

WyCEHG: Water in a Changing West: Wyoming Center for Environmental Hydrology and Geophysics

University of Wyoming



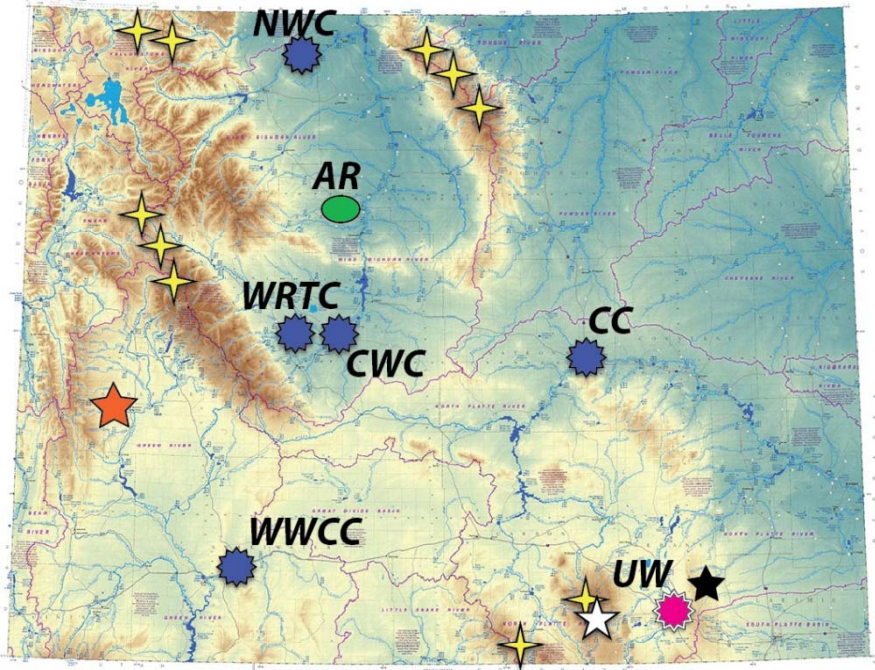
Wyoming EPSCoR RII Track-1 Award

Award of \$20M for 5 years, announced July 13, 2012

- Research Infrastructure Improvement
- One WyCEHG with multiple facets
- Integration of research & education
- Infrastructure investments include people
 - Faculty, post-docs, Program in Hydrology



WyCEHG Overview



The goal of this program is to establish a lasting center of excellence in environmental hydrology and hydrogeophysics that will transform practical approaches to watershed management and runoff prediction across the public and private sectors in the state and region.

Rationale:

Scientific

Fate and transport of water poorly understood; requires coupled surface/subsurface models

Practical

Water managers need predictive models => Requires up-to-date science, which we will provide

Critical Needs for Wyoming

- Snow is the key driver for water, and its fate is still undetermined
 - Links to managers, recreation, municipalities
- Mountain-front recharge of aquifer systems
- Changing hydrological systems
 - Next few decades will be challenging



Research Program

We will establish:

1. *The Wyoming Center for Environmental Hydrology and Geophysics (WyCEHG)*
(co-Directors, Holbrook & Miller)

- Physical and intellectual infrastructure (“stuff, people, and science”)
- Multidisciplinary center
- Links to/strengthen PhD Program in Hydrology

2. *The Facility for Imaging the Near- and Sub-surface Environment (FINSE)*

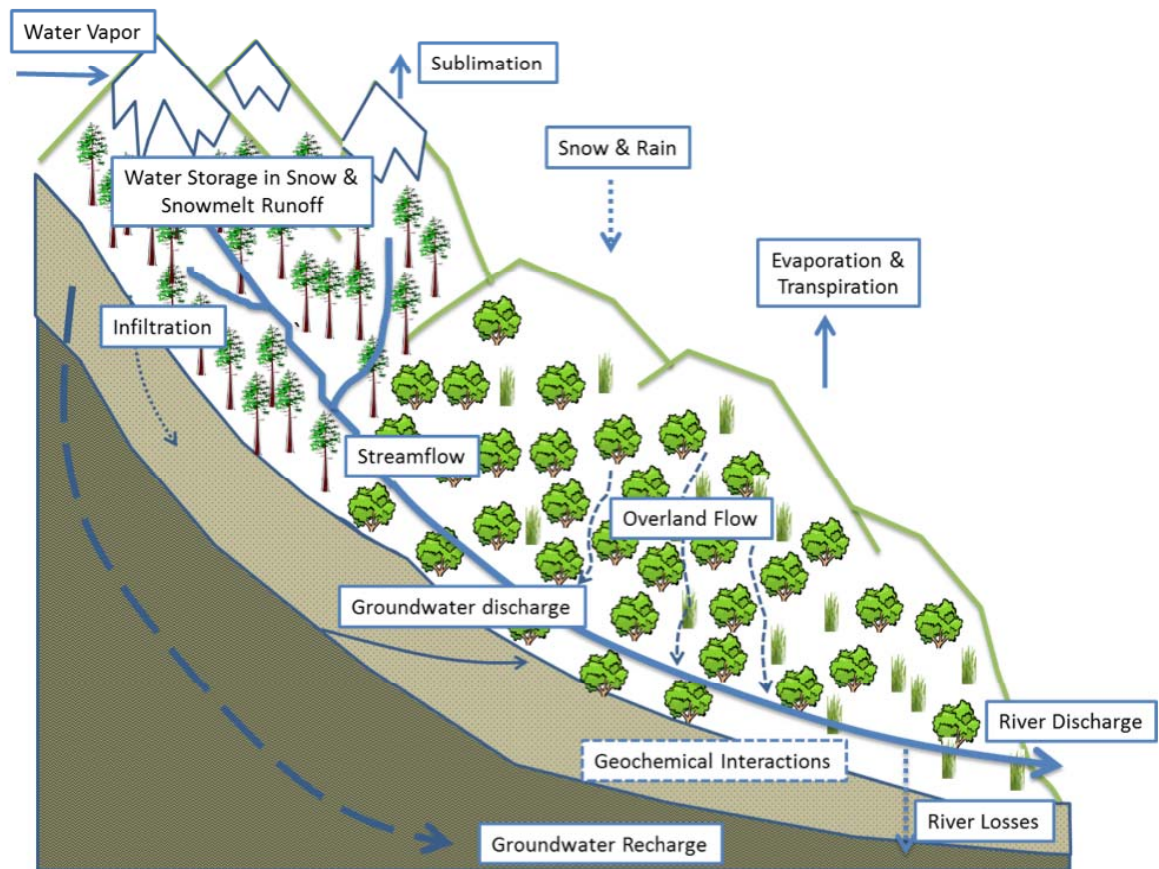
- Integral part of WyCEHG
- Geophysical imaging instrumentation
- Facility manager to be hired on grant & eventually picked up on state line

3. *The Surface and Subsurface Hydrology Lab (SSHL)*

- Co-located with FINSE
- Hydrology, atmospheric instrumentation
- Facility manager & asst. manager

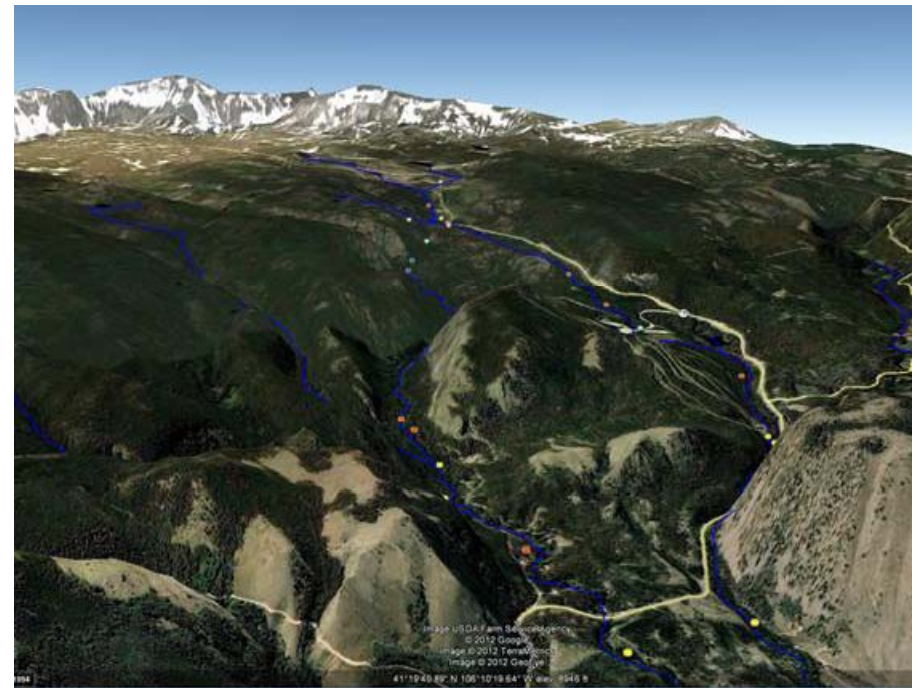
Scientific Questions

- How do hydrological systems respond to change?
 - e.g., oil and gas development, bark beetle infestations, fires, floods, climate change
- How do snow processes, particularly moisture content (SWE) and the timing of snowmelt, affect the downstream system?
- What information and approaches are needed to upscale from the point scale to the watershed scale in hydrological modeling?



Fate of Water in Changing Systems

- Goal is to monitor and interpret changes in flow and temperature in Wyoming rivers
 - Response to GCC, beetle kill, management
- Look for changes in surface / subsurface flux
 - Stress on hydrology, ecology, fish
- Use runoff gaging, temperature probes, and groundwater samples
- Target critical hydrologic & ecologic locations
- Partner with Federal and State Agencies (e.g., USFS, USGS, SEO, WY G&F, etc)
- Share data and resources
- Private landowners as cooperators
- Outreach to agencies, citizens through hydrologic extension

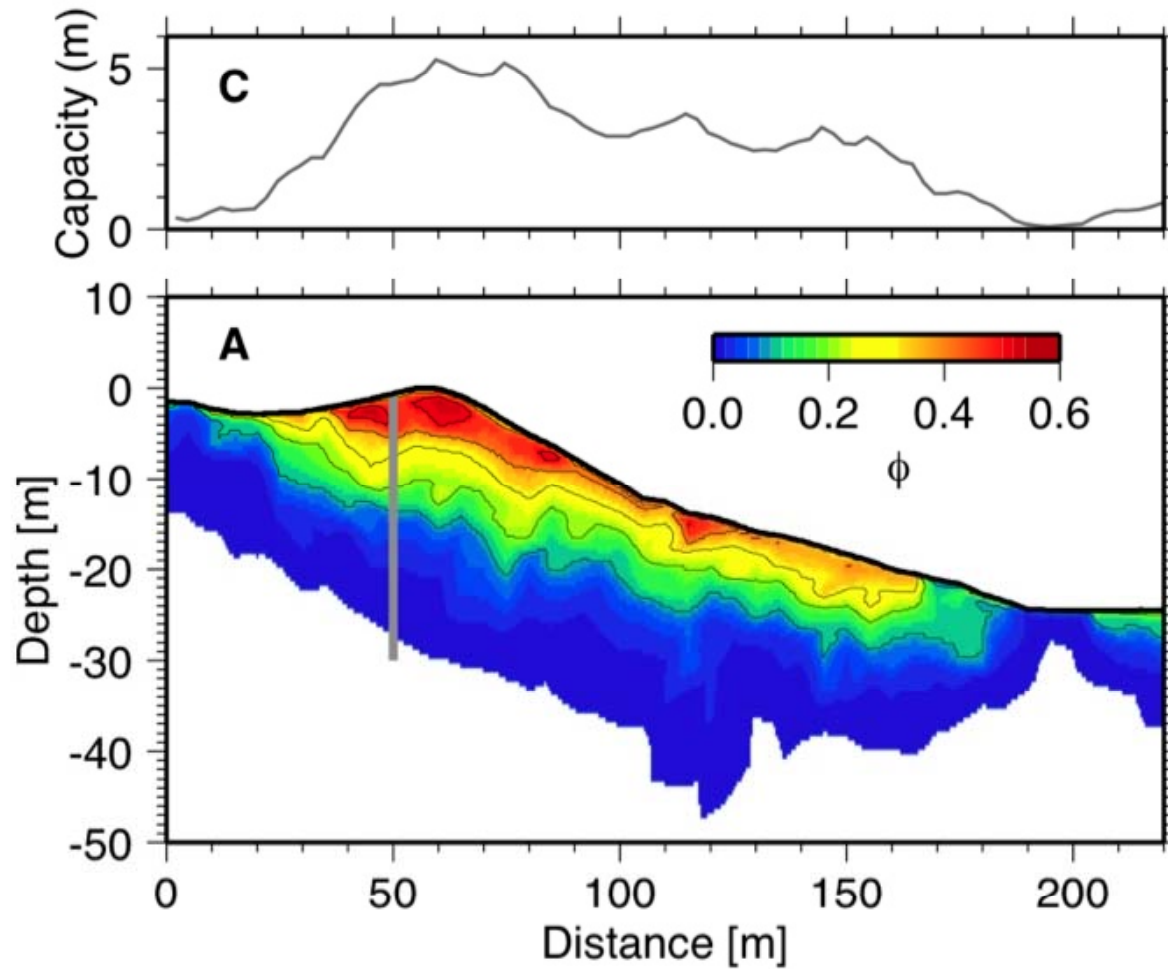


New Infrastructure: Geophysics

- Imaging of Surface and Shallow (upper ~200 m) Subsurface:
 - Seismic (Refraction & Reflection)
 - Magnetic (Total Field and Gradiometry)
 - Gravity (Precision microgravity)
 - MRS (Magnetic resonance sounding)
 - Resistivity (DC)
 - Induced Polarization
 - Self Potential
 - Ground-Penetrating Radar
 - CHIRP
 - CSEM (Controlled-source EM)
 - Surface LiDAR



Water Storage Capacity on a Hillslope



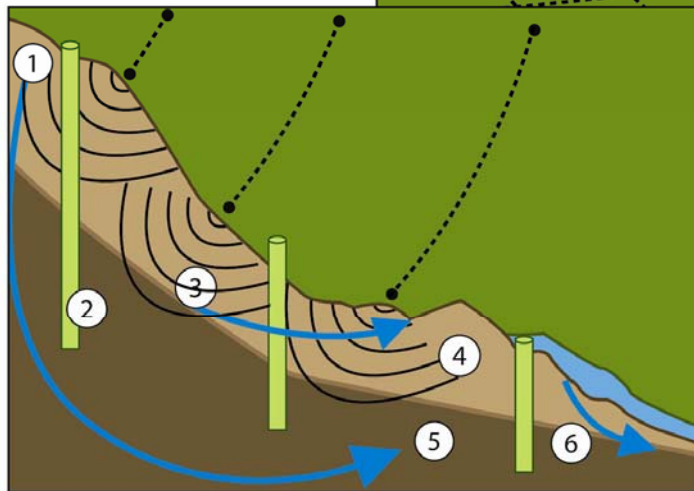
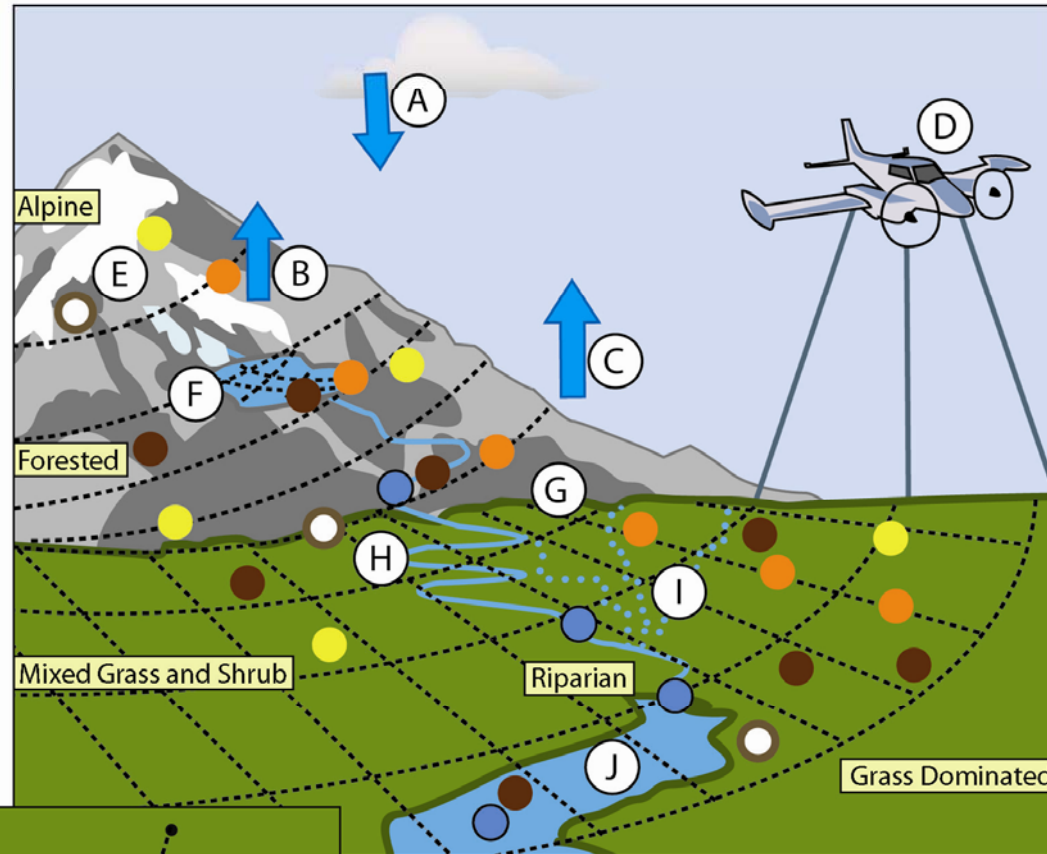
A Field-Based Framework for HydroGeophysics

Surface Processes and Measurements

- A: Snow and Rain
- B: Sublimation
- C: Evaporation and Transpiration
- D: LiDAR and Airborne Geophysics
- E: Water Storage in Snow and Snowmelt Runoff
- F: Water Storage in Lakes
- G: Aquifer Recharge
- H: Streamflow
- I: Overland Flow
- J: River Discharge

Subsurface Processes and Measurements

- 1: Infiltration
- 2: Boreholes for Ground Truth
- 3: Groundwater Discharge
- 4: Geochemical Interactions
- 5: Groundwater Recharge
- 6: River Losses



- Sapflux, Isotopes
- Runoff, Isotopes, Geochemistry
- Climate, Soil Moisture, Snow
- Groundwater Depth, Isotopes, Geochemistry
- Lysimeters, Geochemistry
- Geophysics Arrays

New Infrastructure: Environmental Hydrology

- Surface & Subsurface Hydrology:

- Flow gages
- Climate stations
- Snow water equivalent
- Groundwater wells / piezometers

- Tracers:

- Stable isotopes
- Radiogenic isotopes
- Real-time chemistry
- Met-flux towers

- Goal of these measurements

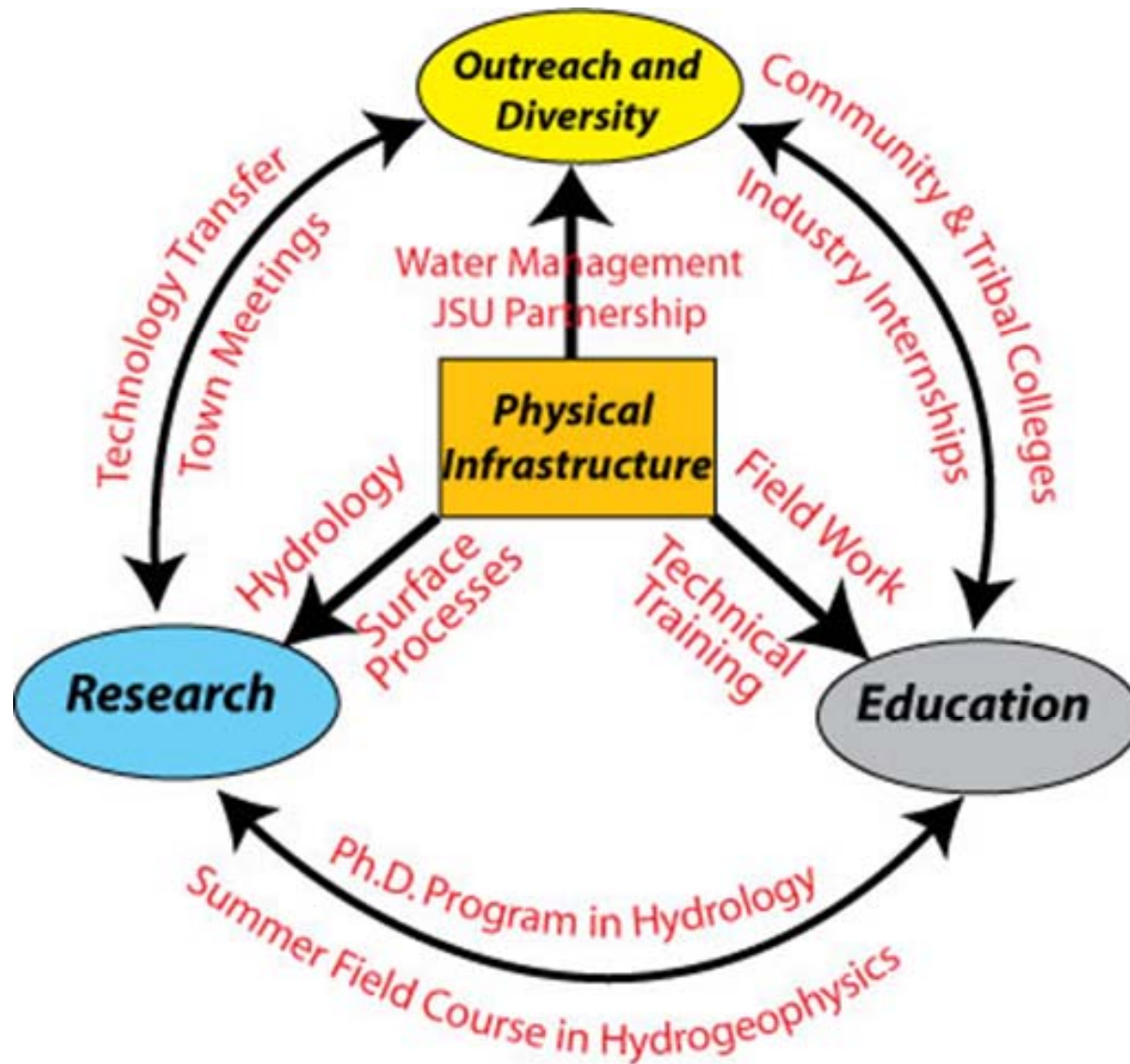
- Provide field link to geophysical instrumentation
- Build new models; support existing systems
- Rapid response team



Field Instrumentation



Linkage Between Research, Outreach & External Engagement



Workforce Development

Goal of Workforce Development Plan: Implement a S2W (Science to Work) program that produces an educated workforce in STEM and will contribute to continued economic growth and public/private sector engagement in Wyoming

| Objectives | Implementation Strategies | Outputs |
|--|--|--|
| 1. Offer G6-14 teacher training with Teton Science School: = WY Water in the Classroom (WWC) | Train teachers at WyCEHG research sites around Wyoming Engage teachers in research using FINSE equipment Transfer knowledge to the classroom to practice citizen science | Train 50 new teachers, 10% from water districts |
| 2. Offer research to undergrads and community college (CC) students | Offer undergrad and CC student fellowships Establish CC Transition to UW program Partner with CC faculty to incorporate FINSE instrumentation | Support 75 undergrads /yr; 25% from Geohydro Transition 5 CC/ yr |
| 3. Career path to public /private sector | Support the new Graduate Program in Hydology Offer \$10K student/postdoc entrepreneurial competition Support student internships in the private sector | Support 10 new PiH students/yr |

Teacher training program using FINSE with TSS/SMTC/EPSCoR

Community College partnerships:

- training in FINSE equipment at CC's; they will use FINSE
- fellowships and transitions to UW

Private Sector partnerships:

- summer internships offered by 3 companies (TriHydro, Lowham-Walsh, Intertech)

WyCEHG Summary

With WyCEHG we seek these outcomes:

- Nationally significant facilities in near surface geophysics and hydrology;
- Interdisciplinary, cross-institutional teams focused on transforming water research in Wyoming;
- A comprehensive external engagement program that includes stakeholders and new tools for decision-makers in water management;
- A novel workforce development program that will train students and connect them to industry internships;
- An open-access, national facility for hydrogeophysics that will include state-of-the-art instrumentation and will be sustained by an industry endowment;
- Cutting-edge computational research that makes use of the new NCAR-Wyoming Supercomputing Center.
- Transformative outreach and diversity programs that establish research linkages with underserved populations inside and outside the state; and
- A broad educational program that boosts STEM education in Wyoming's tribal college and bolsters the recently established Ph.D. Program in Hydrology at UW.

Contact Information

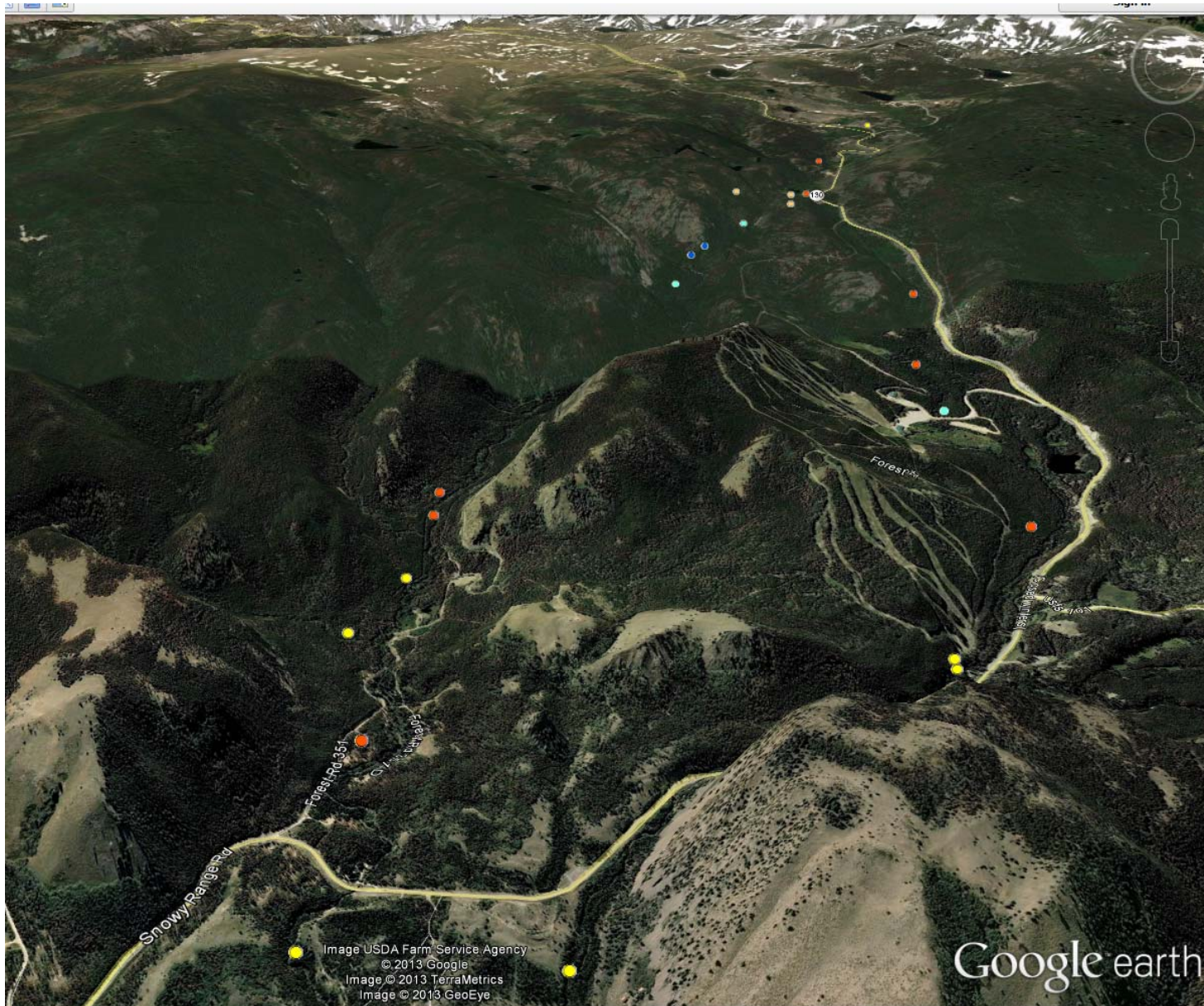
- WyCEHG home: uwyo.edu/wycehg
- Steve Holbrook: SteveH@uwyo.edu
- Scott Miller: snmiller@uwyo.edu
- Ginger Paige: gpaige@uwyo.edu

Field Studies Student Training

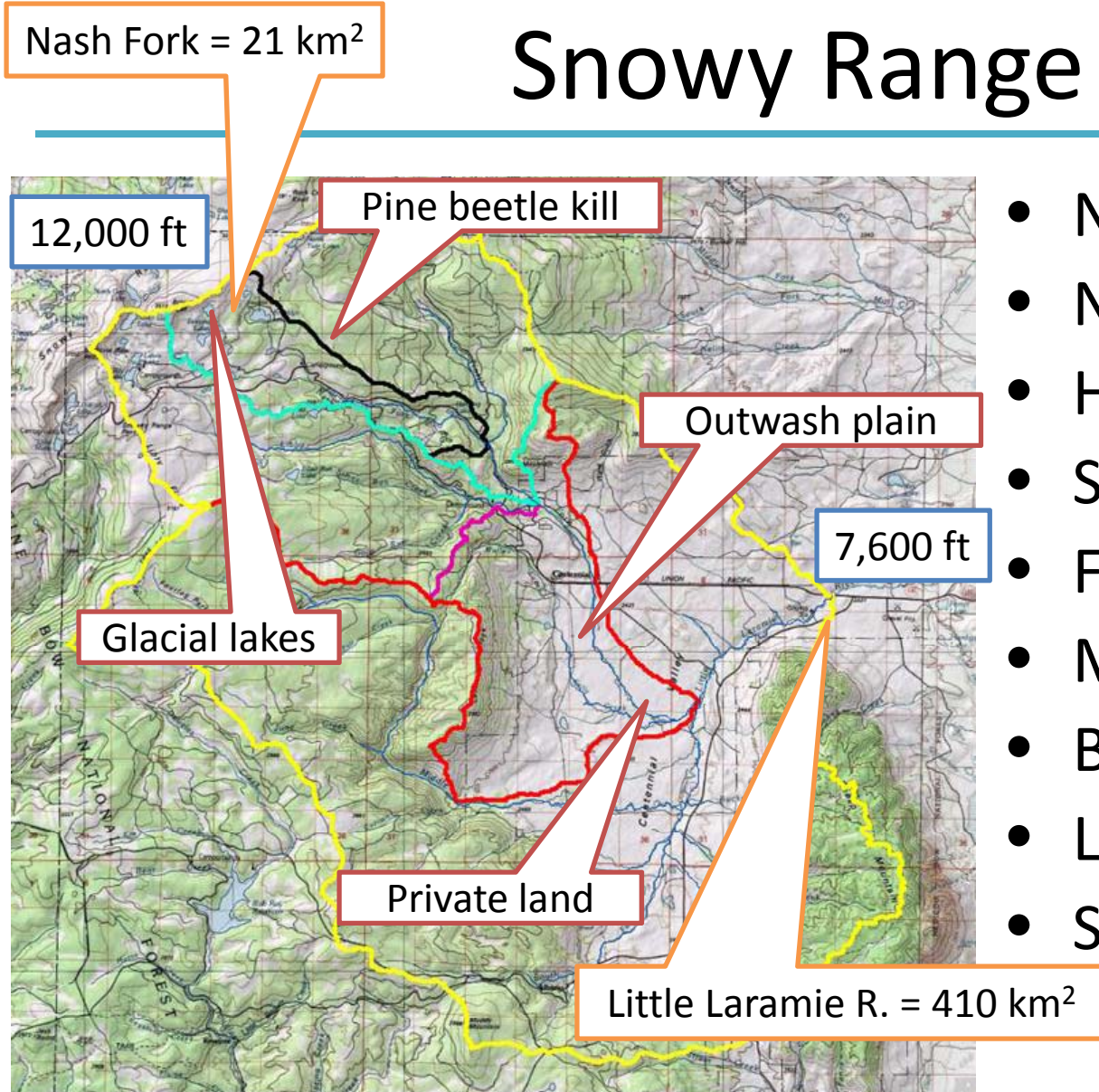
- Summer Field Course in hydrogeophysics
- Hydrology, ecology, field observations, geophysical instrumentation
- Training for students
- Opportunity for faculty
- Integrated education & research



Looking Upstream



Snowy Range Field Site



- North Platte Drainage
- Nested sample design
- High mountain to valley
- Snow-driven
- Fracture flows
- Managed water
- Beetle-kill pervasive
- Local field site
- Summer field course

Significant Features

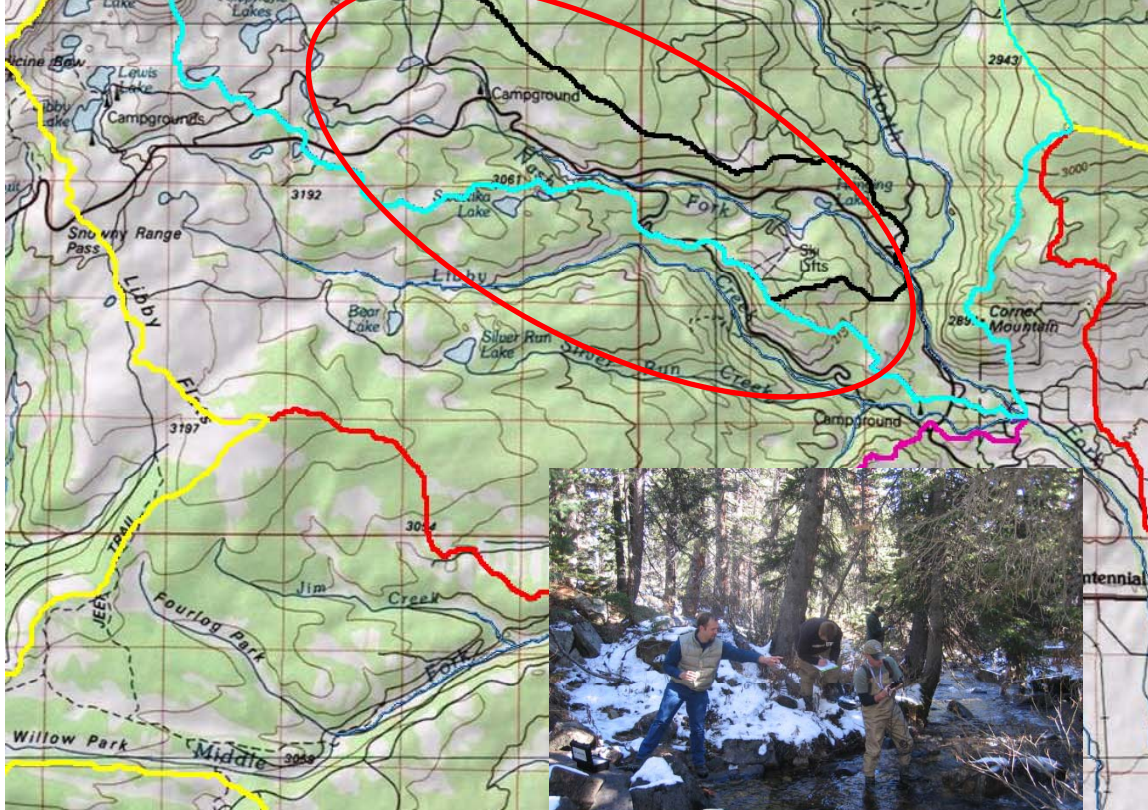
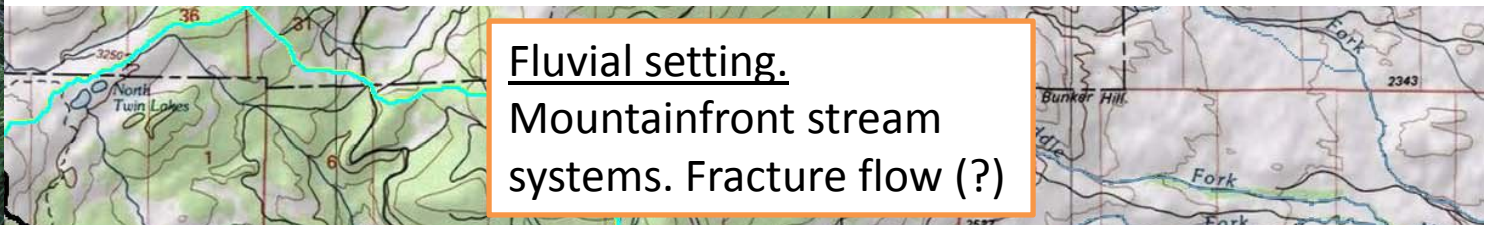
Lakes Region. Steep
Quartzite gives way to
undulating terrain.



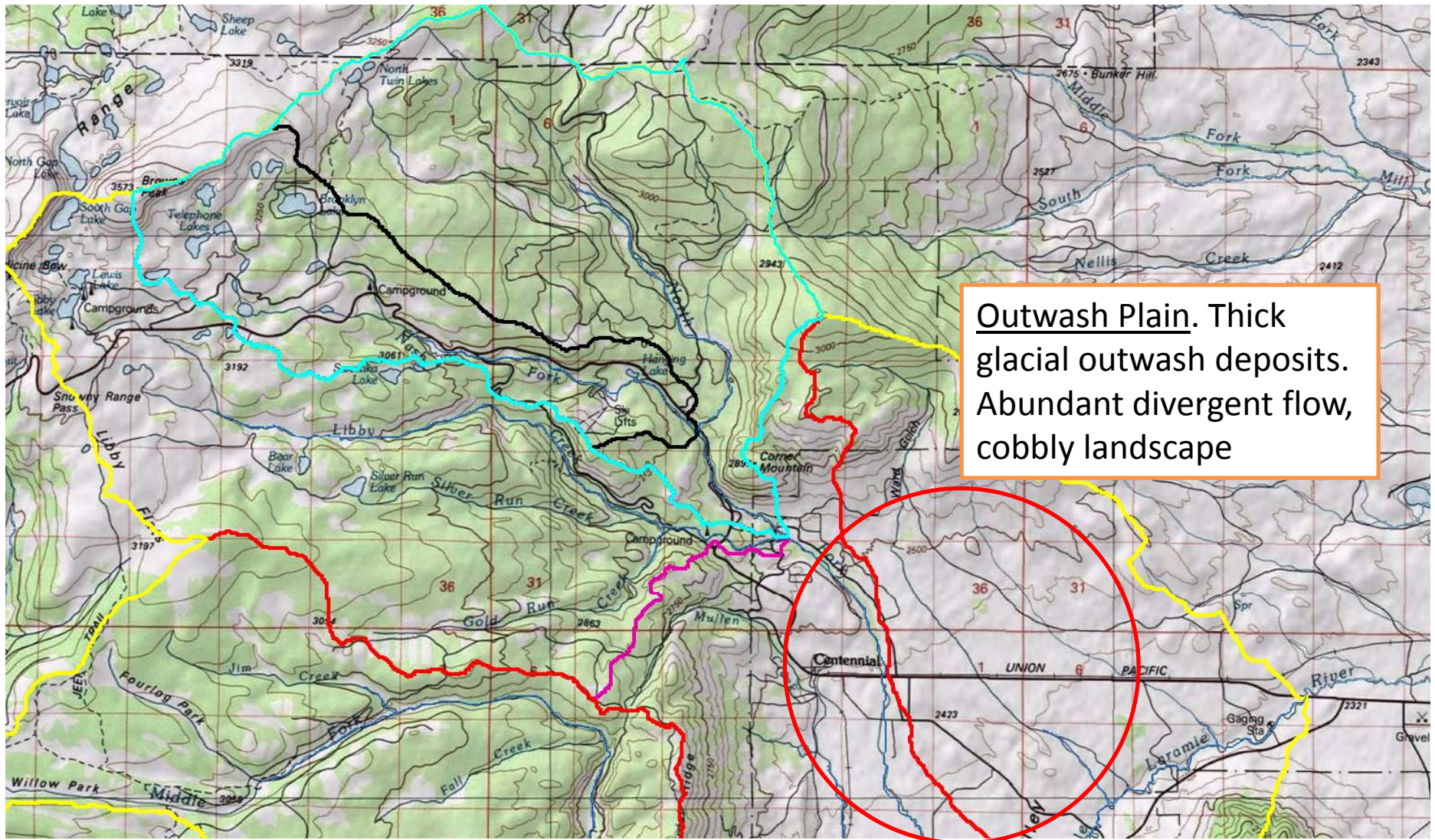
Significant Features



Fluvial setting.
Mountainfront stream
systems. Fracture flow (?)



Significant Features



Outwash Plain. Thick glacial outwash deposits. Abundant divergent flow, cobbly landscape

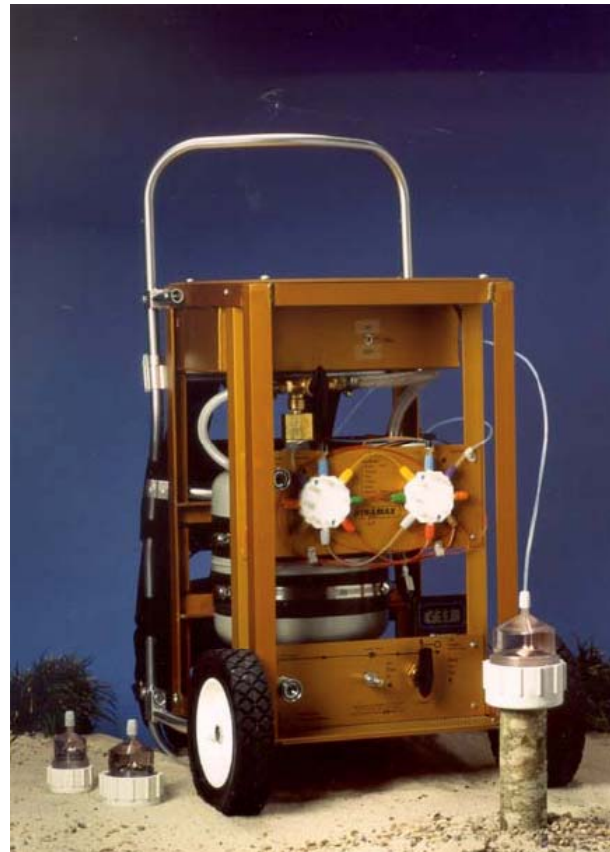
Tools to Answer the Questions

- Sap flux and leaf gas exchange quantify plant water loss from different plant types



Tools to Answer the Questions

- Plant hydraulic measurements connect plant evolutionary tradeoffs to watershed hydrology



From green trees...

To red trees... in less than a year



Tools to Answer the Questions

- Eddy covariance flux towers directly measured evapotranspiration from ecosystems

