Climate Change/Non-Stationarity/Extreme Events
What This Means to Practitioners

Jeanine Jones, California Department of Water Resources

California a Leader in Climate Change Adaptation

- Enactment or adoption of statues, regulations, executive orders
- Publication of state-level assessments, guidance , support of research
- For water sector:
  - Supply impacts characterized (e.g., snowmelt)
  - NRC sea level rise study underway
  - **Extreme events/flood hydrology, the next challenge**

DWR's Role – Climate Change & Extreme Events

- Guidance to CAT (e.g. flood frequency analysis)
- Flood project operations & emergency response
- State-level flood planning, including flood plain management
- Data collection, dissemination, analysis
- Assistance to local agencies

Workshop Goals

- Science that (eventually) facilitates adaptation
- Identification of low-hanging fruit, longer-term objectives
- Outcomes that can (eventually) be incorporated in guidance or standards of practice
- Roadmap for making incremental progress

Flood Hydrology Applications

- Infrastructure design & analysis
  - Flood frequency analyses
  - PMP/PMF
- Flood control project operations
  - Flood forecasting and routing
- Hazard mapping (eg, FIRMs)
  - Floodplain management
  - Coastal inundation mapping

Flood Hydrology Information Needs

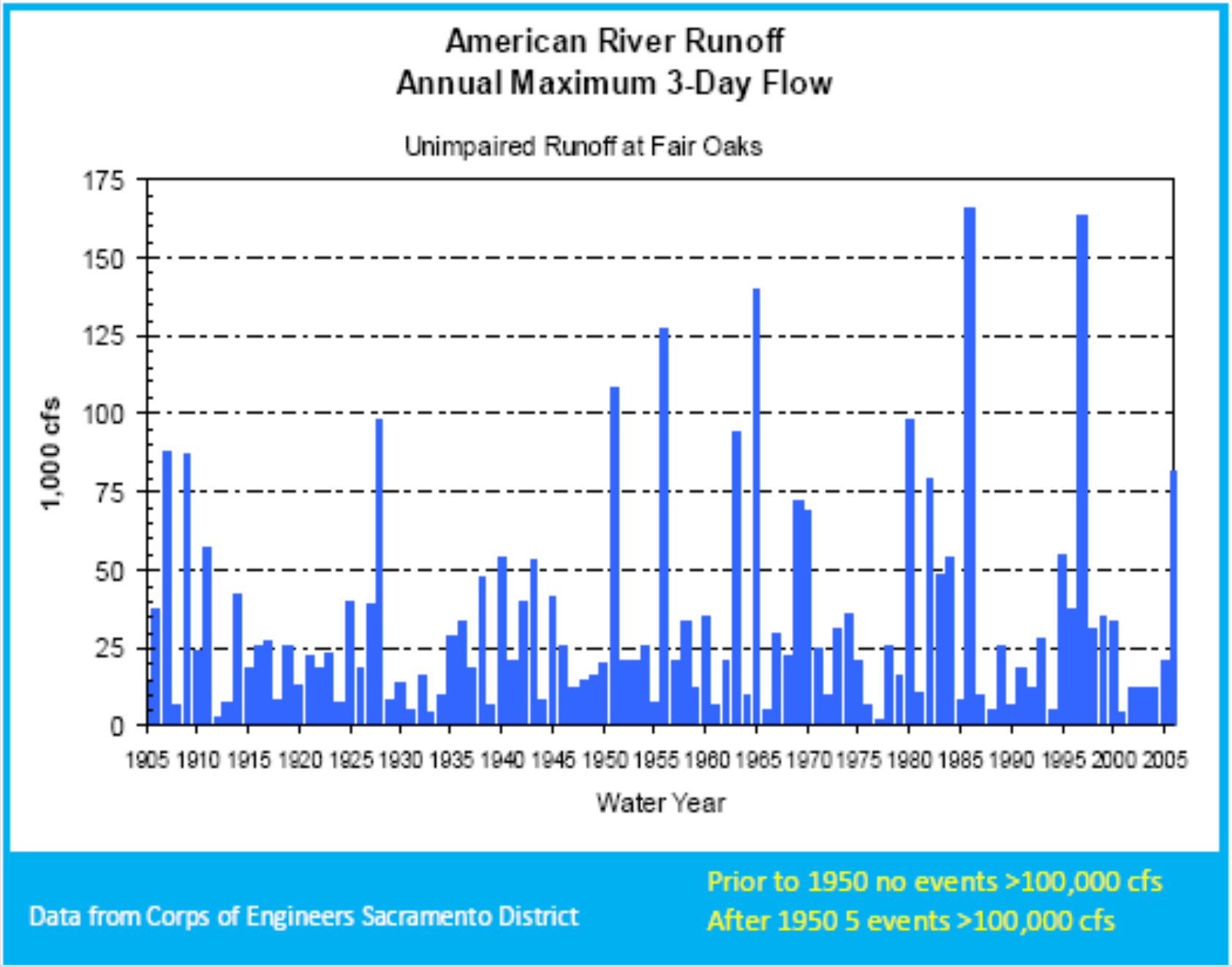
- Vary with application
- Vary with time period of analysis
- Vary with importance of facility or infrastructure
- Vary with design life of facility or infrastructure

Different Storm Types/Sizes Matter for Different Purposes

- Atmospheric Rivers (Marty, Mike)
- Meteorological types associated with extremes (courtesy of Ken Kunkel, NOAA)
  - 68% for Fronts-Extratropical Cyclones
  - 13% for Nonfrontal-Extratropical Cyclone
  - 8% for Tropical Cyclones
  - 6% for Mesoscale Convective Systems
  - 1% for Southwest Monsoon
  - 1% for Air Mass Convection
  - 0.1% for Upslope Flow

Flood Hydrology Limitations

- Observed records often relatively short, don't capture extreme events
- WRT runoff, non-stationarity not limited to climate change – land use changes, for example, (urbanization) can confound observed record
- Accurate floodplain mapping constrained by additional factors (e.g. topo mapping) (see NRC, 2009)
- Key hydrologic data sets & analytical methodologies are not being updated
- Hydrology research not keeping pace with climate science



From Mike Anderson, CDWR

Adding Climate Change to the Mix

- What does extremes get more extreme really mean?
- And how quickly do they get more extreme?
- And what do we do about it?

Key Areas

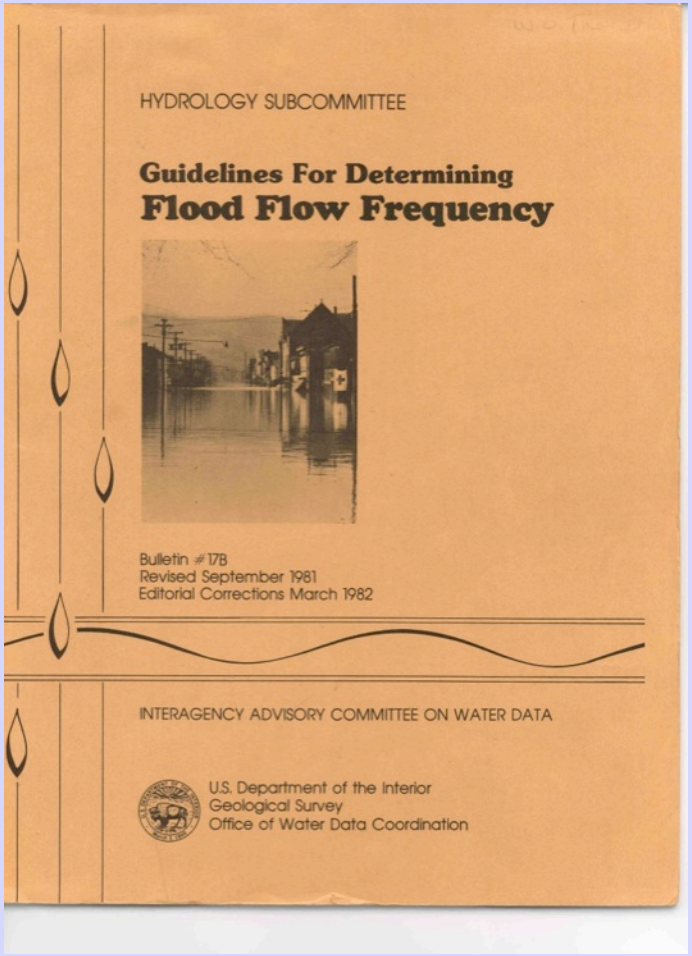
- Tools for engineering analyses
- Flood forecasting
- Observations
- Predictions (of change over the long-term)

Tools for Engineering Analyses

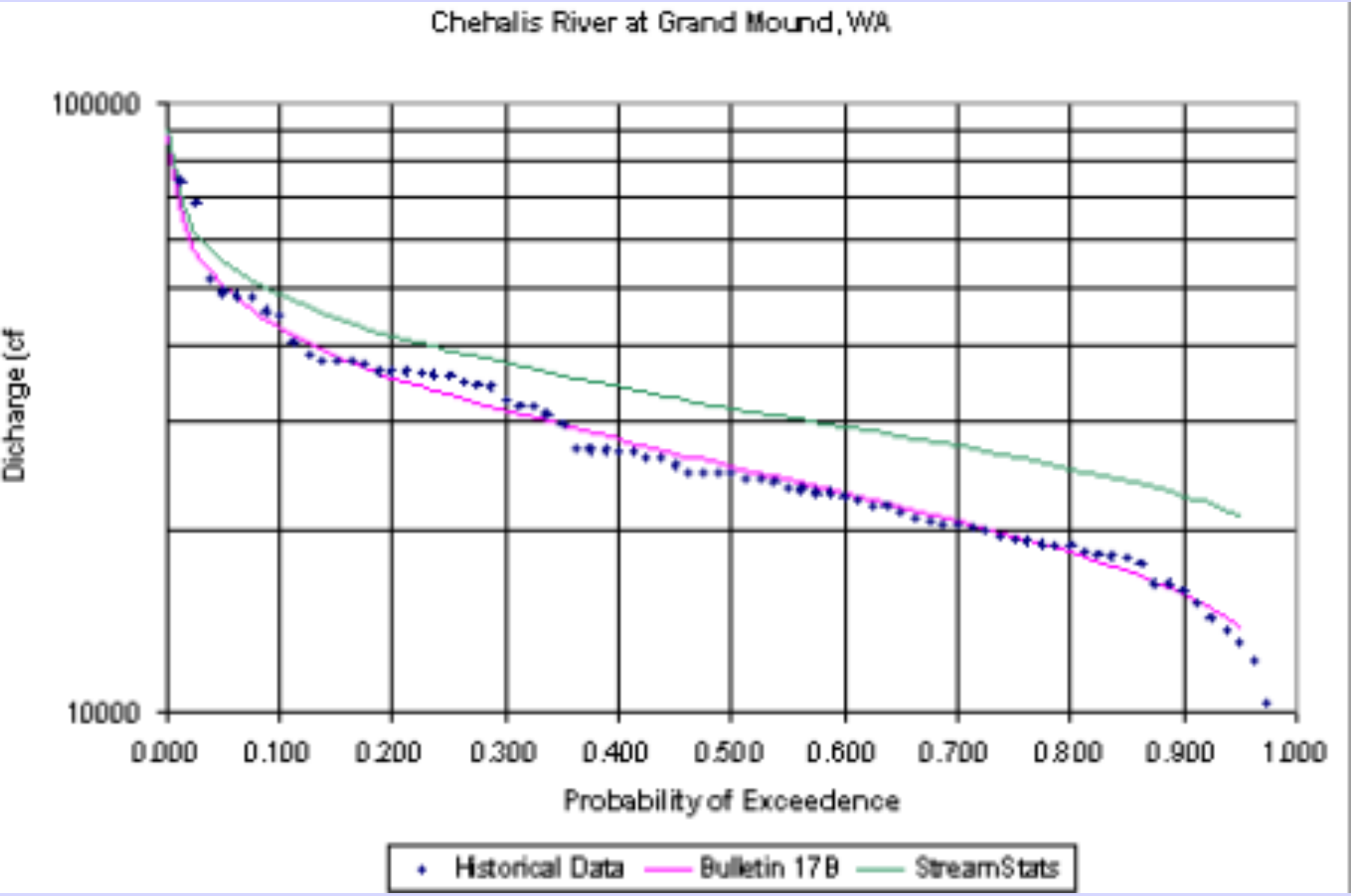
- Flood frequency analysis, long-standing traditional statistical approach
- PMP, theoretically the greatest depth of precipitation for a given duration that is physically possible over a given drainage basin at a given time of year
- Both of these approaches are codified in federal agency publications

Flood Frequency Analysis

- 1961, Water Res. Council Proposed
- 1966, Bulletin 13
- 1966, House Doc. 465
- 1967, Bulletin 15
- 1976, Bulletin 17
- 1977, Bulletin 17A
- 1982, Bulletin 17B
- 1983, WRC abolished
- 2001, ACWI H-FAWG



source: Robert Mason, USGS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Probability of Exceedence
Historical Data
Bulletin 17B
StreamStats

FFA & Climate Change

- Bulletin 17B not updated since 1982 to include subsequent observations. An update now in process; neither the original nor the update address climate change.
- Bulletin 17B is a de facto standard of practice nationally, its approach is widely used for public works, highways, stormwater, flood control design, floodplain mapping
- Revising this approach to address climate change is a priority, has significant policy implications

COUNTY OF SACRAMENTO
Municipal Services Agency

IMPROVEMENT STANDARDS
October 1, 2006

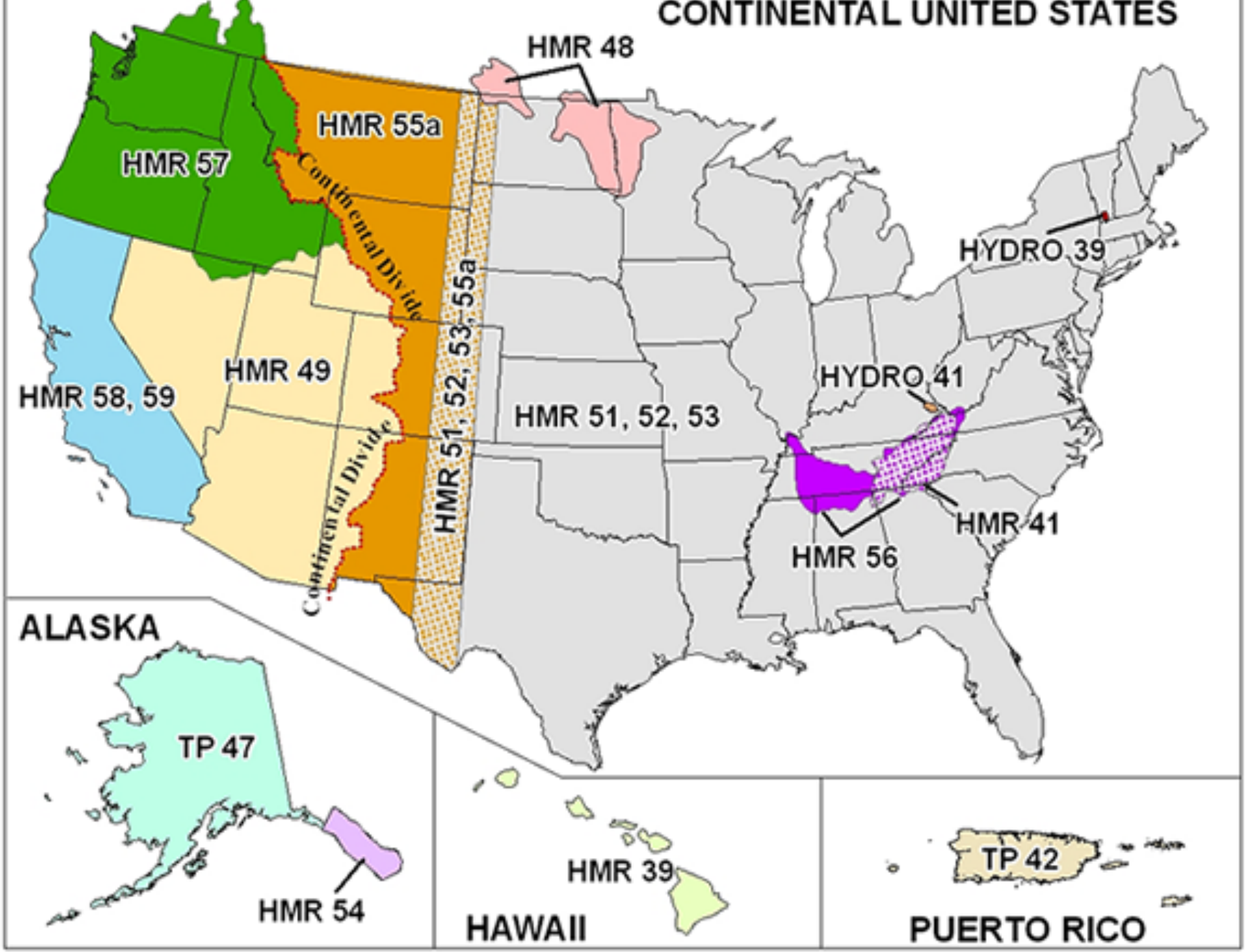
Cheryl Creson, Administrator
Municipal services Agency

California Department of Transportation

Highway Design Manual

PMP Estimation

- From series of NOAA Hydromet reports (next slide)
- Dates of reports varies (CA is 1998-99), not being updated (unfunded)
- Climate change not covered in existing reports, no current plans for addressing
- PMP analysis is de facto standard of practice for major infrastructure such as dams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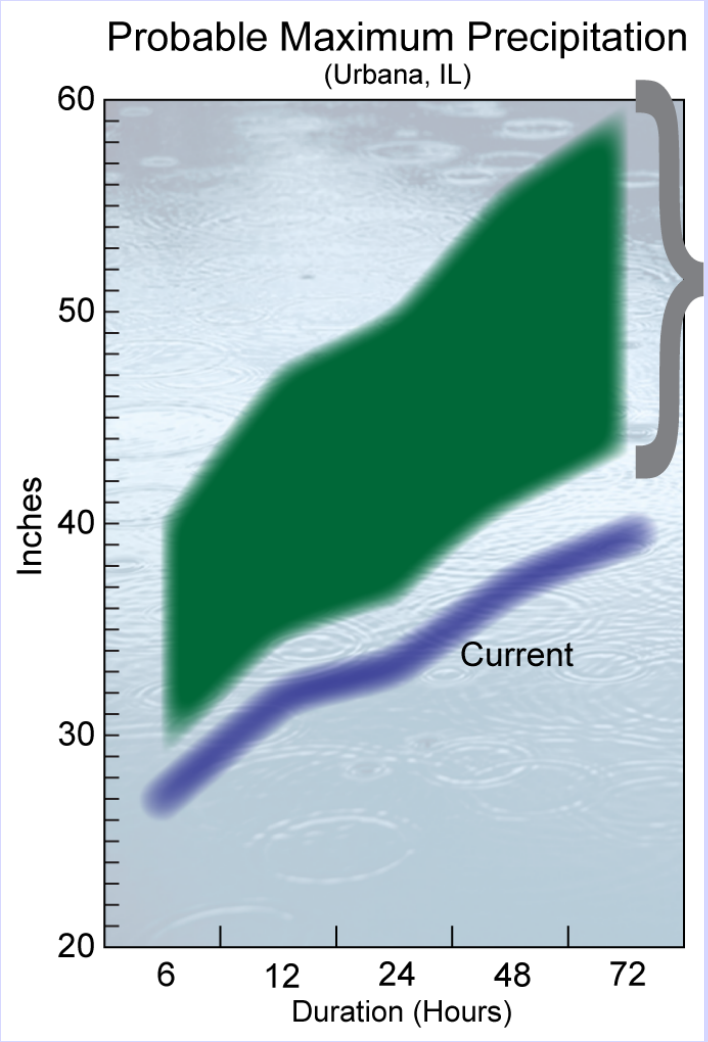
HYDRO 41
HMR 41
HMR 56
Continental Divide
ALASKA
TP 47
HMR 54
HMR 39
HAWAII
TP 42
PUERTO RICO

PMP & Climate Change, Does it Matter?

Example analysis from Ken Kunkel, NOAA

- Urbana, Illinois
  - By 2100, range of maximum precipitation:
    - For 6 hours rises from 27 inches to 30-40 inches
    - Over 72 hours, the maximum rises from 39 inches to 43-59 inches



Flood Forecasting

- Used for operation of flood control projects (not limited to Central Valley, applies to flood control projects statewide), information for emergency responders
- Improved understanding of ARs very promising
- Necessary for forecast-based reservoir operations
- High potential as early adaptation tool

Observations

Uses

- Support flood operations
- Improve understanding of processes
- Feed into improving predictions & forecasts
- Identify tipping points/ changes of state

Unmet needs?

- What are important gaps – geographic, types of observations, etc?
- What will we need 50 years from now?

Climate Predictions

- All questions, no answers!
- How might observed flood frequency distributions shift in the future?
- Is there a change in occurrence of storm types (ARs, rain on snow events)?
- When do significant changes start occurring?
- Can factors affecting coastal inundation be modeled (e.g., increased wave height/run-up during storms)?

Putting Climate Change & Extreme Events into Perspective

- Long lead times required to institute new standards of engineering practice, or defensible guidance
- Practitioners make decisions under uncertainty every day
- Many existing traditional tools to manage risk associated with extreme events, e.g.
  - Engineering safety factors
  - Adoption of regulations
  - Zoning/floodplain management
  - etc

Existing Regulatory Environment

- FEMA flood maps
- EPA stormwater permitting
- USACE reservoir rule curves, water control manuals
- State dam safety requirements

Approaches in the Longer-Term

- Build on existing regulations or policy guidance (CEQ, NEPA, CEQA, P&G)
- Develop coalitions of user groups (e.g. WSWC, ASCE, APWA, ASFPM, AMS)
- Support development of new/updated federal technical manuals & guidance

Next Steps Now

- Brainstorm, test ideas
- Scope of work for low-hanging fruit
- Road map for longer-term activities