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Demand Hardening:
Big Myth, Small Reality

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Demand Hardening – Why Care?

- Important issue for water conservation professionals, water planners, utility managers, drought planners, etc.
- Often used as a critique of long term water conservation efforts.
- Poorly documented and understood.

What is Demand Hardening?

"By saving water, long term conservation can also reduce the water savings potential for short term demand management strategies during water shortages" - Flory and Panella. 1994

"a result of longer term conservation measures...that make it increasingly difficult for the utility to induce further reductions in water use during a drought" - Howe and Goemans. 2007

From the Definition...

- Demand hardening is only an issue during a supply shortage (drought).
- Demand hardening is only an issue if a portion of conserved water has been used to serve new customers.

Planning Implications of Demand Hardening

Since long term conservation savings are achieved by existing customers, it is important that the supply reliability for these existing customers not be negatively impacted as new customers are added to a system.

Evidence of Demand Hardening

There is little if any documentation in the literature of it ever occurring in Colorado or elsewhere (Mayer and Little 2006).

Demand hardening could be an issue for water providers in certain situations, but its importance has been overstated (Chesnutt 1997).

Where is the evidence that demand hardening has impacted drought response?

Example 1: Demand Hardening and Drought Model

Two identical communities of 10,000 people with one important difference:

Community 1 = Non-conserving

Community 2 = Conserving

Normal year water supply = 5,000 af

Drought year water supply = 3,312 af

END USE	NON-CONSERVING	CONSERVING/ NEW	UNIT
Toilets	3.5	1.6	**gallons/flush**
Showers	3	2	gpm
Clothes washer	40	25	gallons/load
Baths	2	2	gpcd
Faucets	2.5	1.5	gpm
Dishwasher	10	7	gallons/load
Leaks	9.5	9.5	gpcd
Other	1.6	1.2	gpcd
Irrigation standard	16	12	gal/sf/yr
Irrigation drought	12	9	gal/sf/yr

			Standard Daily Per Capita Use		Drought Daily Per Capita Use	
STANDARD USE	DROUGHT USE	UNIT	Non-Cons	CONS/NEW	Non-Cons	CONS/NEW
6	4	Flushes/Person/day	21	9.6	14	6.4
0.7	0.5	shower/person/day	2.1	1.4	1.5	1
0.4	0.3	loads/person/day	16	10	12	7.5
0.1	0.1	baths/person/day	0.2	0.2	0.2	0.2
8.1	6	minutes/person/day	20.25	12.15	15	9
0.1	0.1	loads/person/day	1	0.7	1	0.7
1	0.8	Leaks	9.5	9.5	7.6	7.6
1	0.8	Other	1.6	1.2	1.28	0.96
		Total	71.7	44.8	52.6	33.4

Key Model Outcome

# of Non-Conserving Customers who could be reliably served by system with 3,313 af	**10,000**
# of Conserving Customers who could be reliably served by system with 3,313 af	**14,313**

Example 2: Which is Better?

- Conserve before the drought?
  - Building codes, retrofits, Xeriscape, leak management, non-potable irrigation supply.
- Rely on restrictions during drought to capture waste and inefficiency?
  - Mandatory indoor and outdoor reductions.

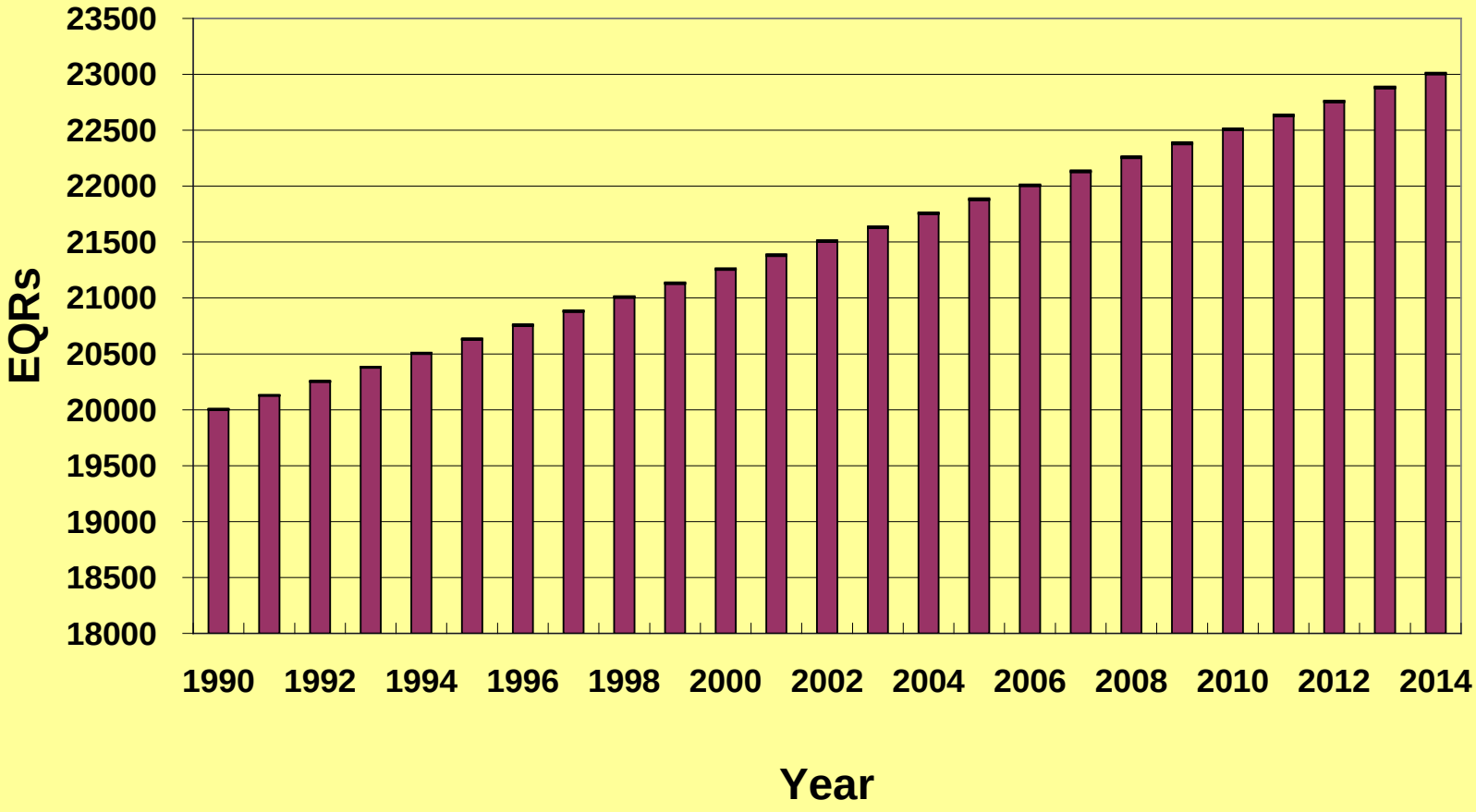
Spreadsheet Model to Test Alternatives

- Model applied to a hypothetical system
- 25 year, monthly time step model
- Demands disaggregated
  - New/existing; by end uses
  - Baseline (non-cons.) and Conservation
- Water supply including 300 year drought
- Reservoir operations
- Reliability Criteria (rules).

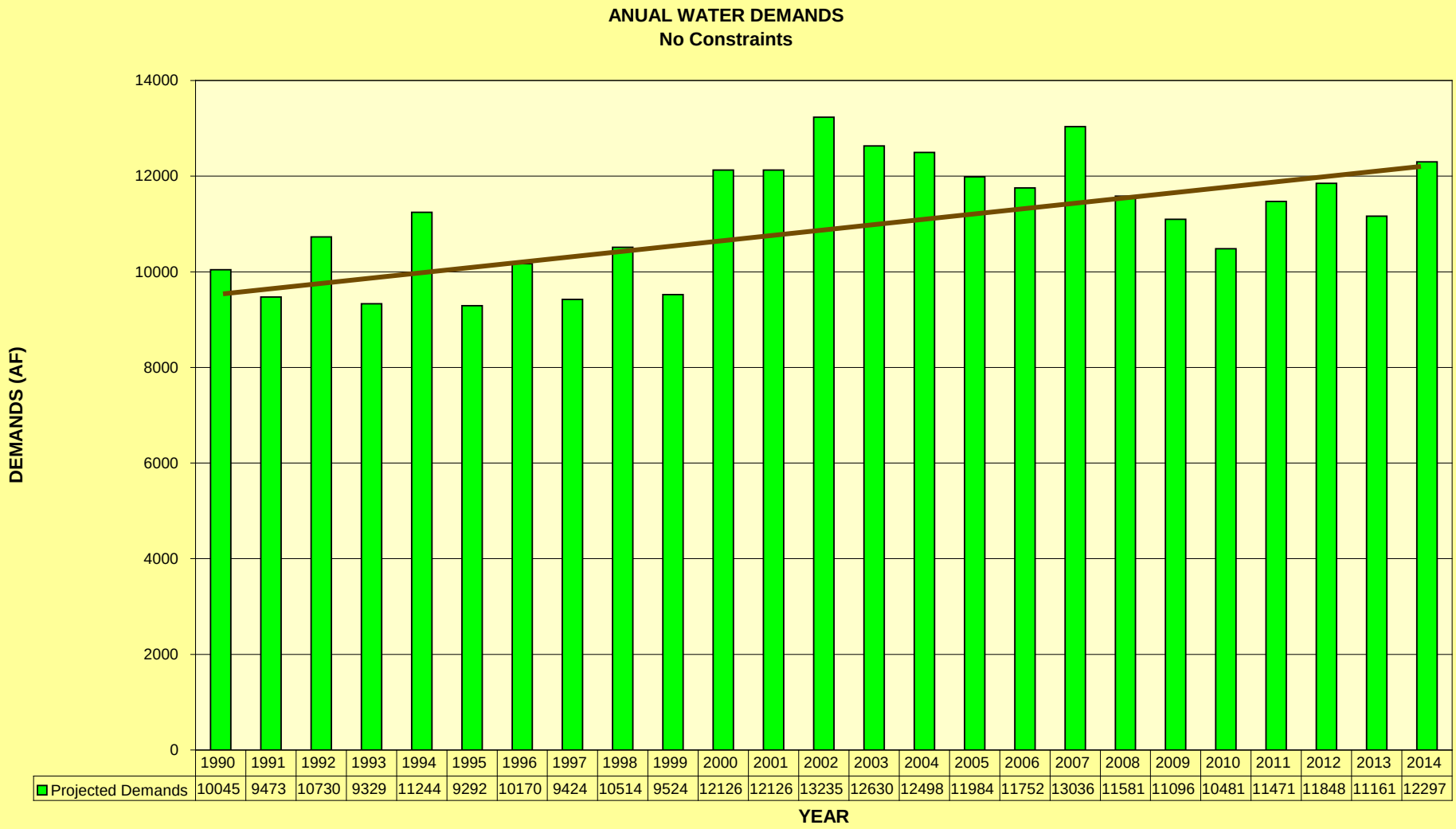
Drought Recognition

- Available Storage = 12,000 af = 1 yr demands
- Reliance on spring snowmelt
- Failure to fill to at least 67% of capacity triggers drought response.

Projected Growth ~ 11% over 25 years

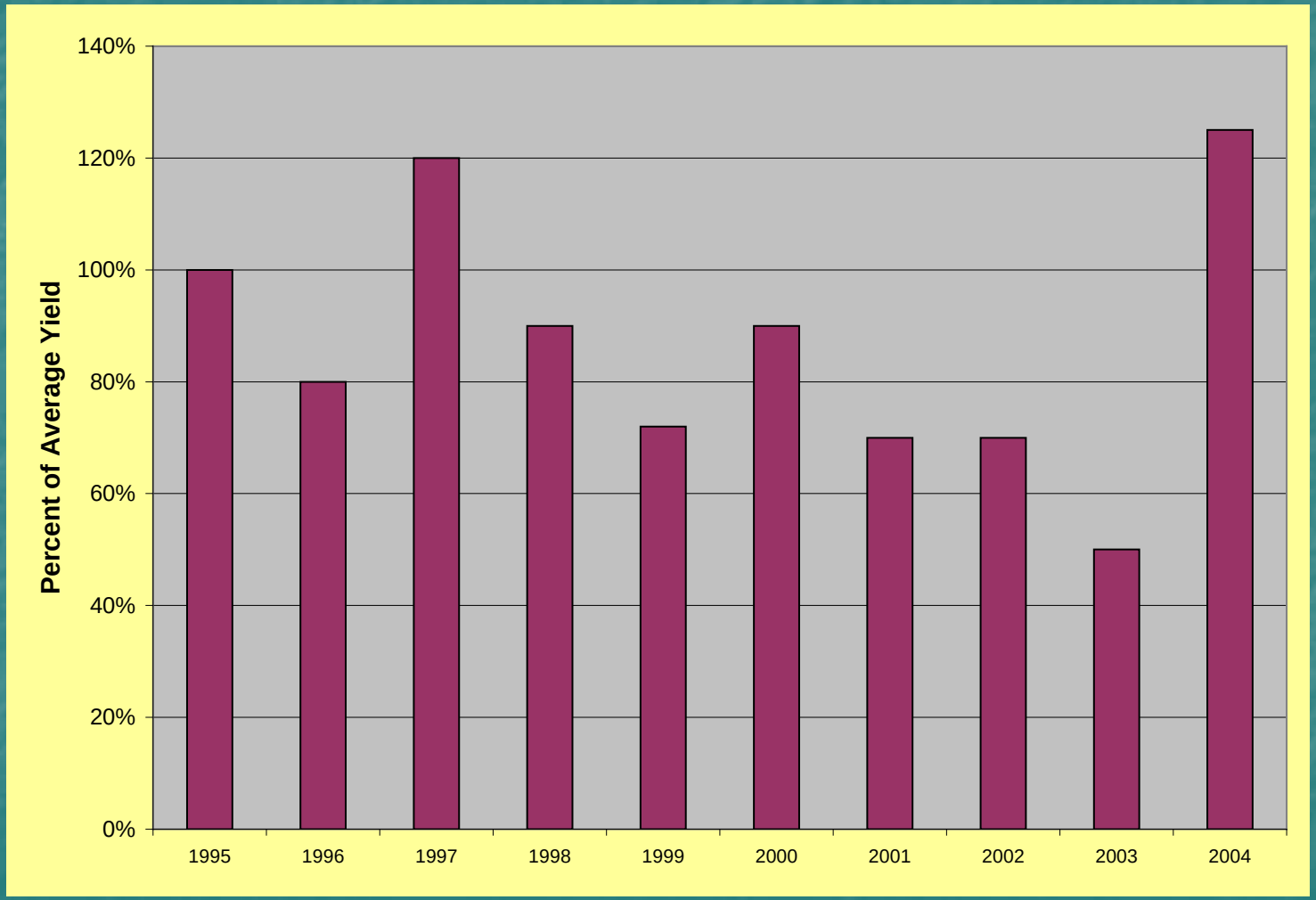


Non-Conserving Community Annual Demands



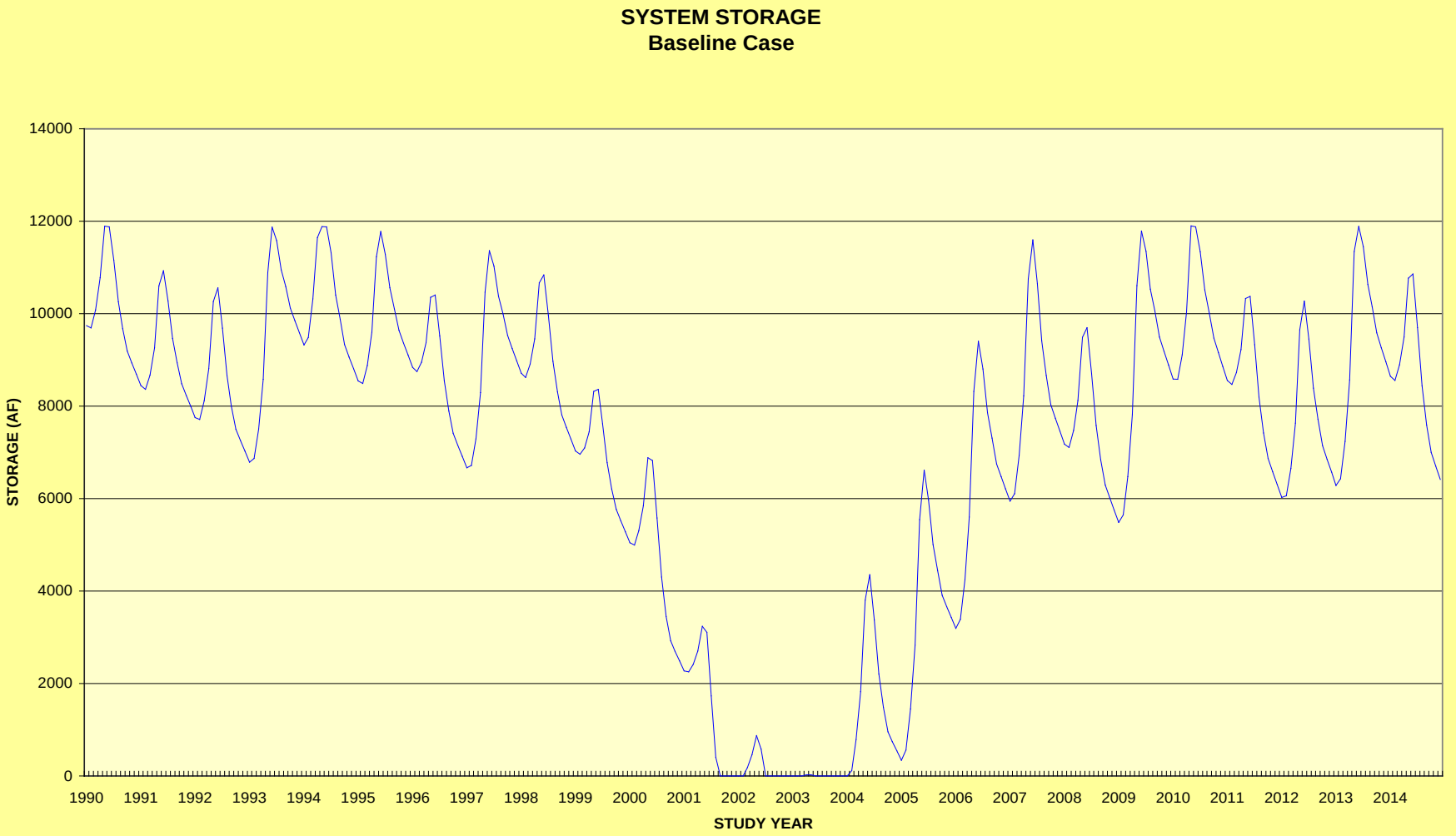
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Projected Demands	10045	9473	10730	9329	11244	9292	10170	9424	10514	9524	12126	12126	13235	12630	12498	11984	11752	13036	11581	11096	10481	11471	11848	11161	12297

Drought Pattern



300 year drought pattern. In 2003 supply = 50% of average yield

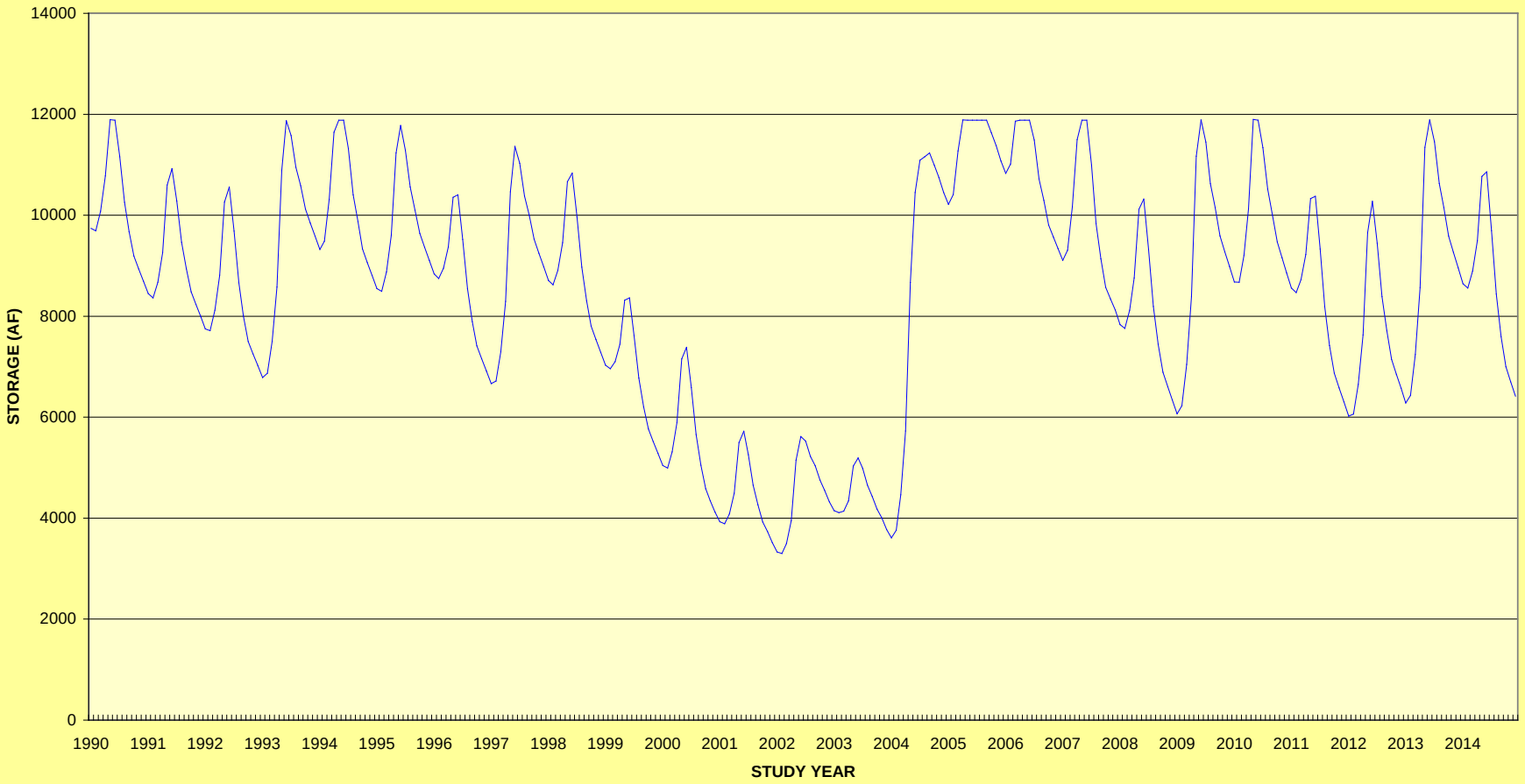
Baseline – No Drought Response



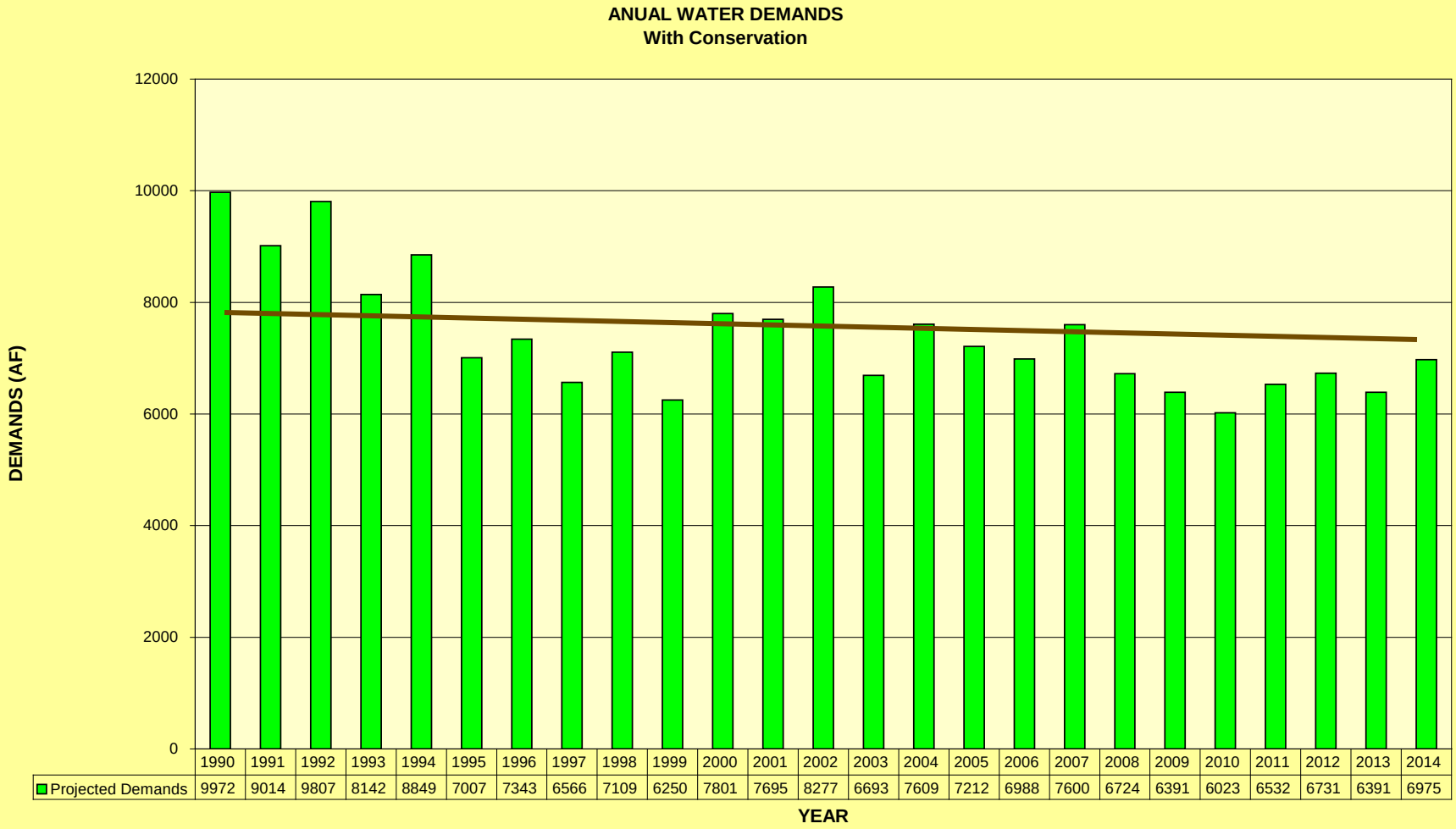
Required Rationing Factors

Year	Indoor	Outdoor
2000	1.00	0.75
2001	0.90	0.50
2002	0.90	0.25
2003	0.85	0.25
2004	0.85	0.00
2005	0.85	0.00
2006	0.85	0.90
2007	0.85	1.00

With “Draconian” Restrictions

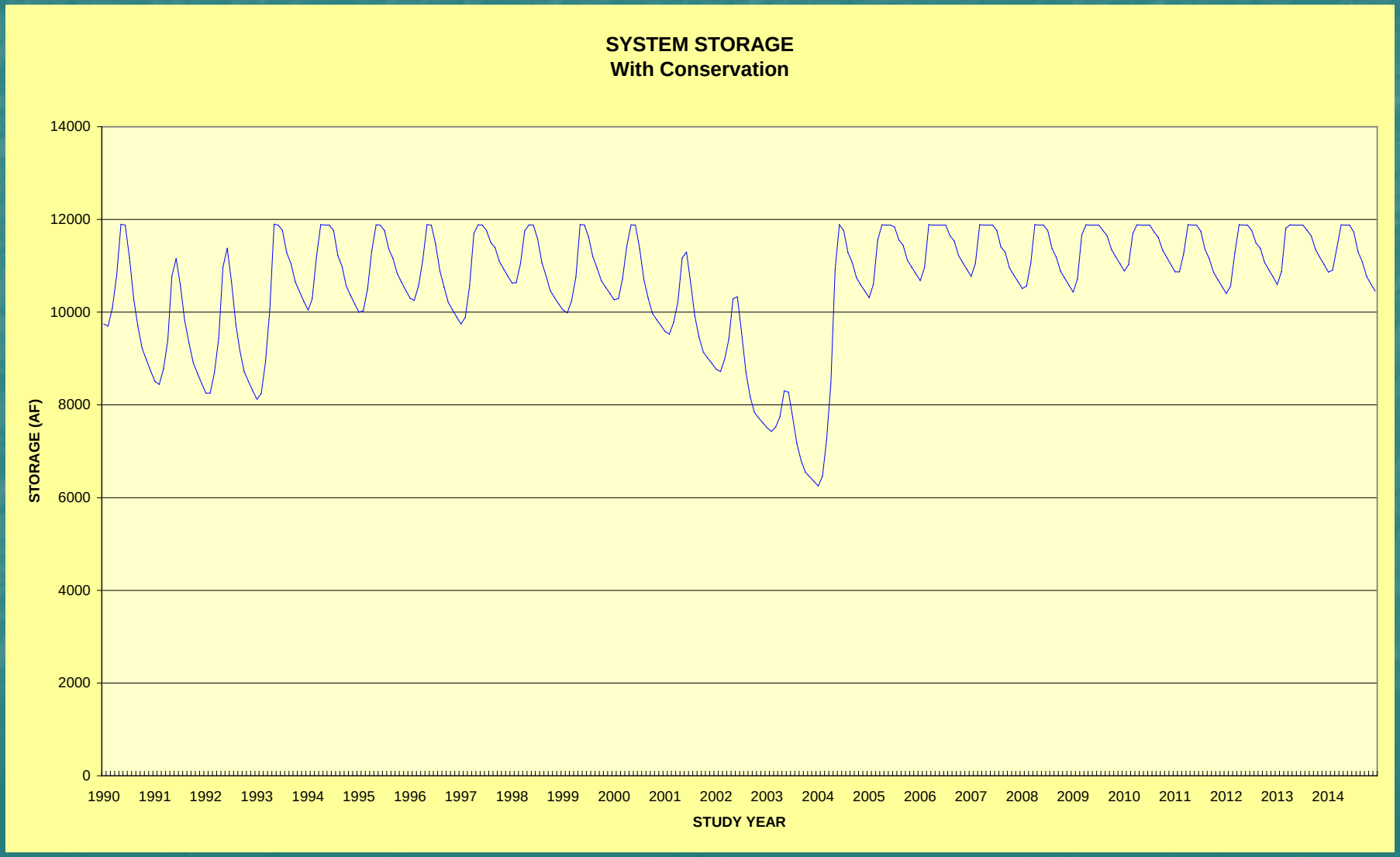


Conserving Community Annual Demands



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Projected Demands	9972	9014	9807	8142	8849	7007	7343	6566	7109	6250	7801	7695	8277	6693	7609	7212	6988	7600	6724	6391	6023	6532	6731	6391	6975

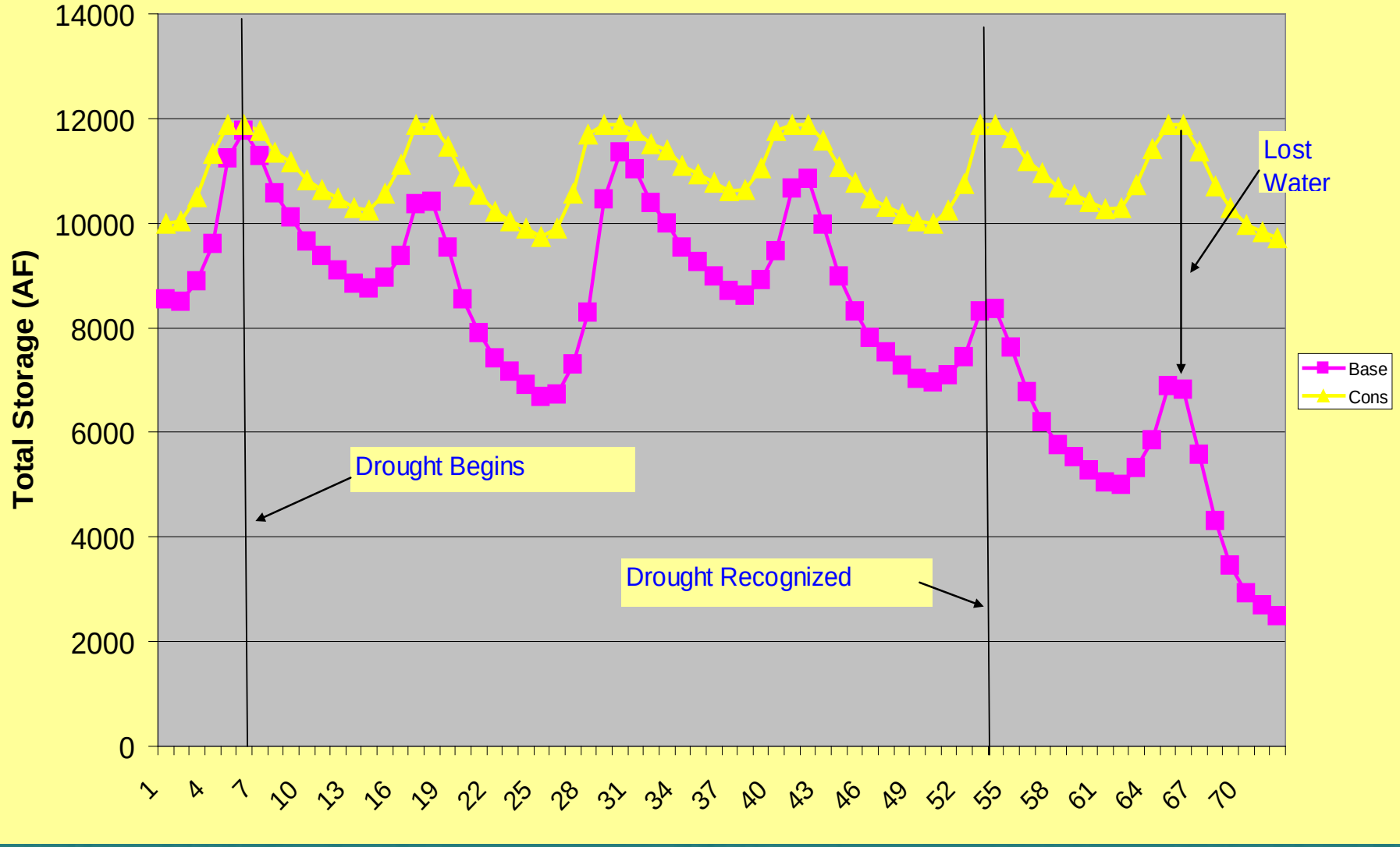
No Restrictions Necessary



Problems With Droughts:

- They can come on quickly
  - Over a few months
- They are difficult to predict
  - Practically impossible over short term
- Difficult to recognize early
  - By the time you know you are in a drought it may be too late to respond effectively.

Conserving vs. Non-Conserving



Implications of Demand Hardening

"the existence of demand hardening...does not imply that a utility should 'oversize' its systems and ignore wasteful water use by its clients just so it will be easier to cut back when a drought comes along. System capacity decisions and linked supply reliability should be based on long-term, net-benefit criteria."

"to ignore long-term conservation benefits and to build excess water supply capacity simply to facilitate cutbacks during a drought can be highly uneconomic, akin to overfeeding people so that dieting will be easier."

Howe and Goemans. AWWA Journal, 2007.

Conclusions

- Demand hardening is a real phenomena, but there are no examples in the literature.
- Demand hardening is only an issue during a supply shortage requiring cutbacks.
- Models indicate that a substantial portion of conserved water can be used to serve new customers without impacting system reliability.
- Concern about demand hardening is not a sound argument against implementing long-term water conservation.

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