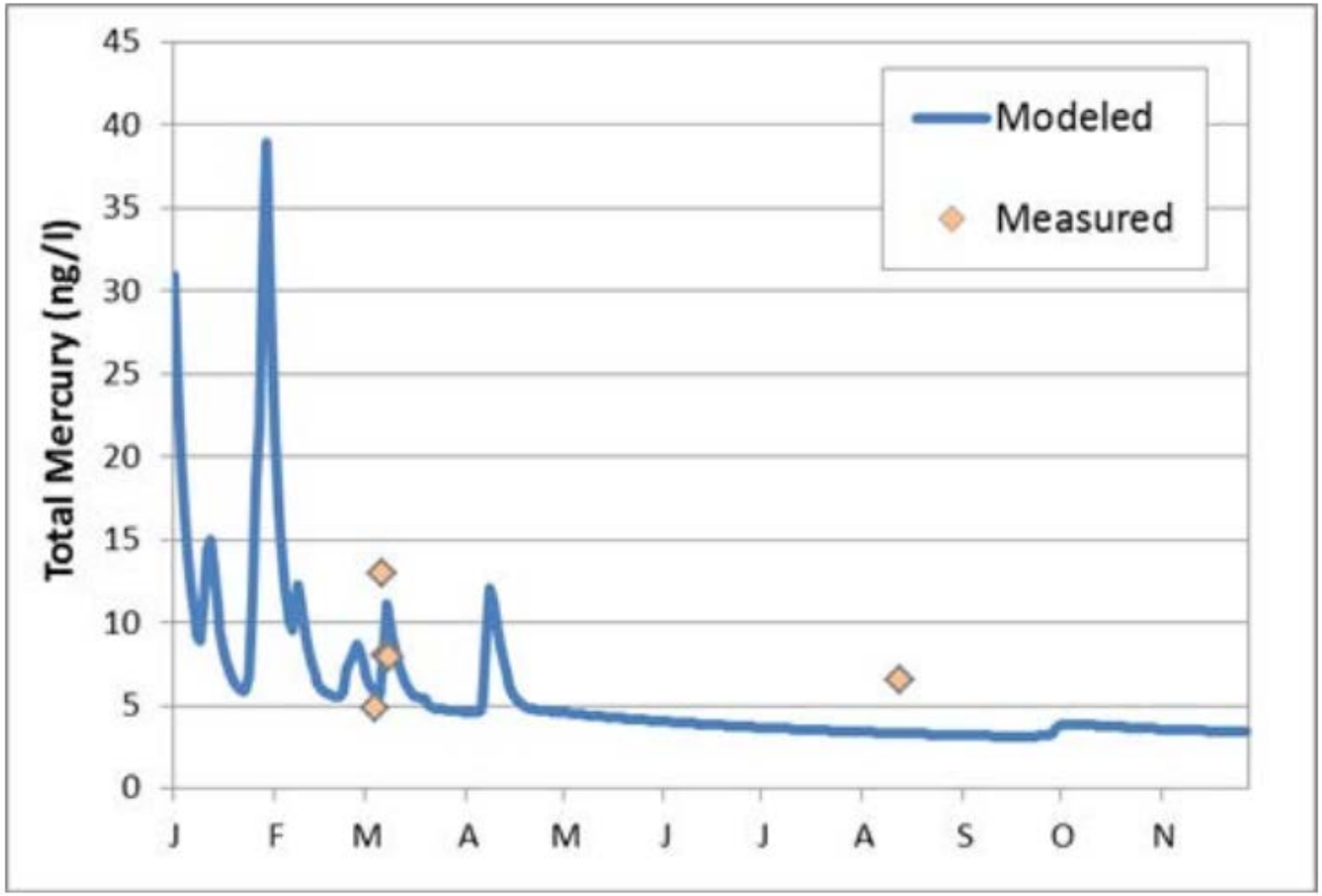
Model Inputs:

- Site digital elevation model (DEM)
- Subcatchment areas and stream locations
- Land use distribution
- Subcatchment soil types
- Time series of available meteorological, hydrologic, and water quality data

Preliminary Model Hydrology Calibration
Furnace Creek



Preliminary Model Mercury Concentration Calibration Upper Garoutte Creek



Findings

- Mercury in surface water is present primarily as suspended mercury
- Mercury flux in downstream Garoutte Creek is greater than at upstream Garoutte Creek
- Estimated annual mercury loads indicate that Furnace Creek contributes only 24% of the total mercury load to Garoutte Creek
- High flow storm events have potential to generate very high suspended mercury concentrations and a much higher flux of mercury from Furnace and Dennis Creek to Garoutte Creek.
- The watershed model is capable of predicting mercury concentrations in downstream watershed

Next Steps

- Update annual mercury loading calculations using Storm Event #2 and Storm Event #3 mercury data and available discharge data
- Calibrate the watershed model using Storm Event #2 and Storm Event #3 mercury data and all available discharge data
- Storm event surface water and sediment sampling at multiple stations to identify particulate mercury source areas
- Use the watershed model to simulate source control alternatives

QUESTIONS?