American Water Works Association
2004 Annual Conference

Long Beach Water Department's Approach to Seawater Desalination

Presented by
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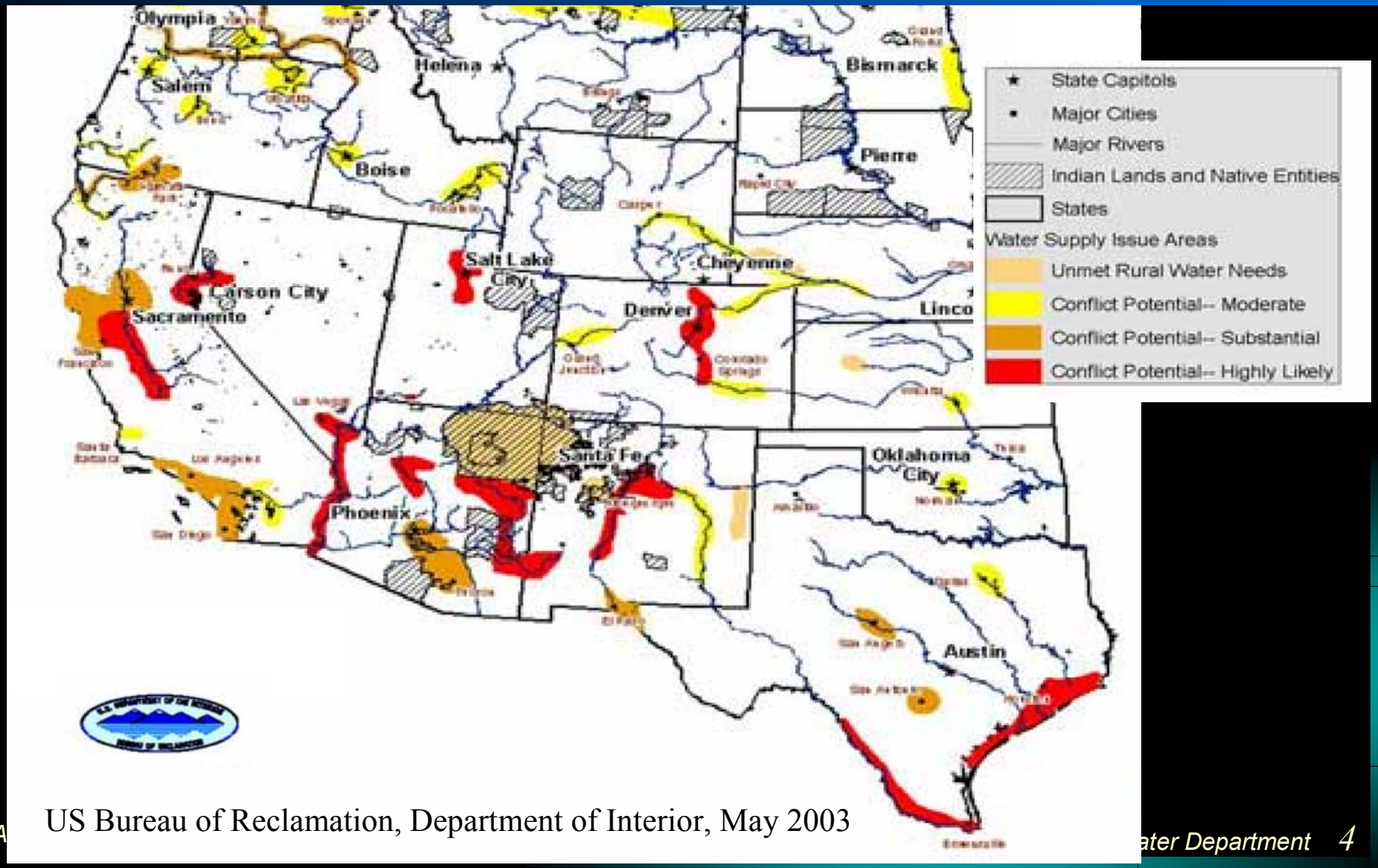
Seawater Desalination Issues

- National Perspective
- State Perspective
- Community Issues
- LBWD's Efforts

National Perspective

Federal Interest in Desalination: Potential Water Crisis - 2025



US Bureau of Reclamation, Department of Interior, May 2003

Federal Desalination & Water Purification Technology Roadmap

- January 2003
- 30 participants
  - Consultants
  - Membrane Manufacturers
  - Engineering firms
  - Water agencies
  - Research institutes
  - Legislative representatives
  - Federal government
  - Universities

Report available at http://www.usbr.gov/pmts%5Cwater/desalroadmap.html

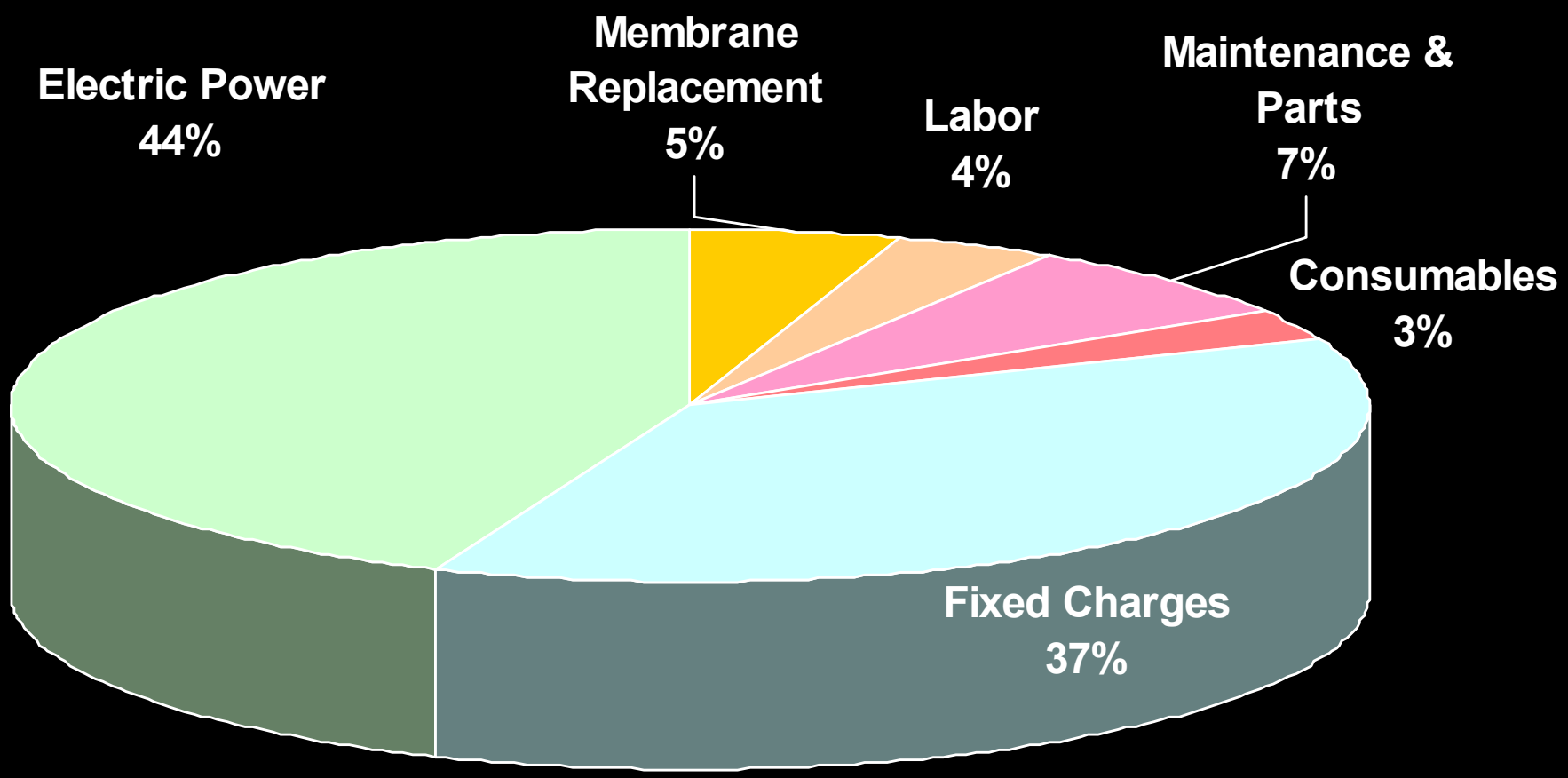
Federal Desalination & Water Purification Technology Roadmap (cont'd)

"**The Achilles Heel of these desalination technologies, however, is cost – they are currently expensive to purchase and operate.**" *(exec summary)*

"**…the treatment cost of a gallon of purified seawater today currently costs approximately five to six times the treatment cost of fresh water** (Water Treatment Estimation Routine User Manual, U.S. Bureau of Reclamation, Water Treatment Technology Program Report No. 43)…" *(pg 19)*

Cost

Federal Roadmap Estimate: Power + Debt = 81%



Federal Desalination & Water Purification Technology Roadmap (cont'd)

"Even with this wealth, Southern California is unable to afford water purification and desalination plants without public sector funding to offset some portion of the up-front capital cost. If the economic powerhouse that is Southern California can't afford current-generation technologies without assistance, then smaller communities across the nation have even less of an opportunity to employ needed desalination technologies." *(page 40)*

...and hence the need for federal support of research

Federal Desalination & Water Purification Technology Roadmap (cont'd)

Short-term Federal Research Goals (Reducing Desalination Cost):

- 20% increase energy efficiency
- 20% lower capital cost
- 20% lower operating costs
- 20% lower zero-liquid-discharge cost

State Perspective (California)

State Desalination Task Force

- 28 participants; representing
  - State agencies
  - Federal agencies
  - Water agencies
  - Research agencies
  - Environmental agencies
  - County governments
  - City governments
  - Desalination industry

- DWR Report to Legislature *(October 2003)*

Report available at: http://www.owue.water.ca.gov/recycle/desal/desal.cfm

Task Force Findings

41 Findings, including:

- **Environmental impediments include**
  - Feedwater intake
  - Concentrate disposal
  - Cost
  - Siting
  - Siting
- **Current energy requirement of RO:**
  - ~130% of inter-basin transfers
- **Viability may depend on cost of power**
- **Unique issues with private-sector involvement**

Findings: Co-located with Power Plant

Benefits

- Compatible land use
- Use of existing infrastructure for intake and outfall
- Location security
- Use of warmed cooling water as feed for desalter
- Potential to purchase power at below-retail rates

Drawbacks

- May justify continued use of once-through cooling

Findings: Recommendations

- **29 major recommendations**
  - General
  - Energy and Environmental
  - Planning and Permitting
- **Funding Recommendations**
  - Research
  - Projects with greatest public benefit *(environmental, improved water quality, environmental justice, agencies maximizing conservation,reclamation, etc.)*

California
California Coastal Commission
Draft Seawater Desalination & the Coastal Act

Final report expected to be adopted March 2004
Draft report available at http://www.coastal.ca.gov/

"Main Points"

- **Privatization/commodification of public trust resource (e.g. seawater) represent major shift in public policy**
- **International agreements/legal decisions may hamper ability of state and local governments to regulate activities of multinational corporations**
- **Coast Act's priority use policies likely differ for public vs. private desalination proposals**
- **Desalination plants may not be "priority use" of coastal zone**
- **In some coastal areas, water supply provided by desalination may remove primary constraint to growth, substantially affecting coastal resources**

"Main Points" (cont'd)

- **Proposed plants must:**
  - Conduct economic, environmental, social, and technological feasibility studies
  - Identify and incorporate conservation, reclaimed water, reallocating existing supplies, and market-based measures
- **May cause significant adverse effects on marine organisms**
  - Impingement
  - Entrainment
  - Brine discharge
  - Discharge of biocides, cleaning compounds, and other chemicals
- **Must evaluate alternative locations and feasible mitigation measures**
  - Beach wells

"Main Points" (cont'd)

- **Advantages to co-location with power plants**
  - Existing intake and outfall structures
  - Requires little to no electrical transmission capacity
  - Other existing infrastructure (parking lots, security)
  - Cooling water for blending (seawater concentrate)
- **Concerns with co-location with power plants**
  - Once-through cooling, sited 50 years ago, not subject to current standards of environmental review
  - Entrainment studies 20 to 30 years old
  - Assume power plant entrainment mortality of 100%
  - Desalter entrainment when power plant not operational
  - Impact on desalter of potential future requirement of power plant to reduce take of seawater
  - If desalter not "coastal-dependent", then siting at power plant may be non-conforming use

Community Issues

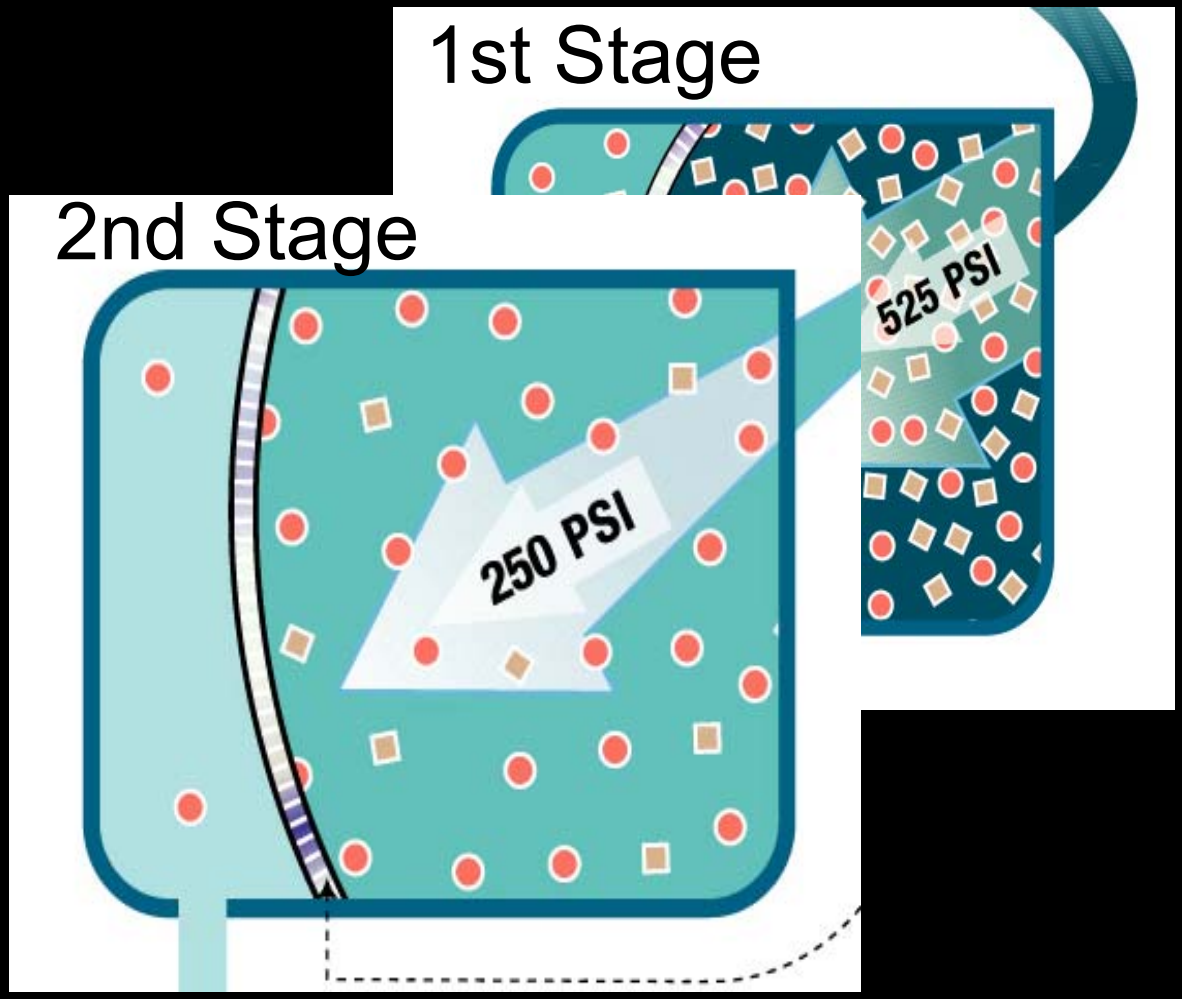
Issues Raised by Community

- **Alternative supplies may be preferable**
  - Lower cost: Potentially lower capital or operating costs (conservation, reclaimed water, conjunctive use, etc.)
  - Less environmental impact
- **Co-location may extend life of coastal power plants**
- **Coastal community incurs cost (forced to site industrial plant) while inland community receive benefits (reliable water)**
- **Private sector ownership**
  - Grants = taxpayer subsidy of corporate profits
  - Loss of control of essential public resource (water)

Long Beach Water Department's Efforts

2-Stage Nanofiltration (NF^2)

- Patent pending 2-stage process



- Potentially Lower Energy Consumption
- 2-pass Membranes for Added Water Quality Protection and Operational Flexibility

LBWD's Phased Approach

① **Pilot Testing** (on-going)
- AWWARF

② **Prototype** (2004 - 2006)
- USBR
- LADWP

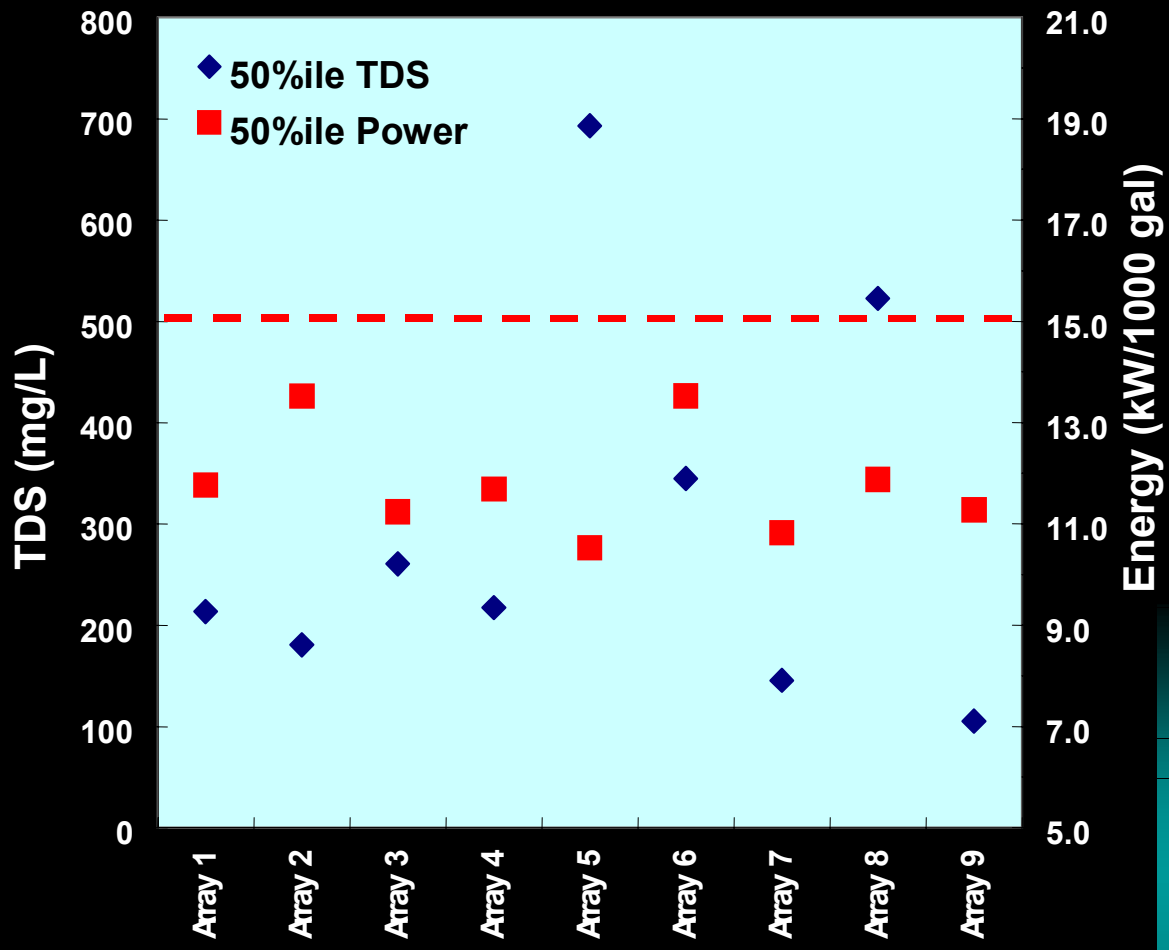
③ **Production Plant** (~2010)

LBWD's Pilot Test Results

- Estimated Power vs. Salinity
- Specific Water Quality
- Emerging WQ Concern

Estimated Power and Salinity

- **Multiple array tests performed.**
  - Power consumption evaluated concurrently with water quality
  - Multiple tests show TDS < 200 mg/L with energy ~ 11 KW/kgal possible (arrays 7 & 9).
  - Further optimization may reduce energy consumption.



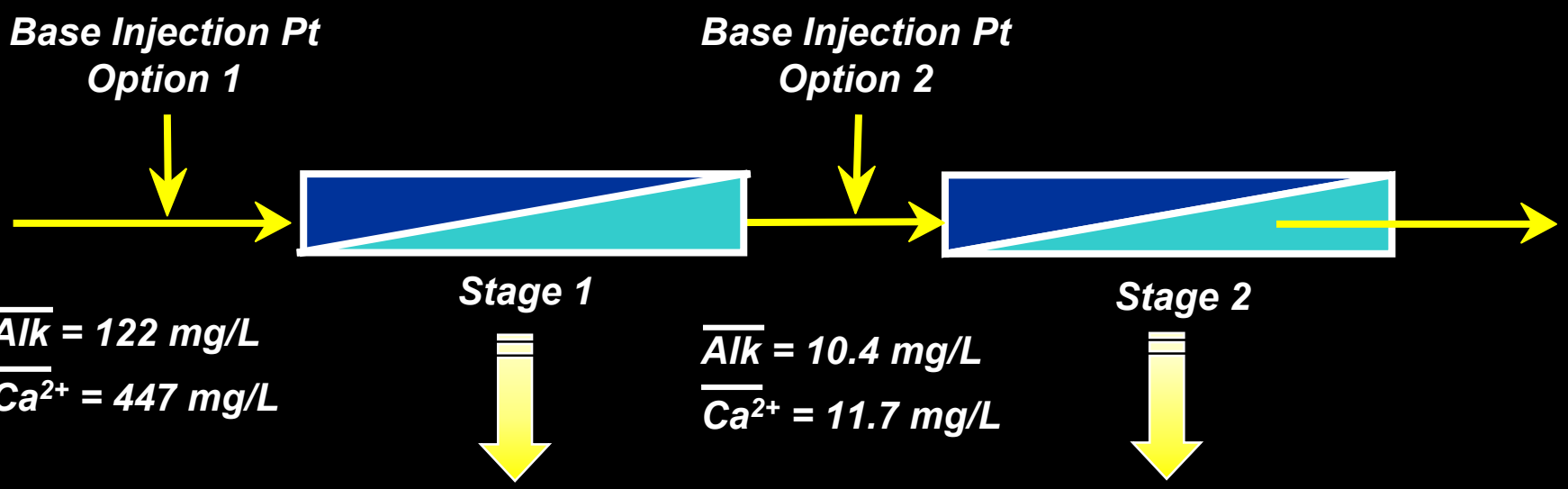
Specific Water Quality

	LBWD Tap	Raw Seawater	NF^2 Permeate
TDS	260 - 430 mg/L	~ 34,500 mg/L	< 300 mg/L
Bromide	0.1 - 0.3 mg/L	~ 62 mg/L	0.4 - 0.6 mg/L
Boron	< 0.1mg/L	~ 4.5 mg/L	?

- **Boron is emerging concern for seawater desalination.**
  - Human reproductive affects
  - Toxic to certain plants at very low levels
  - WHO guideline (0.5 mg/L) and CA Action Level (1 mg/L)

Boron: Emerging Concern

- Single-pass SWRO achieves 43% - 78% rejection
- Baseline NF^2 process achieves ~ 50% rejection
- Enhance boron rejection through base addition in NF^2

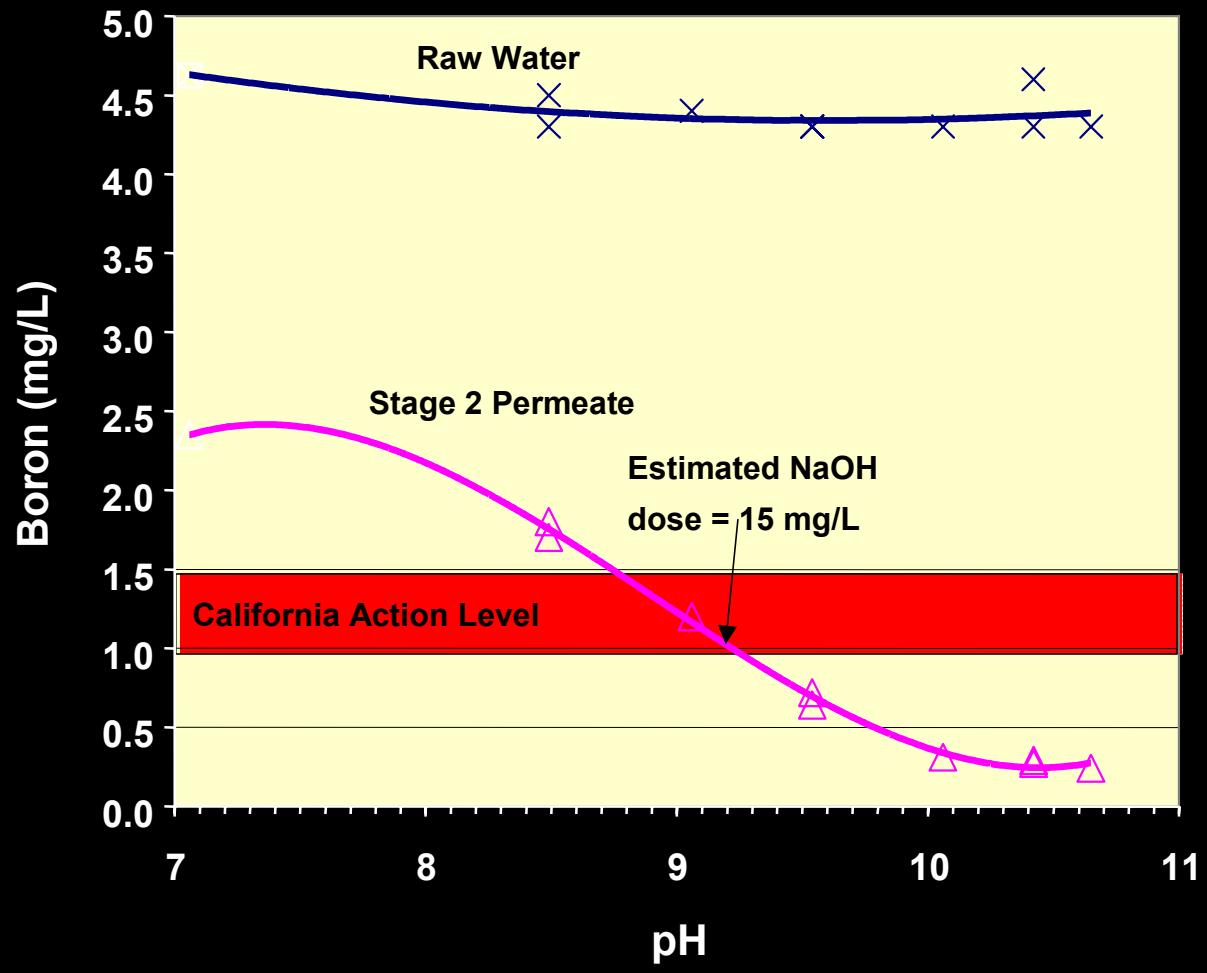


- *More base required to alter pH*
- *HIGH potential for fouling*

- *Less base required to alter pH*
- *97% rejection of Ca^{2+}. Decreased potential for fouling*

Enhanced Boron Rejection

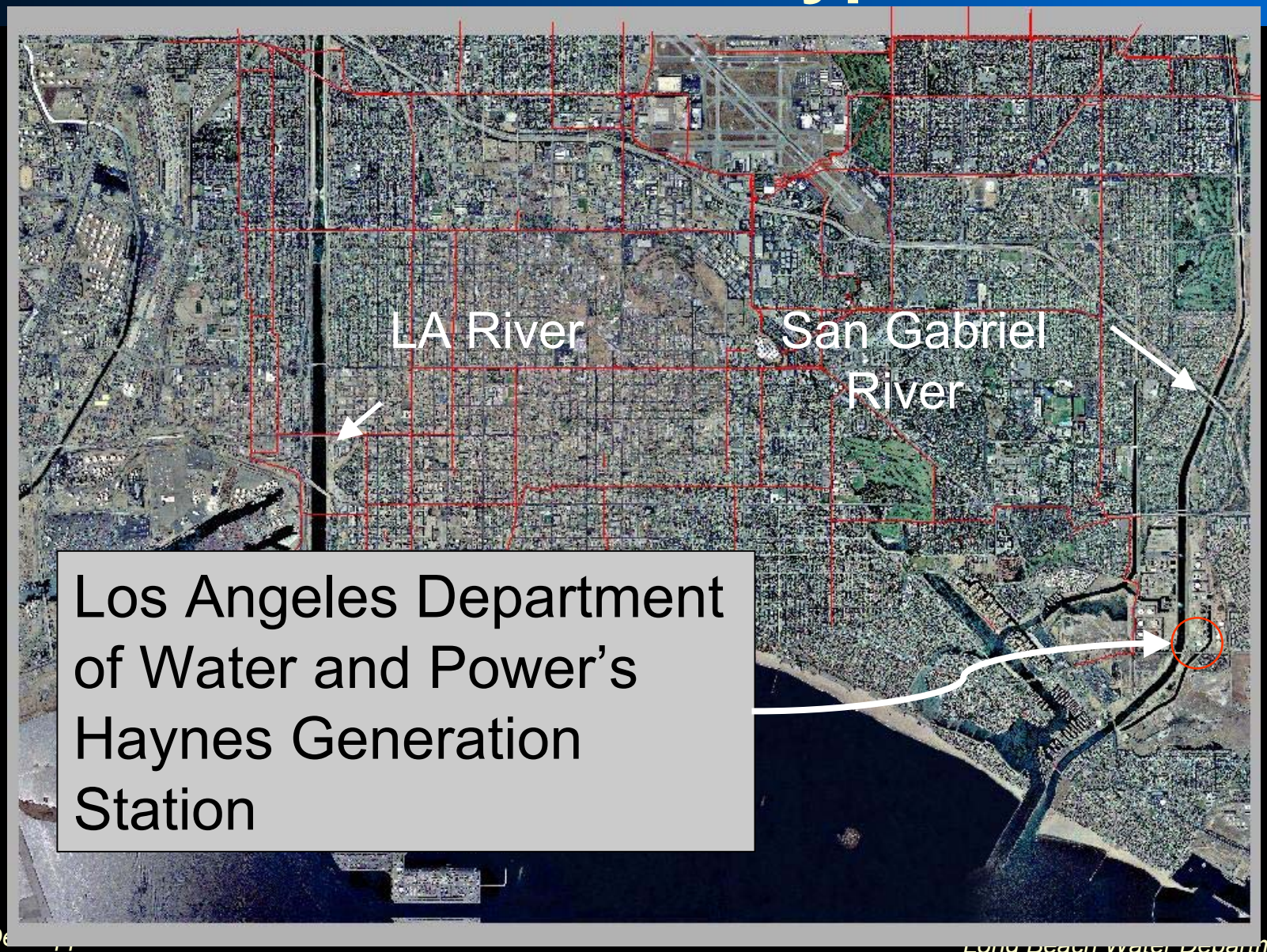
- NF^2 process allows base addition at pass 2 feed, prevents inorganic precipitation.
- For membranes and water tested, pH 9.2 achieves boron < 1.0 mg/L.
- pH 9.8 meets World Health Limits of 0.5 mg/L



Prototype Testing

- 2004 - 2006
- Siting
- Goals

Site of Prototype



Goals of the Prototype

- **Optimize process to determine:**
  - NF^2 performance vs traditional single pass SWRO
  - Optimizing system integration
  - Detailed capital and O&M costs
- **Evaluate long term performance:**
  - Pre-treatment
  - Membrane performance
  - Water Quality
  - Emerging contaminants (ie. Boron, Marine Biotoxins)
- **Provide sufficient information to regulators**

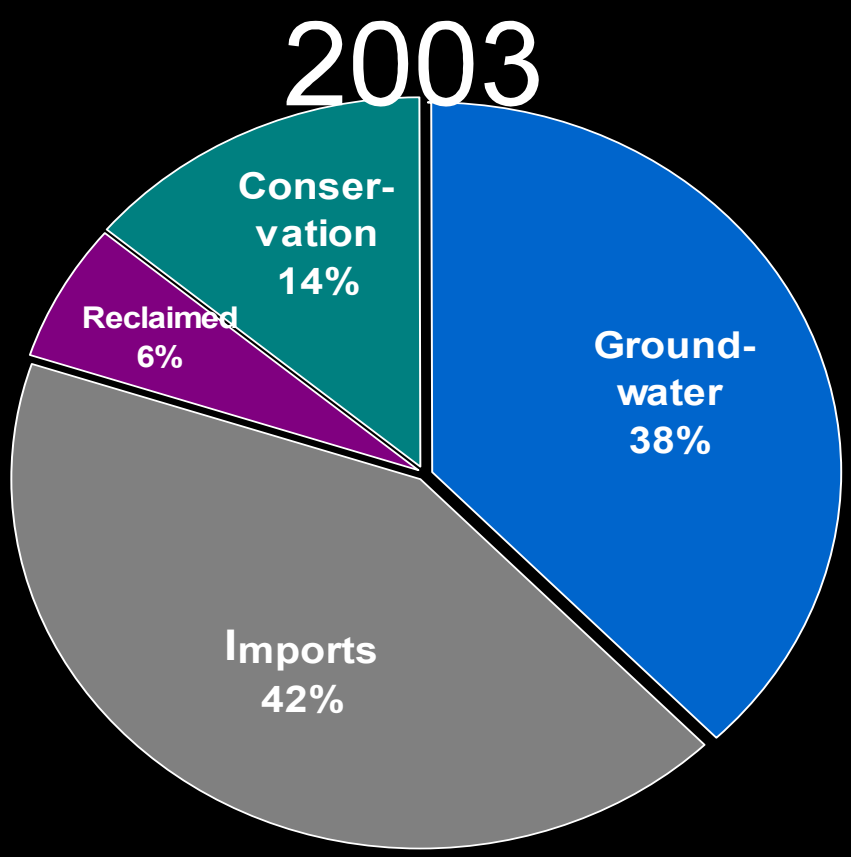
Production Plant

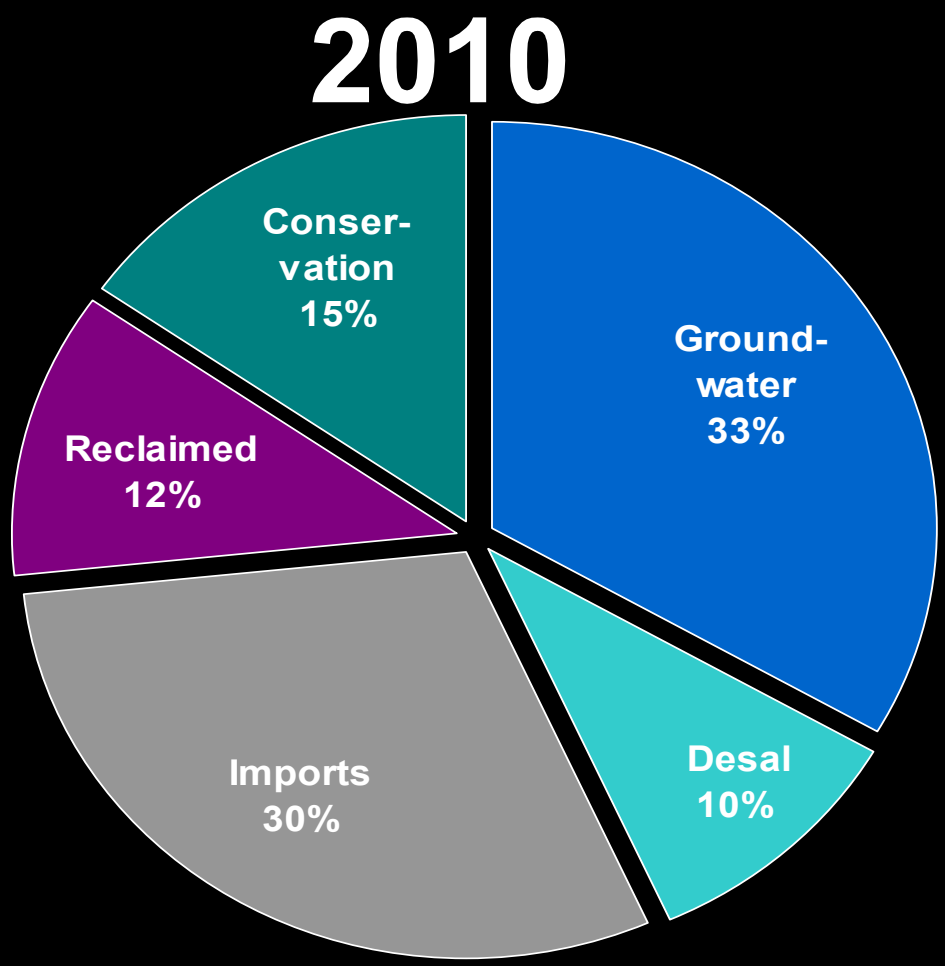
- ~ 2010
- Overview
- Resource Mix

Production Plant

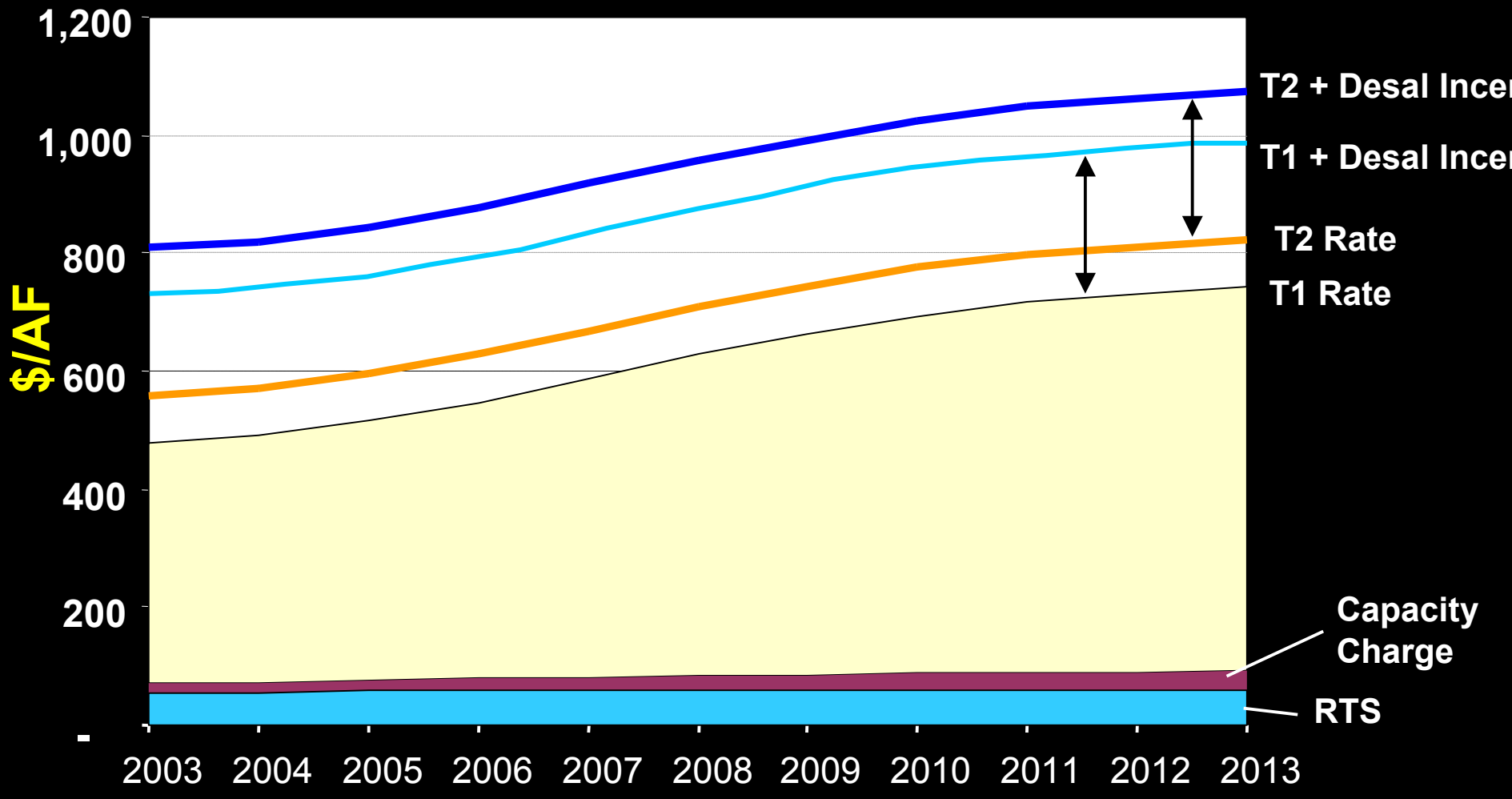
- **Improving reliability while reducing dependence on imported water**
- **9 million gallons per day**
- **In partnership with:**
  - US Bureau of Reclamation
  - Metropolitan Water District of Southern California

LBWD's Resource Mix





Projected MWD Water Rates



Concluding Remarks

- LBWD's desalination research program approach consistent with federal and state workgroup findings.
- Applied research focused on reducing energy consumption while meeting current and potential WQ regulations.
- NF^2 process offers opportunity to reduce energy cost and flexibility to meet water quality challenges.

Acknowledgements

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