Road Assessments

Michael Fuller, CEG, PG
Senior Engineering Geologist
California Geological Survey

Road Assessments

What are road assessments?

Why assess your roads?

How to assess your roads?

What methods exist?

What tools to use?

How to manage the data?

What data to collect?

CGS
CALIFORNIA
GEOLOGICAL SURVEY

What are road assessments?

- Road assessments are multidisciplinary
  - Engineering, planning, safety
  - Geologic hazards, natural resources, cultural resources
- Road assessments are data collection efforts to:
  - Identify features, conditions, constraints, potential treatments, and costs
  - Integrate the data with operations

CGS
CALIFORNIA GEOLOGICAL SURVEY

Why assess your roads?

- Grant eligibility or compliance
- Regulatory compliance
  - Sediment budget, TMDL, CWE
- Environmental protection
  - Listed species, reduce degradation, ecological effects, scenic values
  - Baseline conditions
  - Monitoring

CGS
CALIFORNIA GEOLOGICAL SURVEY

Why assess your roads?

- Updating an old system to meet current needs
  - Downsizing, standardizing, or upgrading
- Most roads are over 50 years old - some are over 100.
  - Design life for most road components is less than 50 years.
  - Unless removed, existing roads can remain indefinitely in the landscape.

CGS
CALIFORNIA GEOLOGICAL SURVEY

Why assess your roads?

- Planning and cost management
  - Road assessments are long-term investments focused on managing your roads.
  - Particularly useful to organizations that manage large and diverse transportation systems but any land and road manager can benefit from the assessment process.

CGS
CALIFORNIA GEOLOGICAL SURVEY

How to access roads?

1. Getting the Data
   - methodology
     - speed vs. detail
   - terminology
2. Managing the Data
   - database
   - archives, updates
3. Using the Data
   - products
   - projects

CGS
CALIFORNIA
GEOLOGICAL SURVEY

Methodology

- There is no one right way. Focus on desired **products**.
- **Qualifications** of assessors should be consistent with the methods and products.
- Collect data that is easily **repeatable** and consistent. Keep it simple.

CGS
CALIFORNIA GEOLOGICAL SURVEY

Methodology

- Be as comprehensive as affordable.
- Consistency is key to keeping the products robust and useful for the long term.
- Define and adhere to data standards.

Standards and Methodology

- Standards include **methods of data collection**, equipment settings, required data attributes, documentation, and accuracy levels.
- Standards improve efficiency and ensure the data and products are **useful and reliable**.
- This is especially important because **multiple agencies or organizations** are often involved in road projects.

What methods already exist?

- Fish orientated approach
- Sediment orientated approach
- Fish and sediment orientated approach
- Condition assessment approach

What methods already exist?

Fish orientated approach

- US Forest Service and partners
  - **Fish Xing**
  - High level of detail
  - Predicts fish passage
- Scale: stream crossing sites

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?

Sediment orientated approach

- US Forest Service
- **Methods for Inventory and Environmental Risk Assessment of Road Drainage Crossings**
  - High level of detail
  - Consequences inventory
    - Estimates Fill Volume
  - Connectivity/cross drain inventory
  - Hazard assessment
  - Environmental risk assessment
- Scale: stream crossing sites

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?
Sediment orientated approach

- CalFire, CGS, DFG, and RWQCB
- **IMMP Interagency Mitigation Monitoring Program**
  - High level of detail
  - Performance-based effectiveness
  - Protocol consists of 270 questions
  - 45 minutes to two hours per crossing
- Scale: stream crossing sites

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?

Sediment orientated approach

- US Forest Service
- **Water Erosion Prediction Project: Roads**
  - **(WEPP: Road)**
  - Intense level of detail broadly extrapolated
  - Predicts sediment production and delivery
    - Extrapolated from high resolution measurements of erosion rates for surface types.
    - Relies on synthetic hydrography.
- Scale: segments

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?

Sediment orientated approach

- National Council for Air and Stream Improvement (NCASI)
- **Sediment Model 2 (SEDMODL2)**
- Low level of detail broadly extrapolated
- Predicts sediment production and delivery
  - Extrapolated from GIS data describing basic surface characteristics.
  - Relies on few field attributes and synthetic hydrography.
- Scale: segments

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?

Fish and Sediment orientated approach

- US Forest Service
  - **GRAIP Geomorphic Road Analysis and Inventory Package**
  - Refines synthetic hydrography
  - Predicts sediment production and delivery, mass wasting risk, surface erosion risk, and fish passage at stream crossings
  - 2-5 miles per day, 2 person team
- Scale: segments to watersheds

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?

Fish and Sediment orientated approach

- California Fish and Game
- **California Salmonid Stream Habitat Restoration Manual**
  - High level of detail
  - Part X Upslope Erosion Inventory and Sediment Control Guidance
  - Predicts sediment production and delivery
- Scale: sites to watersheds

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?

Condition assessment approach

- California State Parks, CGS, multiple partners
  - Off-Highway Vehicle Recreation Division
  - **2008 Soil Conservation Standard and Guidelines**
  - Moderate level of detail
  - Condition Assessment
    - 2-5 miles per day, 1-2 person team
- Scale: segments to watersheds

CGS
CALIFORNIA GEOLOGICAL SURVEY

What methods already exist?
Condition assessment approach

- California State Parks, CGS
  - Facilities Management Division
  - Moderate level of detail
  - Condition assessment – under development
    - Observations and Recommendations
  - 2-5 miles per day, 1-2 person team
- Scale: sites to watersheds

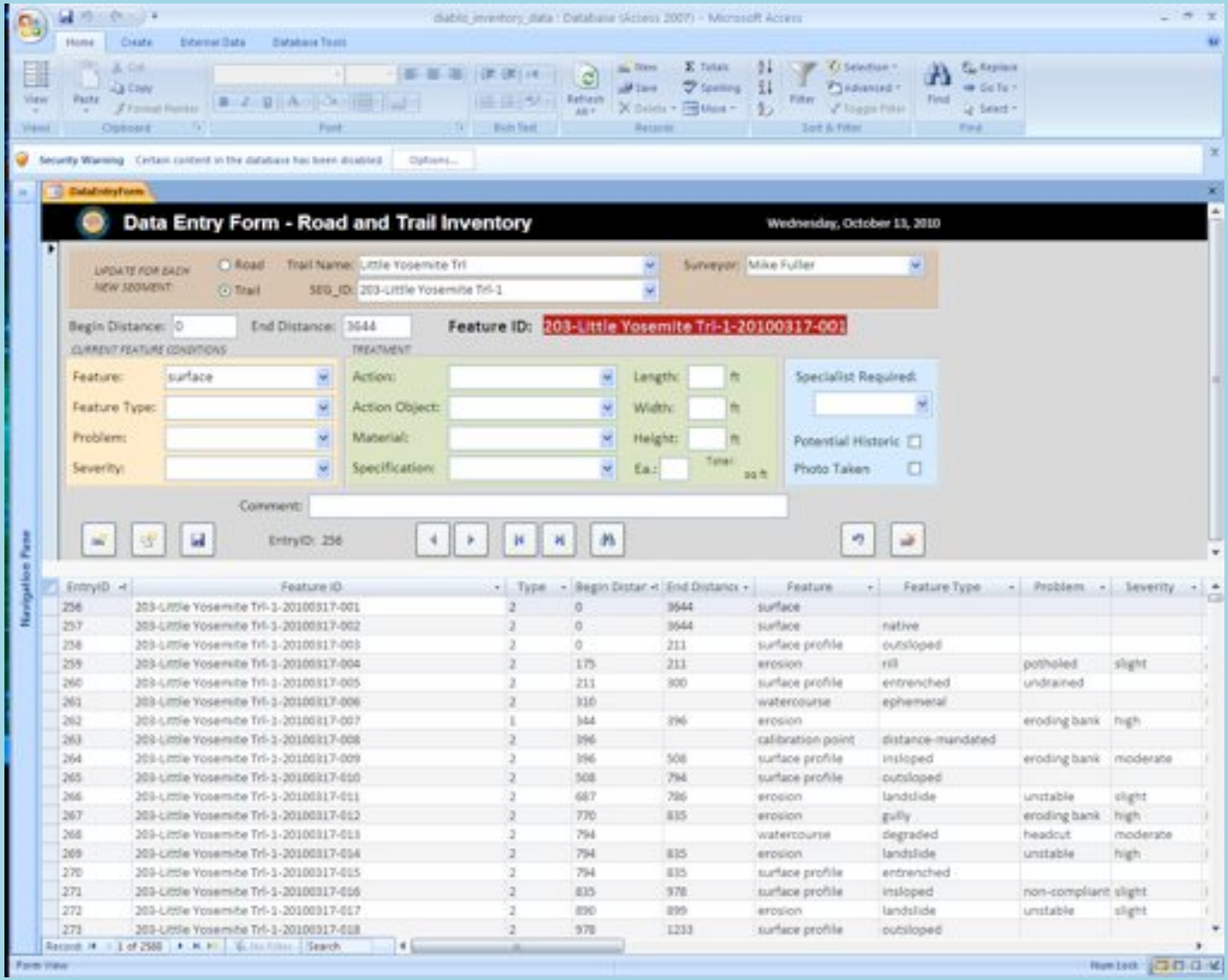
What tools to use?

Odometer and wheel

Forms

CALIFORNIA GEOLOGICAL SURVEY

What tools to use?



CGS
CALIFORNIA GEOLOGICAL SURVEY

What tools to use?

Project

Photo ID and date

Lat-long

Bearing and distance

CALIFORNIA GEOLOGICAL SURVEY

What field tools to use?

Clinometer

Camera

GPS device

25-ft stadia rod

300-ft measuring tape

Folding rule or tape measure

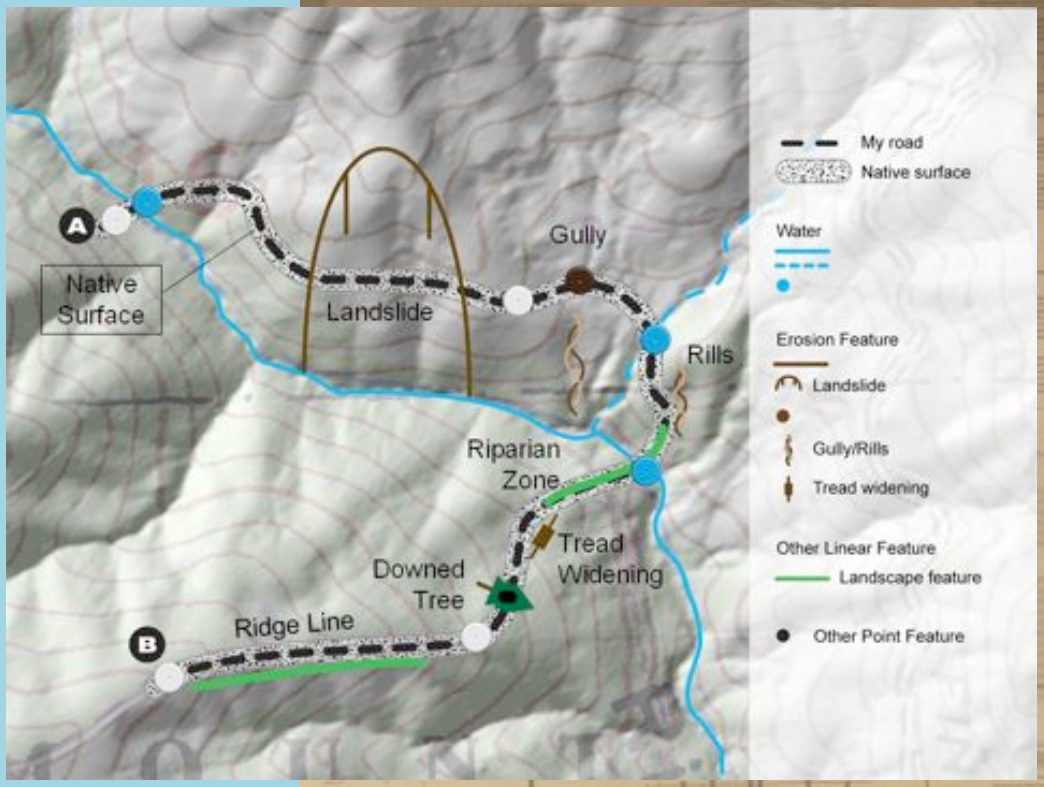
Odometer and wheel

CGS
CALIFORNIA GEOLOGICAL SURVEY

What field tools to use?

CGS
CALIFORNIA
GEOLOGICAL SURVEY

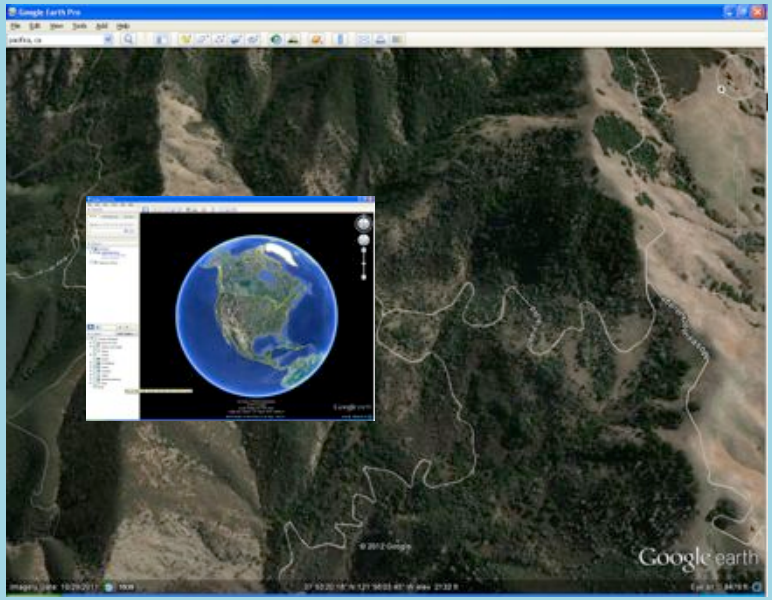
What tools to use?
What are the desired products?



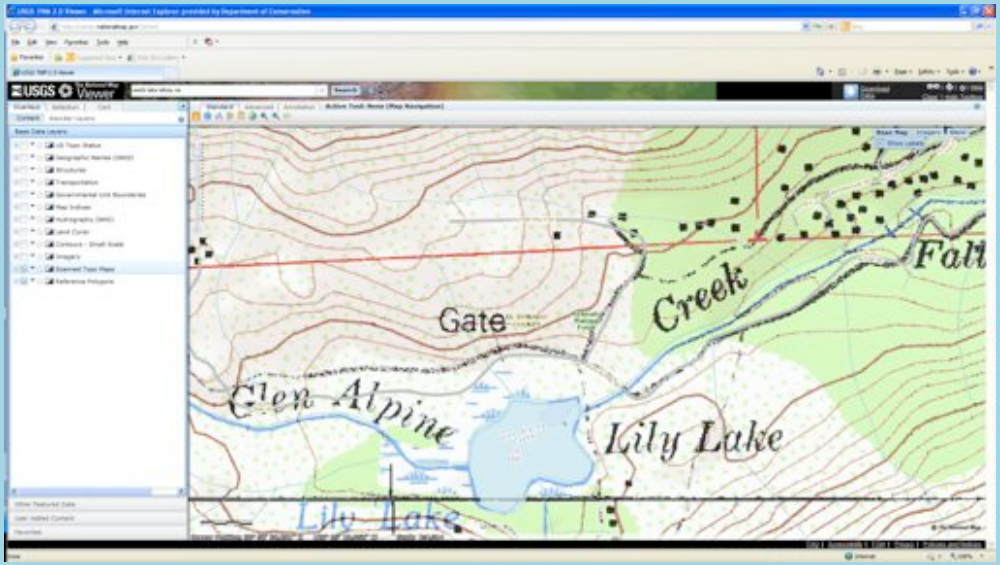
CALIFORNIA GEOLOGICAL SURVEY

What office tools to use?

Geographic Information System (GIS)



Google Earth



USGS National Map

Decide how to analyze and synthesize the data and how to communicate the results.

CGS
CALIFORNIA GEOLOGICAL SURVEY

What office tools to use?

- Viewing existing geographic data helps to:
  - Pre-identify features of interest
    - Watercourse crossings
    - Unstable areas
    - Sensitive areas
  - Provide quality control comparisons
  - Augment the dataset
  - Improve understanding of field relationships

CGS
CALIFORNIA GEOLOGICAL SURVEY

Data Sources

- **DFG GIS Clearinghouse**
- http://www.dfg.ca.gov/biogeodata/gis/clearinghouse.asp
- **US Interagency Elevation Inventory**
- http://www.csc.noaa.gov/inventory/#
- **USGS National Map**
- http://nationalmap.gov

CGS
CALIFORNIA GEOLOGICAL SURVEY

Examples

Pre-identify features of interest

- Watercourse crossings
- Unstable areas
- Sensitive areas

USGS National Map

USGS National Map

CGS
CALIFORNIA GEOLOGICAL SURVEY

GoogleEarth

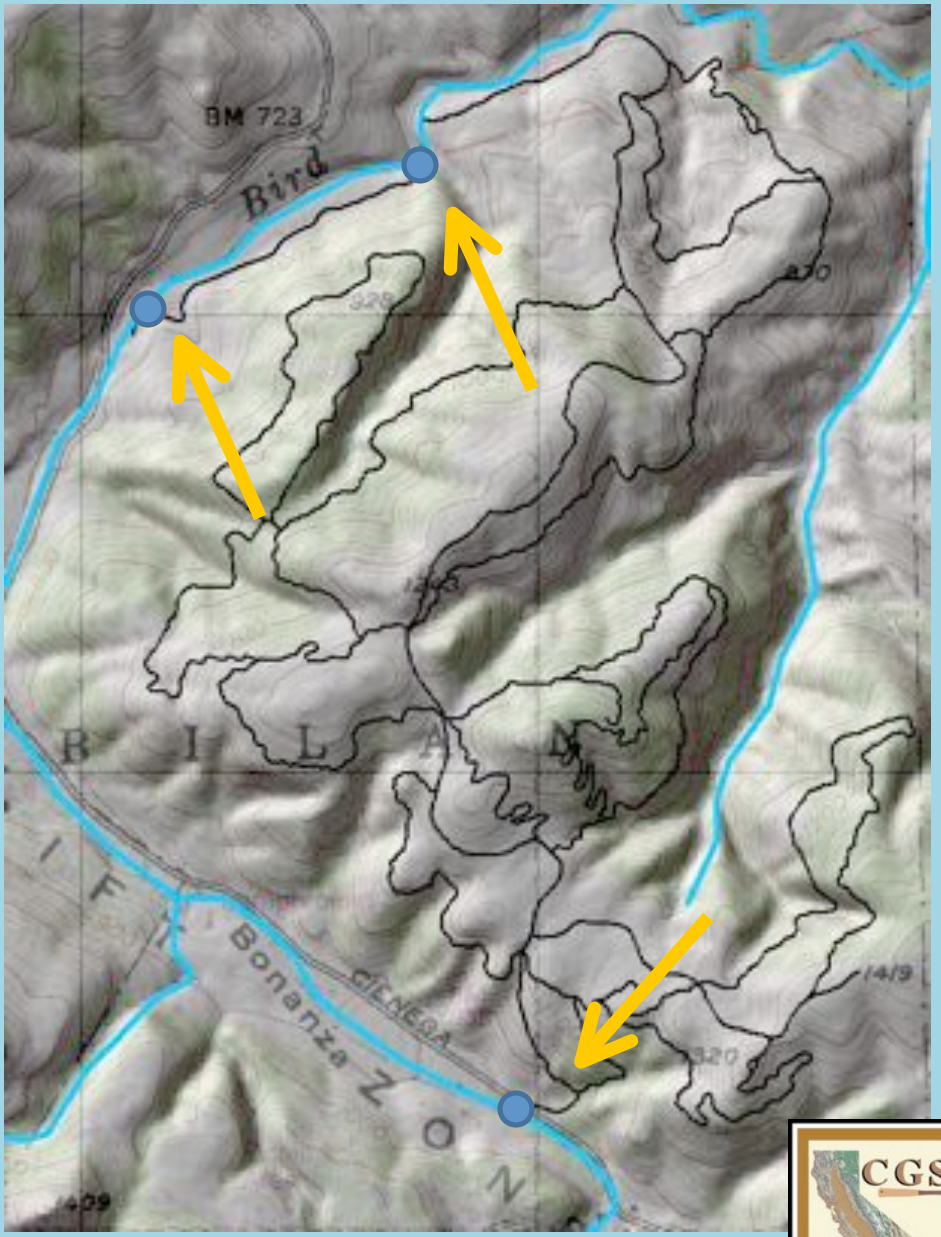
CGS
CALIFORNIA
GEOLOGICAL SURVEY

Pre-identifying stream crossings

USGS “blue line” streams from 7.5 minute topographic maps

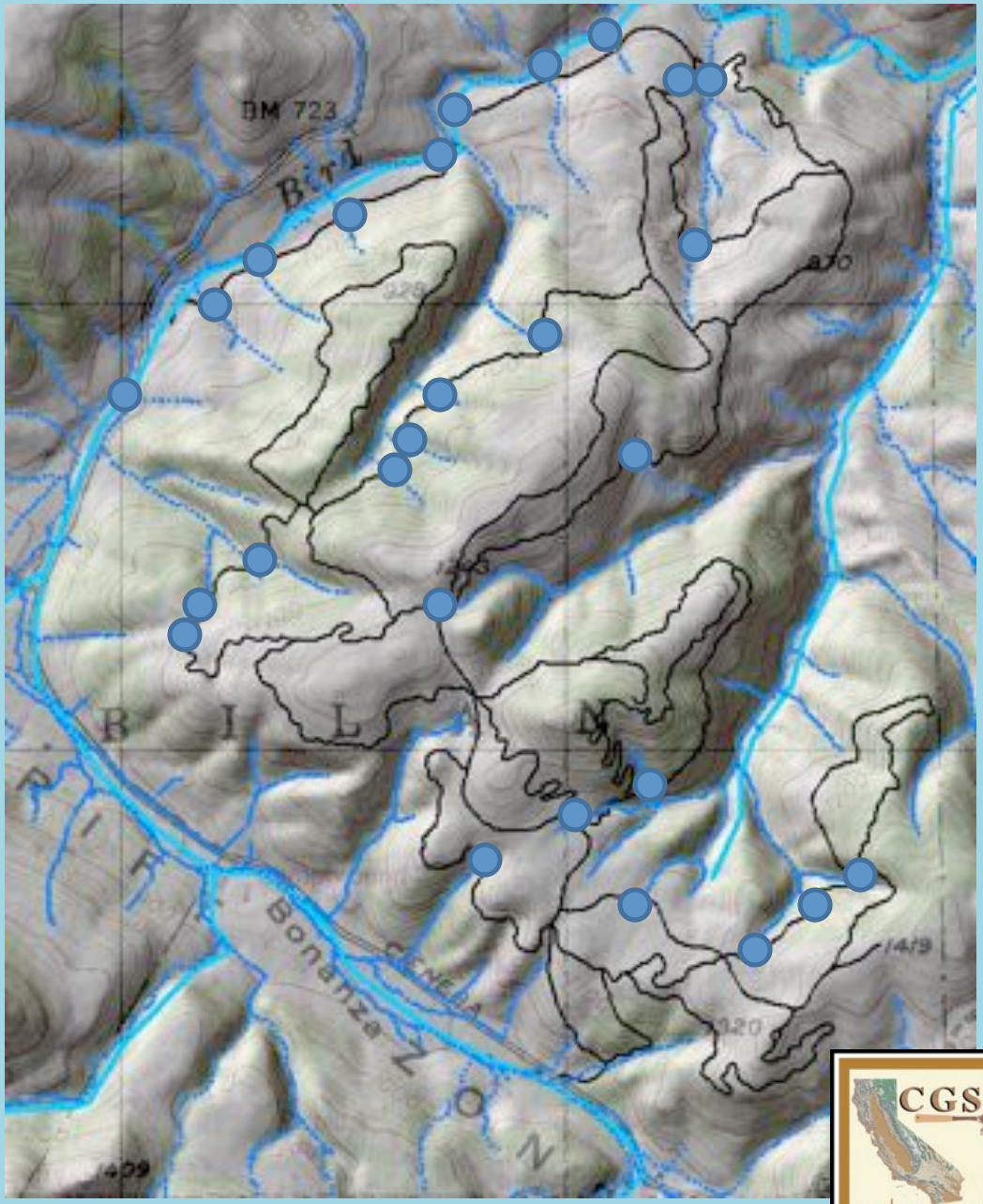
3 watercourse crossings

Not always sufficient.



CGS
CALIFORNIA GEOLOGICAL SURVEY

Pre-identifying stream crossings



Synthetic hydrography derived from 3m-DEM

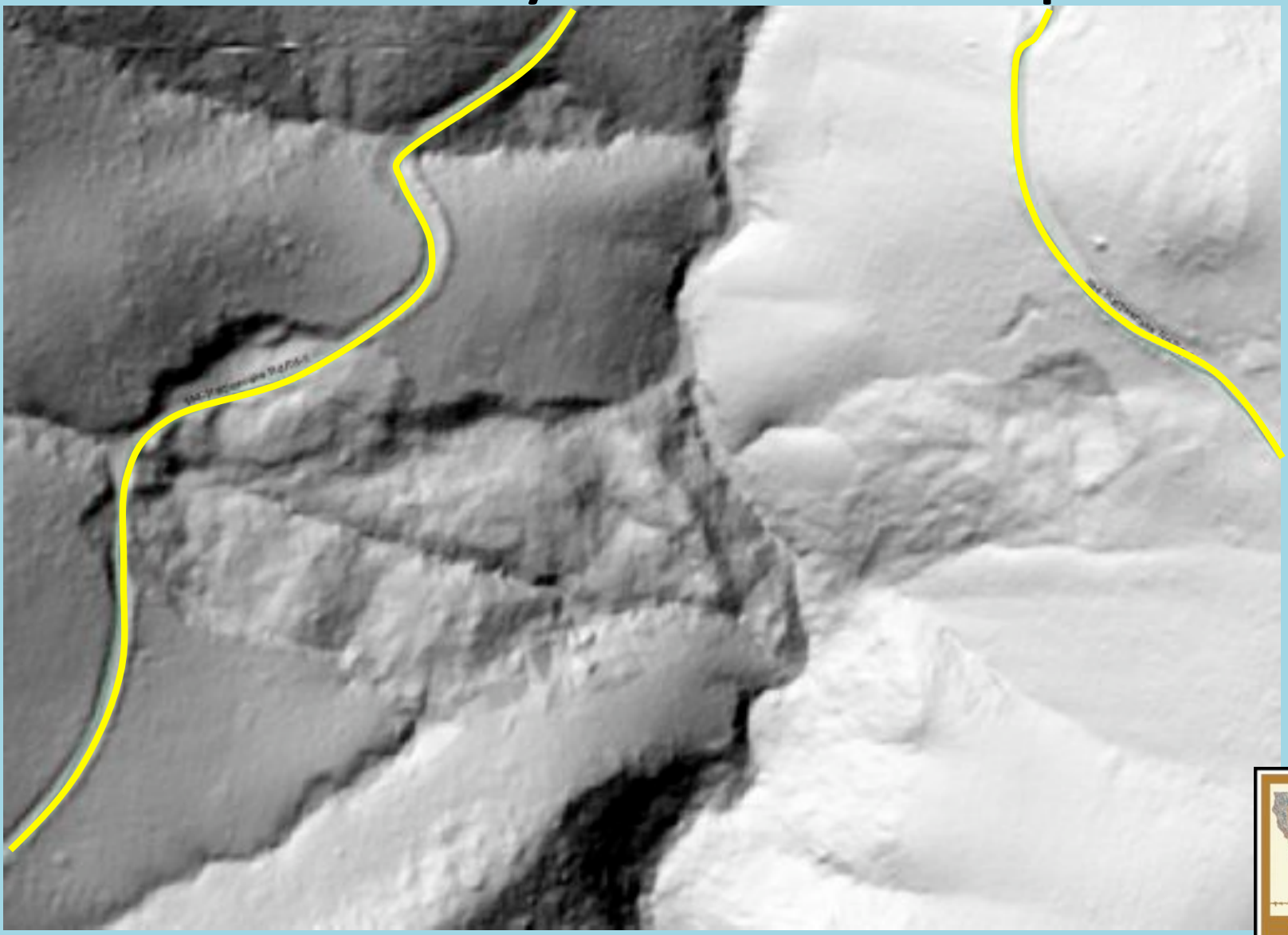
27 watercourse crossings

CGS
CALIFORNIA GEOLOGICAL SURVEY

Pre-identify unstable slopes

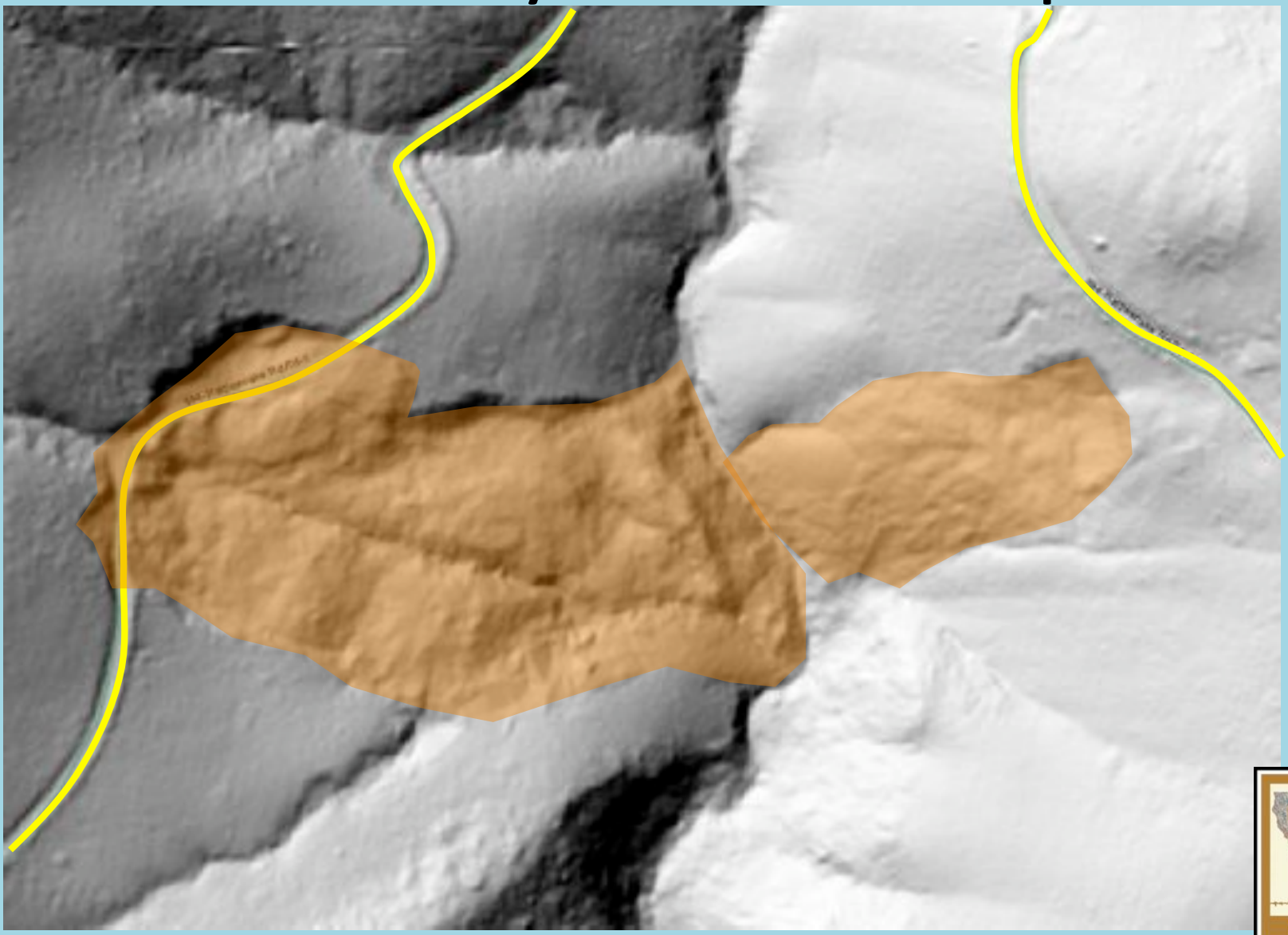
CGS
CALIFORNIA
GEOLOGICAL SURVEY

Pre-identify unstable slopes



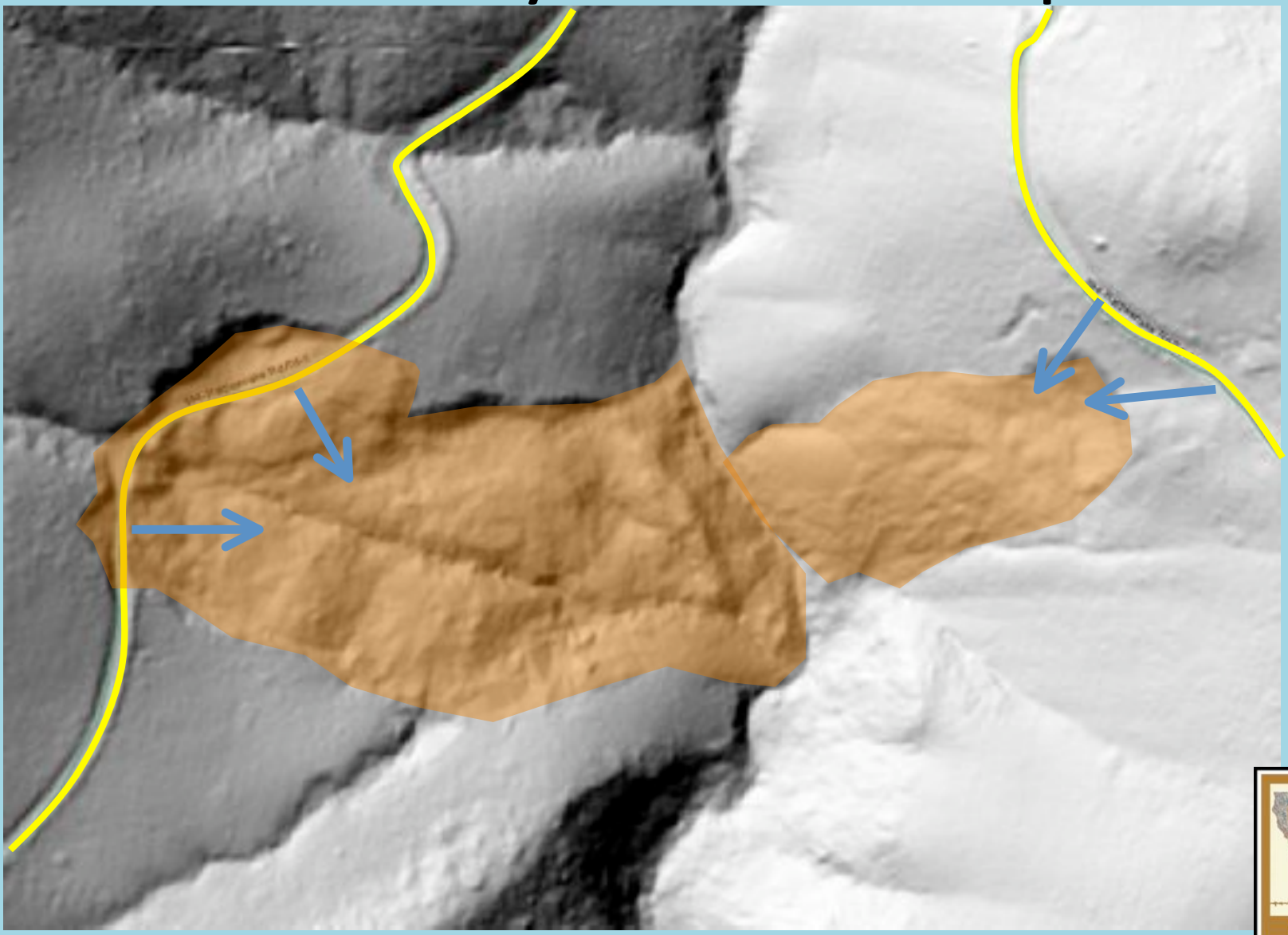
CGS
CALIFORNIA
GEOLOGICAL SURVEY

Pre-identify unstable slopes



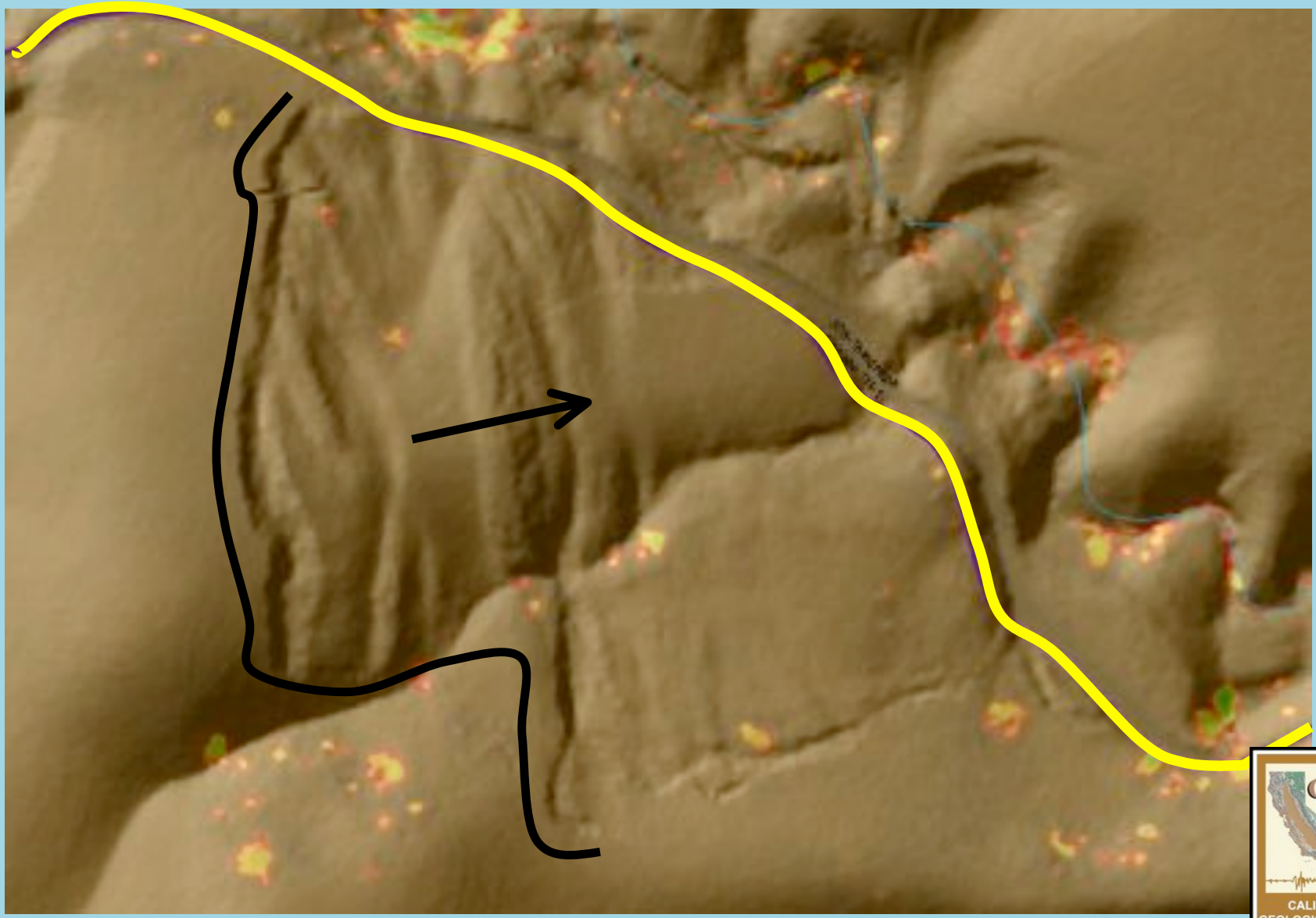
CALIFORNIA GEOLOGICAL SURVEY

Pre-identify unstable slopes

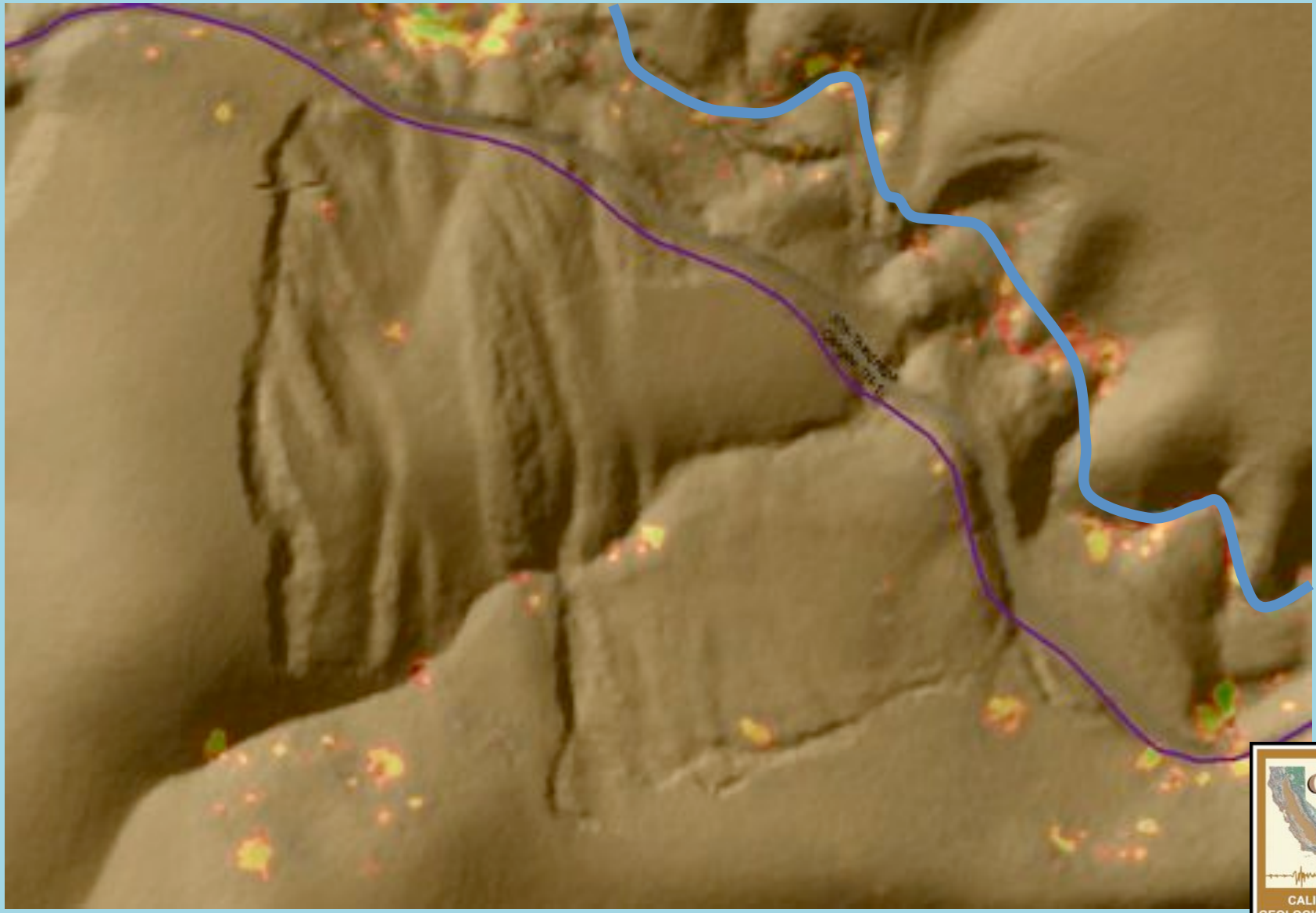


CALIFORNIA GEOLOGICAL SURVEY

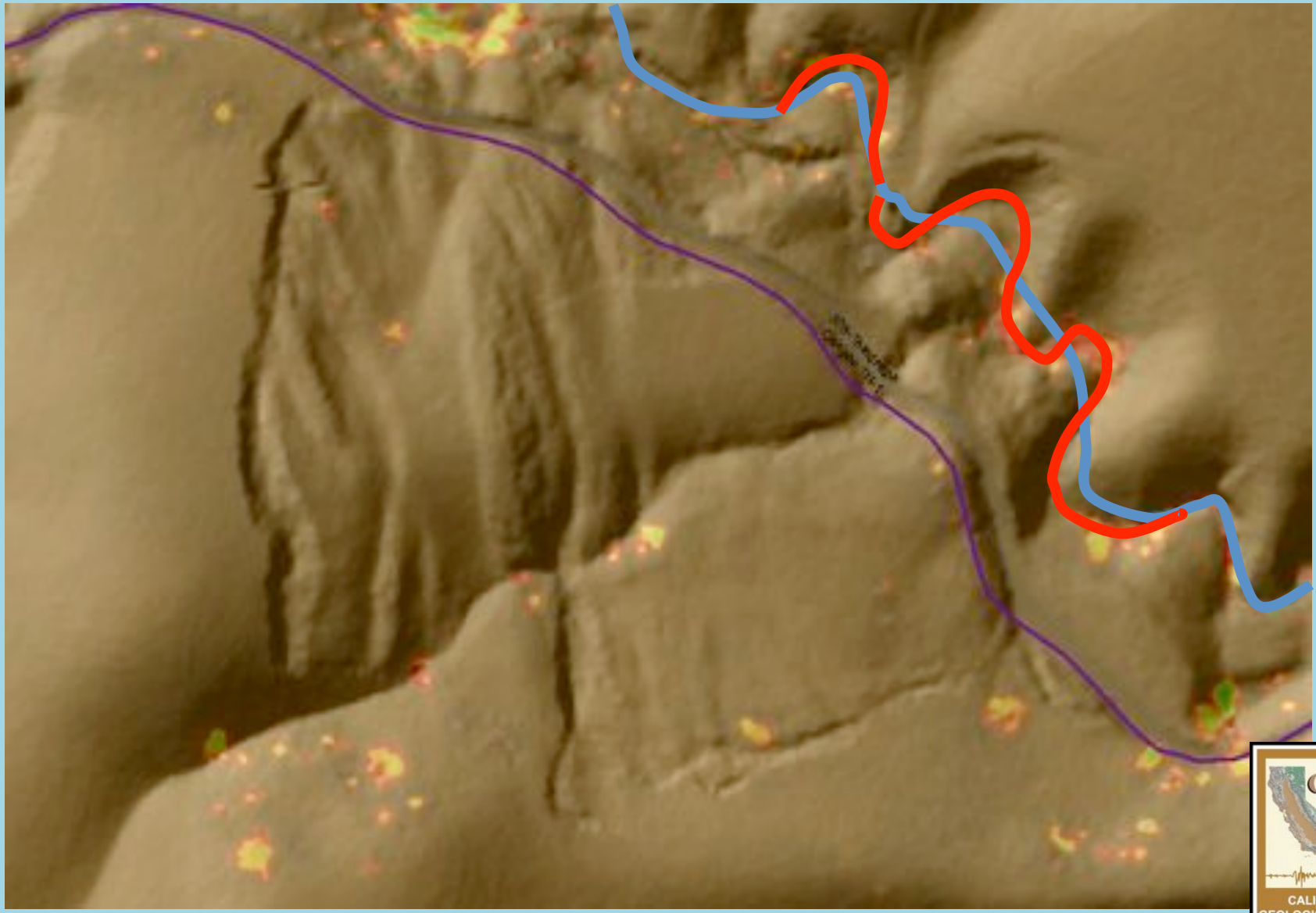
Pre-identify unstable slopes



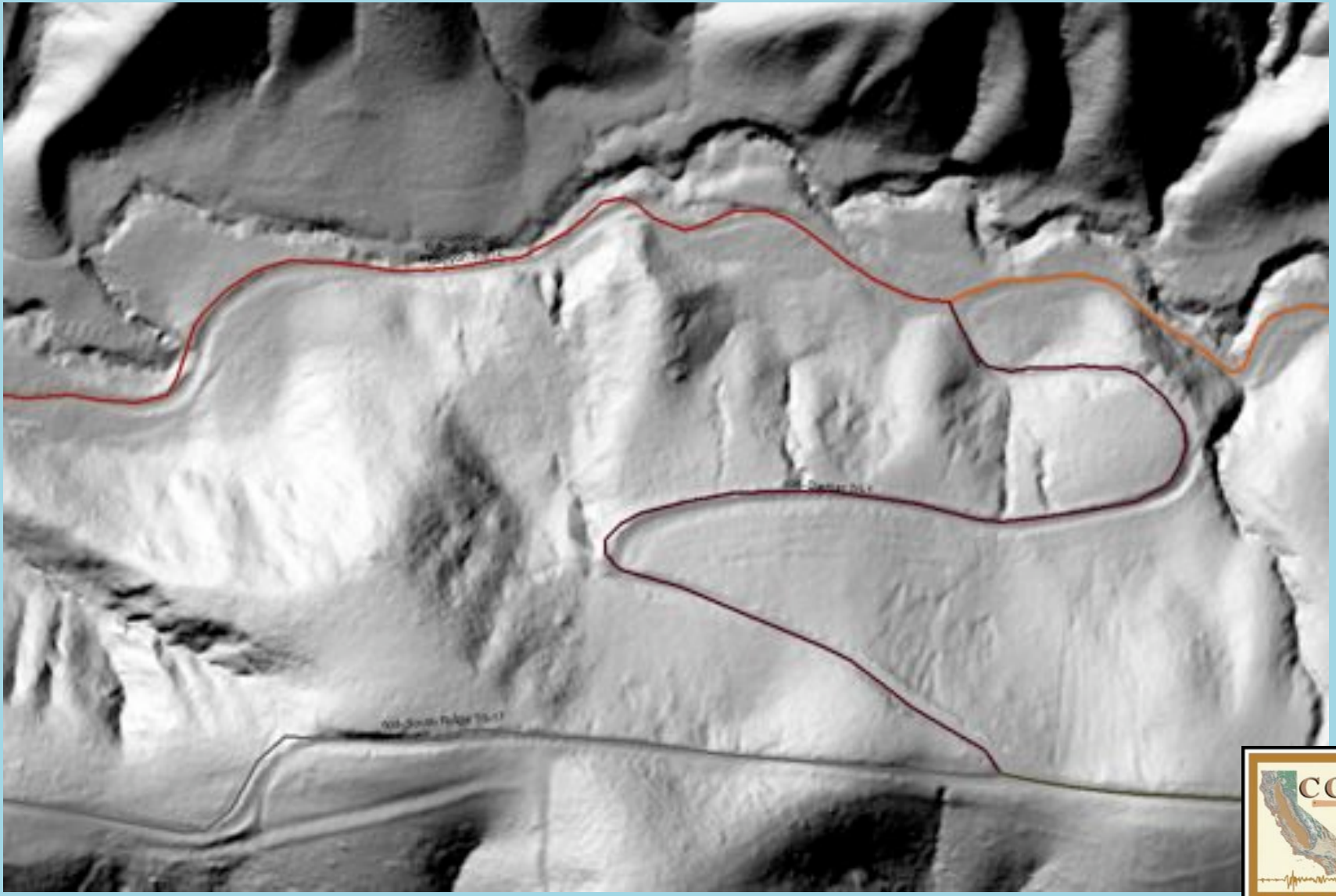
Pre-identify unstable slopes



Pre-identify unstable slopes



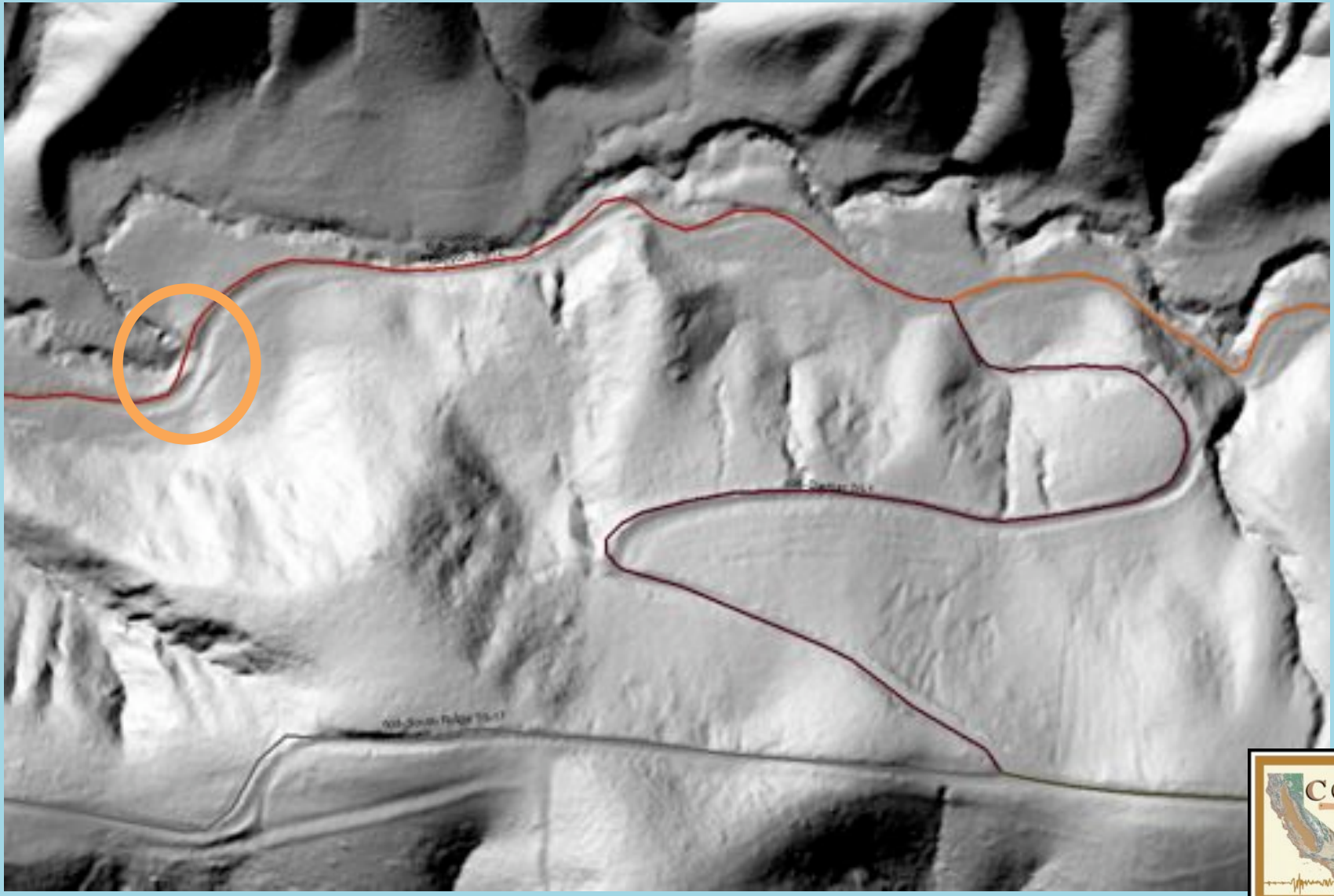
Pre-identify erosion problems



CALIFORNIA GEOLOGICAL SURVEY

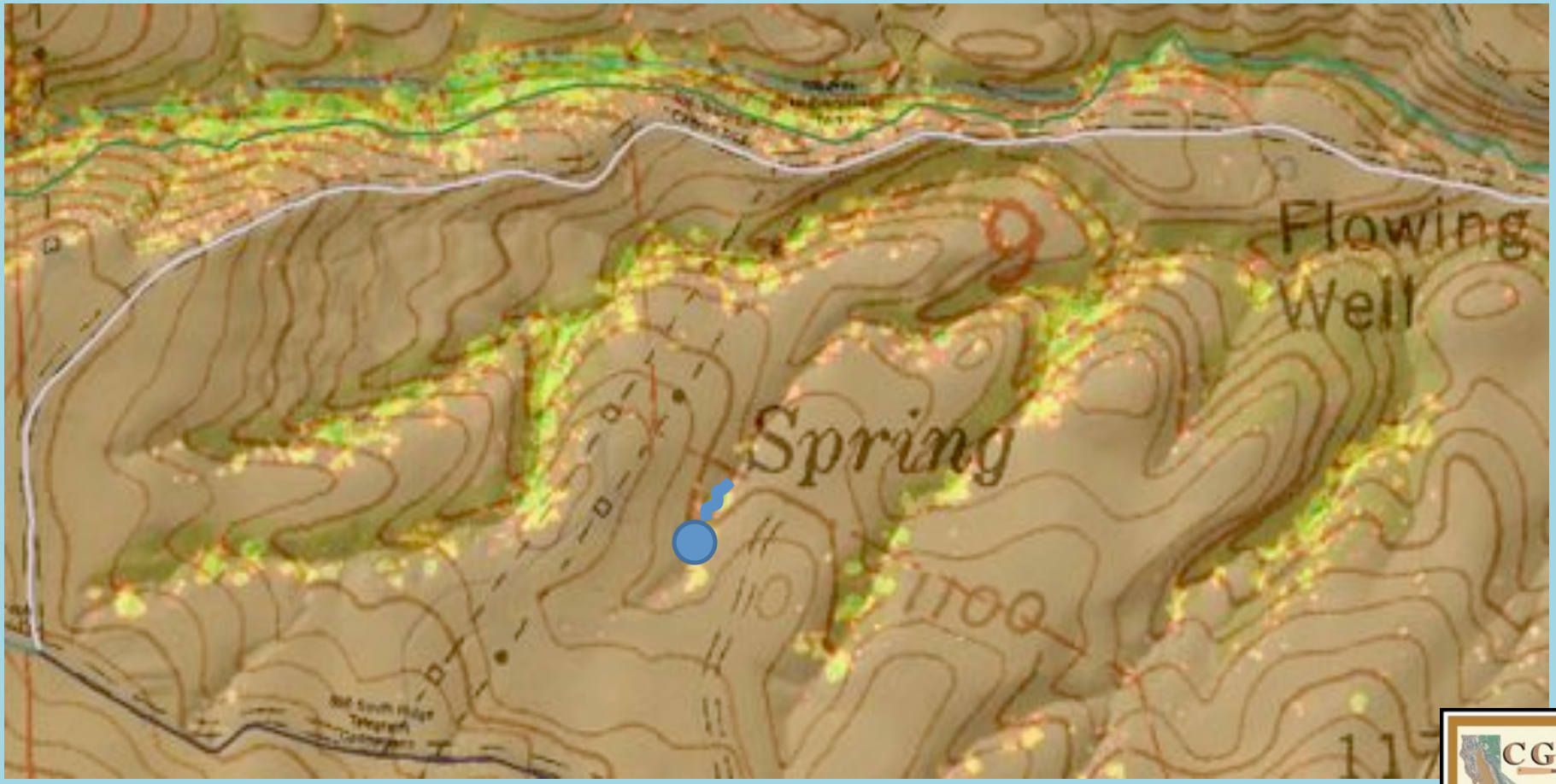
Pre-identify erosion problems

Pre-identify erosion problems



Pre-identify erosion problems

Pre-identify springs and wells



CALIFORNIA
GEOLOGICAL SURVEY

Field Data Collection

- What to collect data about?
  - Level of detail
- Databases
  - Structured language
- What to observe?

CGS
CALIFORNIA
GEOLOGICAL SURVEY

What to collect data about?

- **Rural Roads Webinar Series One**
  - 1) Hydrologic and water quality impacts
  - 2) Geologic constraints on road design and operations
  - 3) Effects of roads on wildlife
  - 4) Roads and exotic species
  - 5) Fish passage

CGS
CALIFORNIA GEOLOGICAL SURVEY

What to collect data about?

- **Rural Roads Webinar Series Two**
  - 6) Road drainage
  - 7) Stream crossings
  - 8) Roadway materials
  - 9) Slope stability and wet areas
  - 10) Erosion control

CGS
CALIFORNIA GEOLOGICAL SURVEY

What to collect data about?

- **Rural Roads Webinar Series One and Two**
  - Ten general topics each with many details
    - Hundreds to thousands of possible concerns depending on the level of detail.
  - Data should clearly identify, describe, and locate the important physical parameters for every concern and proposed action.
  - Data should be *observations not interpretations*.
  - Data and the level of detail should serve the products and decisions that are to be made.

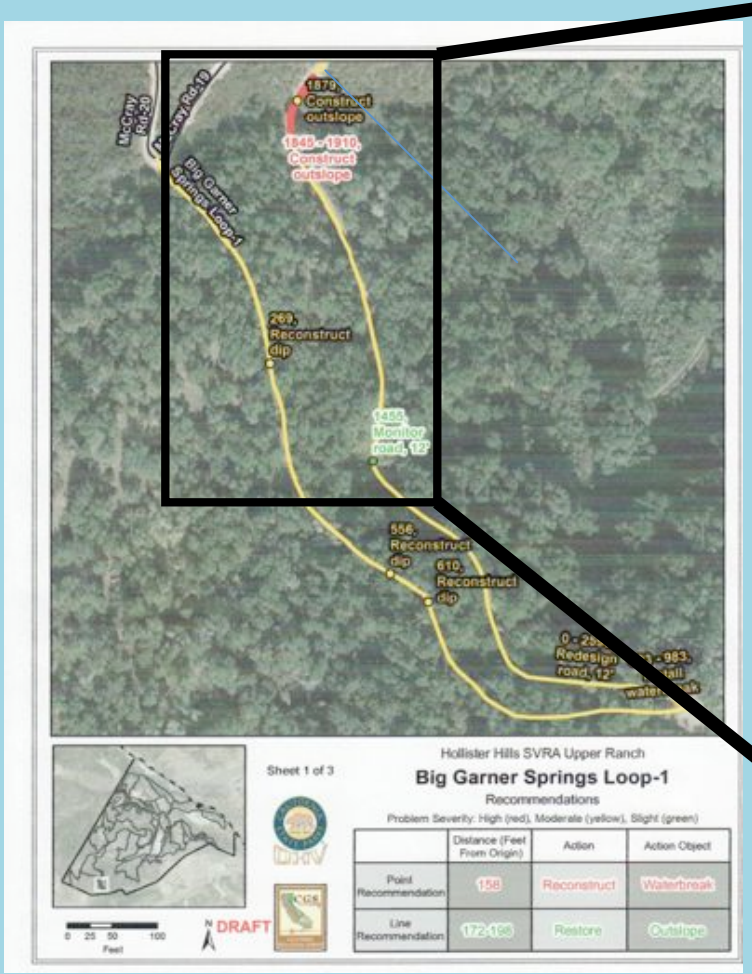
CGS
CALIFORNIA GEOLOGICAL SURVEY

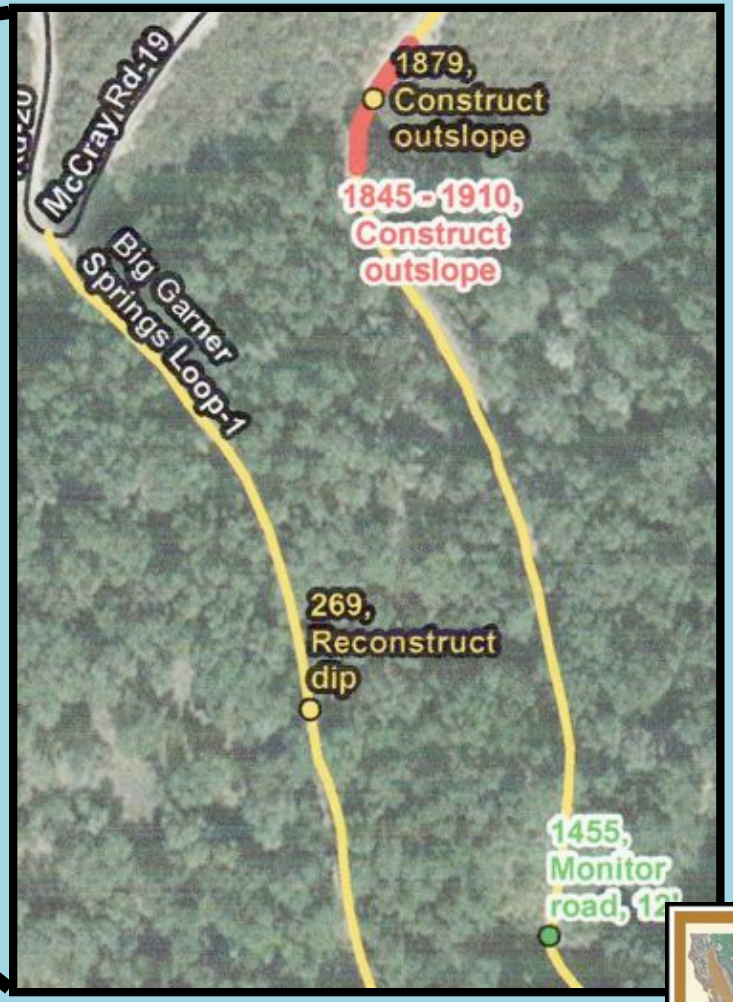
Level of Detail

- General or specific?
- Should the information include:
  - Specific data for use in specific models
  - Observations only
    - Terms defined in the data dictionary
    - Comments
    - Metrics or indicators
  - Observations and recommendations
    - Advisory
    - Specific treatments

CGS
CALIFORNIA GEOLOGICAL SURVEY

Treatment Plan



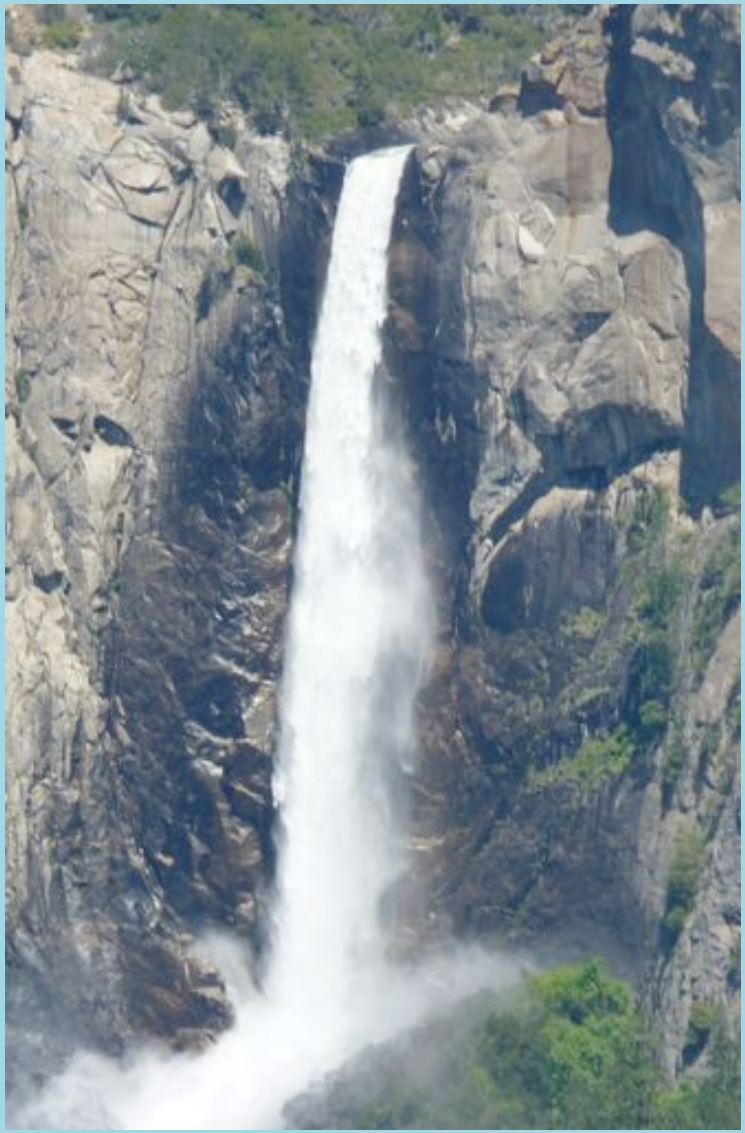


CALIFORNIA GEOLOGICAL SURVEY

Database

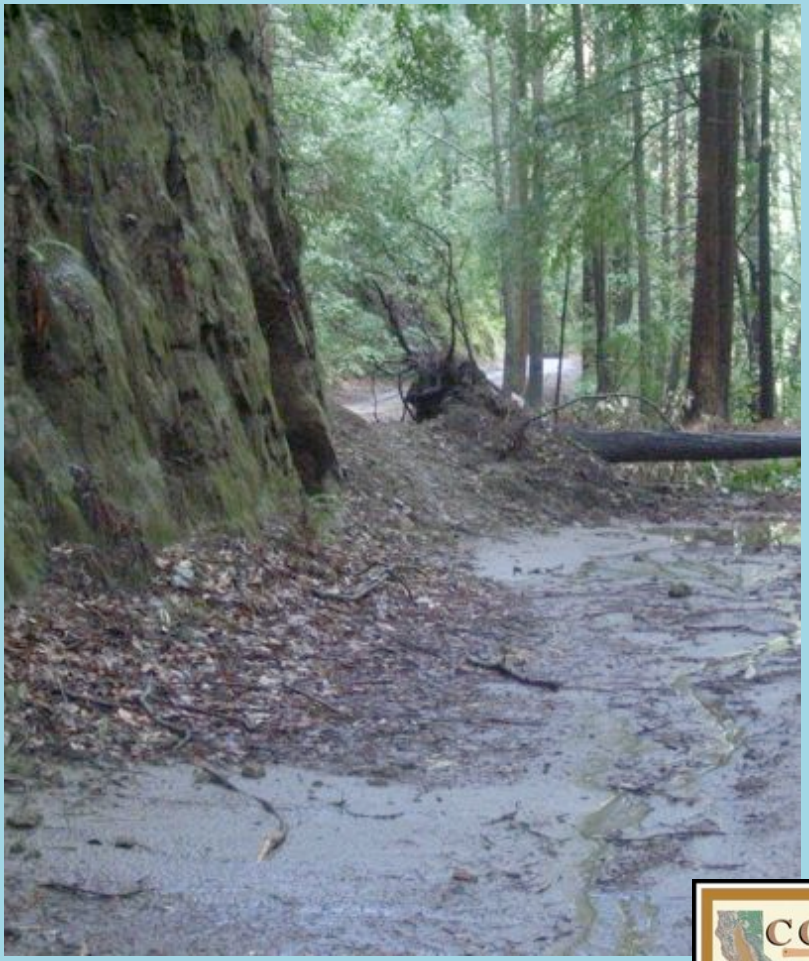
- Database design
  - A profession all by itself
  - Needs to be product orientated
  - Structured terminology
    - Need a data dictionary
    - Everyone needs to call things by the same name
    - The size of the data dictionary will vary with the size and complexity of roads or networks of roads.

Define your terms – rock fall



CGS
CALIFORNIA
GEOLOGICAL SURVEY

Define your terms - slough



CGS
CALIFORNIA
GEOLOGICAL SURVEY

Define your terms – Infrequent encounters

CALIFORNIA GEOLOGICAL SURVEY

Structured Terminology

- Terms often need to be sorted into categories.
- The same term should not be used in more than one category.
- Terms need to mean the same thing to the data collector as they do to a data user who may have different backgrounds.
- Data dictionaries are key in clarifying communications.

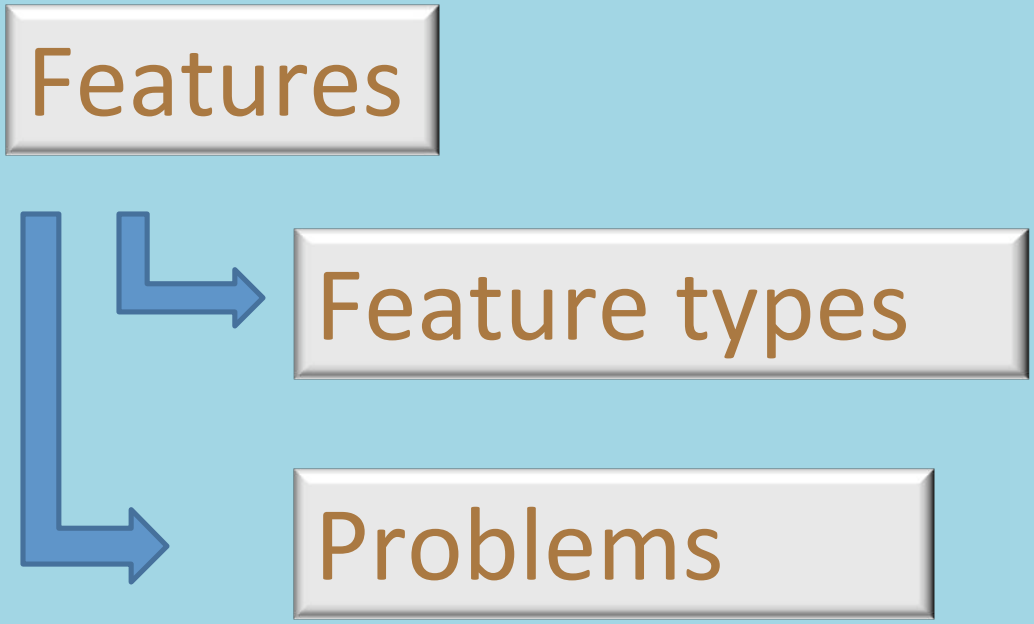
Example of structured terminology

- **Features**: Natural or artificial objects and components encountered along a road (gates, intersections, watercourses, etc.)
  - Feature Type: various subcategories
- **Problems**: Observable aspects of the features that describe any physical impairment.

What to observe?

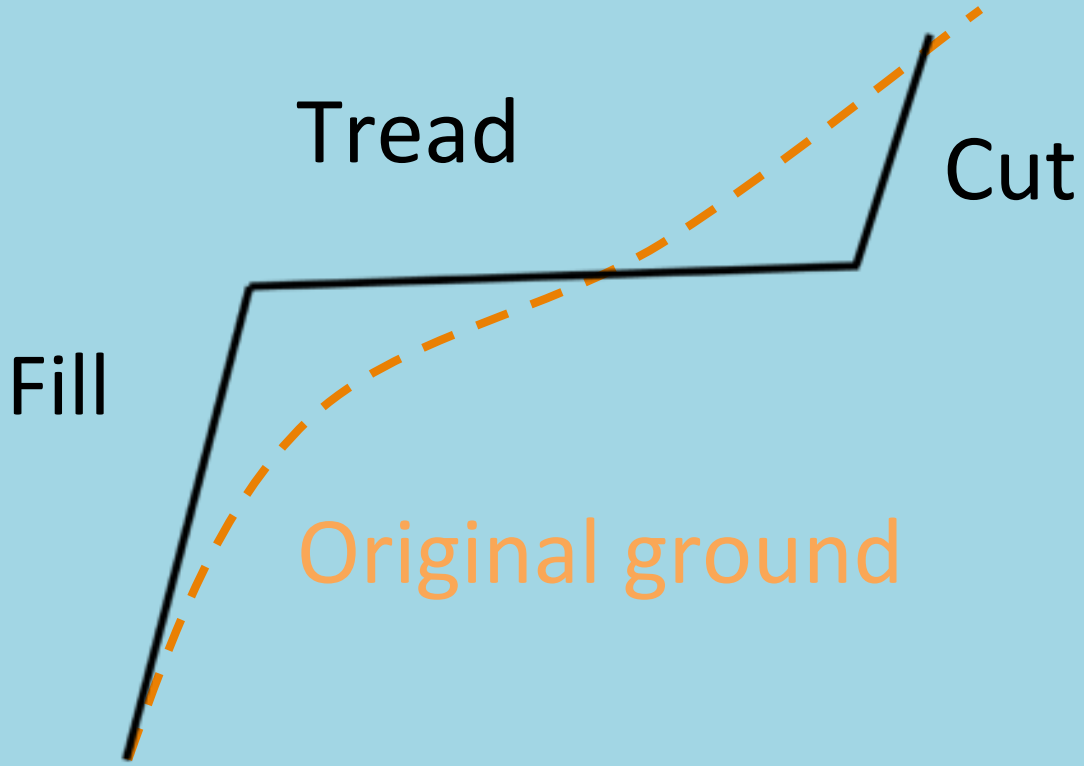
CGS
CALIFORNIA
GEOLOGICAL SURVEY

How to record observations?



CGS
CALIFORNIA
GEOLOGICAL SURVEY

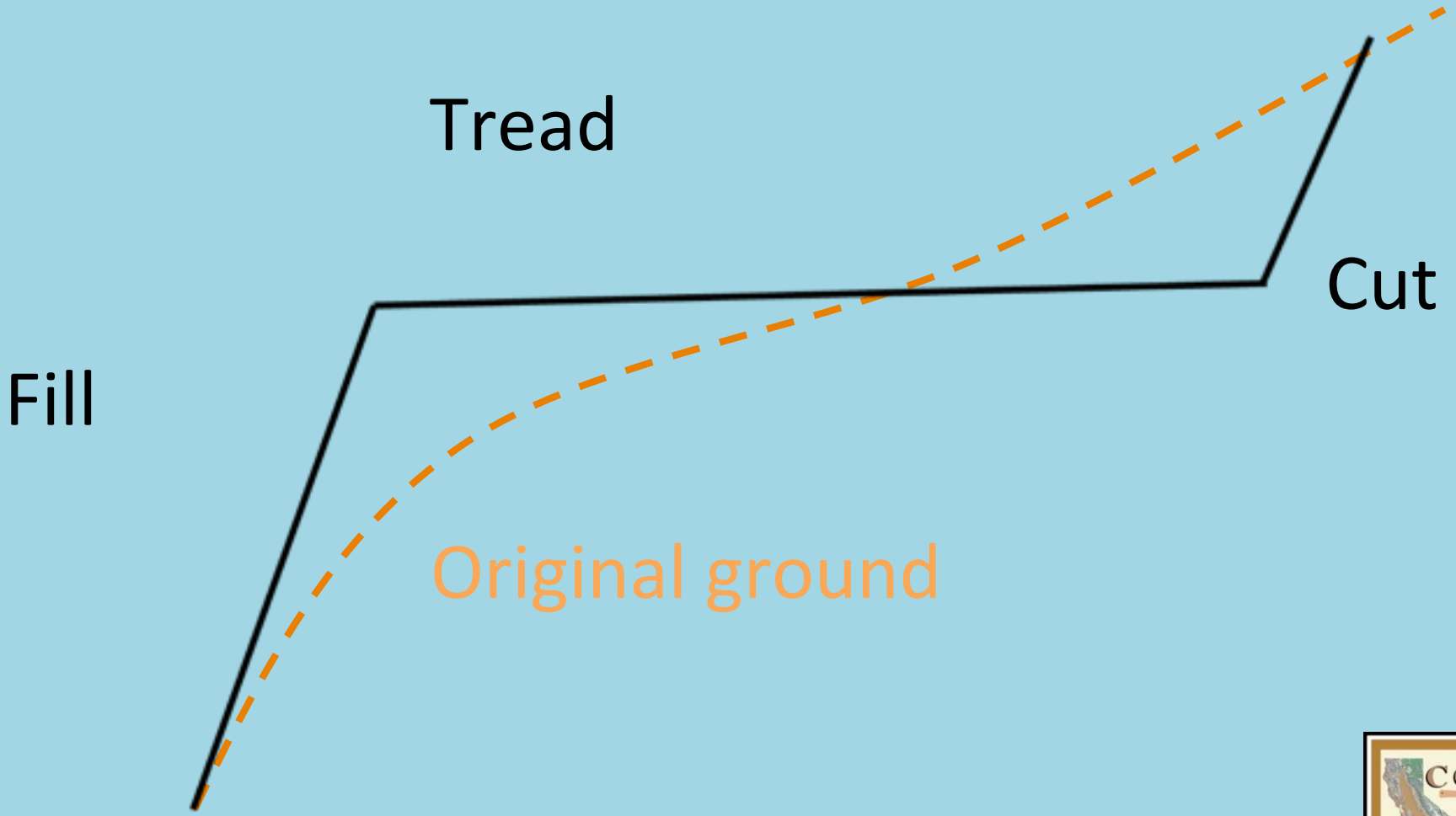
Observe the entire road/trail prism and its environment



Components of a cross-section

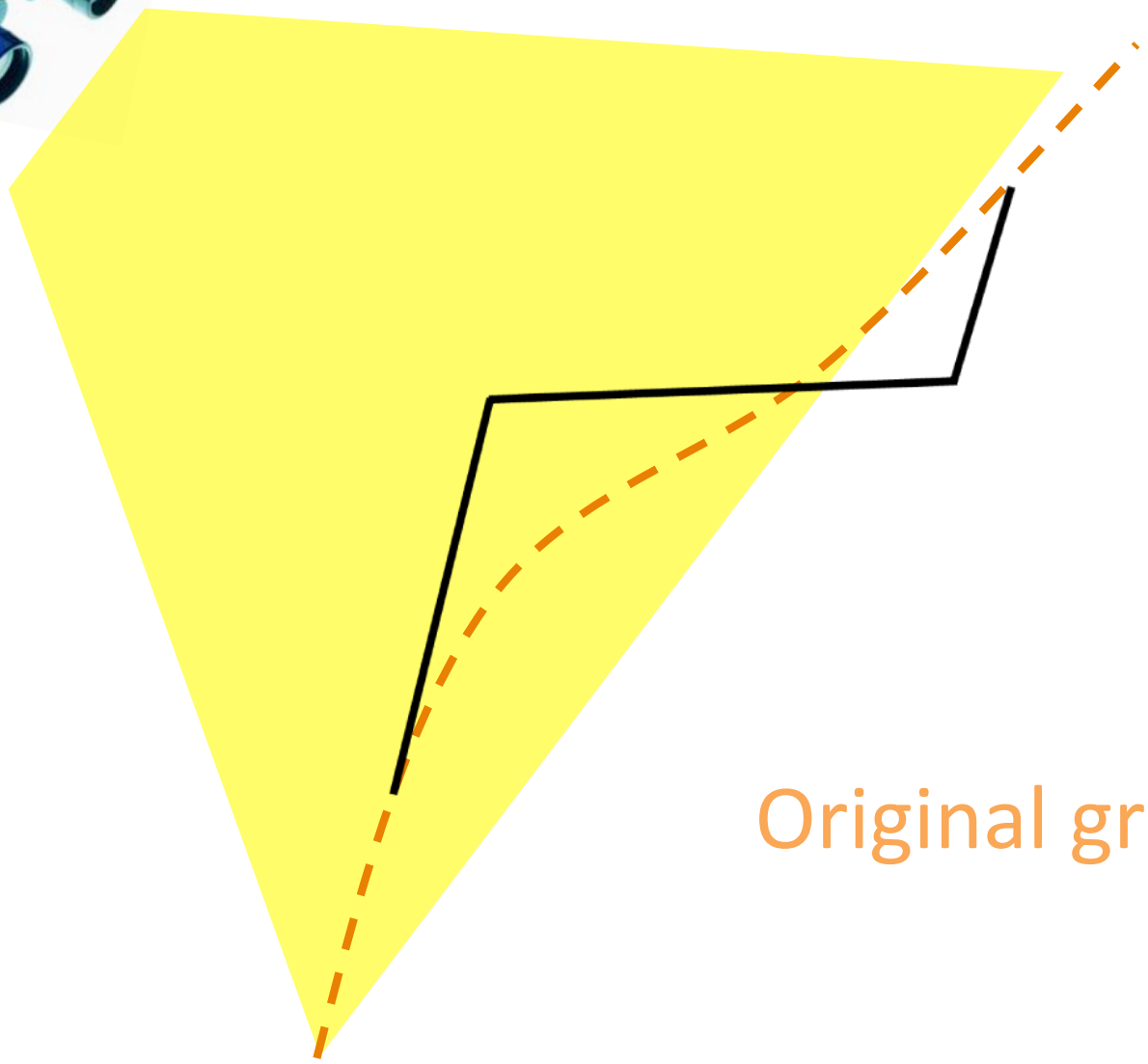
CGS
CALIFORNIA GEOLOGICAL SURVEY

System of Surfaces



CGS
CALIFORNIA
GEOLOGICAL SURVEY

Observe the landscape



Original ground

Feature – Flood plain

Feature – Watercourse

Feature Type– single channel

Feature Type– braided

CALIFORNIA GEOLOGICAL SURVEY

Feature – Watercourse

Problem - Incised

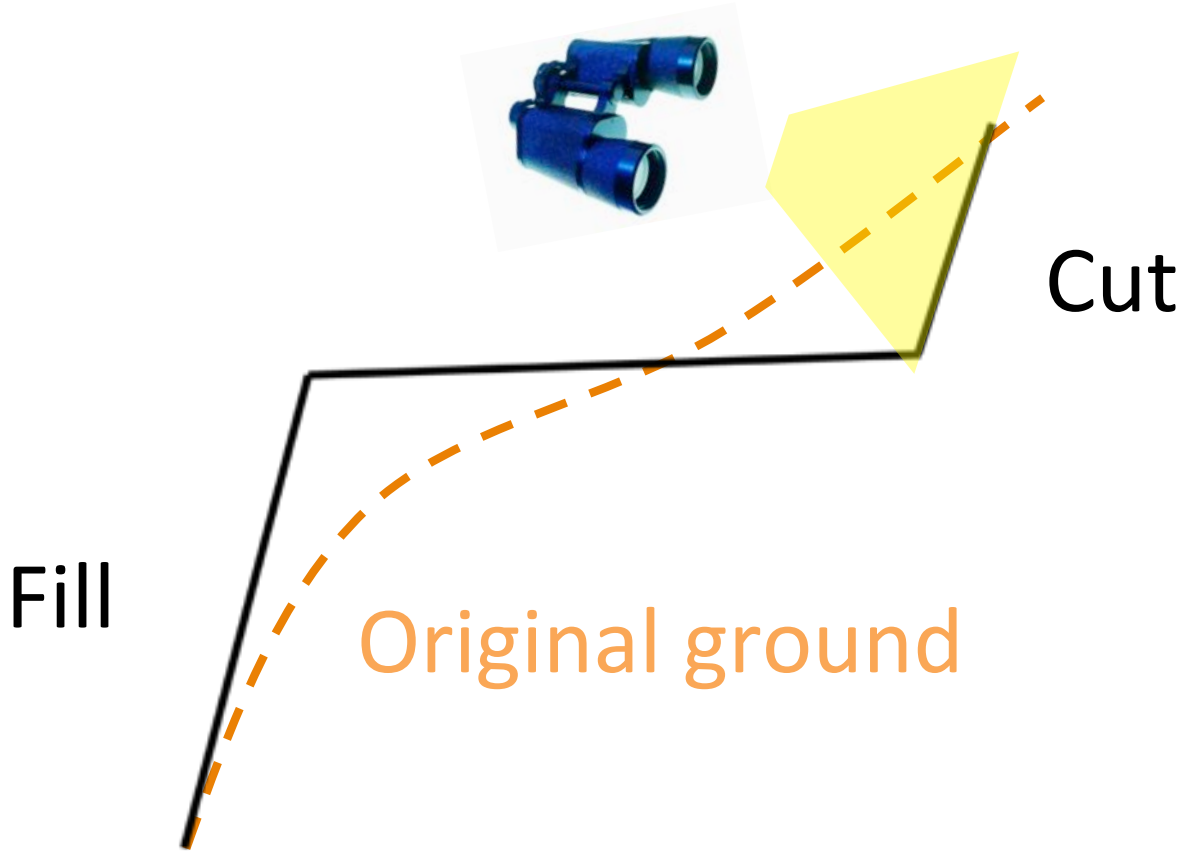
CGS
CALIFORNIA
GEOLOGICAL SURVEY

Feature –Watercourse

Problem - Aggraded

CGS
CALIFORNIA
GEOLOGICAL SURVEY

Observe the cut slope

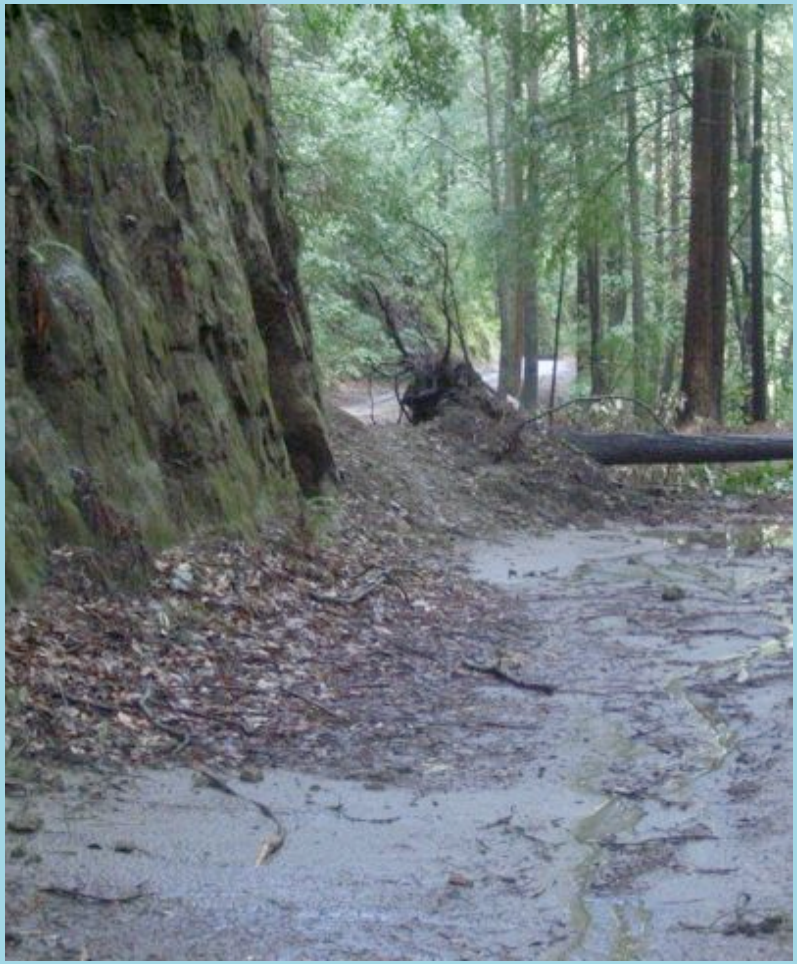


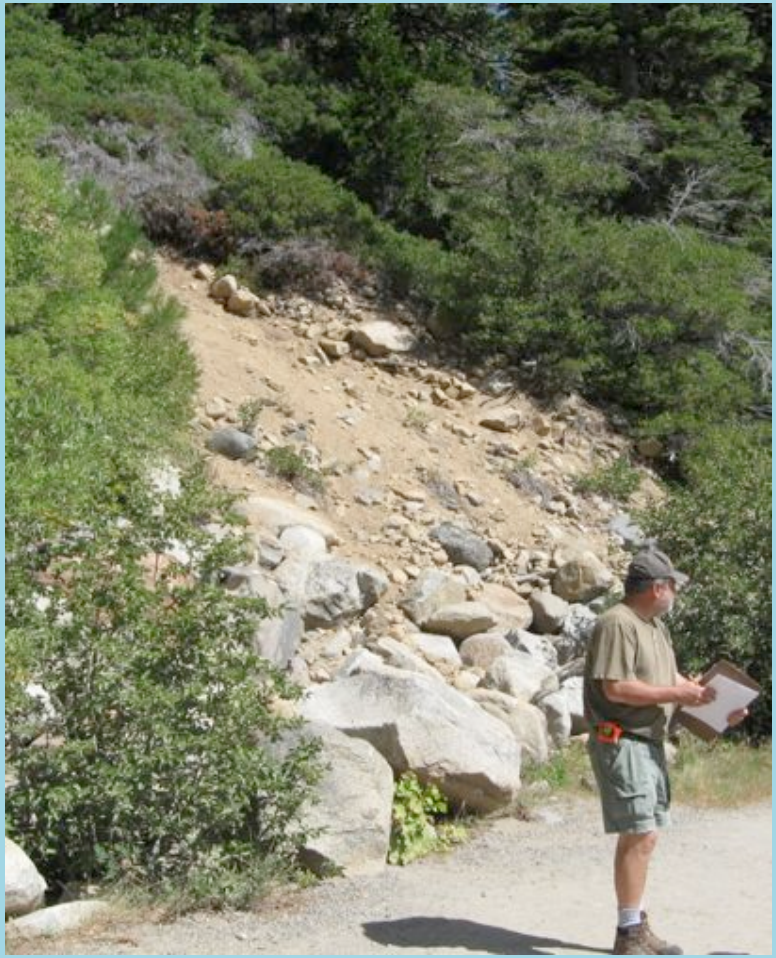
Feature–
Cut slope

Problem –
seepage

CGS
CALIFORNIA
GEOLOGICAL SURVEY

Feature– Cut slope





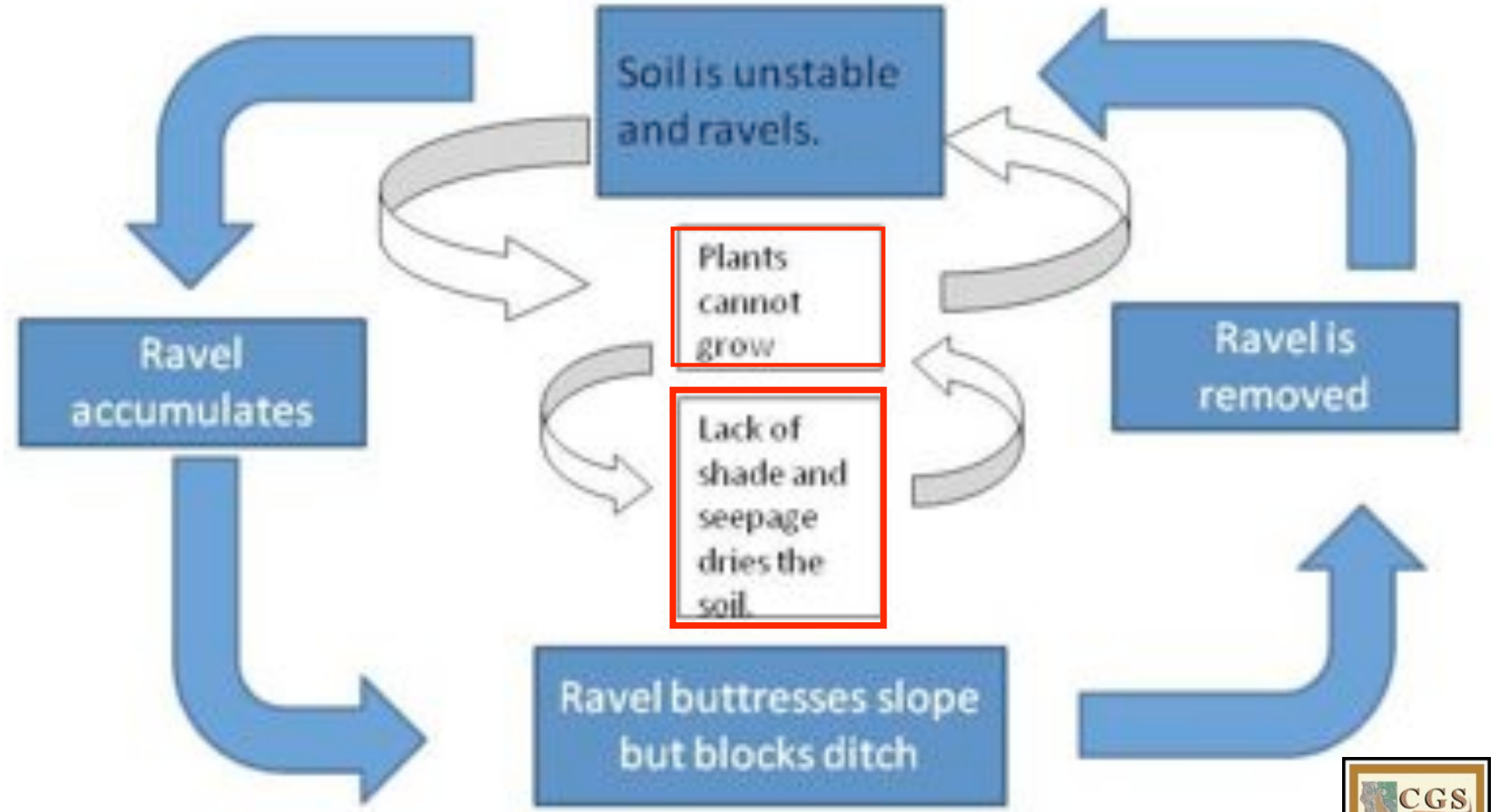
Problem – slough/ravel

CGS
CALIFORNIA
GEOLOGICAL SURVEY

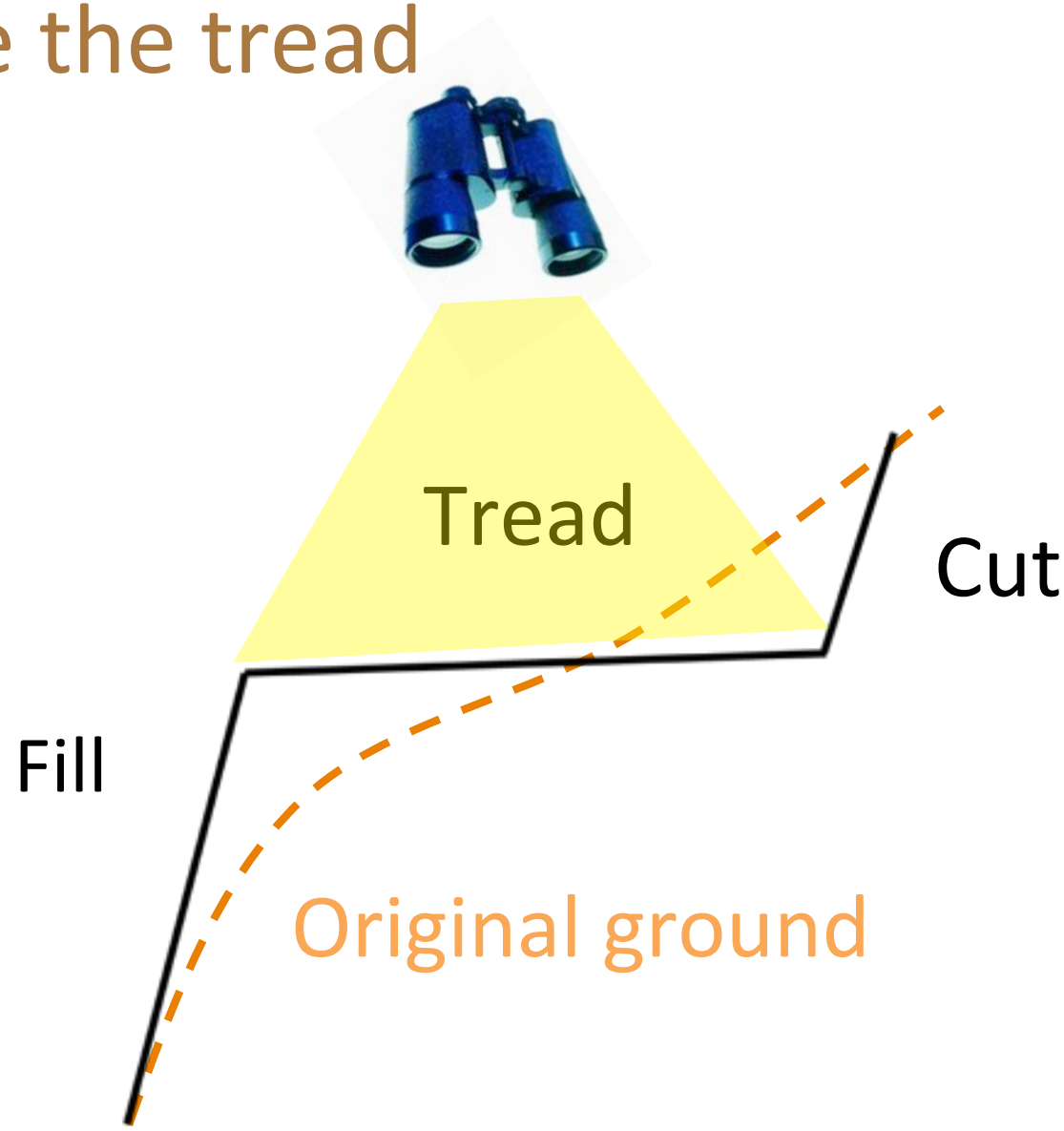
Feature– Cut slope

Problem – unstable

CGS
CALIFORNIA
GEOLOGICAL SURVEY


Soil is unstable and ravels.
Plants cannot grow
Lack of shade and seepage dries the soil.
Ravel accumulates
Ravel buttresses slope but blocks ditch
Ravel is removed
CGS
CALIFORNIA GEOLOGICAL SURVEY

Observe the tread



Feature- Tread

Feature Type - Insloped

Feature- Tread

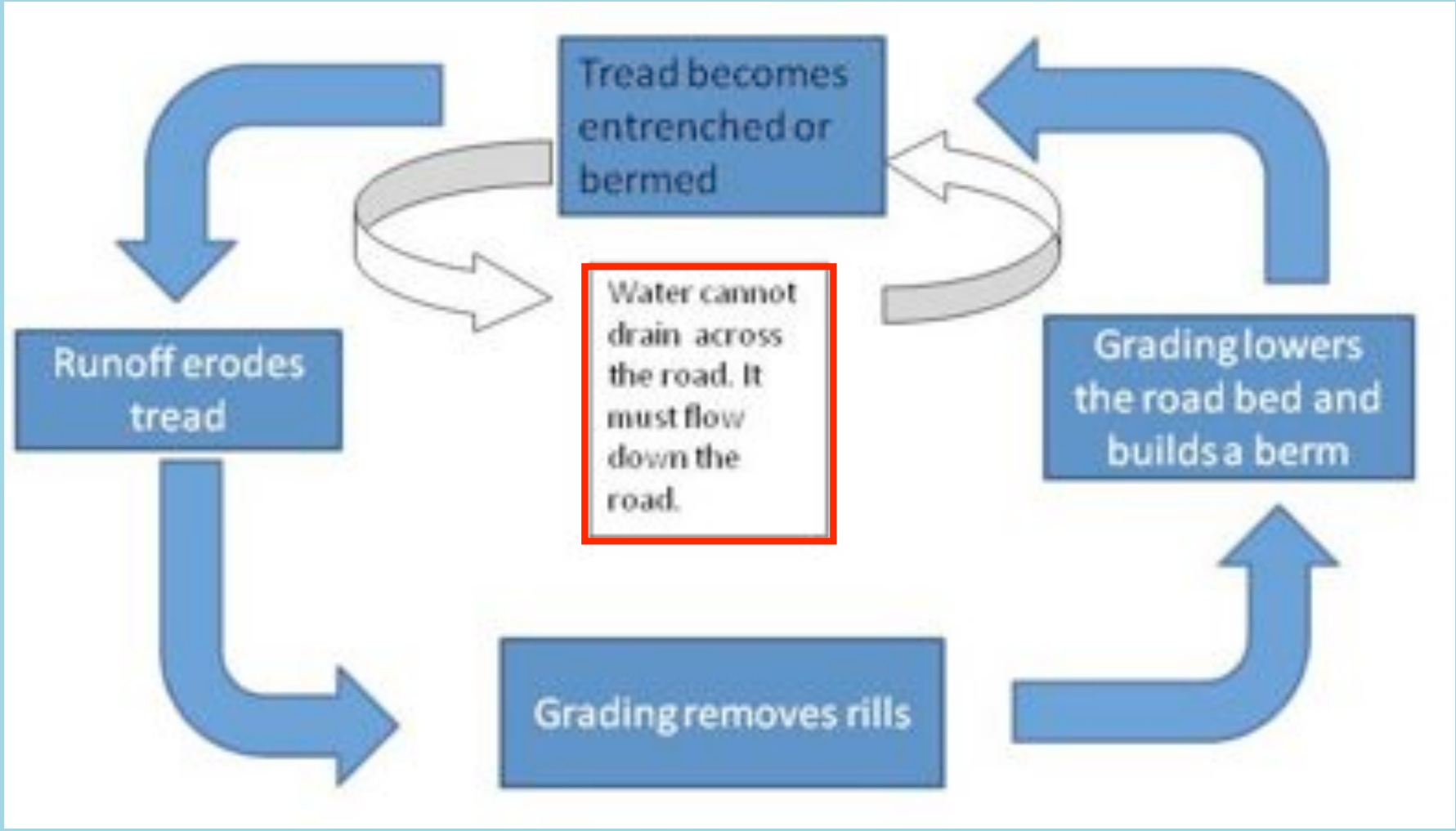
Feature Type - Outsloped

CGS
CALIFORNIA
GEOLOGICAL SURVEY

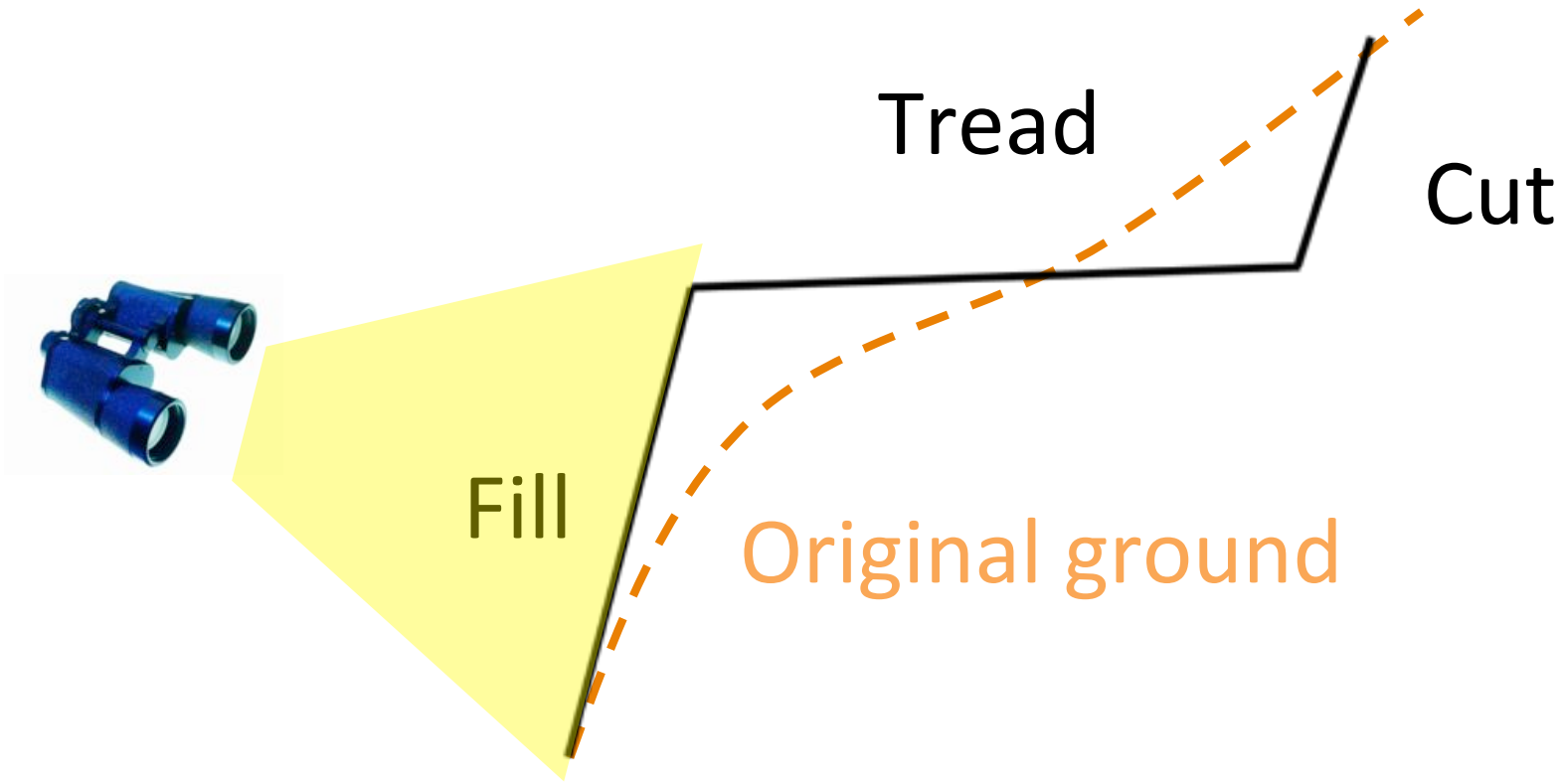
Feature- Tread

Problem- Channelized Erosion

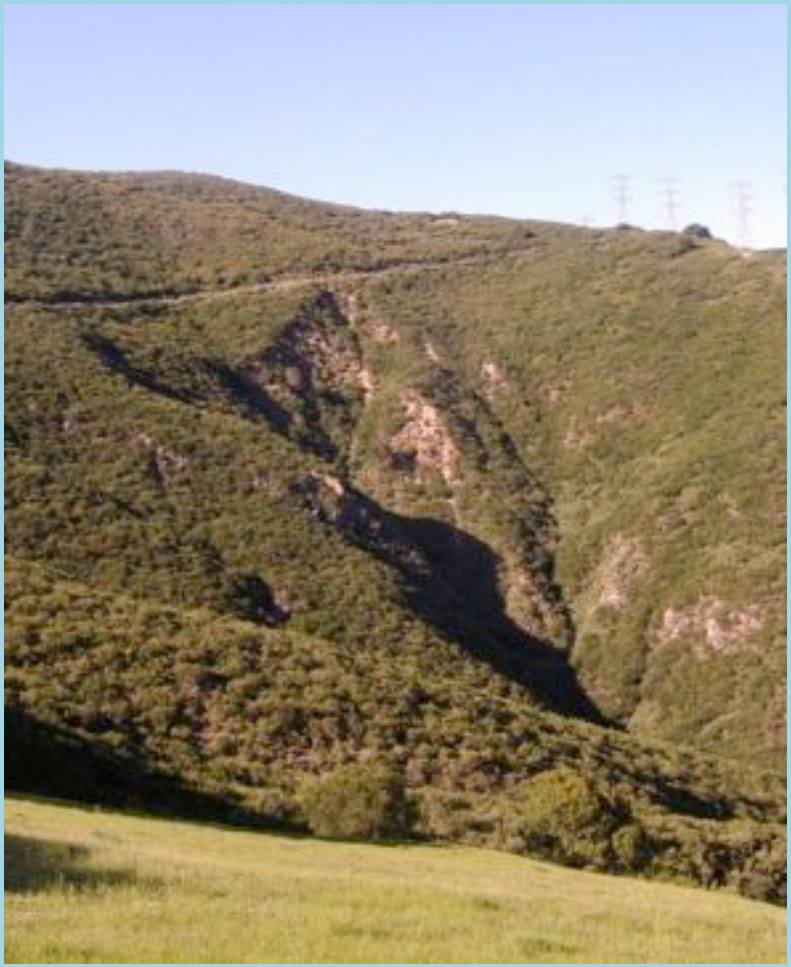
CGS
CALIFORNIA
GEOLOGICAL SURVEY


Tread becomes entrenched or bermed
Water cannot drain across the road. It must flow down the road.
Runoff erodes tread
Grading lowers the road bed and builds a berm
Grading removes rills

Observe the fill slope



Feature – Fill slope



Problem – Gully

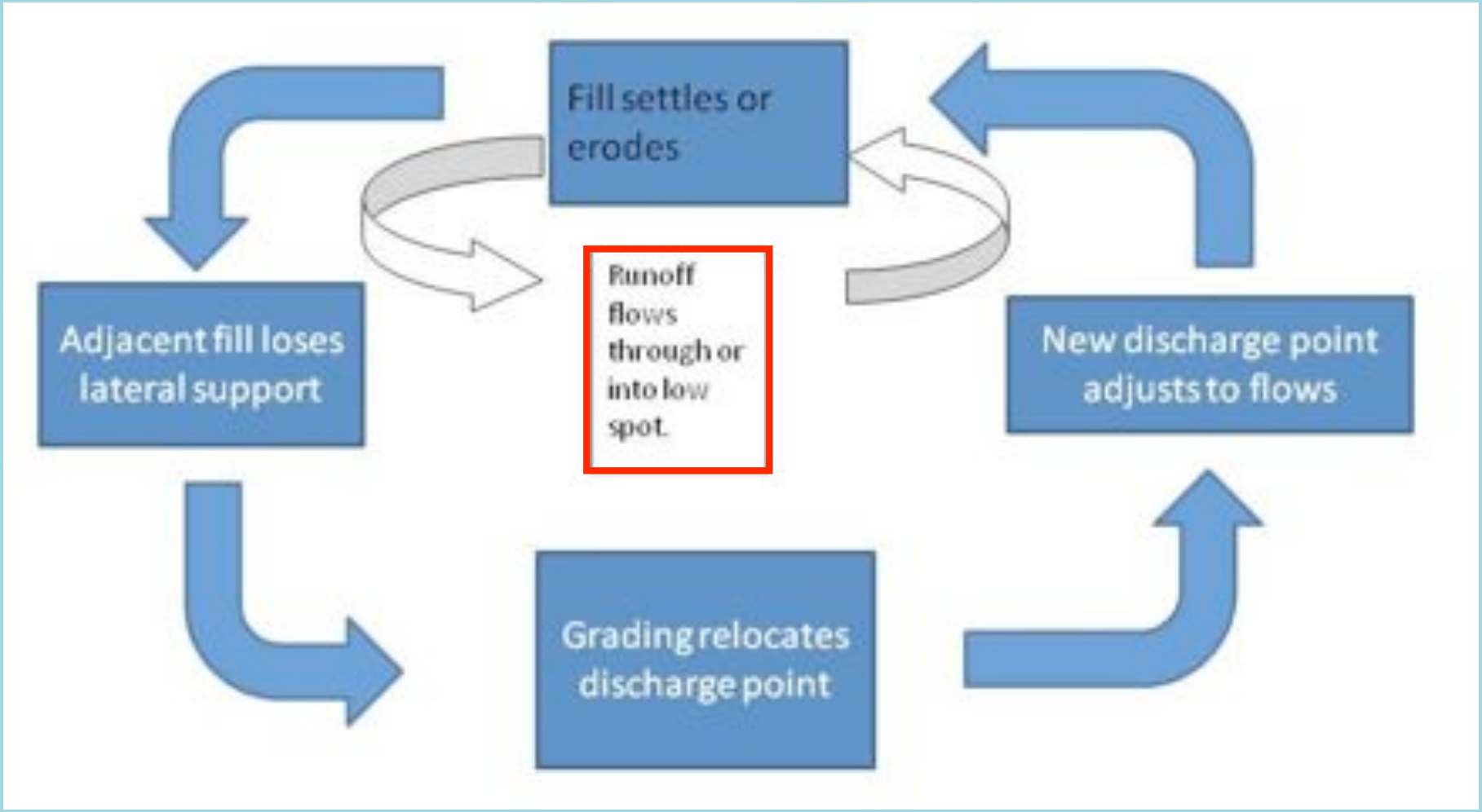
Feature – Fill slope

Problem – Bank erosion

Feature – Fill slope

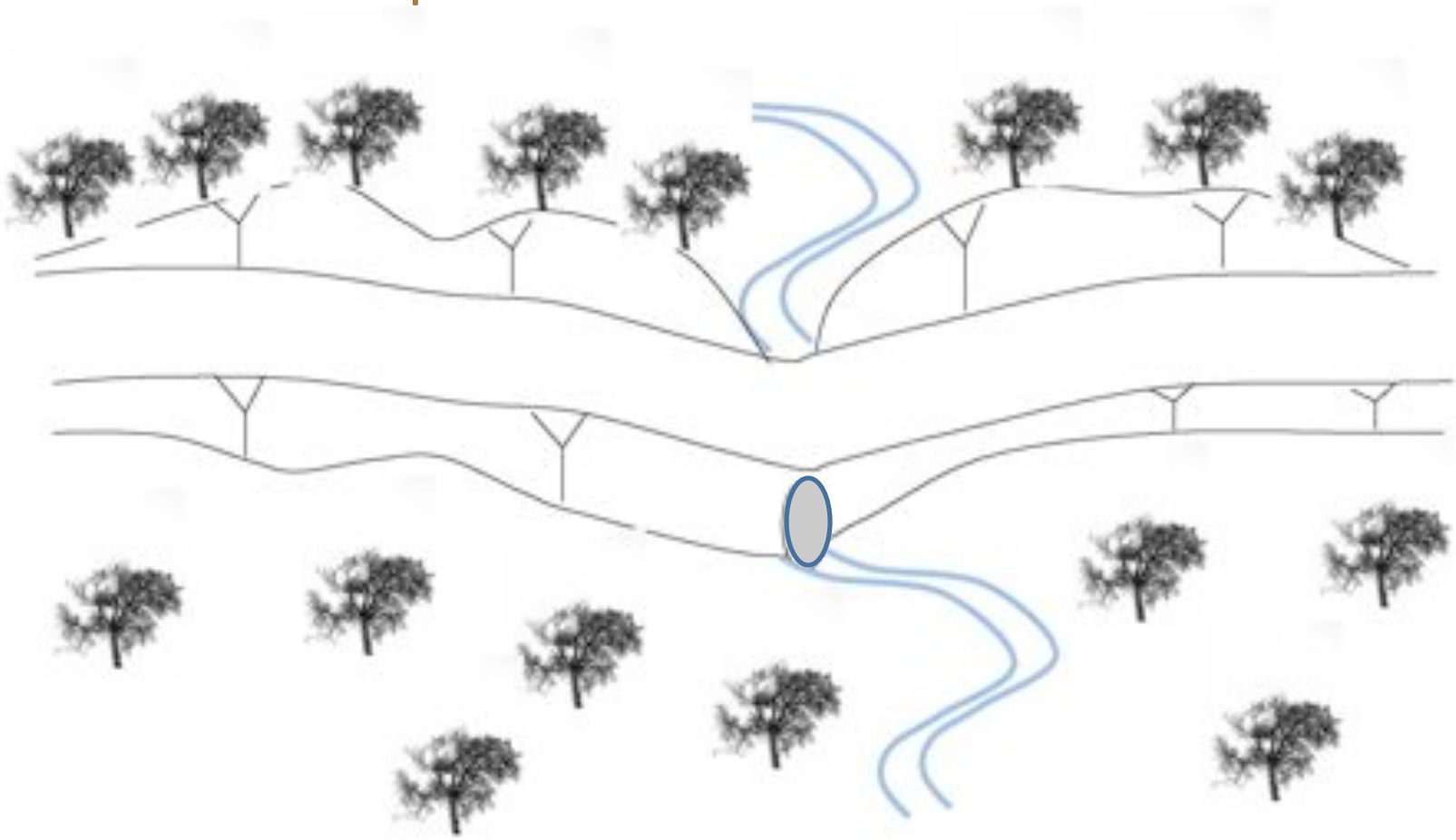
Problem – Unstable

CGS
CALIFORNIA
GEOLOGICAL SURVEY



CGS
CALIFORNIA GEOLOGICAL SURVEY

Observe how water drains across the road and the landscape



CALIFORNIA GEOLOGICAL SURVEY

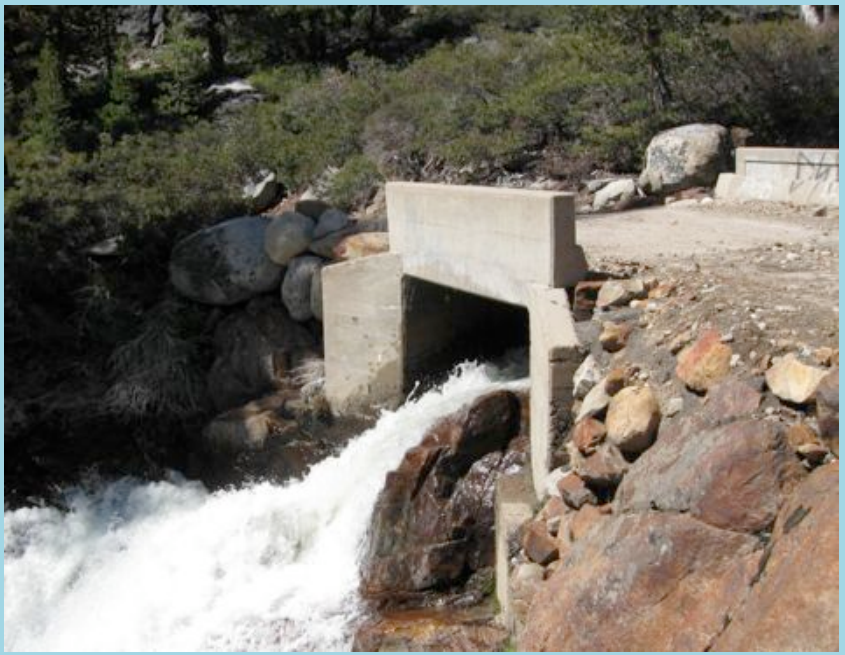
Feature- Drainage Structure

Feature Type – Grade Dip

Feature Type – Waterbreak

CGS
CALIFORNIA GEOLOGICAL SURVEY

Feature- Drainage Structure



Feature Type – Armored ford

Feature Type – Culvert

CGS
CALIFORNIA GEOLOGICAL SURVEY

Feature- Drainage Structure

Feature Type- Ditch, lead off

Feature Type – Ditch, inboard

CGS
CALIFORNIA GEOLOGICAL SURVEY

Feature- Drainage Structure

Problem - Corrosion

Feature- Drainage Structure

Problem – Overgrown

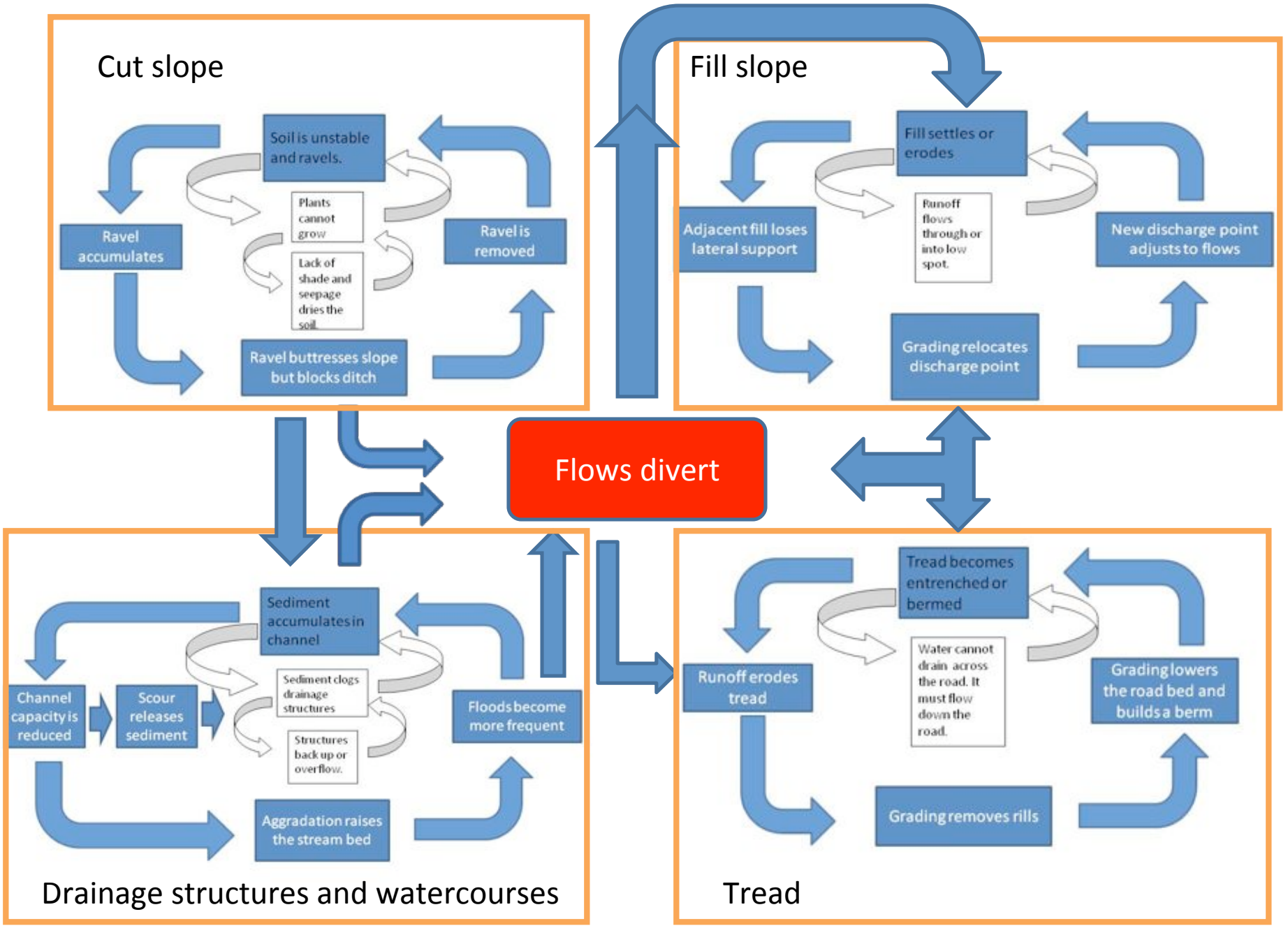
Problem - Wash out

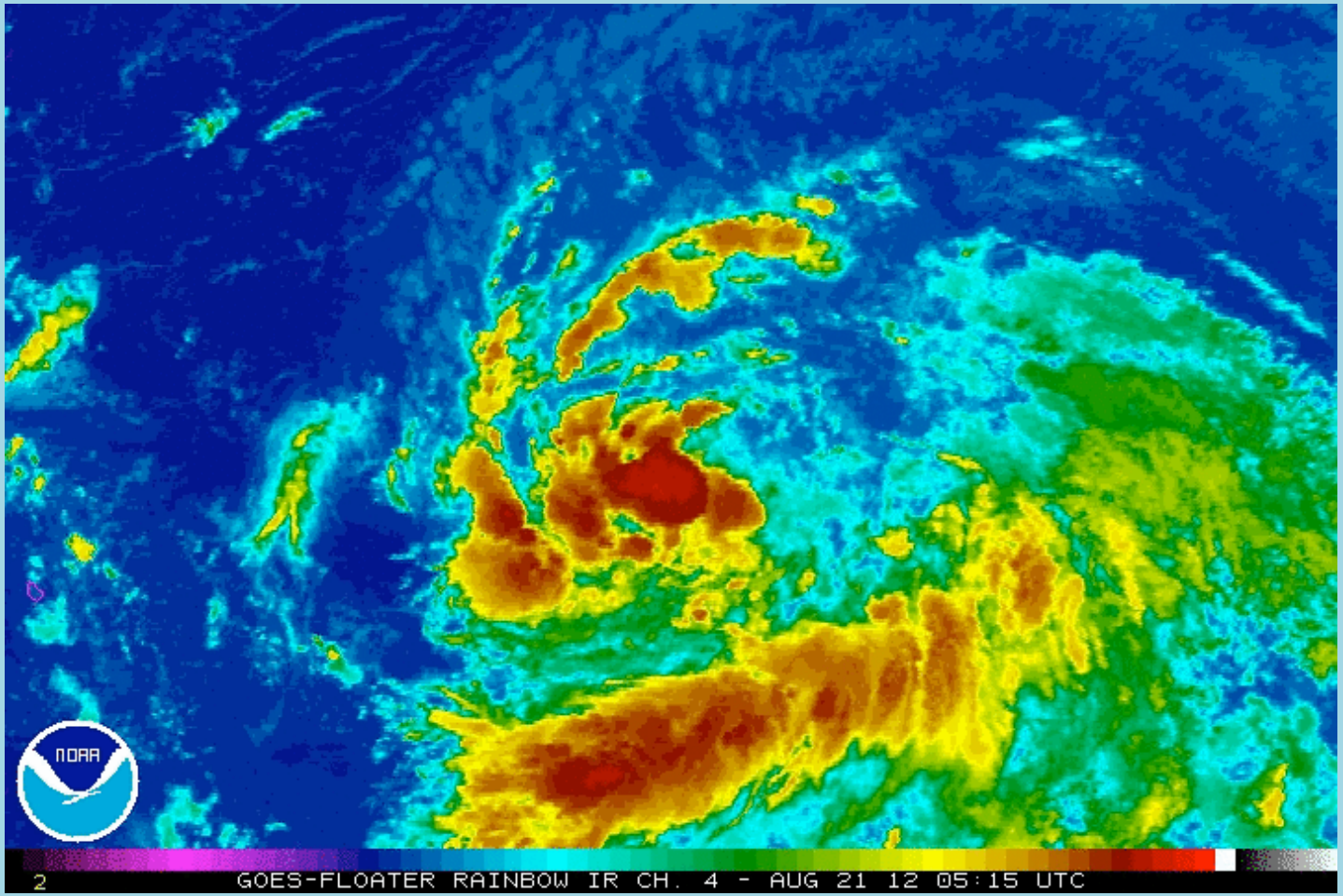
CGS
CALIFORNIA GEOLOGICAL SURVEY

Feature- Drainage Structure

Problem - Diversion

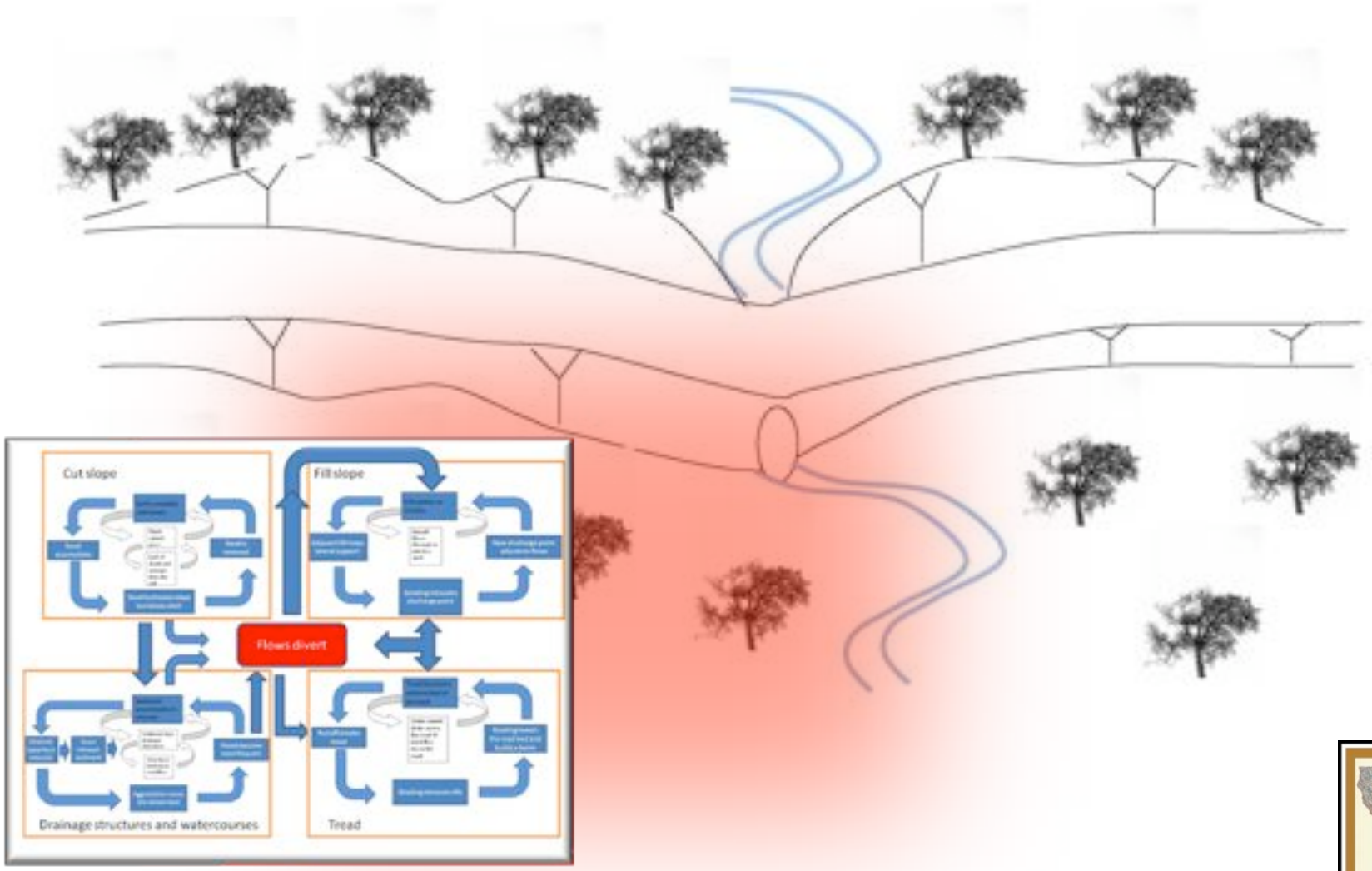
CGS
CALIFORNIA GEOLOGICAL SURVEY


Cut slope
Soil is unstable and ravels.
Plants cannot grow
Ravel is removed
Ravel accumulates
Lack of shade and seepage dries the soil
Ravel buttresses slope but blocks ditch
Fill slope
Fill settles or erodes
Runoff flows through or into low spot.
Adjacent fill loses lateral support
New discharge point adjusts to flows
Grading relocates discharge point
Flows divert
Sediment accumulates in channel
Sediment clogs drainage structures
Channel capacity is reduced
Scour releases sediment
Floods become more frequent
Structures back up or overflow.
Aggradation raises the stream bed
Drainage structures and watercourses
Tread becomes entrenched or bermed
Water cannot drain across the road. It must flow down the road.
Runoff erodes tread
Grading lowers the road bed and builds a berm
Grading removes rills
Tread

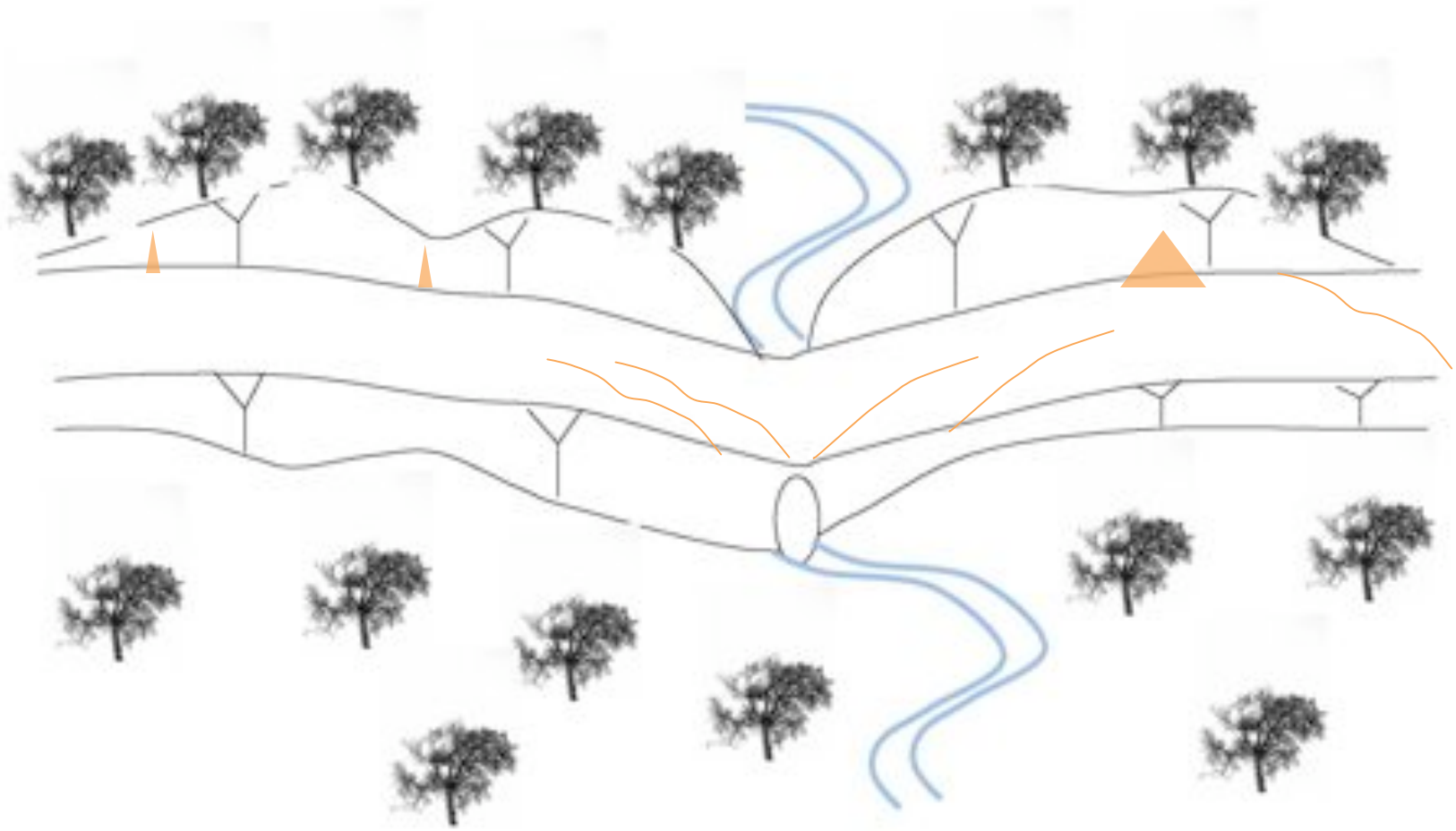


CGS
CALIFORNIA
GEOLOGICAL SURVEY

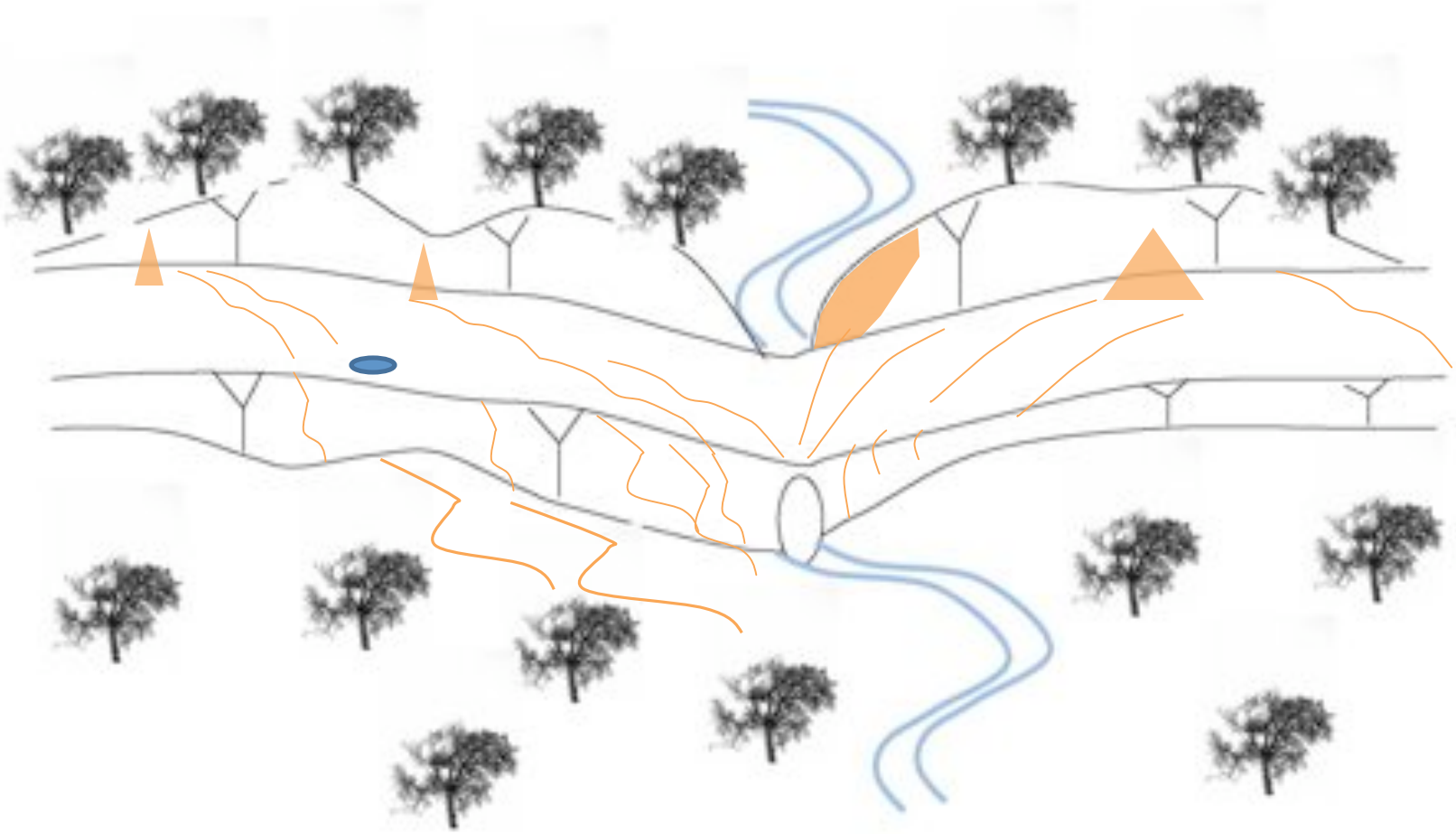
System of surfaces operates within and interacts with the landscape



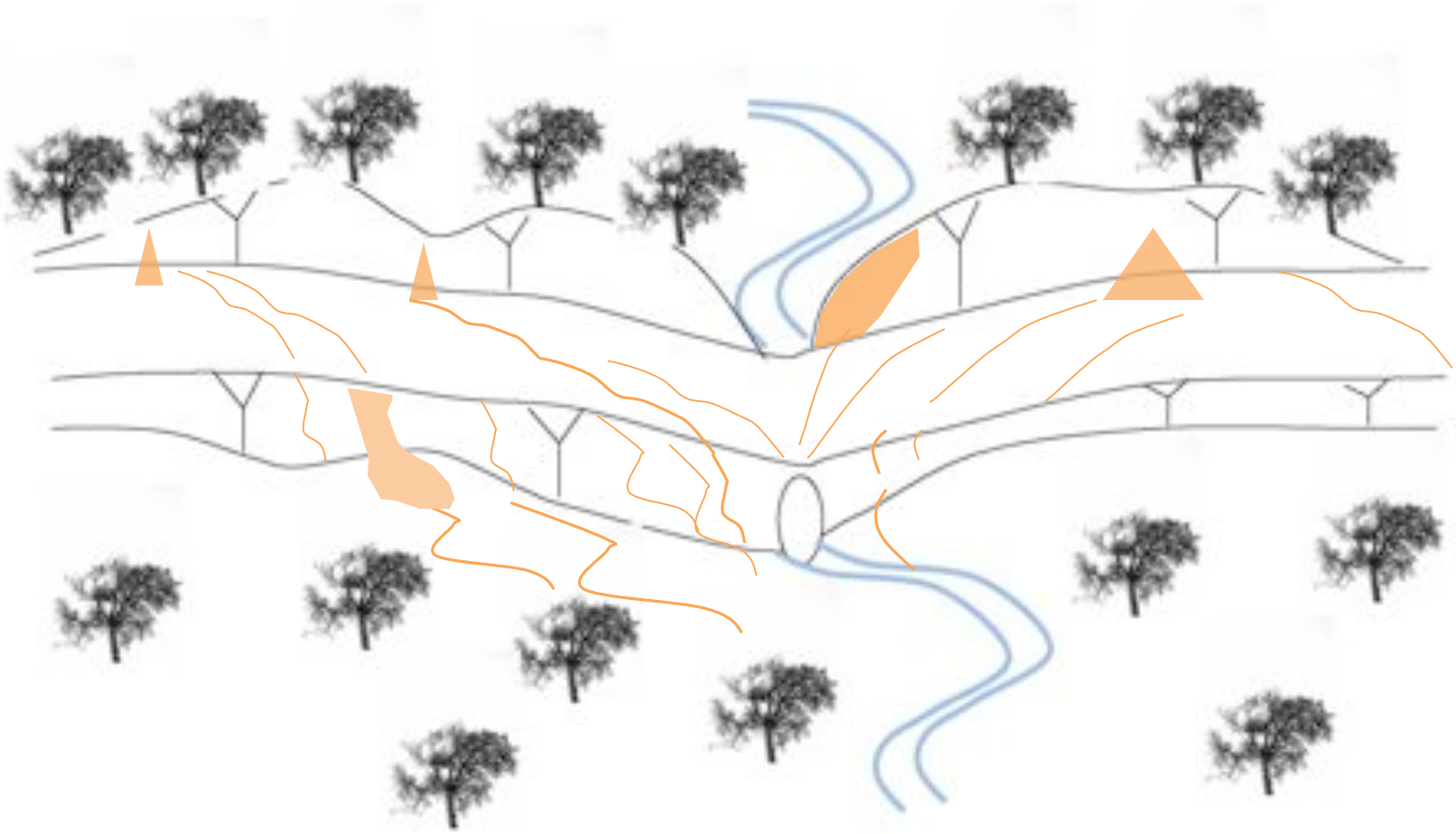
CGS
CALIFORNIA GEOLOGICAL SURVEY



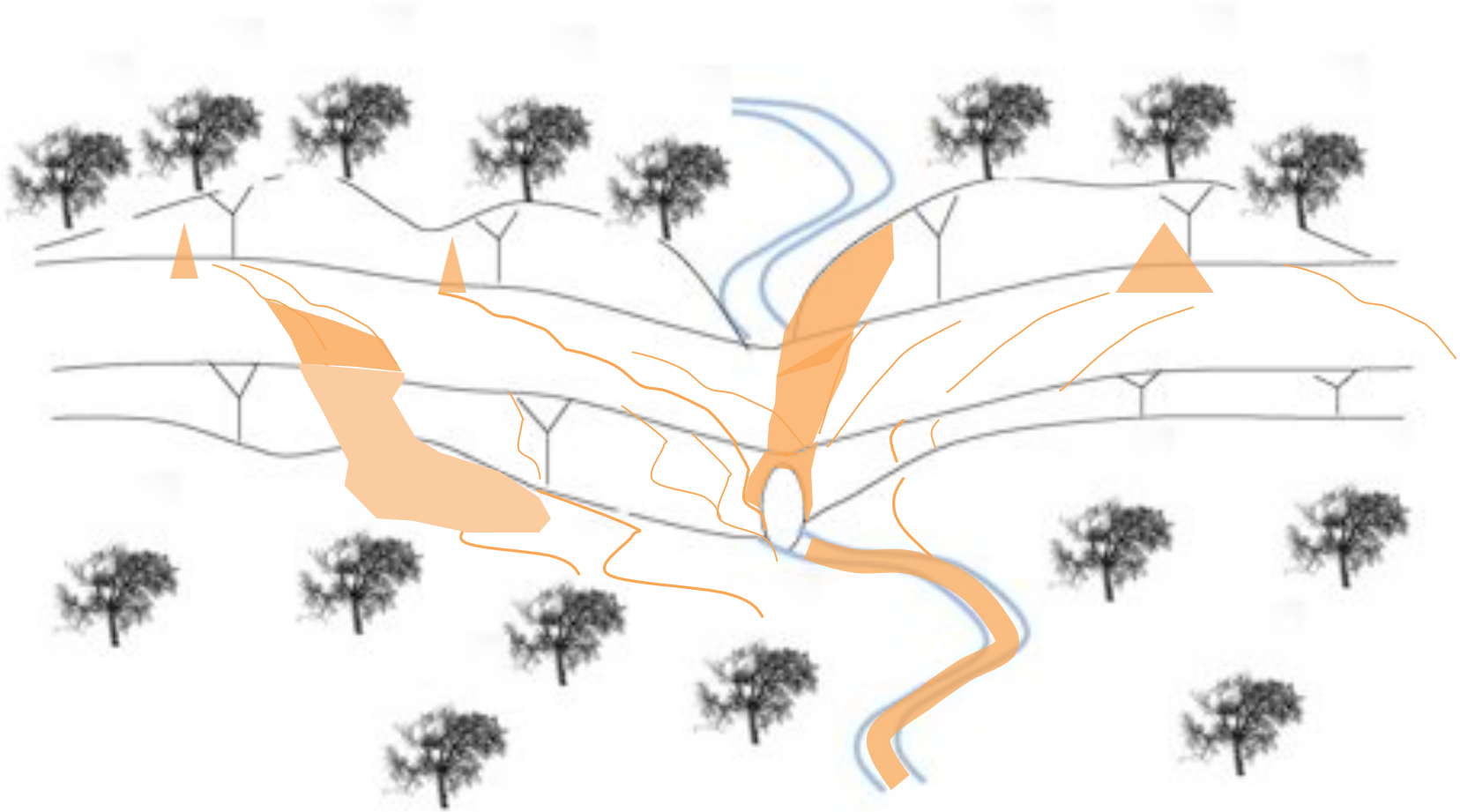
Stage 1 - Post construction adjustment



Stage 2– Drainage impairment



Stage 3a – Drainage failure



Stage 3b – Hydrologic connectivity

Stage 4 – Terminal condition

CGS
CALIFORNIA
GEOLOGICAL SURVEY

Thank You for Your Attention!