Evaluation of River Flow and Groundwater Flux at Springs 13 and 39

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Available Groundwater Flux Measurements

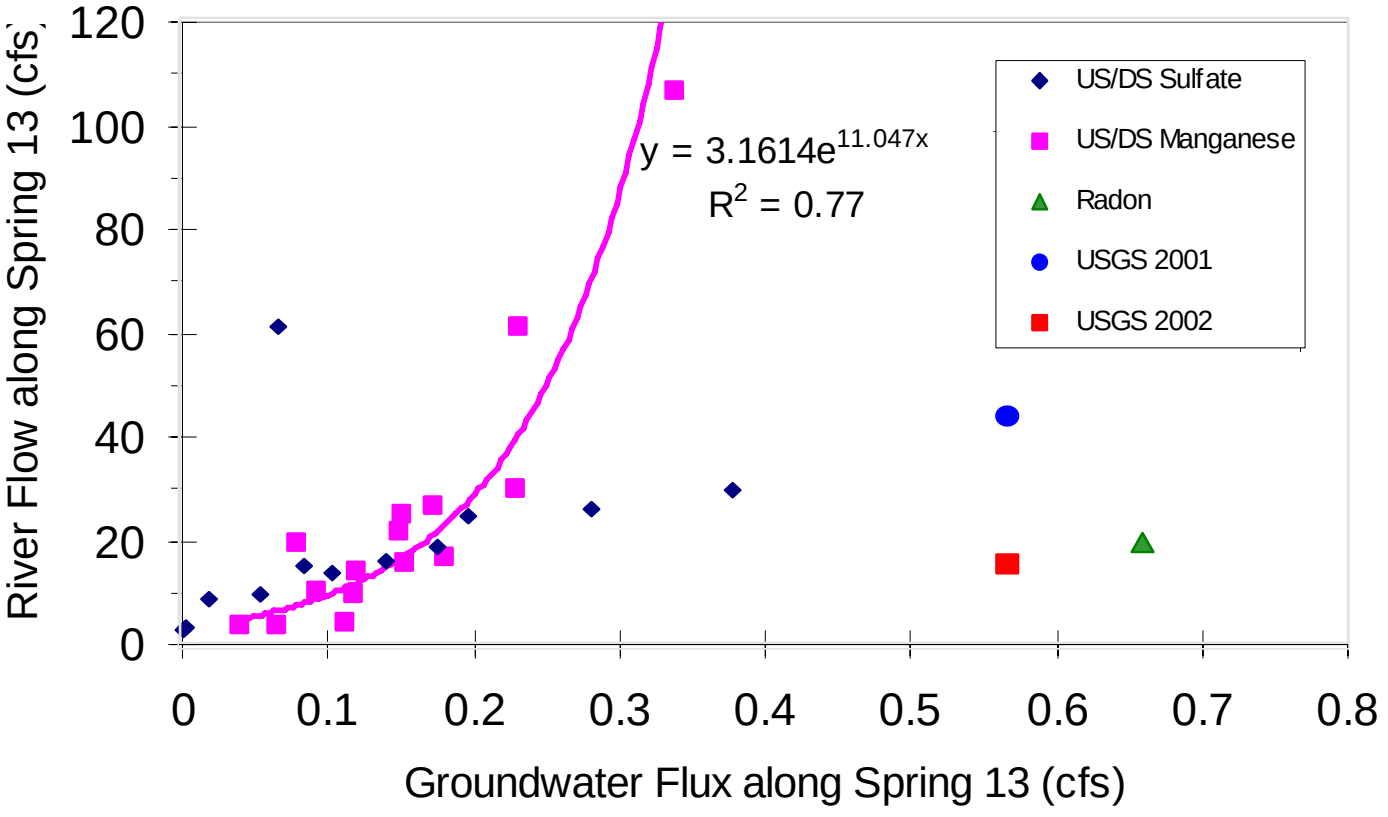
- USGS 2001 and 2002 tracer dilution studies using conservative bromide
- 2004 Radon 222 tracer study
- RI measurements upstream (US) and downstream (DS) of Springs 13 and 39

Goal of Evaluation

- Determine if there is a relationship between river flow and groundwater flux along the two springs
  - Use sulfate and manganese at US/DS locations to augment the evaluation due the limited number of flux values from Radon and USGS tracer studies

Groundwater Flux Along Spring 13

Relationship Between River Flow and Groundwater Fux along Spring 13 Using Sulfate, Manganese and Conservative Tracers



Fluxes based on sulfate and manganese are 3 to 6 times lower than fluxes from Radon and USGS tracer studies

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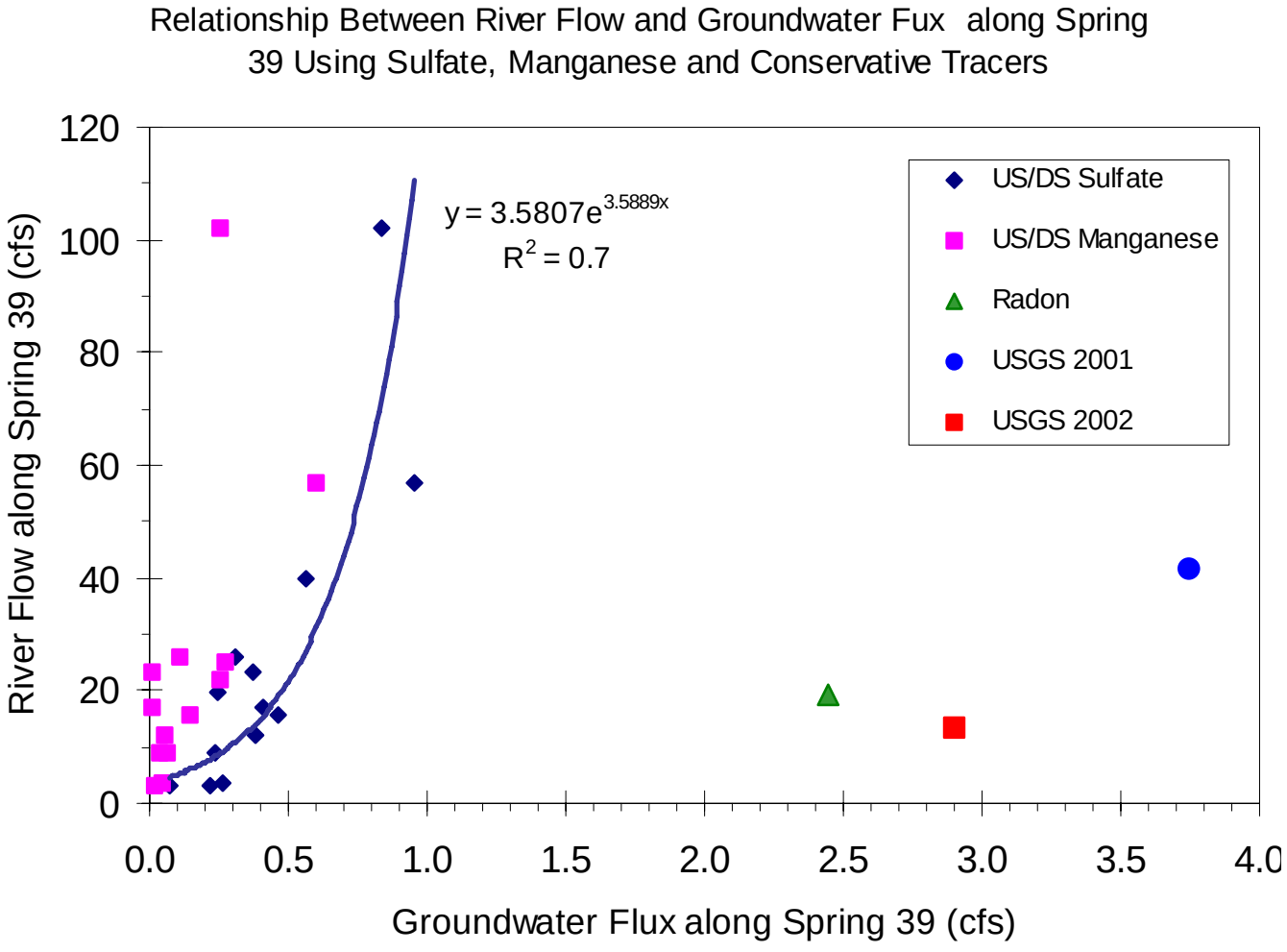
Groundwater Flux along Spring 39



Fluxes based on sulfate and manganese are 5 to 15 times lower than fluxes from Radon and USGS tracer studies

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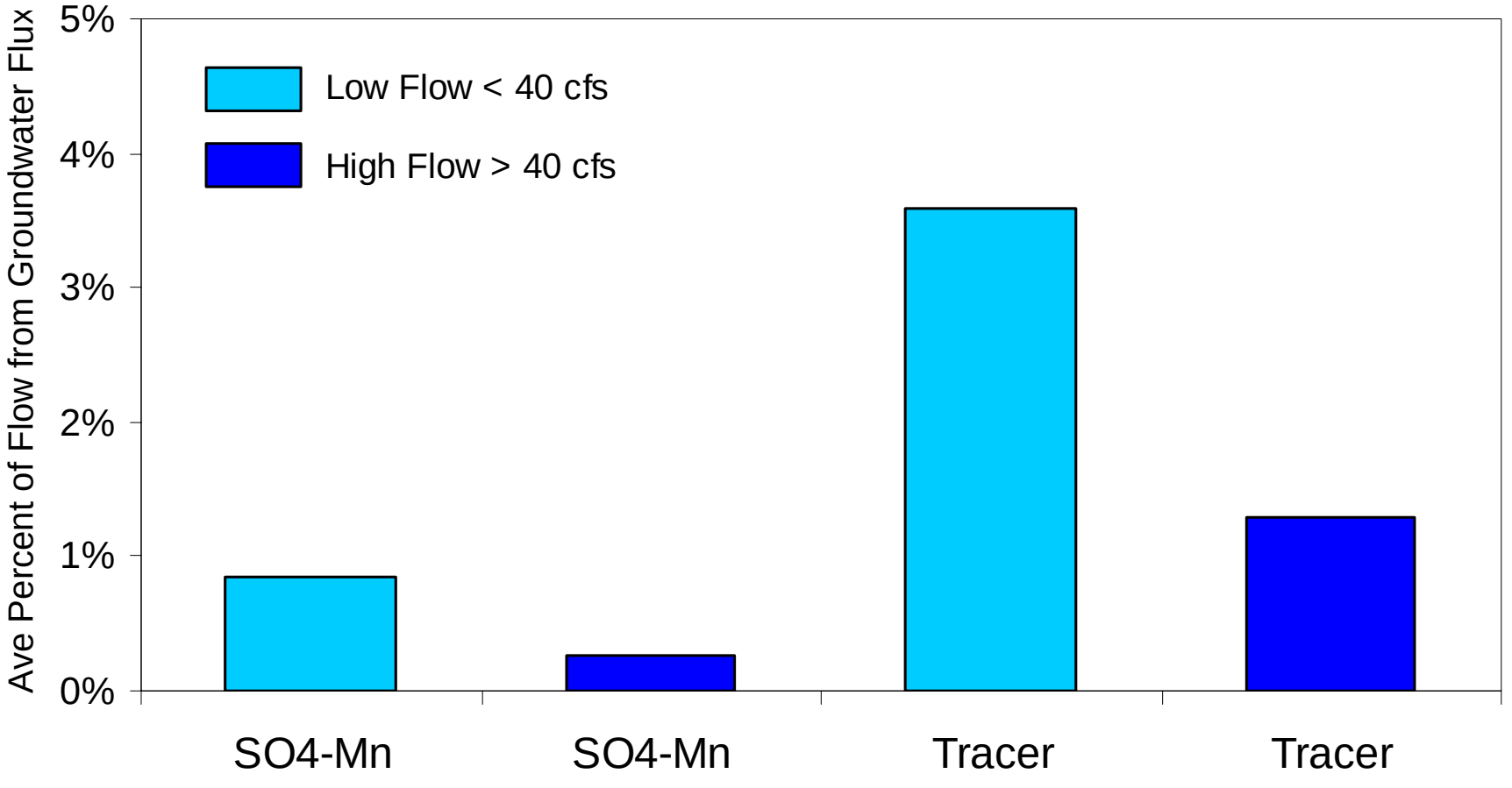
Observations

- Sulfate and manganese may precipitate at the sediment/water interface resulting in lower concentrations in the river, unlike conservative tracers Radon 222 and bromide

Percent River Flow from Groundwater Under Low and High Flow

- Estimate percent of river flow from groundwater flux for:
  - Low flow < 40 cfs
  - High flow > 40 cfs
- Use average of all sulfate and manganese data
- Use average of all tracer data

Spring 13:
Average Percent of River Flow from Groundwater at High/Low Flows



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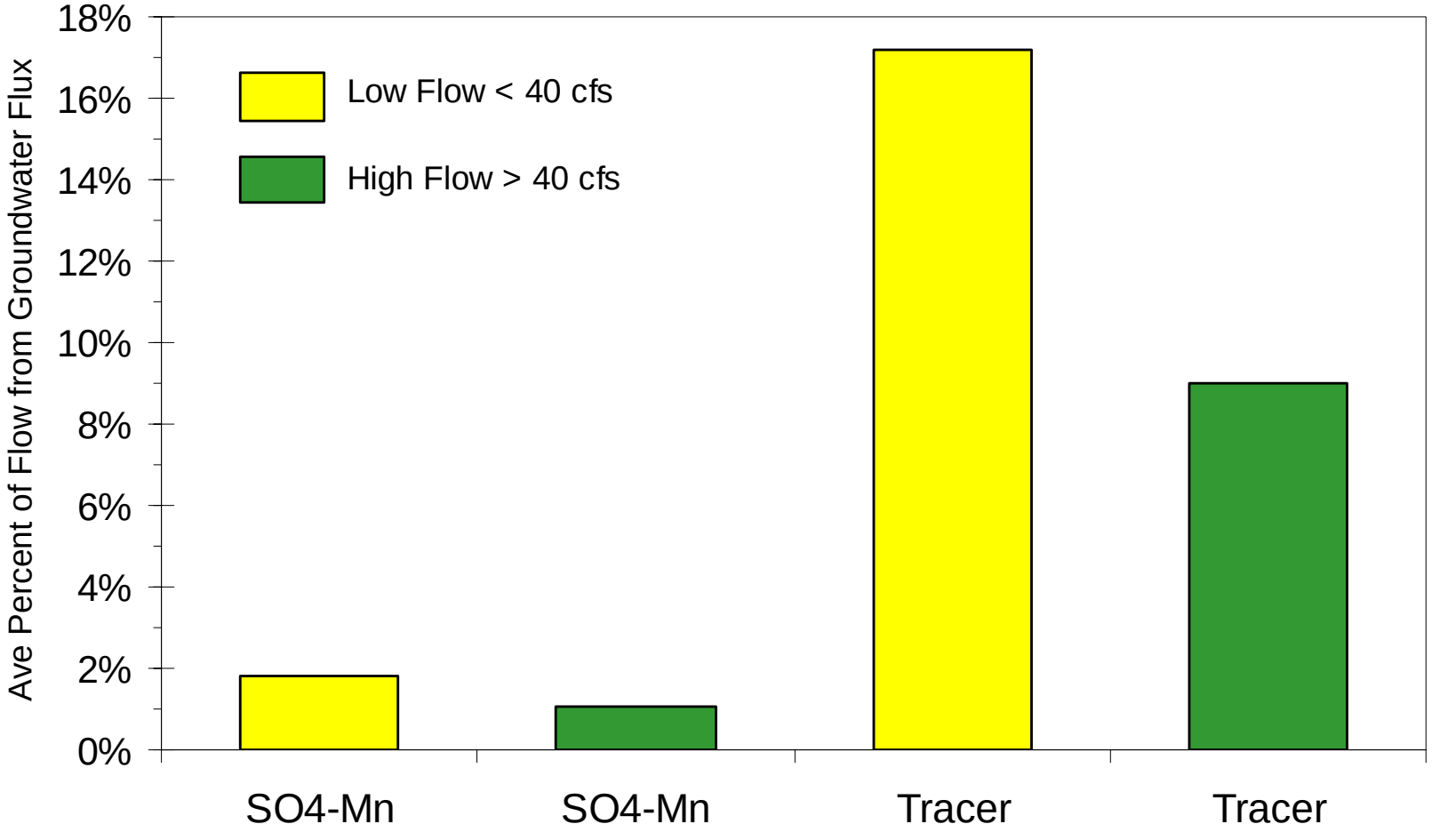
Spring 39: Average Percent of River Flow from Groundwater at High/Low Flows



Spring 13 and 39 Rainbow Trout Serial Dilution Toxicity Test Overview

- Spring 13
  - LC_{50} Survival = 7.5% spring water
  - IC_{25} Growth = 5.9% spring water
- Spring 39
  - LC_{50} Survival = 28.9% spring water
  - IC_{25} Growth = 22.6% spring water

Findings

- Groundwater flux varies with river flow
- Groundwater becomes a greater percentage of river flow at low-flow conditions
- Chemical precipitation may be an explanation for lower flux estimates using SO4 and Mn
- Because of possible chemical precipitation, groundwater fluxes from tracer studies are likely an upper bound of the effect of upwelling groundwater chemistry impacts to the river