Rainfall, runoff and sediment transport in the Napa River watershed:

now and a possible future

Lester McKee

San Francisco Estuary Institute

5/24/2017

The importance of the natural water cycle of infiltration and filtration

A natural watershed-river-groundwater system…

- Ecological health portends economic heath
- Landscape form adjusted to average geology and climatic
- Stable river form of pools, riffles, bars, floodplains predictably distributed
- Inputs of fine and coarse sediment are in balance with the supply of water
- Wide flat and slow flood flows with high infiltration
- High groundwater table connected to rivers and creaks

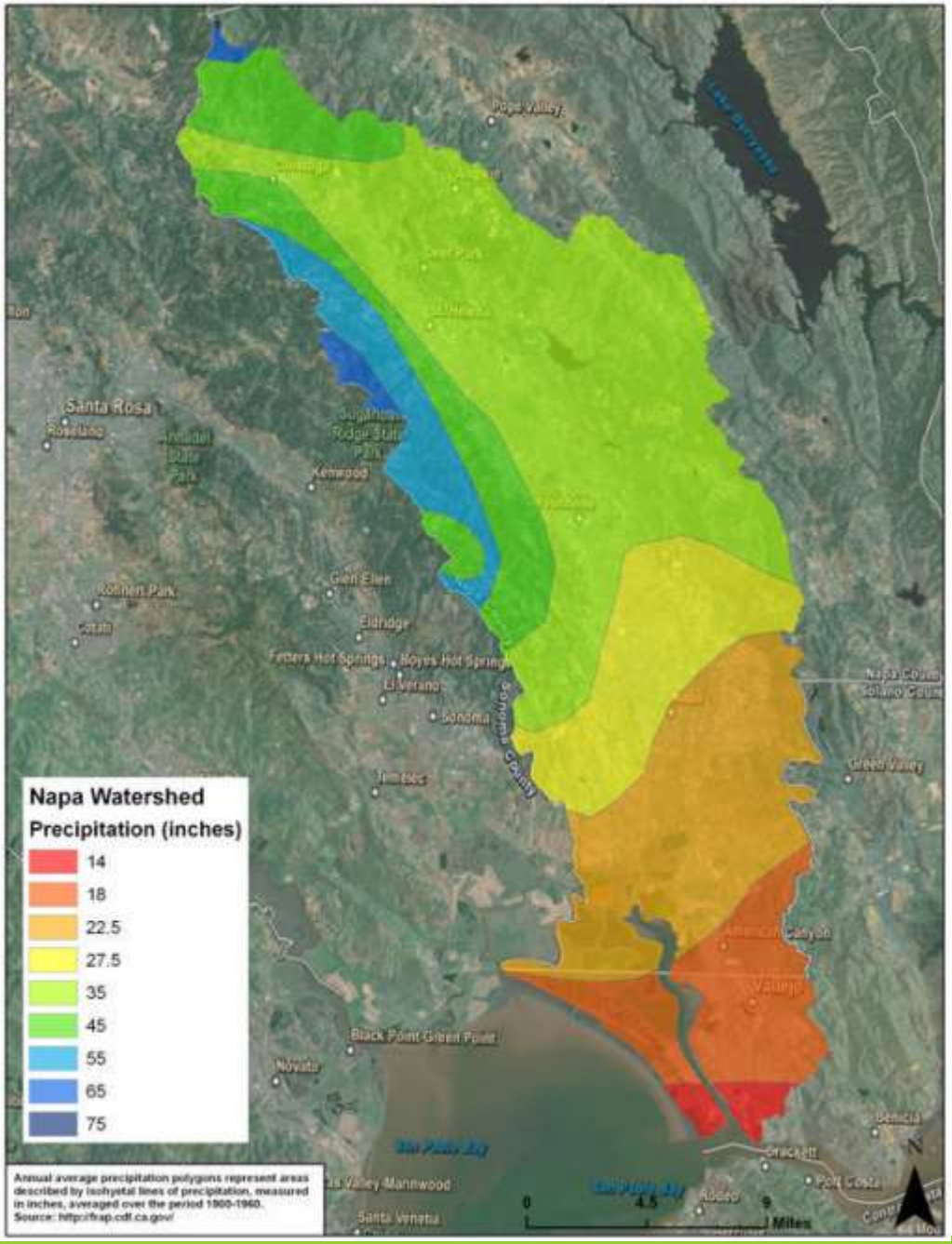
Physical processes that shape our watershed today

Napa in context

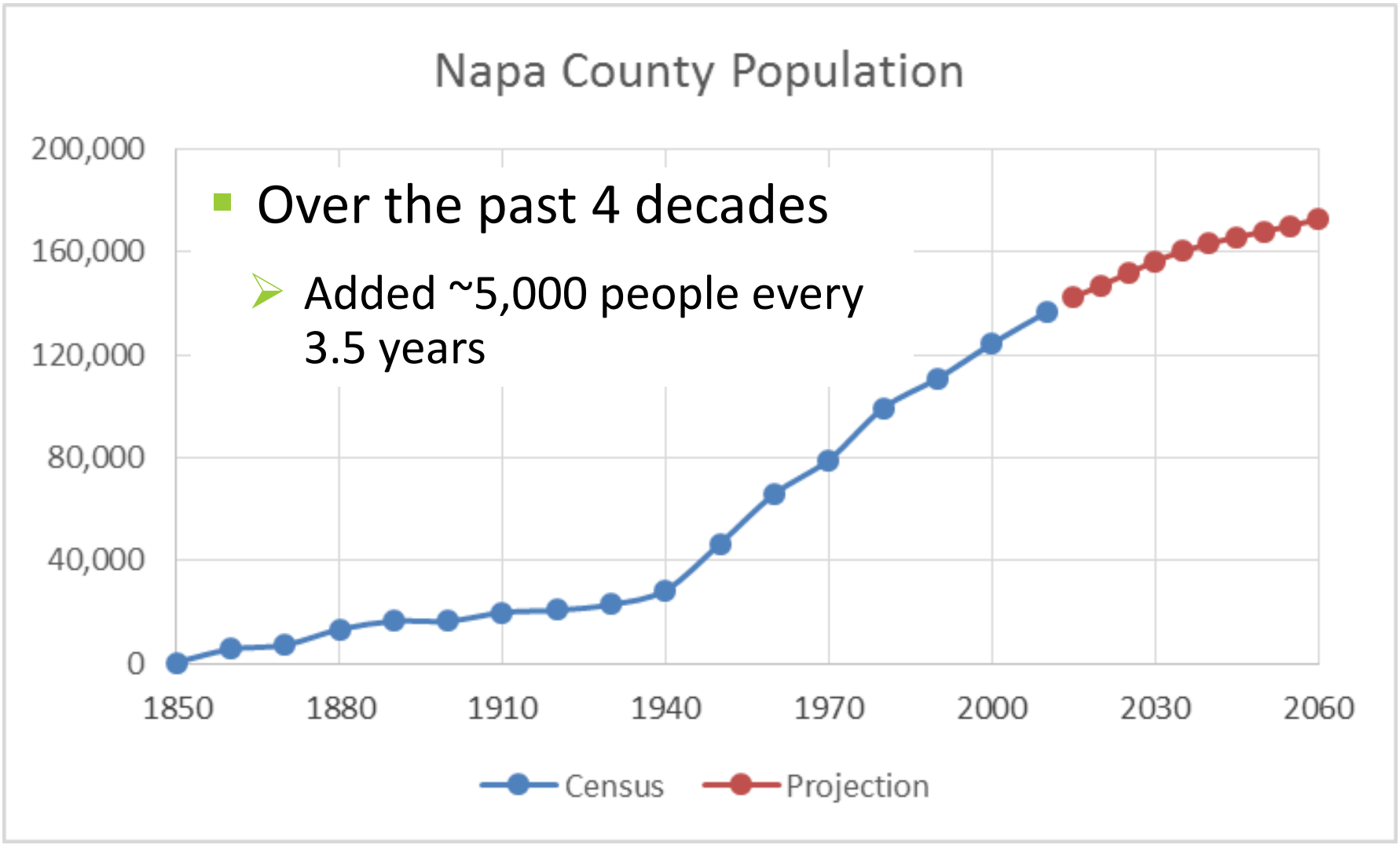
- 1.9 % of the Bay Area population
- 3rd largest watershed (behind Alameda and Coyote)
- ~13% of the freshwater supply to San Francisco Bay from the 9 counties
- ~22% of the estimated annual average sediment supply
- Nicest people!

Rainfall

- Greater in the north and east
- Some of the highest rainfalls of any in the Bay Area

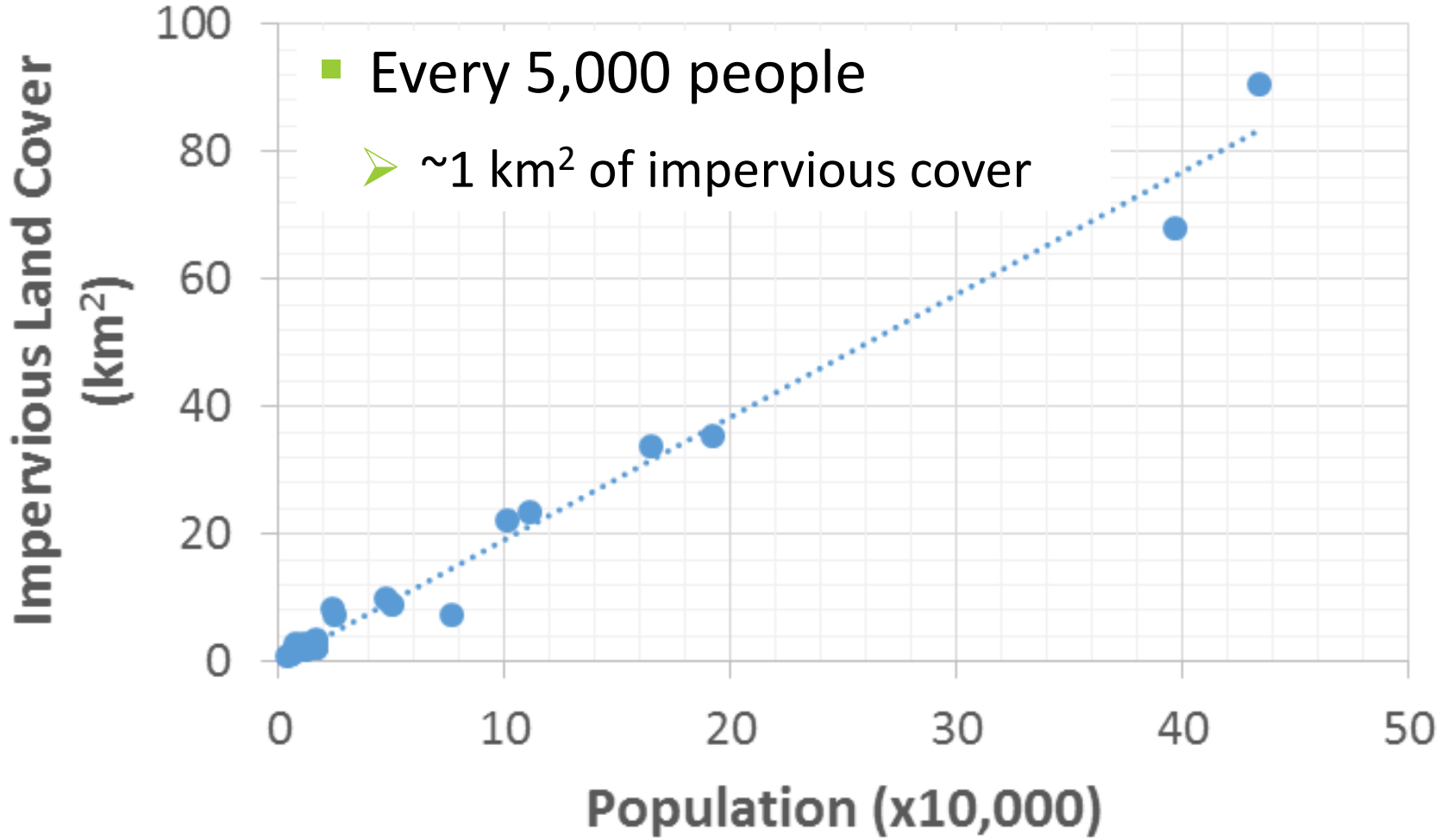


Napa area population



- Over the past 4 decades
  - Added ~5,000 people every 3.5 years

The impact!


Every 5,000 people
~1 km² of impervious cover
Impervious Land Cover (km²)
Population (x10,000)
0
20
40
60
80
100
0
10
20
30
40
50

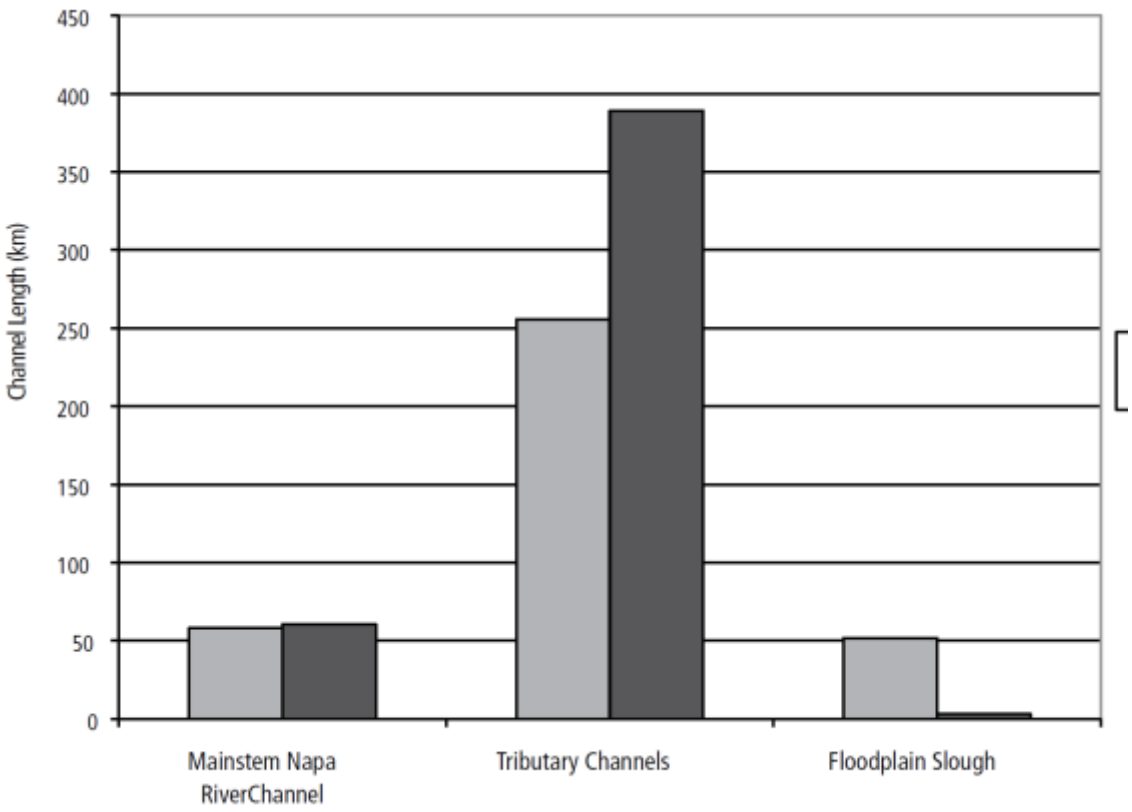
Napa area rainfall-runoff challenge

- Each 1 km^2 of impervious surface added at an annual average rainfall of 25” leads to:
  - ~750 Acre-foot less recharge occurs on average
  - ~1.2 cfs less base flow in our creeks occurs on average
  - Increased peak flow runoff capacity needed in stormwater infrastructure

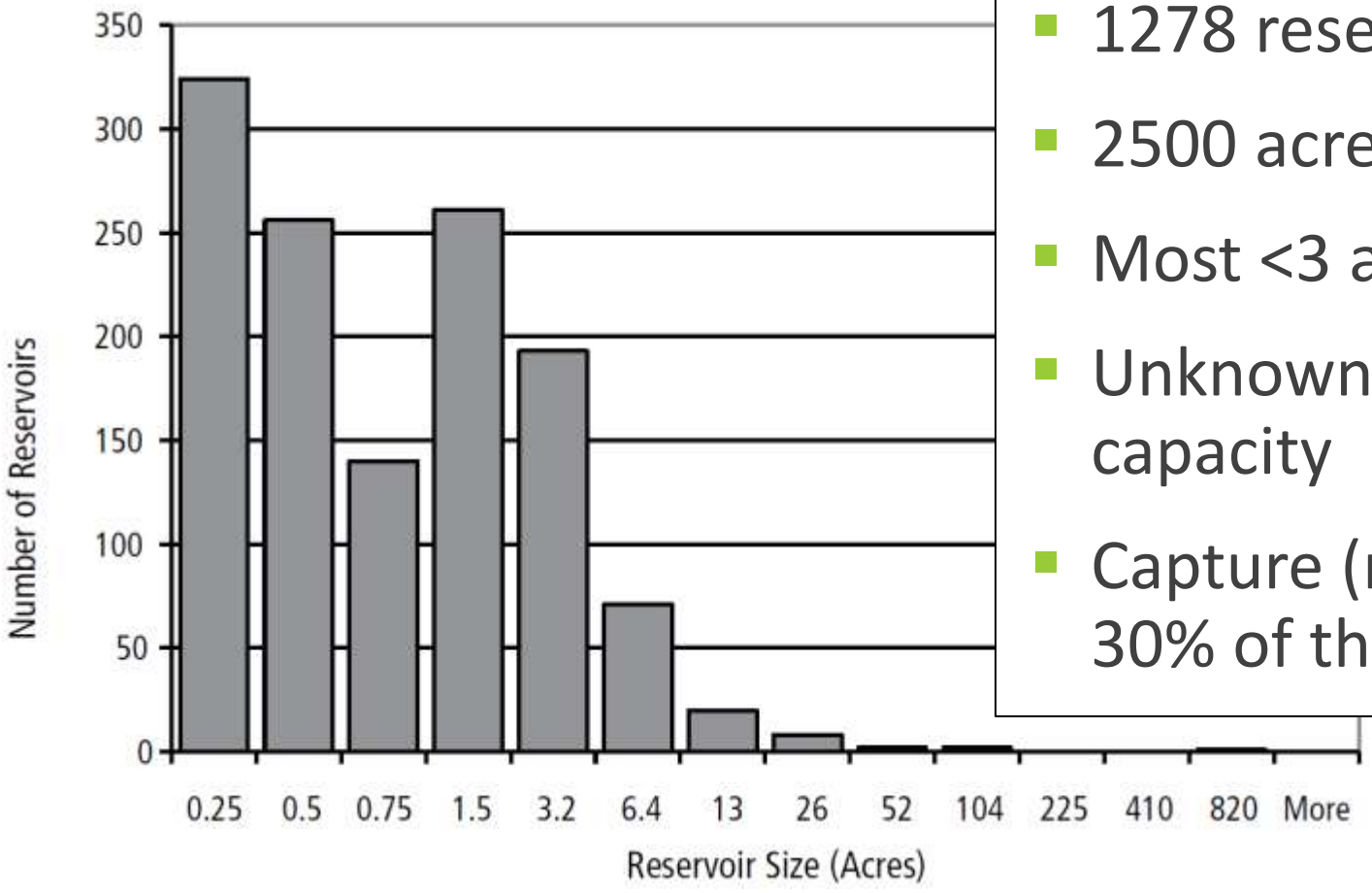
Modified drainage to accommodate agricultural and urban development

- 280 miles of drainage channels and ditches
- Half are artificially constructed
- 25% total extra length

*Does not include subsurface tile drains



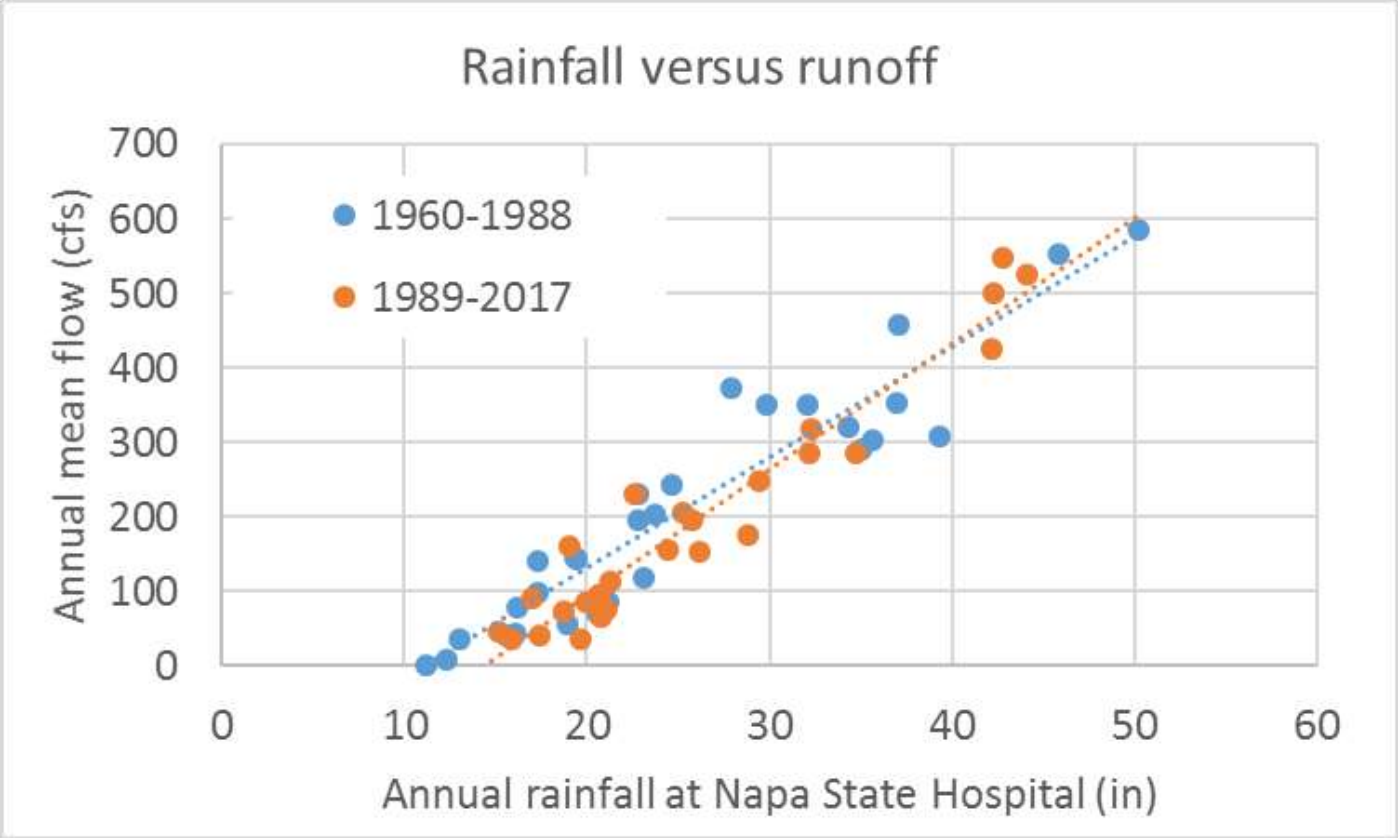
Reservoir storage



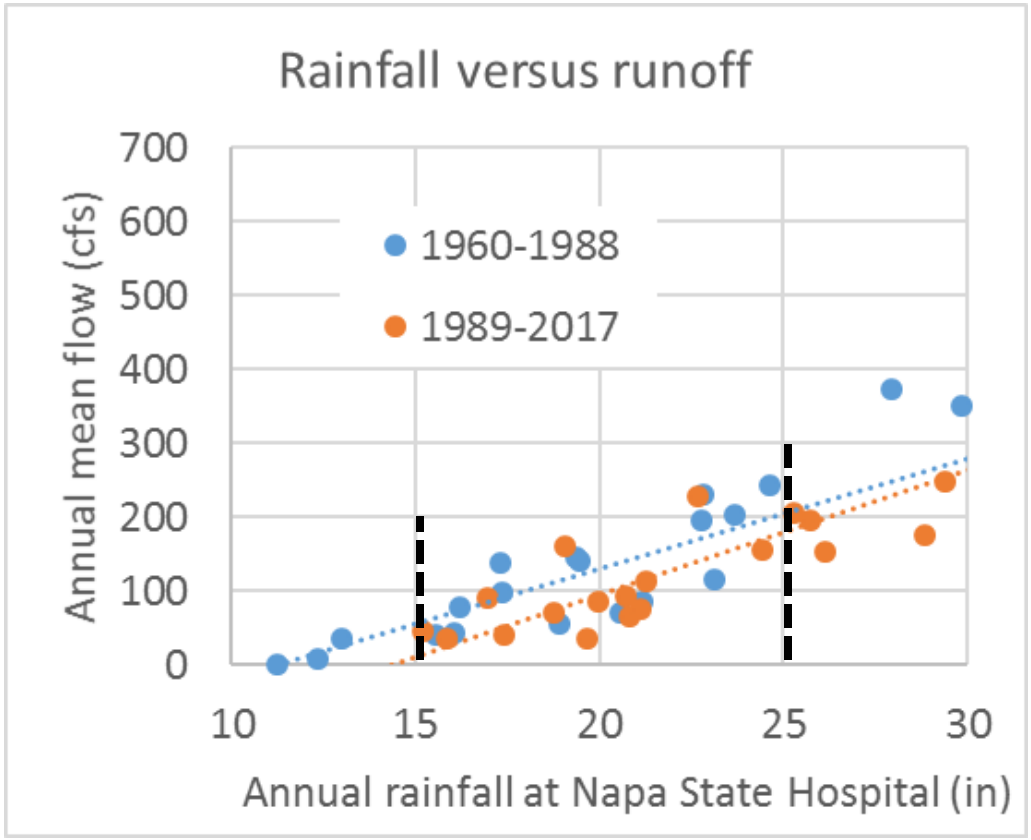
- 1278 reservoirs
- 2500 acres
- Most <3 acres
- Unknown total capacity
- Capture (regulate) 30% of the land area

What do we see in the runoff record?

- No apparent changes in annual flow during wetter years

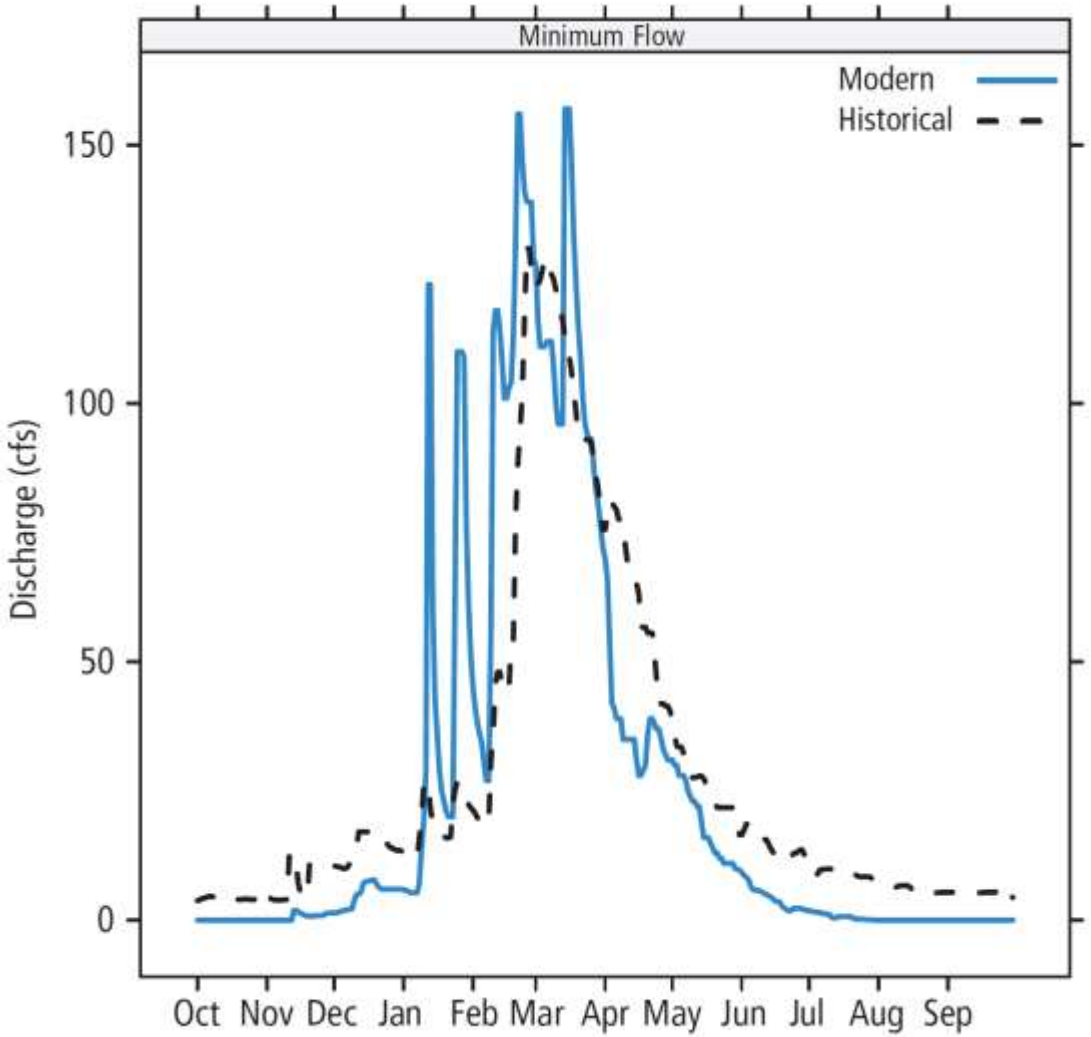


So can we see this in the record?



- 25 inch rainfall – annual flow reduction of:
  - 26 cfs
  - Or 18,685 acre-foot
  - Even more extreme during lower rainfall years
  - 15 in -> 46 cfs -> 33,000 a-f
- **Probably reflects consummative use**

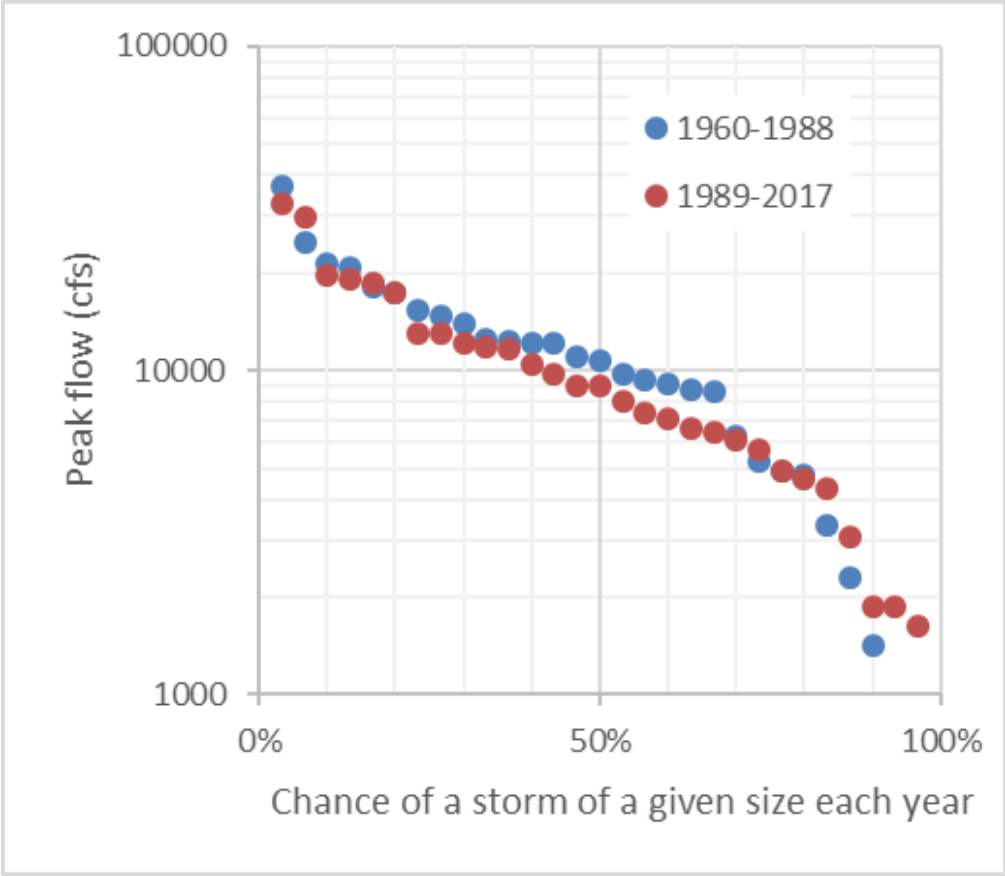
Impacts on peak flow since historic times…



- HSPF model
- Compared to historic condition, flows are
  - More peaked
  - Earlier
  - Lower base flow

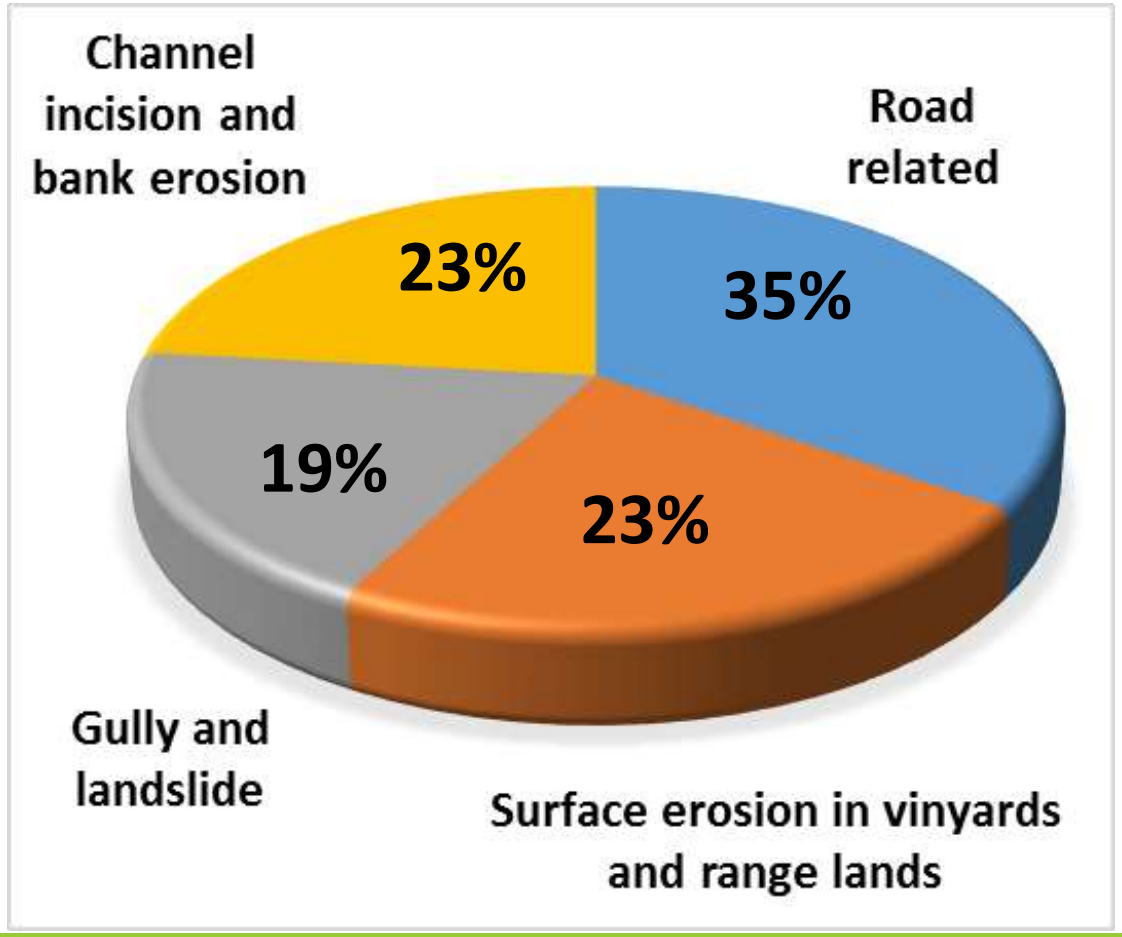
Change in the peak flow record…

- No great impact at the upper and lower storm sizes
- Moderate size storms may be captured in reservoir and dams?



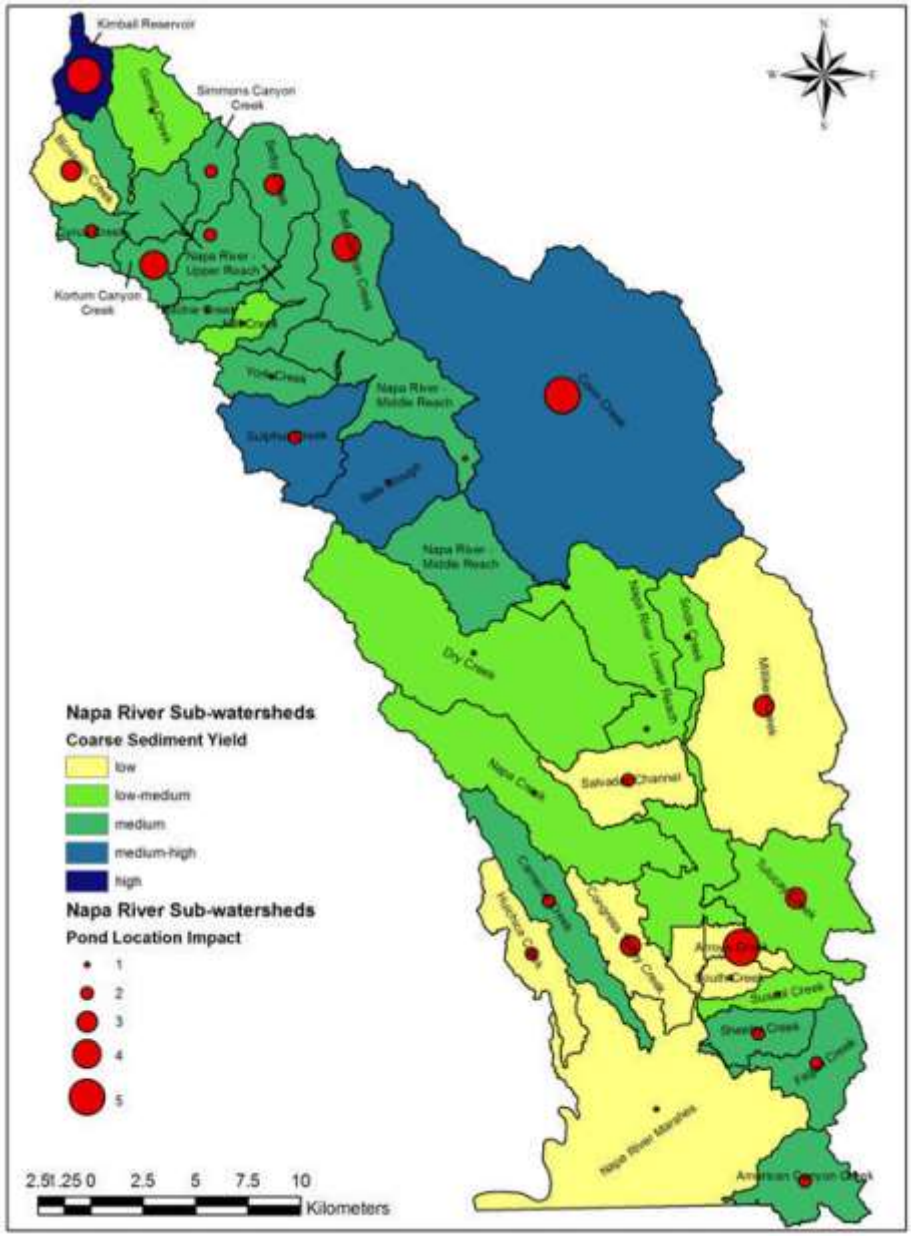
Sediment budget - fine sediment clogging the system

- Fine sediment
  - carries pollutants
  - clogs spawning and raring habitat for salmonids
- Different sources require unique management techniques



Impact of flow mods on coarse sediment

- Greater erosion and supply
  - Bed erosion and transport from quick flows and channelization
- But greater trapping behind reservoirs and farm dams and ponds



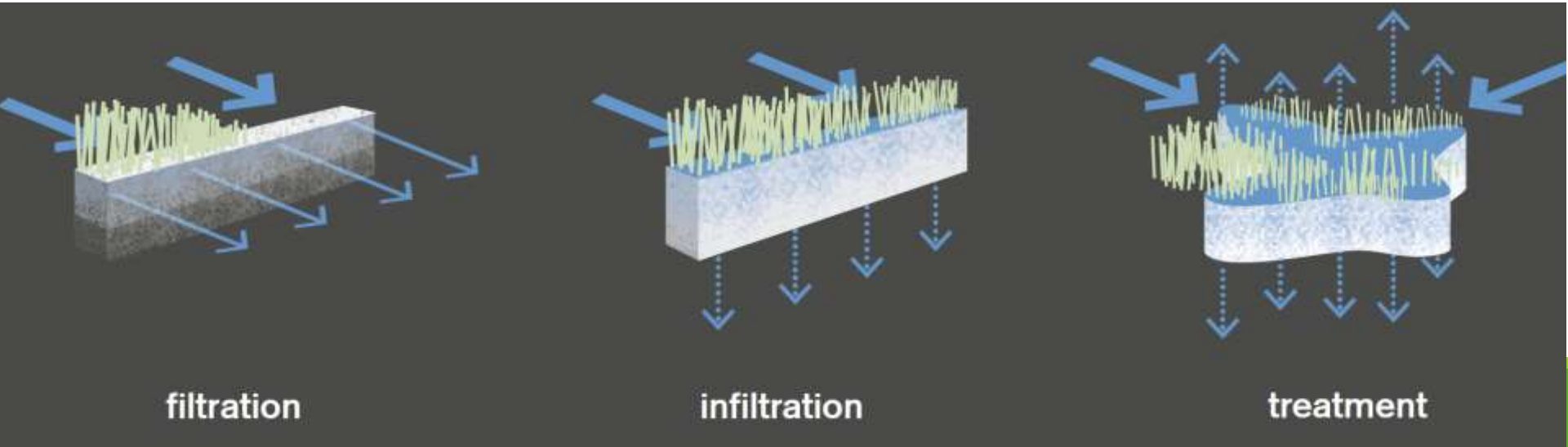
What is ‘green infrastructure’ and can it help us mimic natural processes?

What is Green Infrastructure?

- Rain gardens
- Bioswales
- Green roofs
- Tree well planters
- Pervious pavement
- Green walls
- Cisterns

What does it do for us?

- Mimics the natural water cycle more closely
- Slows, spreads, and sinks rainfall into the ground
- Decreases runoff volume and peak flows
- Keeps more of the water for water supply and base flows



What could it do for us in Napa Valley?

- Estimated 6900 acres of urban area
- Other experience in the Bay Area suggests for an average rainfall of 25 inches:
  - ~400,000 gal of capture per acre
  - ~0.5 cfs/acre less peak flow
- If we assume 20% of the current urban area is retrofitted by 2040
  - 550 Million gallons more capture
  - 700 cfs less peak flow in the Napa River

How can we restore, mimic or maintain natural watershed processes?

Keep working on these!

- Reservoir releases late winter/ dry season

- Coarse sediment augmentation
- Continue restoring the main stem

- Remove dams and fish barriers
- Conservative irrigation/ frost practices
- Incentivize urban infill/ LID
- BMPs for road sediment control

- BMPs for vineyard water/ sediment


TWIST-R

Extended materials for moderated Q&A

Keep working on these!

- Reservoir release
  - dry season – salmonid rearing
  - Late spring to flush fine sediments – spawning habitat
- Coarse sediment augmentation to select reaches
- Continue restoring the main stem to give the river room
  - Promotes sediment sorting (flush the fines)
  - Increases habitat complexity
  - Decreases incision (raises ground water table)
  - Stabilizes banks to maintain riparian structure

Keep working on these!

- Remove dams and fish barriers to promote coarse sediment transport and improve habitat access
- Continue to increase use of conservative irrigation and frost practices
- Incentivize urban infill and low impact development
- Implement targets for road sediment control and work together to design, implement and monitor the outcomes
- Continue to explore water an sediment retention options in vineyards (cover cropping, conservation tillage, composted mulch, traffic control, and infiltration trenches)

Building on the work many groups are doing!

- What are the most effective BMPs for water and sediment control?
- Where should they be most effectively placed in the landscape?
- Are the TMDL targets achievable given the available BMPs?
- What is the linkage between sediment supply, BMP applications, and substrate conditions?
- Is river restoration more effective than upland BMPs?