INFRASTRUCTURE, SAFETY,
AND ENVIRONMENT

A Scenario Framework for the California Water Plan Update 2009

David Groves, Ph.D.
RAND Corporation

CWP Update 2009 Scenario Workshop

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Outline

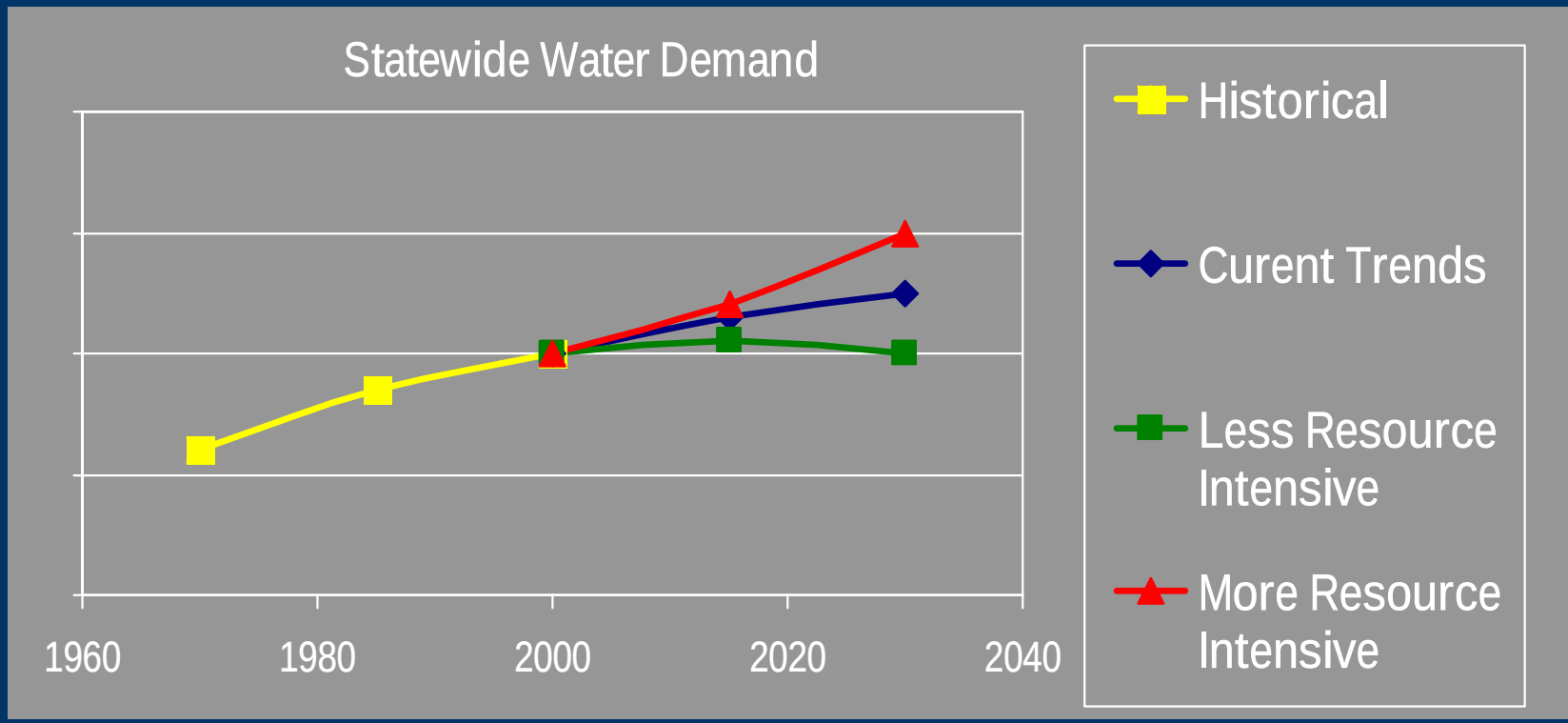
- Recap scenario work done for CWP Update 2005
- Describe a scenario analysis framework
  - based on research by RAND Corporation personnel
  - distinguishes among
    - Exogenous Factors
    - Policy Levers
    - Relationships
    - Performance Metrics
- Introduce next steps

CWP Update 2005
Developed Hand-Crafted Scenarios

- **Identified key drivers**
  - **“Table 1”**
- **Focused on key parameters**
  - **Water demand only**
- **Defined three storylines based on alternative assumptions for key drivers**
  - **Current trends**
  - **Less resource intensive**
  - **More resource intensive**

…and Then Quantified Them

- **Used a simple model of water demand by Hydrologic Region**
- **Defined parameter values consistent with narratives**
- **Evaluated model for each scenario**



CWP Update 2009 Will Build On This Analysis

- **Expand scenarios to consider**
  - **water supply**
  - **climate change**
  - **water quality**
  - **flood issues**
- **Refine scenario narratives**
- **Use analytical framework to support the evaluation of response packages**

This workshop will begin this process

A Scenario Analysis Has Four Key Elements

Exogenous Factors (X)	
Uncertain factors outside of the control of water managers — Basis for "Scenarios"	

See Lempert, Popper, and Bankes (2003)
www.rand.org/pubs/monograph_reports/MR1626/

A Scenario Analysis Has Four Key Elements

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	Performance Measures (M)
	Water outcomes of interest

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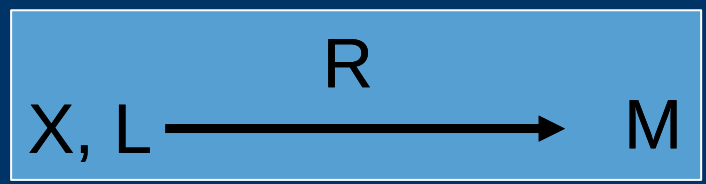
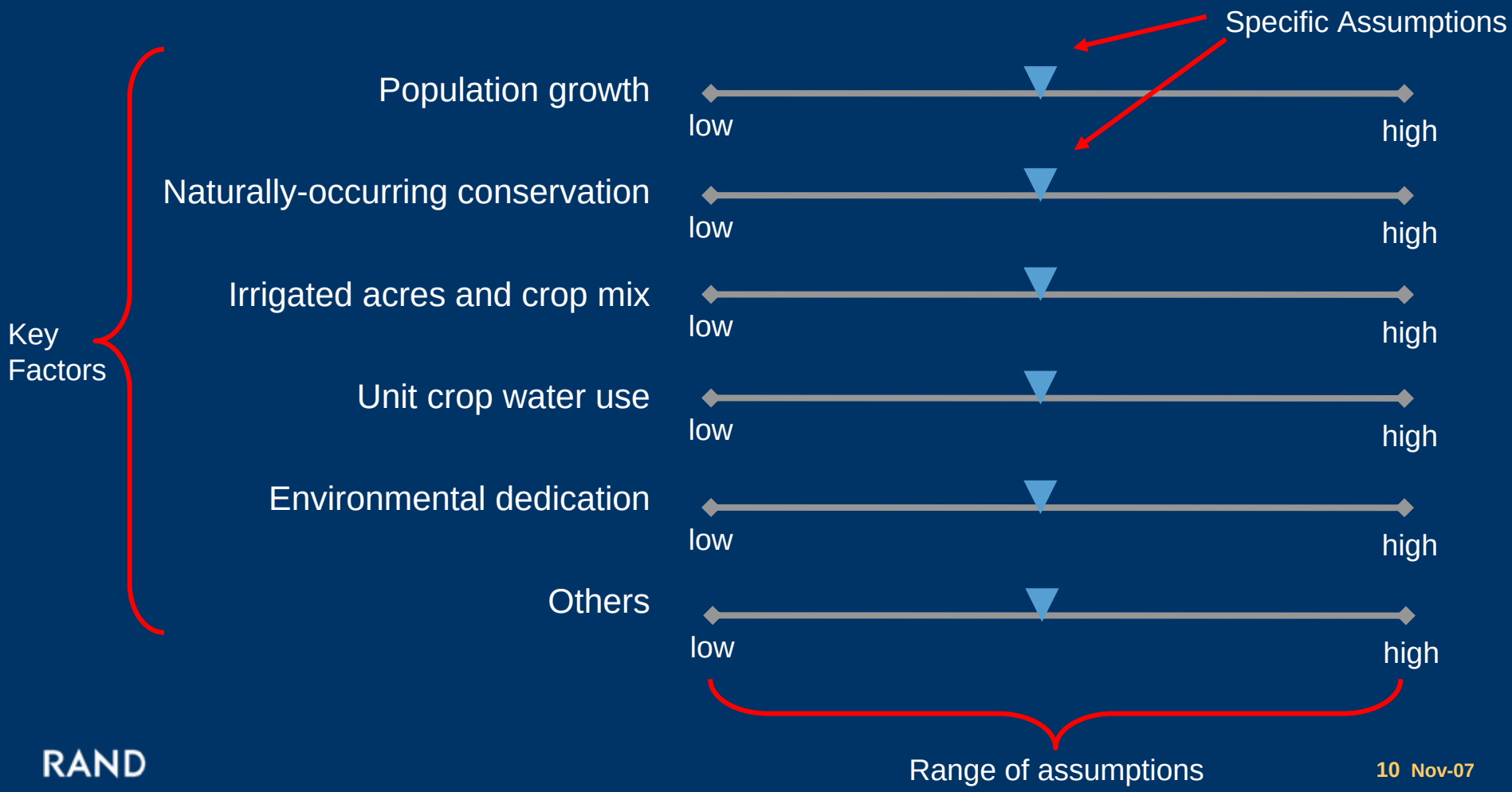
A Scenario Analysis Has Four Key Elements

Exogenous Factors (X)	Management Levers (L)
Uncertain factors outside of the control of water managers — Basis for "Scenarios"	Water management options — "Response Packages"
Relationships (R)	**Performance Measures (M)**
Mapping between combinations of exogenous factors (X) and levers (L) to outcomes (M) — a "Model"	Water outcomes of interest

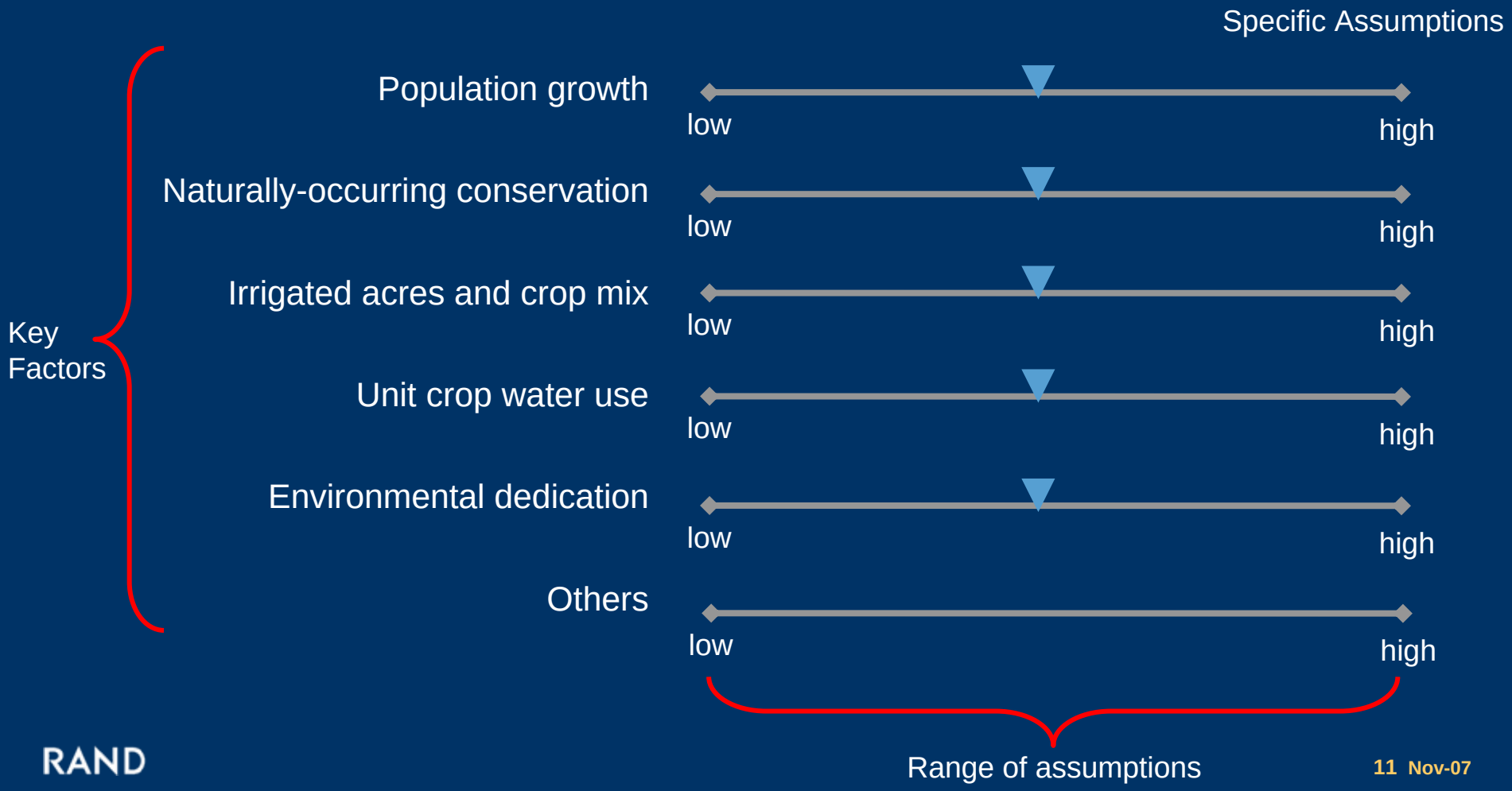


A Single Scenario is Defined by Assumptions about the Key Factors



A Single Scenario is Defined by Assumptions about the Key Factors

Current Trends scenario (CWP 2005)



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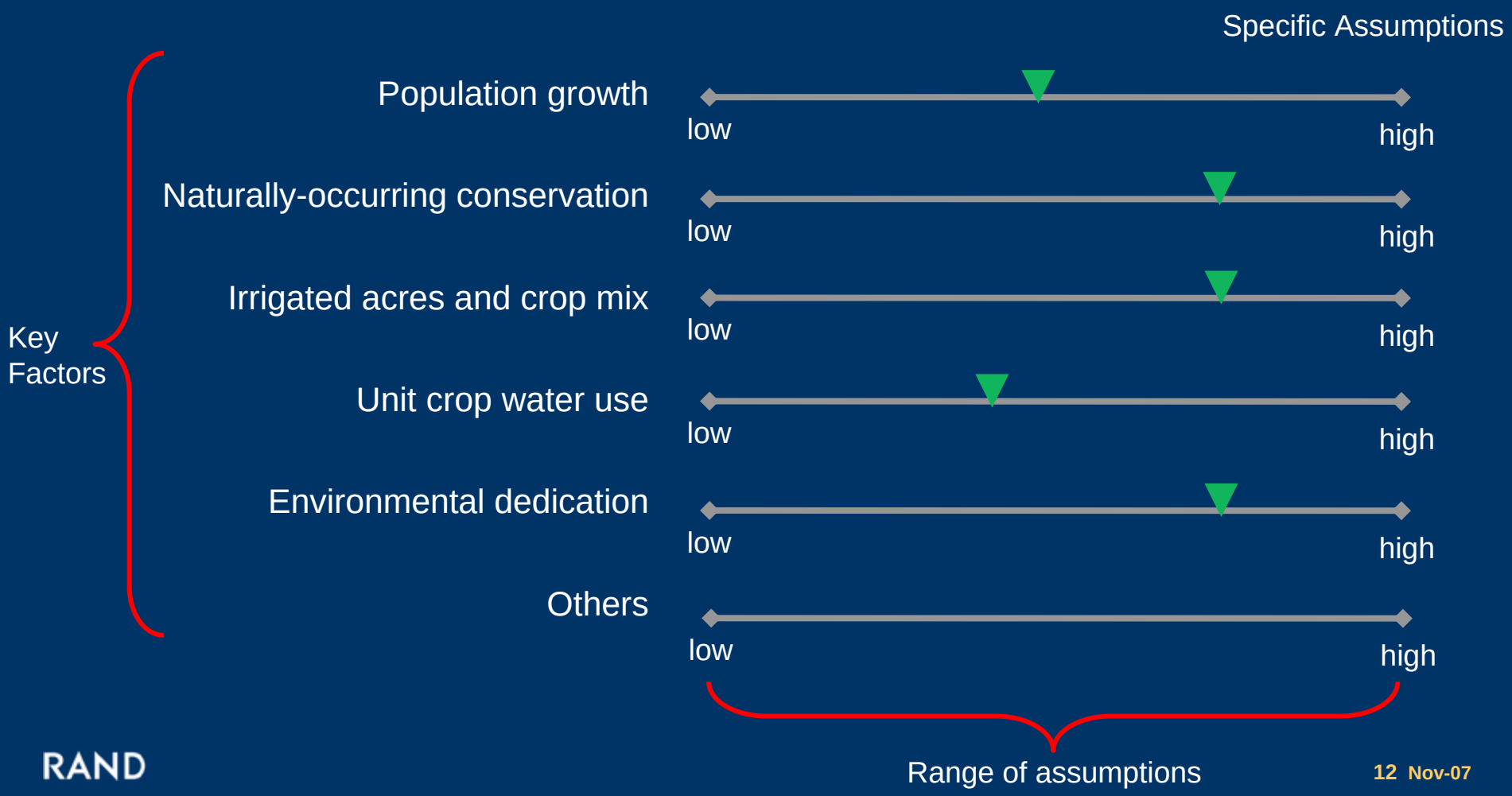
Less Resource Intensive scenario (CWP 2005)



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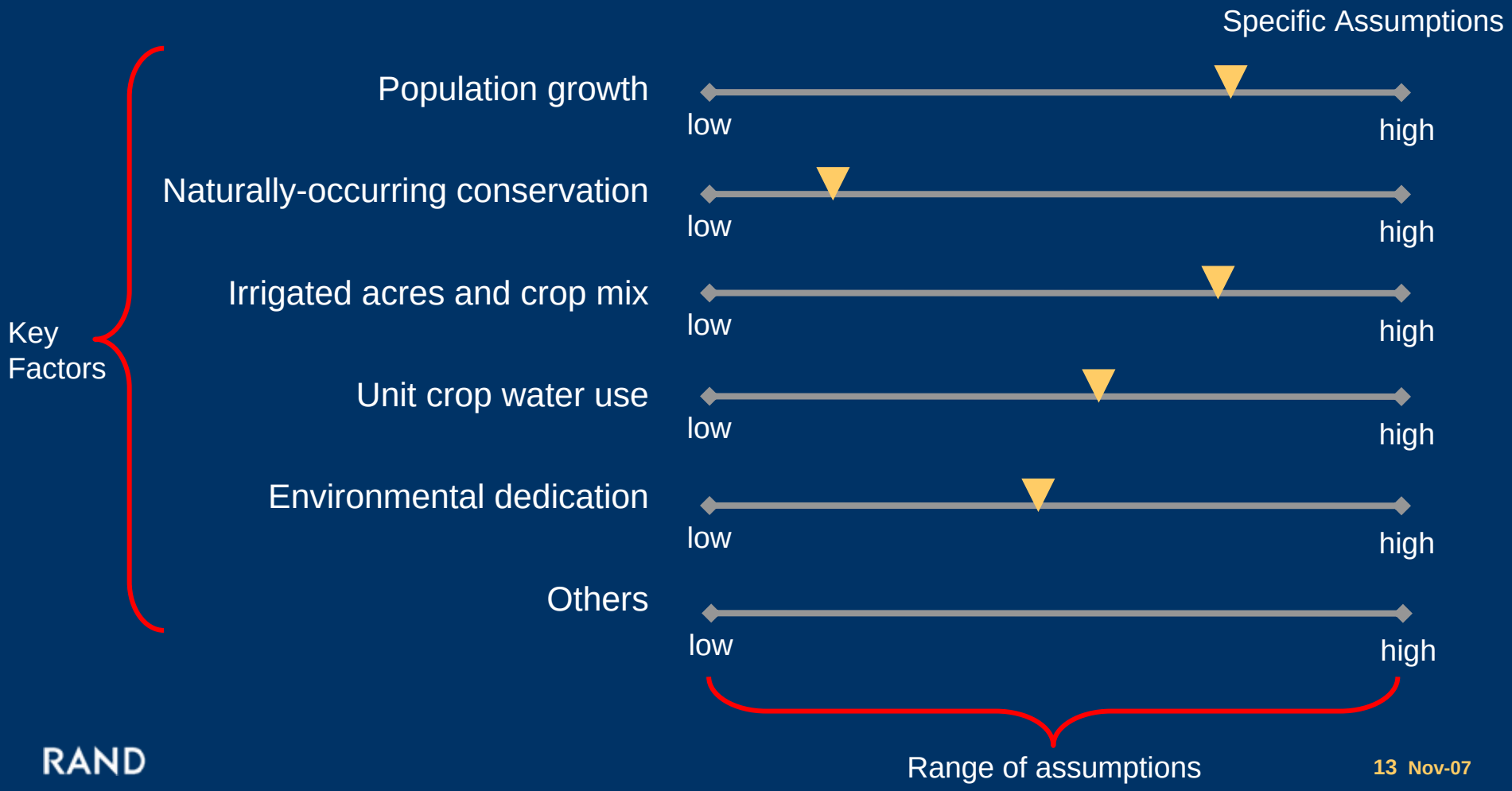

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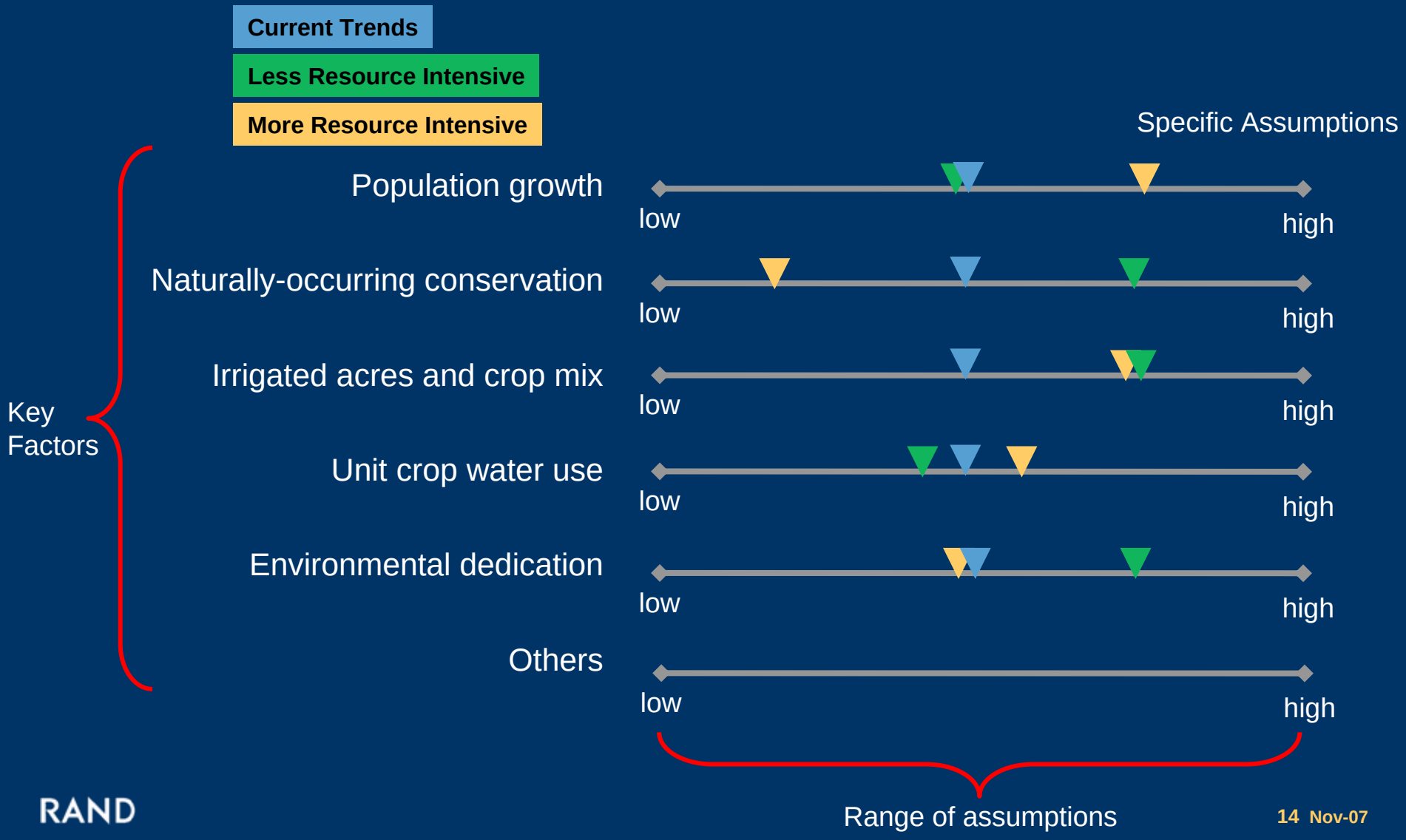

Scenario Framework Supports Quantitative Scenario Analysis of Response Packages

- **Define response packages (L) as bundles of water management actions or policies**
- **Evaluate each response package (L) against a large ensemble of scenarios (X) using scenario model (R)**
- **Seek response packages (L) that**
  - **Are robust to uncertainties about the future (X)**
  - **Balance performance across objectives (M)**

References available at end of presentation

Our Next Steps Today Are ….

1. **Re-examine key exogenous factors (Xs)**
   - **Focusing on factors outside the control of the water community**
   - **Considering several types of uncertainties**
2. **Propose qualitative ranges for key factors**
3. **Define new narrative storylines based on new factors and "themes"**
   - **These become the CWP Update 2009 scenario narratives**

Scenario Factors Are Classified by Type of Uncertainty

- **Natural System Uncertainty (NSU)**
  - Natural system variation (climate change, precipitation, etc.)
- **Financial Uncertainty (FU)**
  - Financial feasibility (cost and funding)
- **Political Uncertainty (PU)**
  - Political context (regulatory, balance of power)
- **Cultural Practices Uncertainty (CU)**
  - Cultural context (social acceptance of technology, personal water practices, values for environment/economics)
- **Technical Uncertainty (TU)**
  - Technical feasibility (engineering performance, technology availability)
- **Institutional Uncertainty (IU)**
  - Institutional practices (mission, funding, capacity, values)

Scenario Factors Worksheet

Factors Affecting Regional and Statewide Water Demands and Supplies											
FACTOR[1]	Types of Uncertainty (See key at bottom of page)								2010		2050
	NSU	FU	PU	CU	TU	IU?	?	?	Near Term	Mid Term	Long Term
Factors Primarily Affecting Water Demand											
Total Population											
Population Density											
Population Distribution											
Total Commercial Activity											
Commercial Activity Mix											
Total Industrial Activity											
Industrial Activity Mix											
Irrigated Crop Area (Includes irrigated land area and multi-crop area)											
Environmental Water-Flow Based											
Environmental Water-Land Based											
Per Capita Income											
Water Price											
Passive Conservation[2]											
Temperature											

1. Identify type of uncertainty

2. Rank importance by time-frame

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Scenario Factors Worksheet

Factors Primarily Affecting Water Supply												
catastrophic events												
sea-level rise												
Precipitation - drought, multi-year drought, extreme weather events, changed patterns (time and place)												
Snowpack												
Colorado River Supply (Reliability)												
Delta Exports (Reliability)												
Flood Requirements												
Energy Costs												
Drinking Water Standards												
Ag Discharge Requirements												
Urban Runoff Regulations												
Recreation Demand												
Desalting (Feasibility)												
Recycled Water (Feasibility)												
Water Transfers Between Regions (Feasibility)												
Conjunctive Use and Groundwater Management (Feasibility)												
Surface Water Storage (Feasibility)												
Conveyance Facilities (Feasibility)												

Table Continued

(1) Factors should be considered as an initial list that will be modified, as needed, as analyses proceed for the next Water Plan Update.

(2) Passive Conservation is the amount of background conservation (changes in plumbing codes, etc.) occurring independently from the BMP and EWMP programs.

Natural System Uncertainty (NSU) = Natural system variation (climate change, precipitation, etc.)
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References

- RAND's NSF-funded project on Decisionmaking Under Uncertainty
  - rand.org/ise/projects/improvingdecisions/
- Groves, D. G., Knopman, D., Lempert, R., Berry, S., and Wainfan, L. (2007). "Presenting Uncertainty About Climate Change to Water Resource Managers - Summary of Workshops with the Inland Empire Utilities Agency." RAND, Santa Monica, CA. Available at: www.rand.org/pubs/technical_reports/TR505 (early December)
- Groves, D. G., and Lempert, R. J. (2007). "A New Analytic Method for Finding Policy-Relevant Scenarios." *Global Environmental Change* 17, 73-85. Available at: www.rand.org/pubs/reprints/RP1244/
- Lempert, R. J., Groves, D. G., Popper, S. W., and Bankes, S. C. (2006). "A General, Analytic Method for Generating Robust Strategies and Narrative Scenarios." *Management Science*, 52(4). Available at: www.rand.org/pubs/library_reprints/LRP20060412/
- Lempert, R. J., Popper, S. W., and Bankes, S. C. (2003). *Shaping the Next One Hundred Years: New methods for quantitative, long-term policy analysis*, RAND, Santa Monica, CA. Available at: www.rand.org/pubs/monograph_reports/MR1626

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