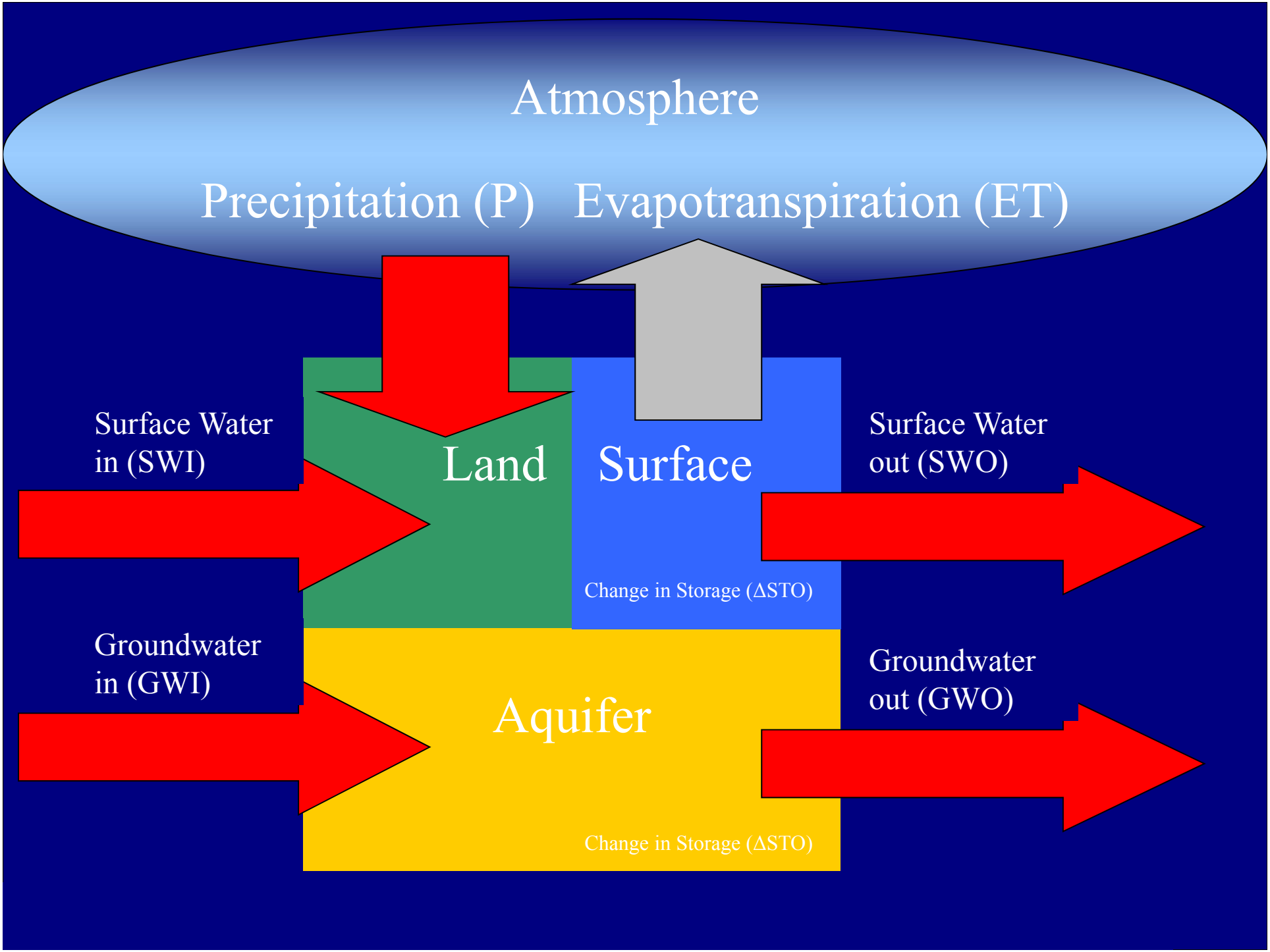
Water Budget Analysis of the Lower Platte River Basin

Presented to the Lower Platte Coalition
April 26, 2011
Jesse Bradley, P.G., Integrated Water Management Coordinator
Nebraska Department of Natural Resources

Total Water Budget

- Determine estimates for water supply and use components
- Develop snapshots in time
- Guide more refined studies (i.e., groundwater models, surface water models, etc.)


Atmosphere
Precipitation (P)
Evapotranspiration (ET)
Surface Water in (SWI)
Land Surface
Surface Water out (SWO)
Change in Storage (ΔSTO)
Groundwater in (GWI)
Aquifer
Groundwater out (GWO)
Change in Storage (ΔSTO)

Total Water Budget

$IN - OUT = \Delta STORAGE$

$IN = P + S_{(in)}$

$OUT = S_{(out)} + ET_{(beneficial)} + ET_{(non\text{-}beneficial)}$

Ignore storage changes and groundwater inflows and outflows (IN = OUT)

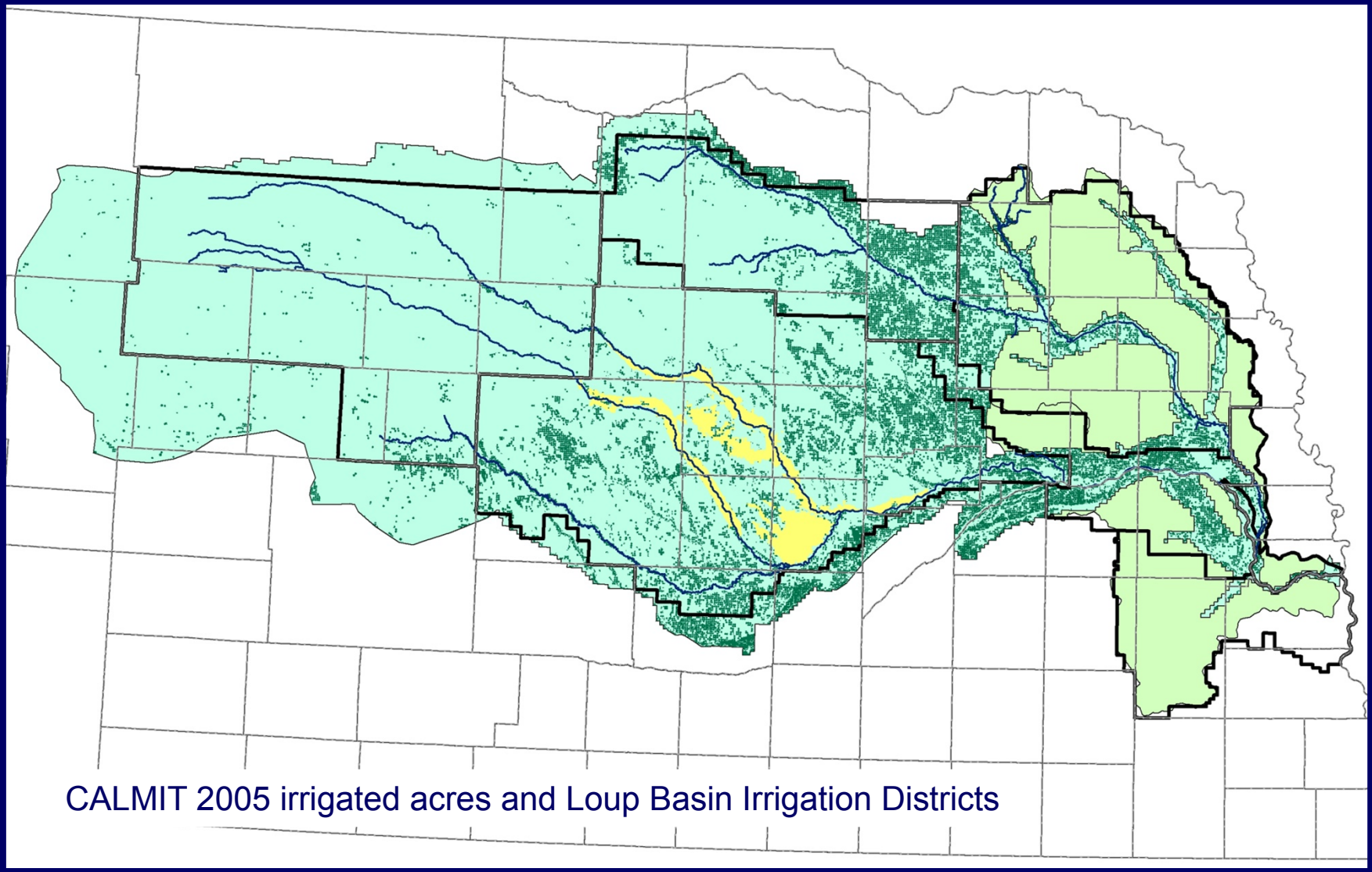
$P + S_{(in)} - S_{(out)} - ET_{(beneficial)} = ET_{(non\text{-}beneficial)}$

Component Description
(Irrigation Consumptive Use)

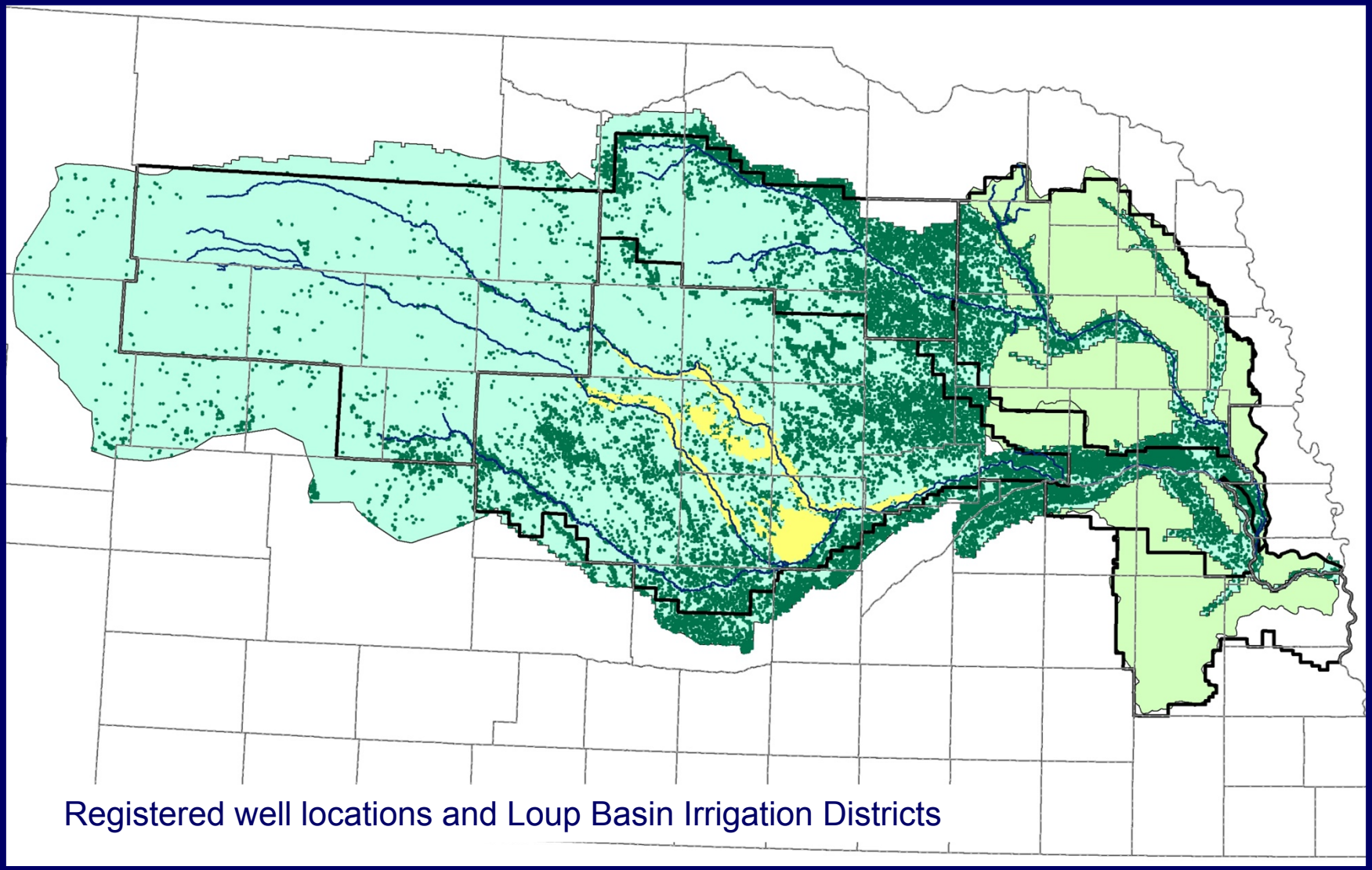
- Loup Basin canals based on delivery/diversion data
- Reservoir evaporation, post-1986 Calamus, Sherman, Davis Creek (all other reservoirs not calculated)
- Other irrigation based on 2005 CALMIT irrigated acres and distributed using active irrigation wells
  - *small pumpers assumed as part of distributed acres
- Consumptive use for irrigation based on NCCIR

Irrigated Acreage Summary

- 2005 CALMIT – 2,289,000 total irrigated acres
- 179,000 irrigated acres in Loup Basin surface water irrigation districts
- 24,800 wells 2,110,000 irrigated acres
- 485 new wells in 2006-2007 (85 acres/well) 41,000 acres



CALMIT 2005 irrigated acres and Loup Basin Irrigation Districts



Registered well locations and Loup Basin Irrigation Districts

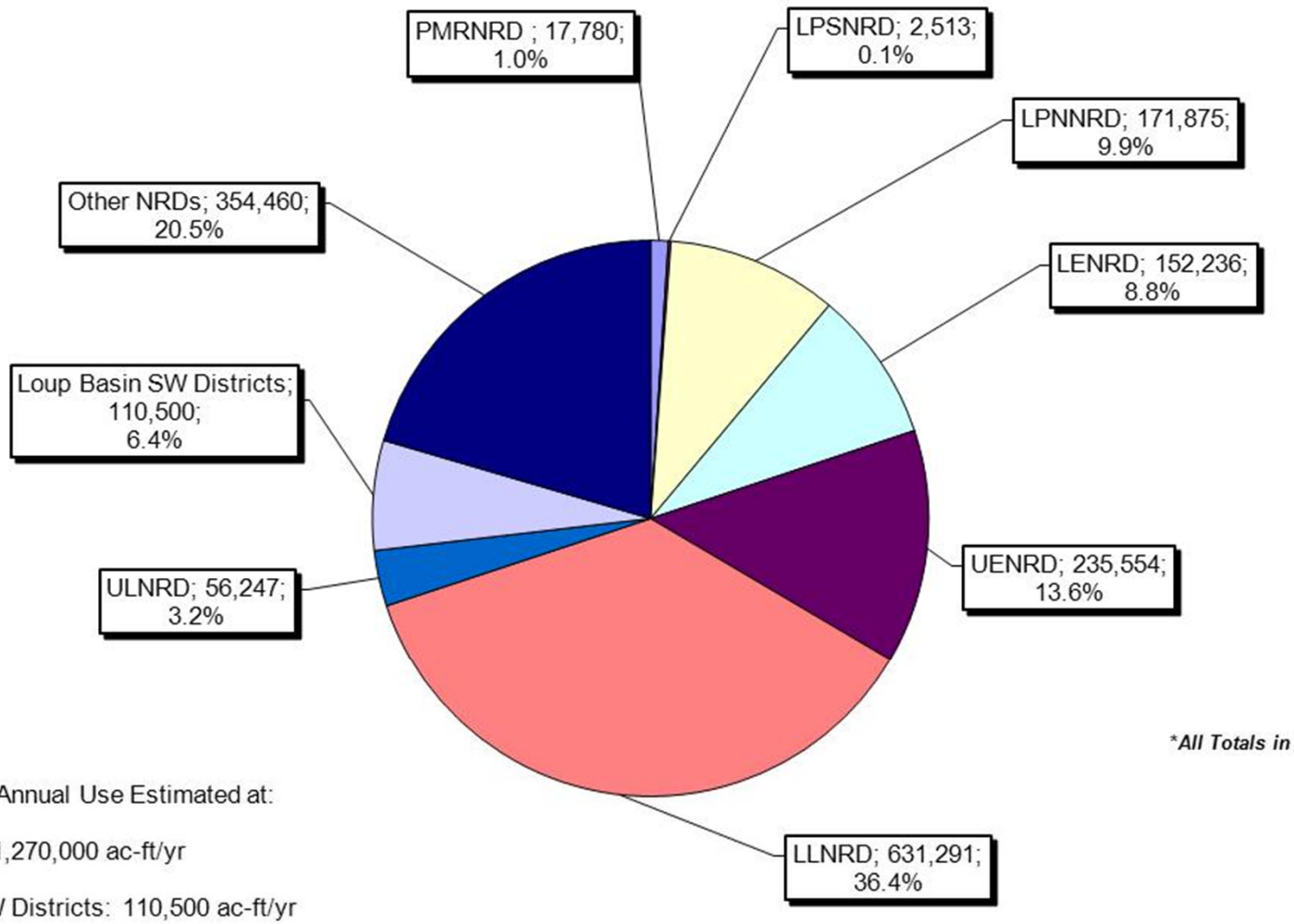
Component Description
(Municipal Use)

- Lincoln 2007 used for 1954 - 2005
  (no return flow assumed)
- Omaha 1968 used for 1954 - 1967
- 2000 census population data for all other municipalities (100 gal/day)
- Industrial, livestock, and rural domestic uses ignored

Key Limitations of Analysis

- Storage changes in surface water and groundwater ignored
- Groundwater inflow/outflow ignored
- Only irrigation and municipal consumptive uses considered

Total Consumptive Use by Groundwater Irrigation and Surface Water Irrigation



*All Totals in Acre-Feet per Year

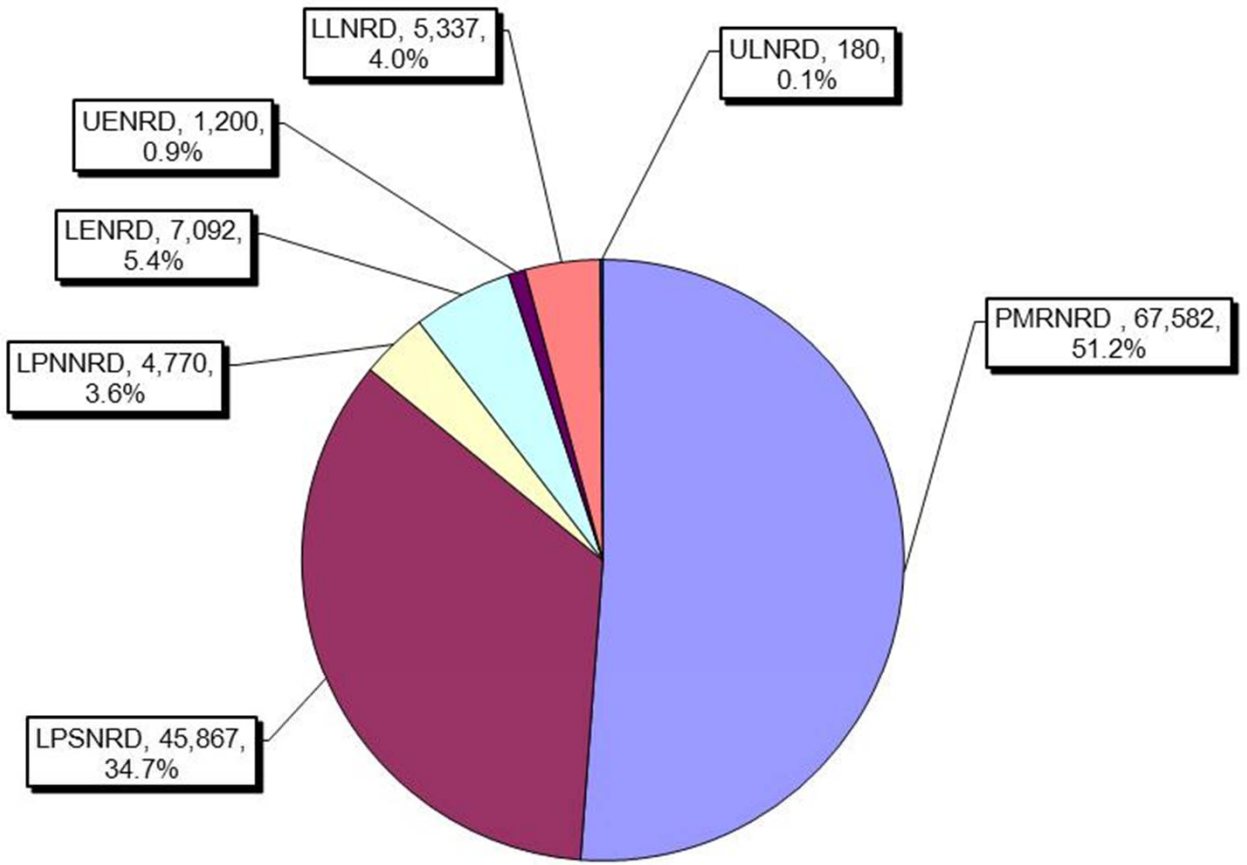
Total Average Annual Use Estimated at:

Basin NRDs: 1,270,000 ac-ft/yr

Loup Basin SW Districts: 110,500 ac-ft/yr

Out-of-Basin NRDs: 350,000 ac-ft/yr

Total Consumptive Municipal Use



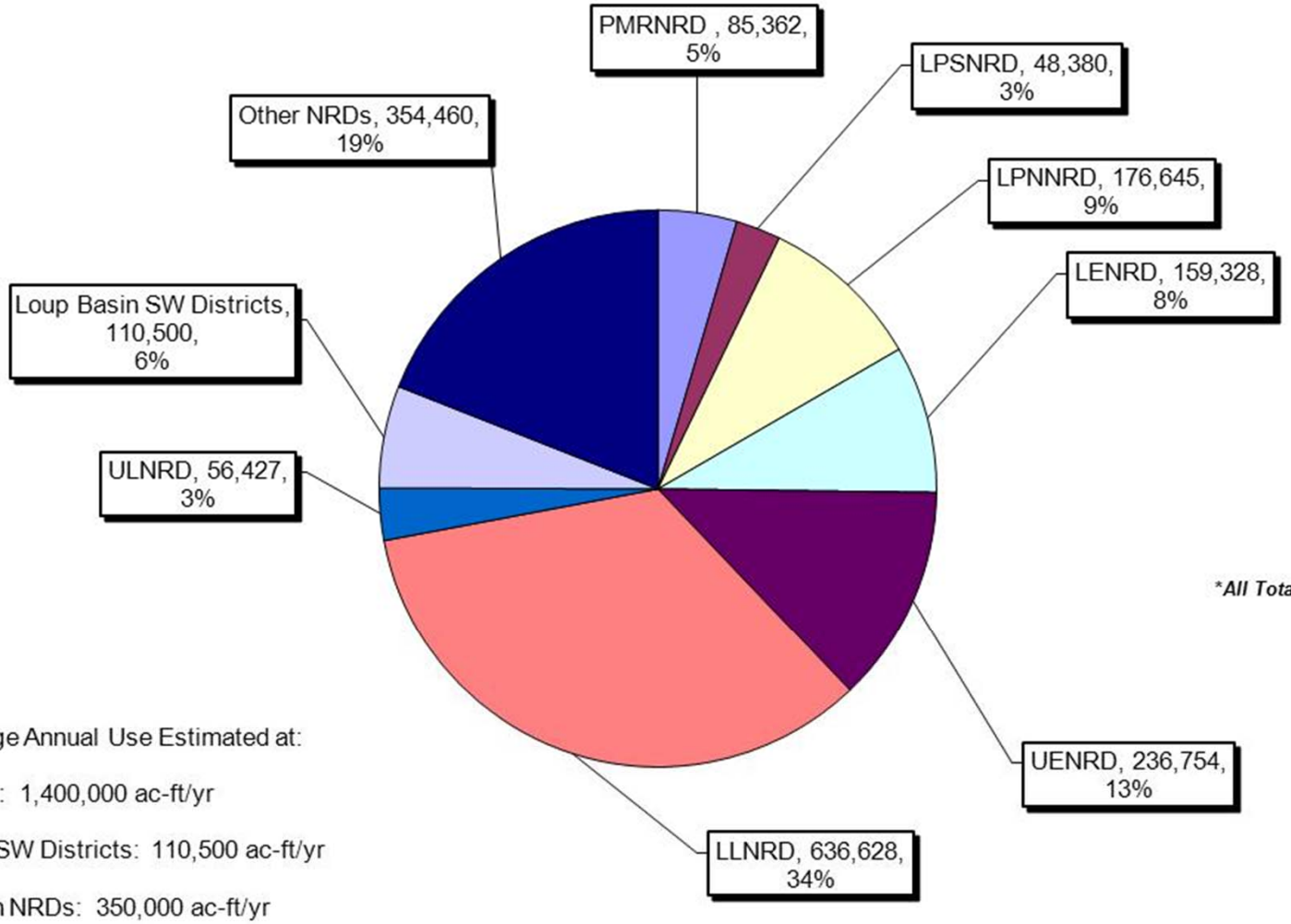
*All Totals in Acre-Feet per Year

Total Average Annual Use Estimated at:

Basin NRDs: 130,000 ac-ft/yr

*Totals for Lincoln and Omaha based on pumping values all others estimated based on 2000 census data and a consumpitve use of 100 gal/day (0.112 ac-ft/yr) per capita

Total Consumptive Use



*All Totals in Acre-Feet per Year

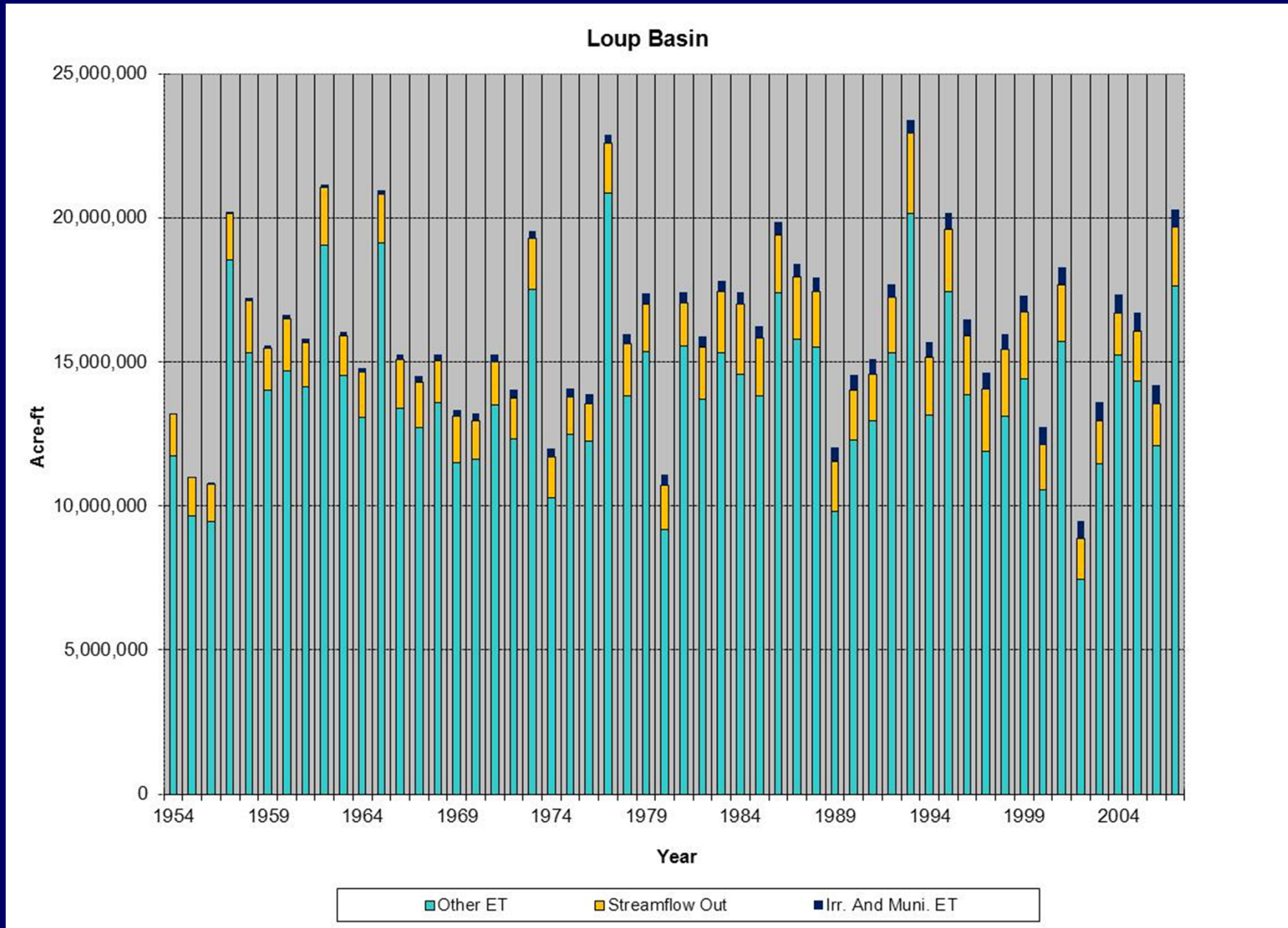
Total Average Annual Use Estimated at:

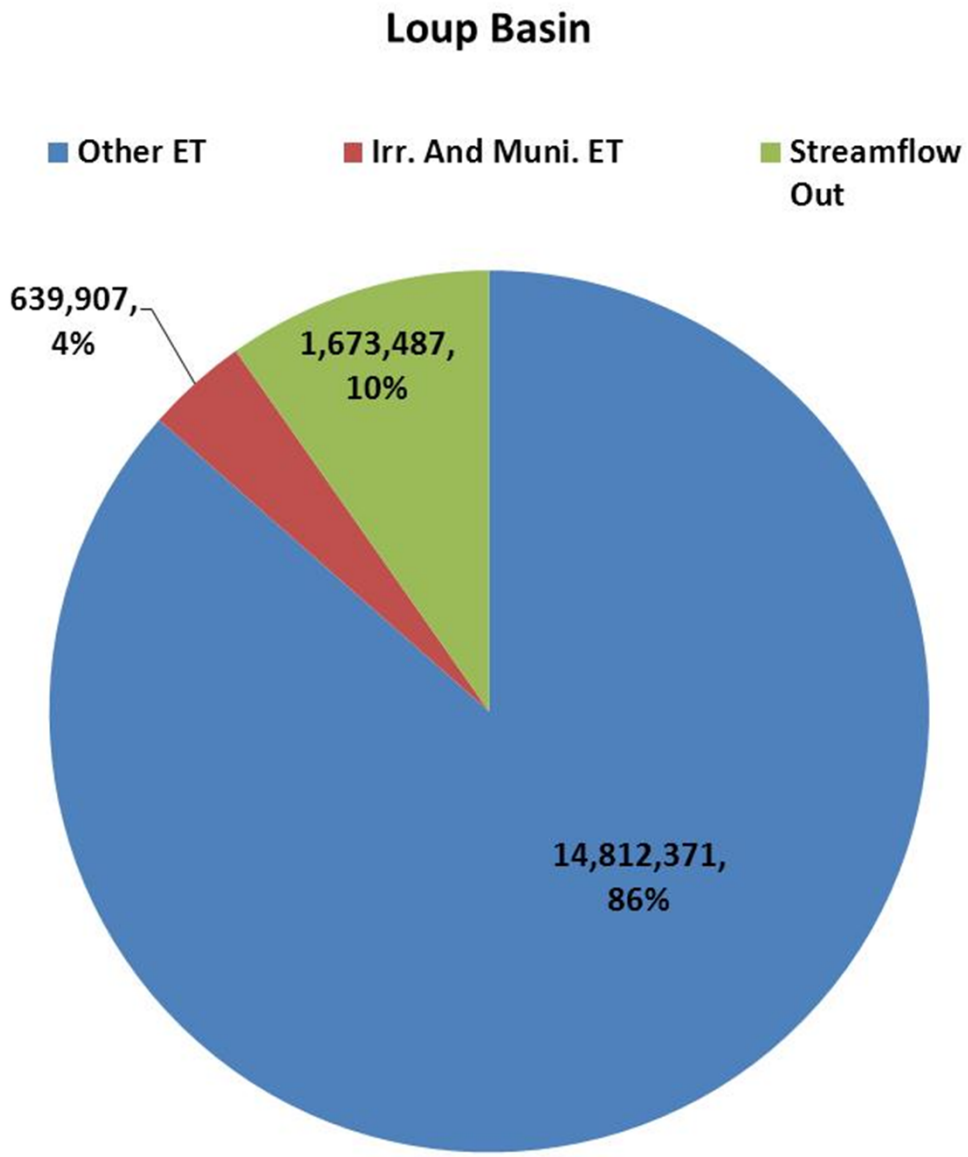
Basin NRDs: 1,400,000 ac-ft/yr

Loup Basin SW Districts: 110,500 ac-ft/yr

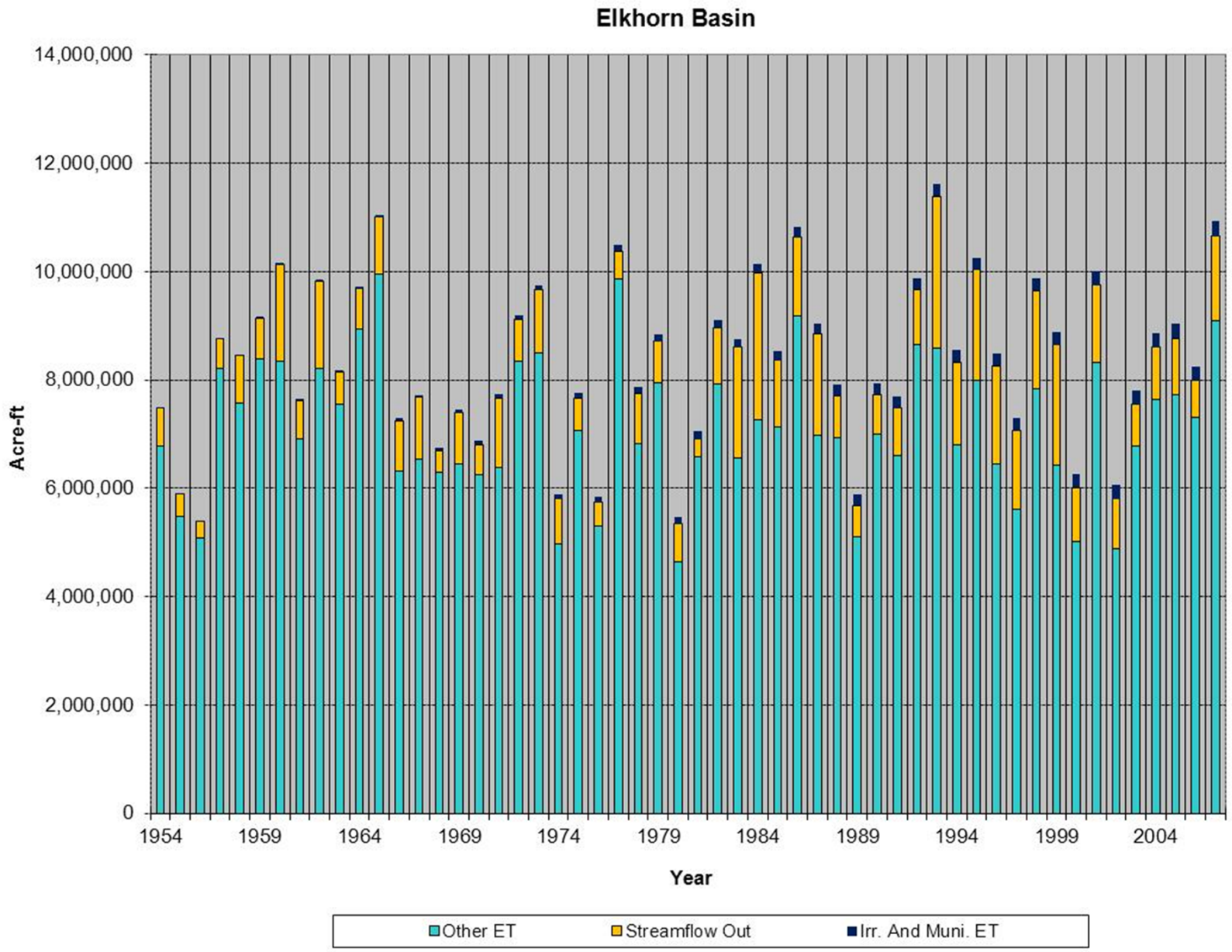
Out-of-Basin NRDs: 350,000 ac-ft/yr

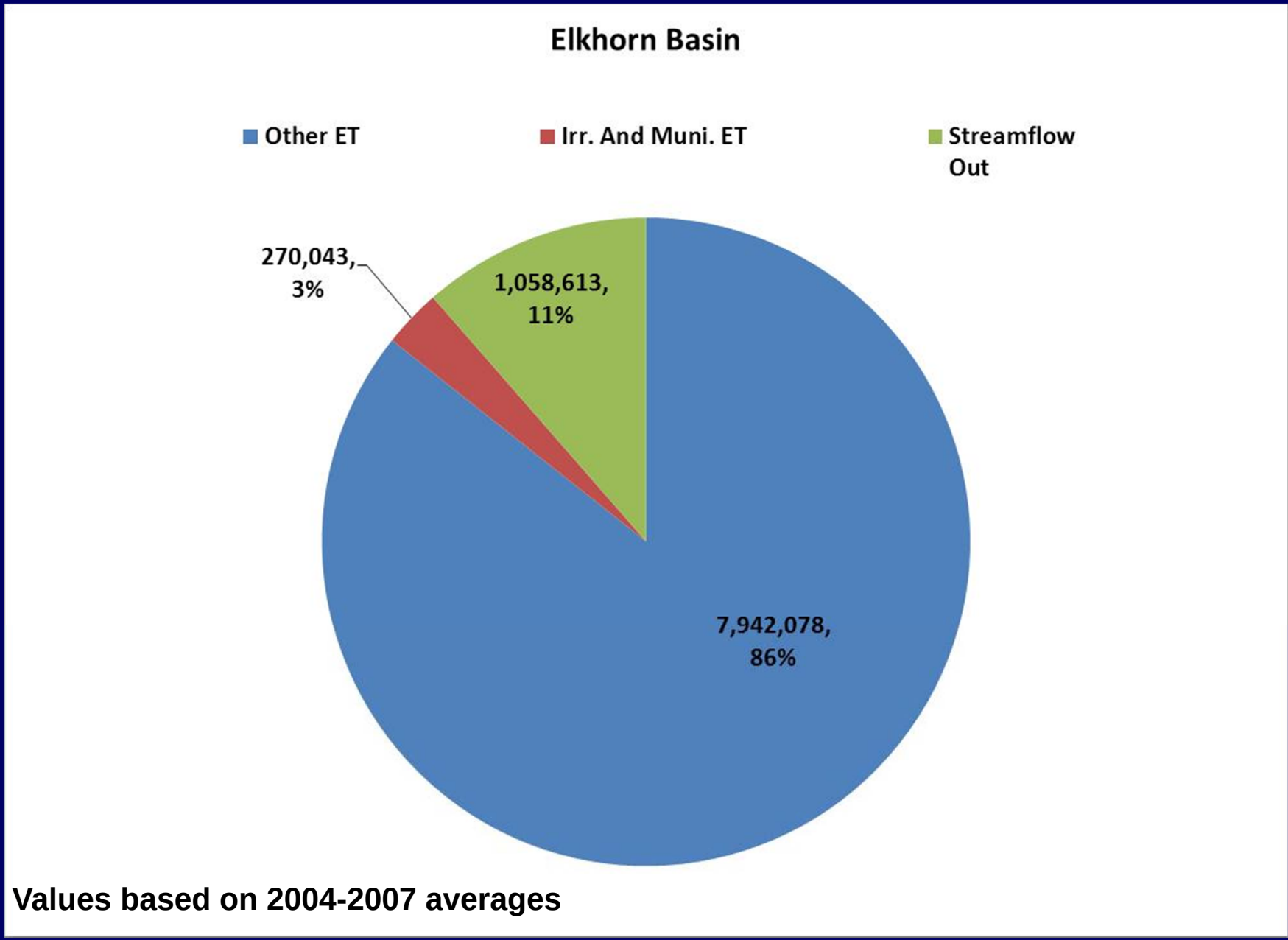
*Excludes municipal uses by NRDs outside of the basin


Loup Basin
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
Acre-ft
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
Year
Other ET
Streamflow Out
Irr. And Muni. ET

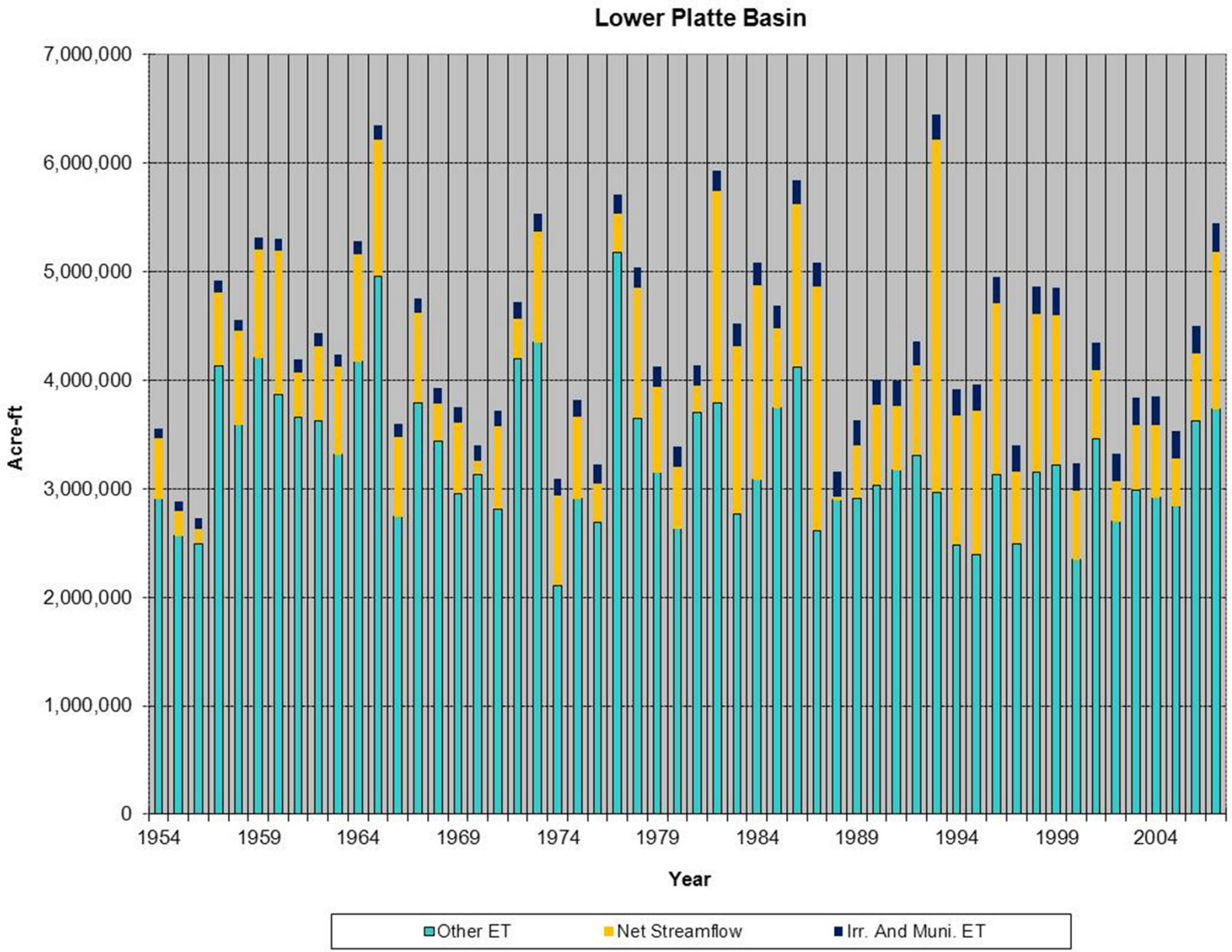


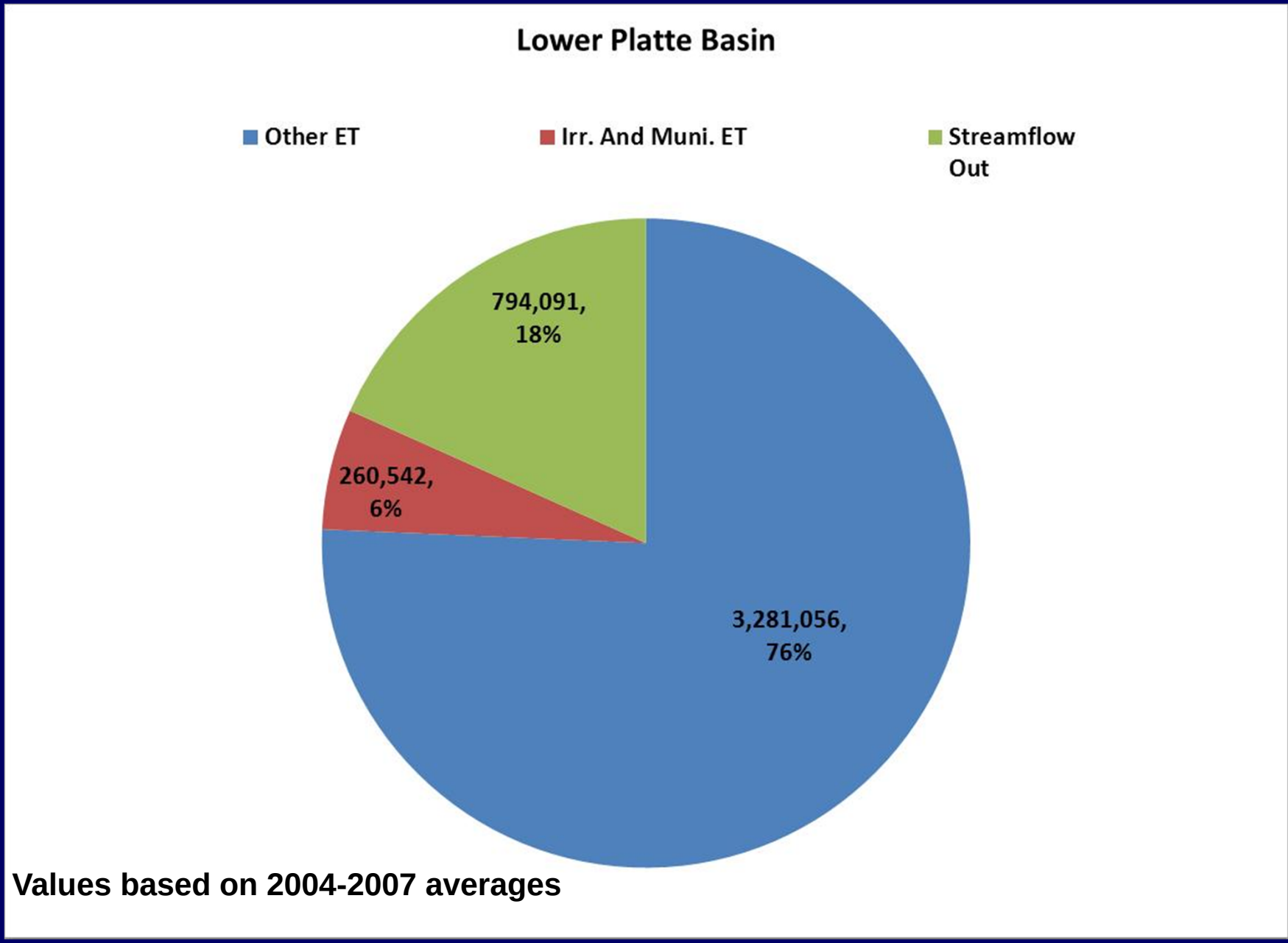
Values based on 2004-2007 averages


Elkhorn Basin
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
Acre-ft
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
Year
Other ET
Streamflow Out
Irr. And Muni. ET



Values based on 2004-2007 averages


Lower Platte Basin
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Acre-ft
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
Year
Other ET
Net Streamflow
Irr. And Muni. ET



Values based on 2004-2007 averages

Summary of Water Budget

- Approximately 85% - 90% of water supply for “Other ET”
- Approximately 10% - 18 % of water supply for streamflow out in Loup, Elkhorn, and Lower Platte rivers
- Approximately 3% - 6% of water supply for Irrigation and Municipal ET

Transient Streamflow Water Budget

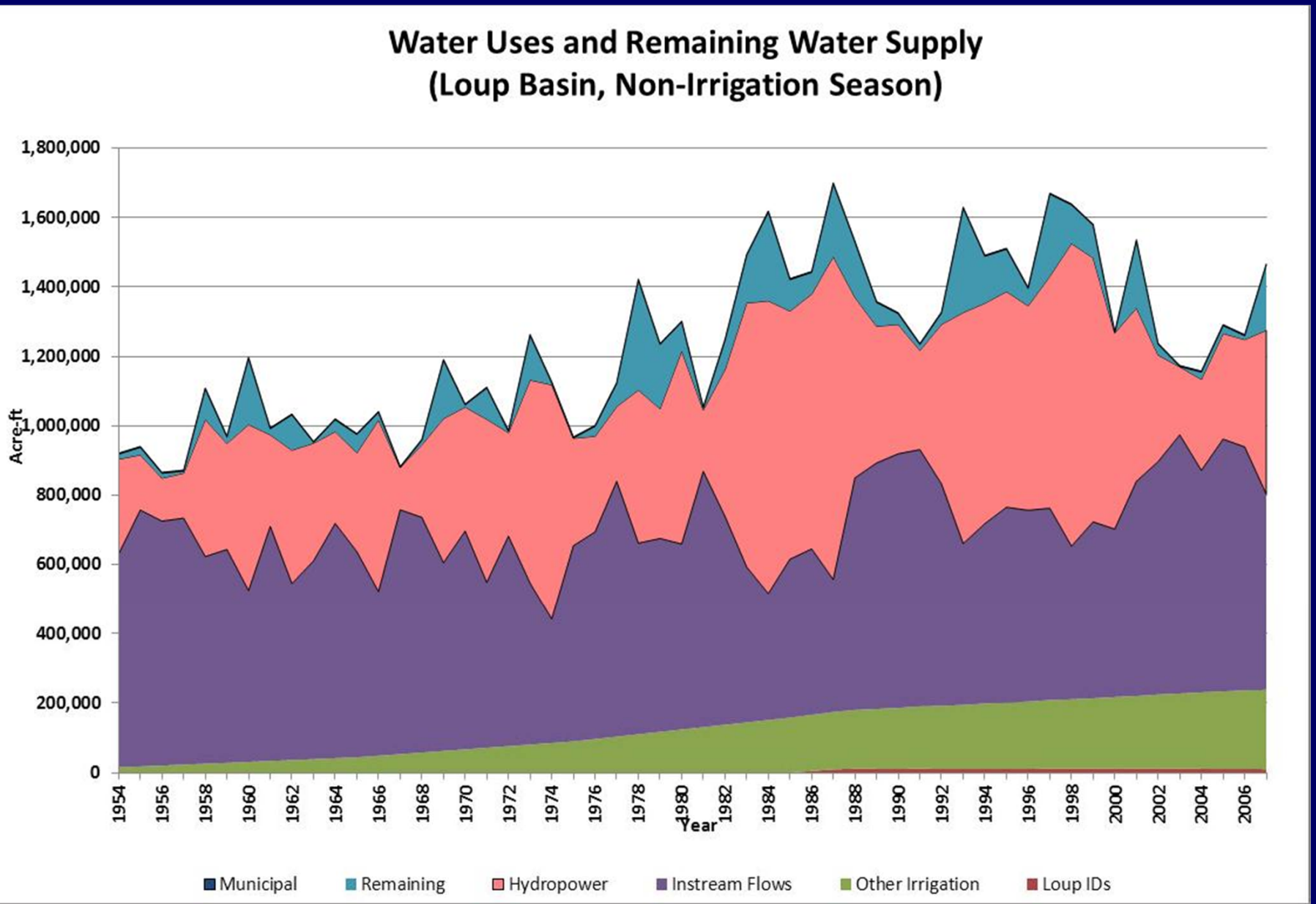
- Determine changes in consumption of streamflow through time
- Determine “remaining” streamflow supply
- Develop long-term water management strategies

* Same assumptions used for irrigation and municipal consumptive uses

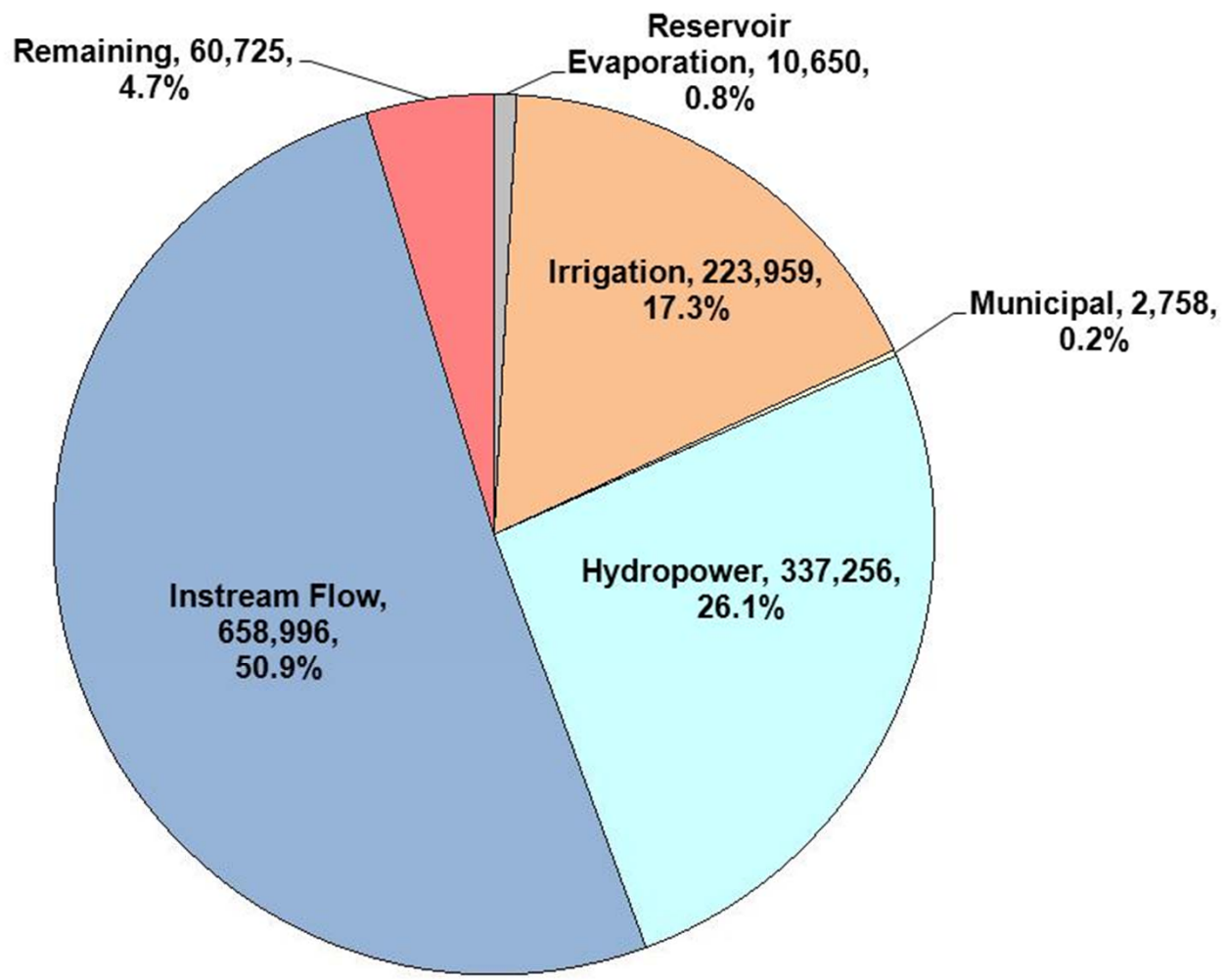
* Divided into irrigation (May - Sept) and non-irrigation season (Oct - April); depletions split equally

Component Description
(Instream Flows and Hydropower)

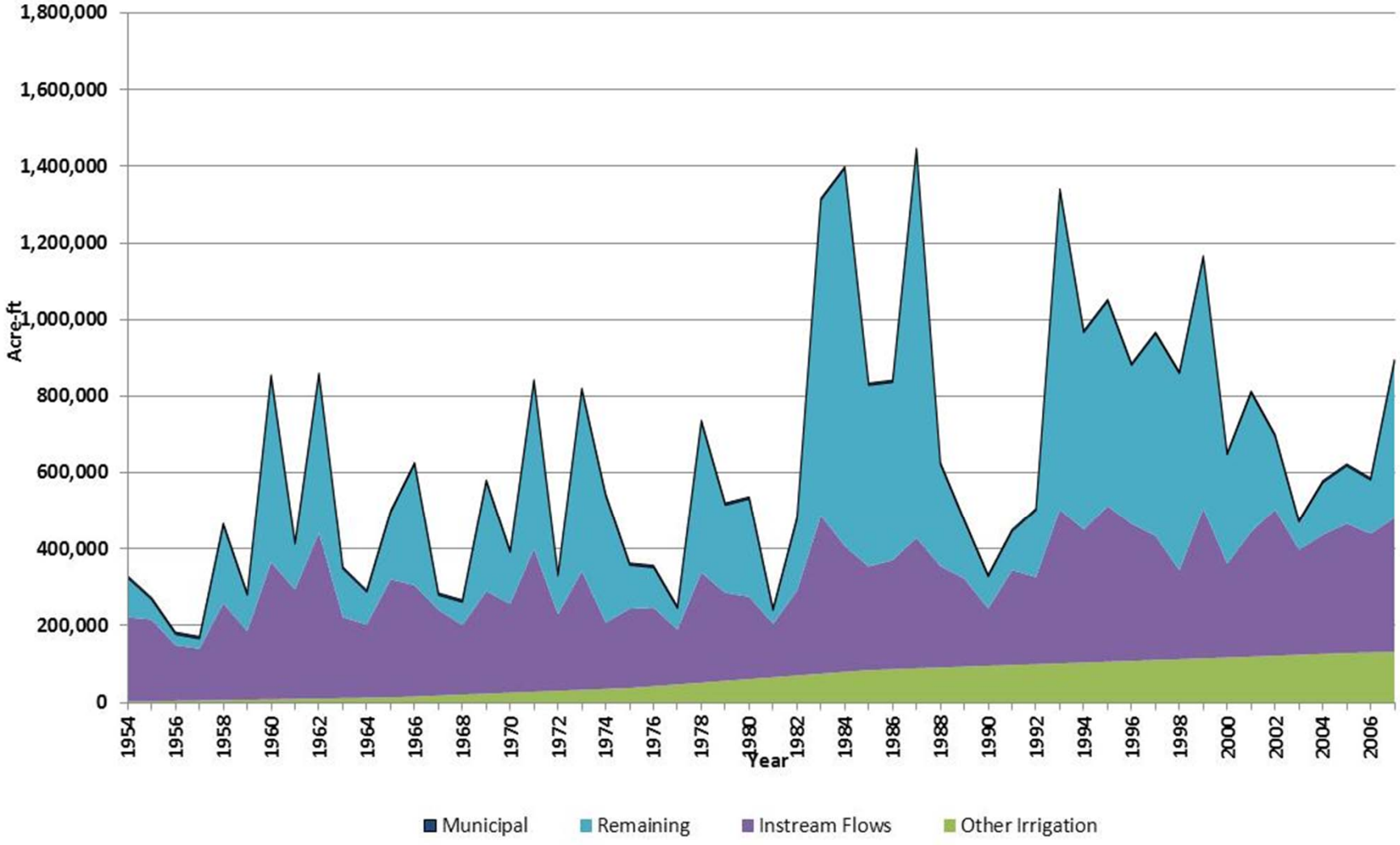
- All subbasins based on percentage of total streamflow at Louisville
- Loup (41% non-irr, 34% irr)
- Elkhorn (19% non-irr, 24% irr)
- Lower Platte (14% non-irr, 21% irr)
- LPPD additional hydropower demands calculated in excess of instream flow


Water Uses and Remaining Water Supply
(Loup Basin, Non-Irrigation Season)
Acre-ft
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Municipal
Remaining
Hydropower
Instream Flows
Other Irrigation
Loup IDs

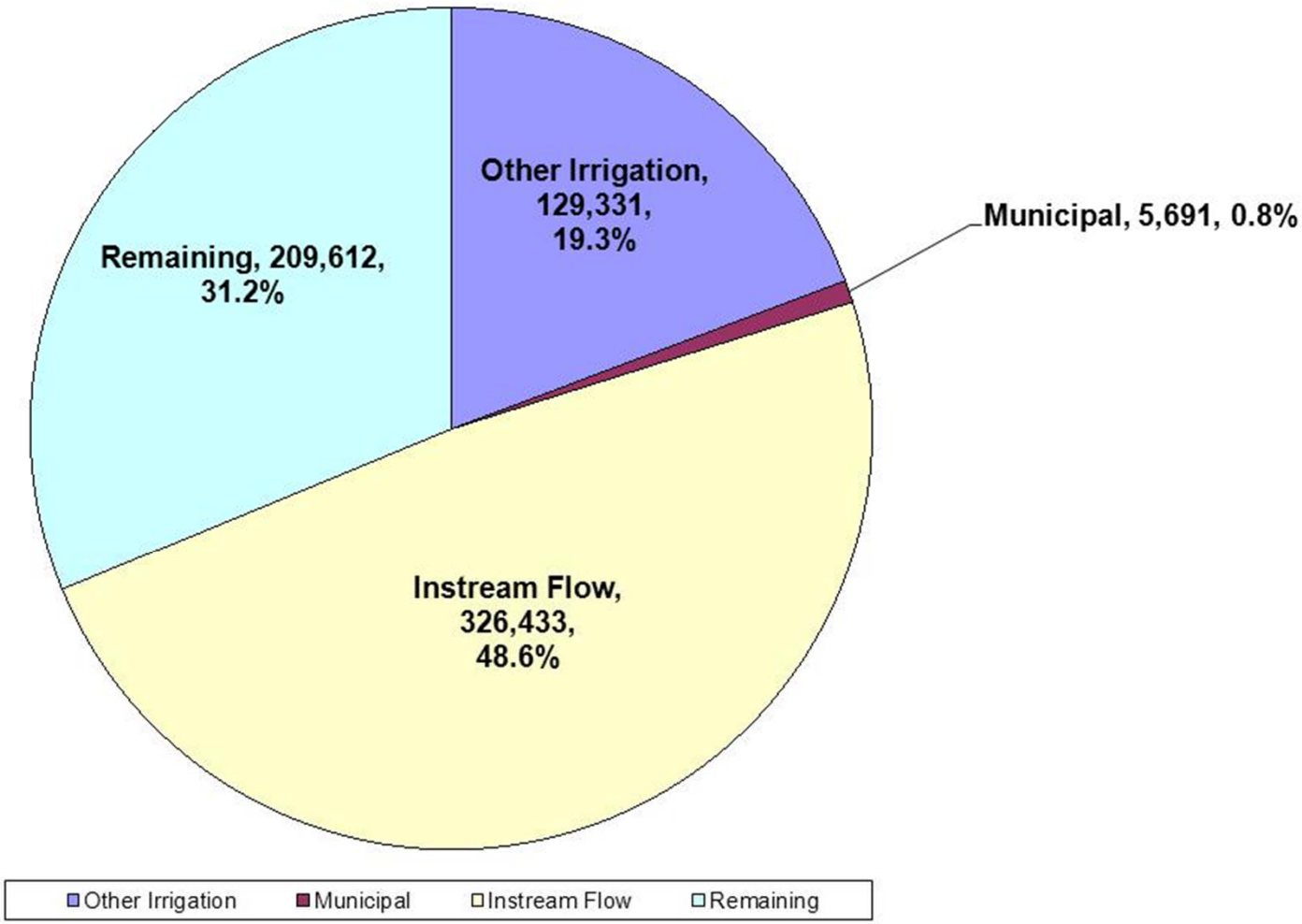
2004-2007 Average Values Loup Basin Non-Irrigation Season

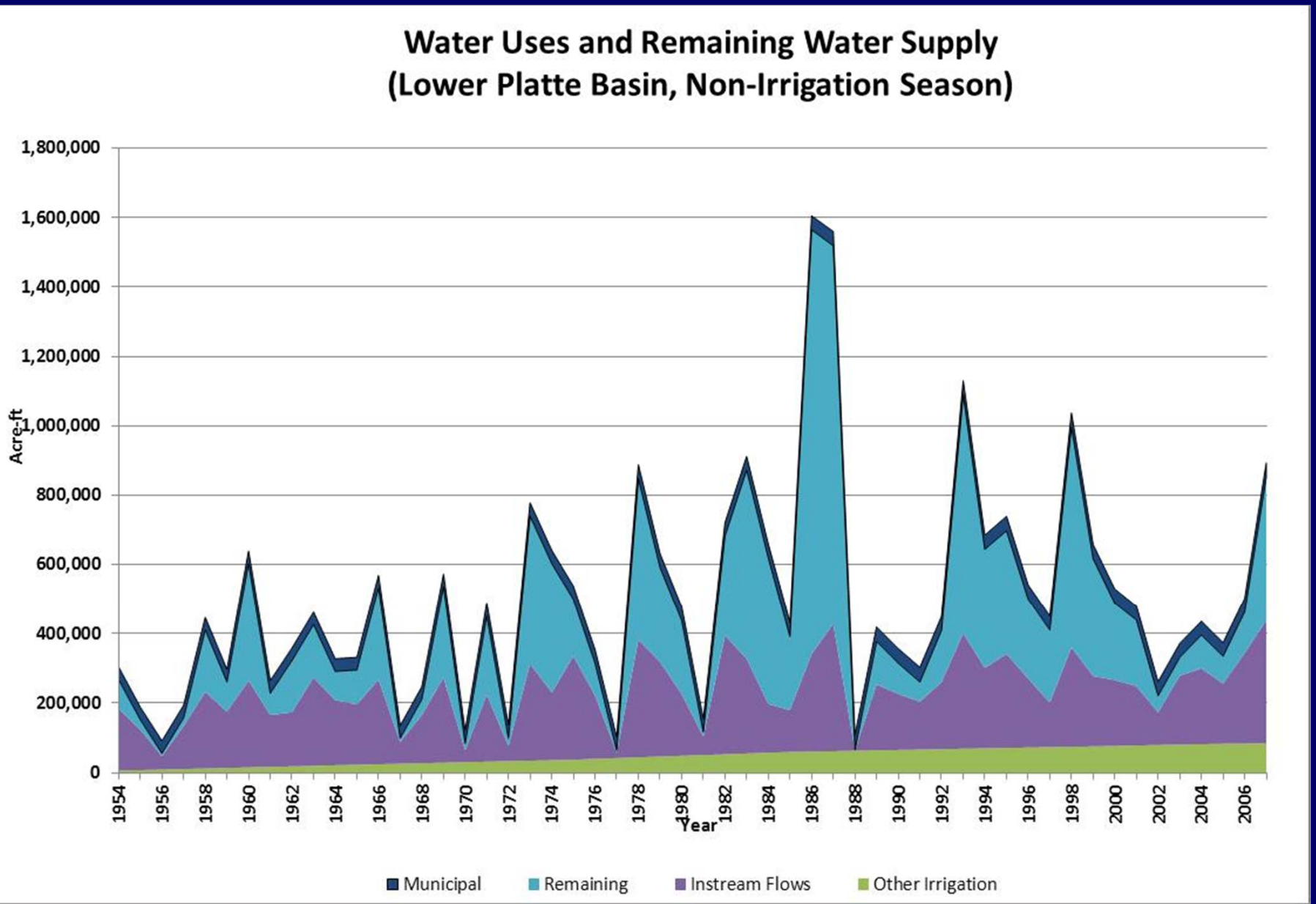


Water Uses and Remaining Water Supply
(Elkhorn Basin, Non-Irrigation Season)

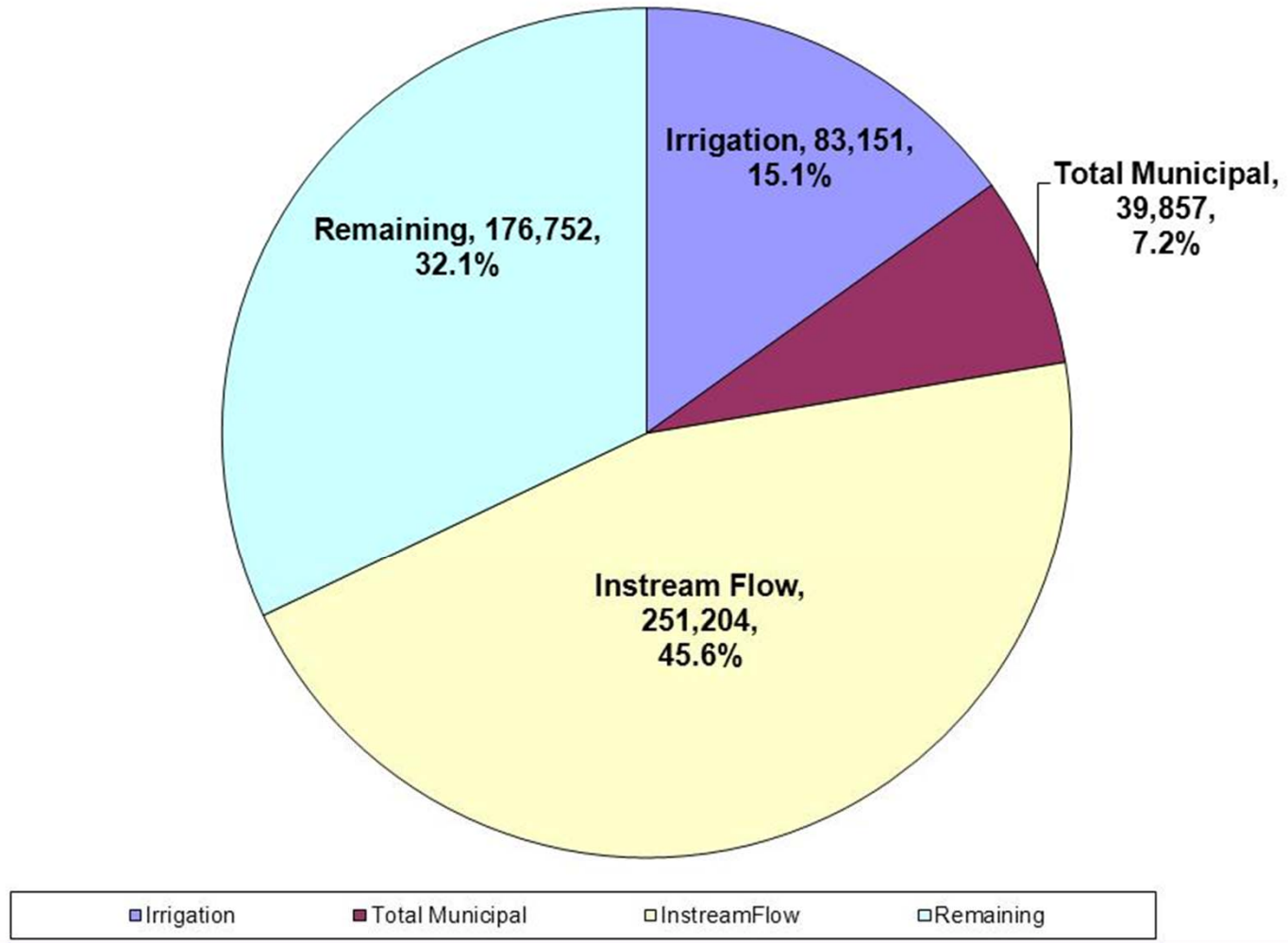


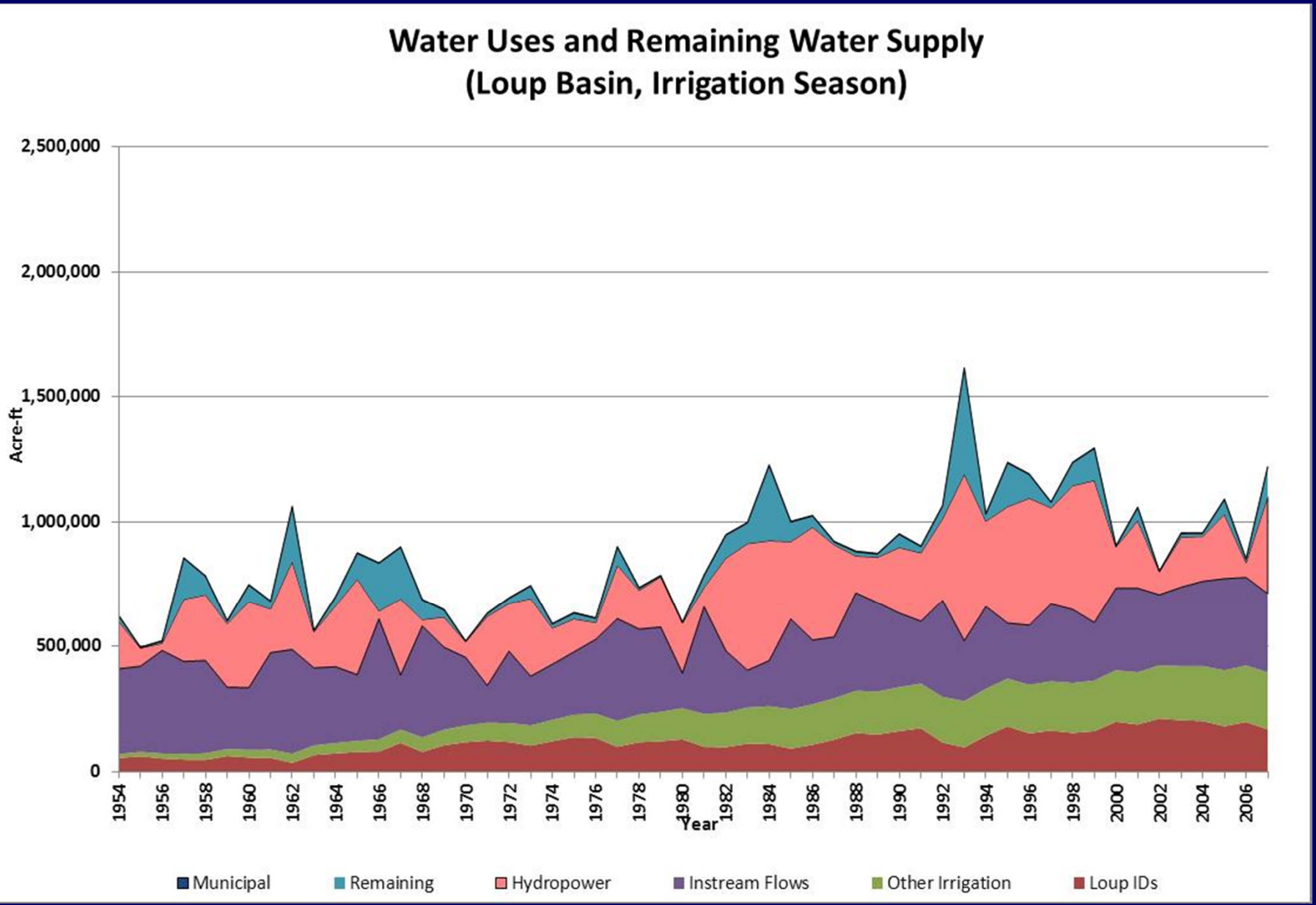
2004-2007 Average Values Elkhorn Basin Non-Irrigation Season



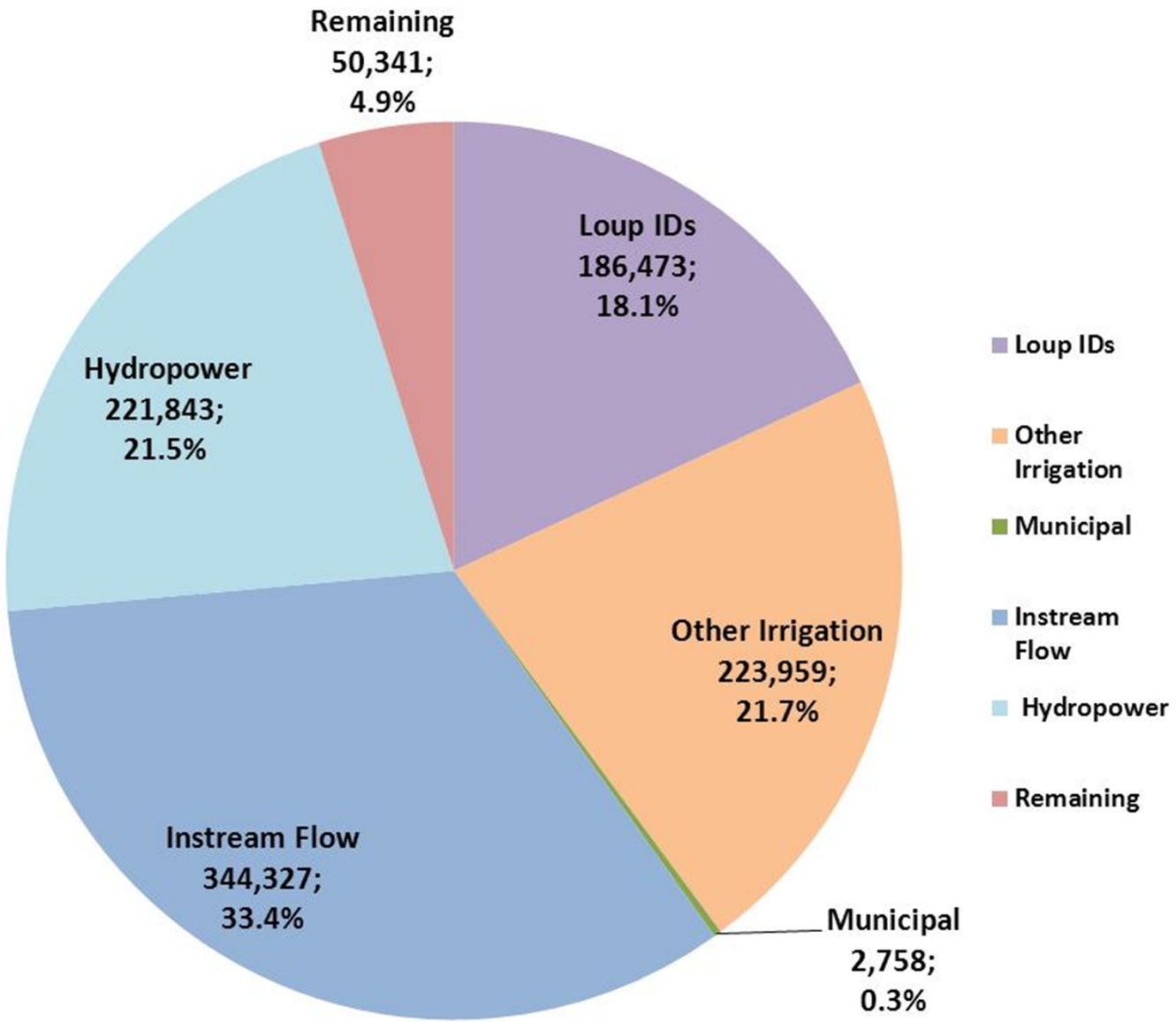

Water Uses and Remaining Water Supply
(Lower Platte Basin, Non-Irrigation Season)
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Acre-ft
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Municipal
Remaining
Instream Flows
Other Irrigation

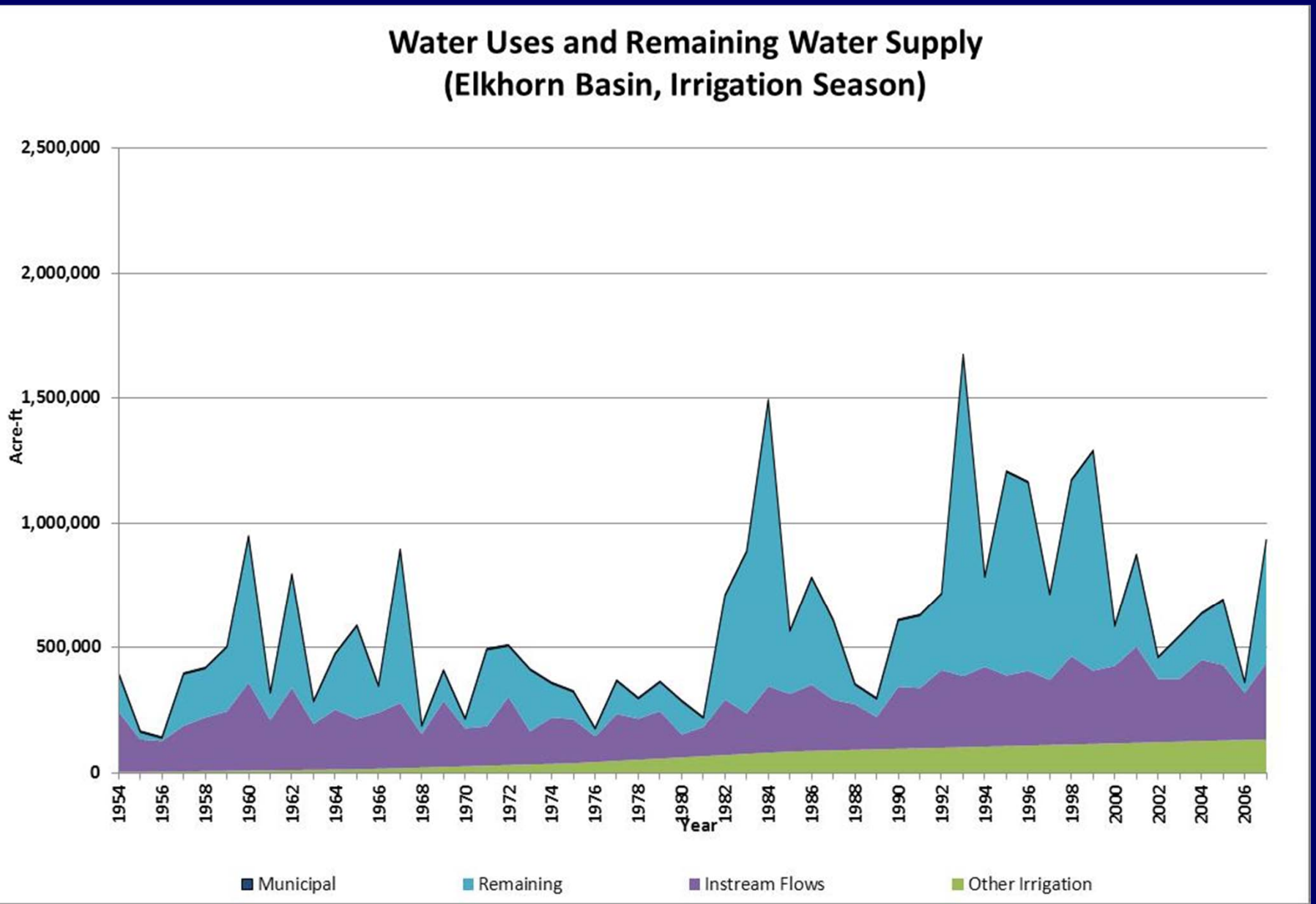
2004-2007 Average Values Lower Platte Basin Non-Irrigation Season



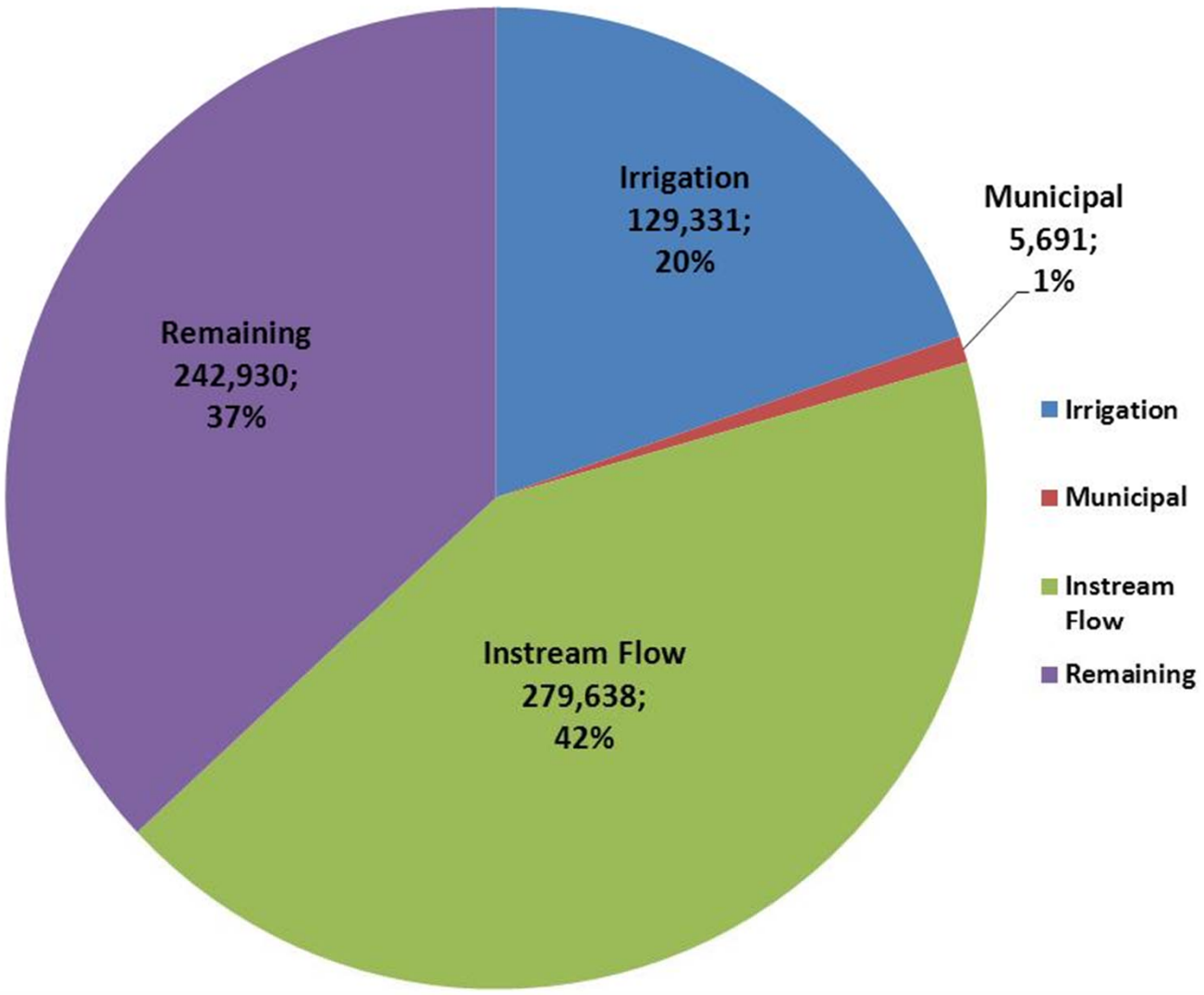

Water Uses and Remaining Water Supply
(Loup Basin, Irrigation Season)
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Acre-ft
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Municipal
Remaining
Hydropower
Instream Flows
Other Irrigation
Loup IDs

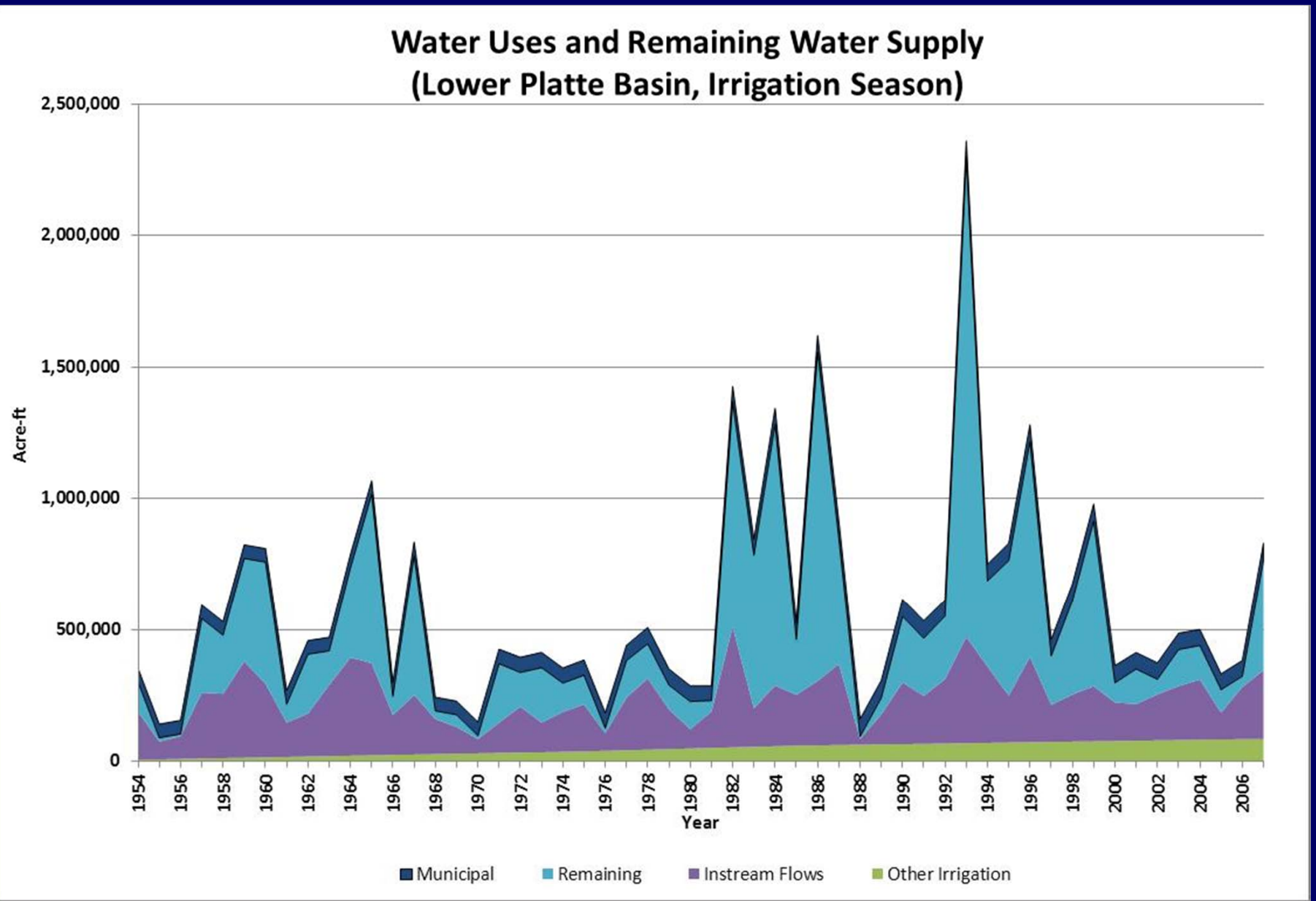
2004-2007 Average Values Loup Basin Irrigation Season



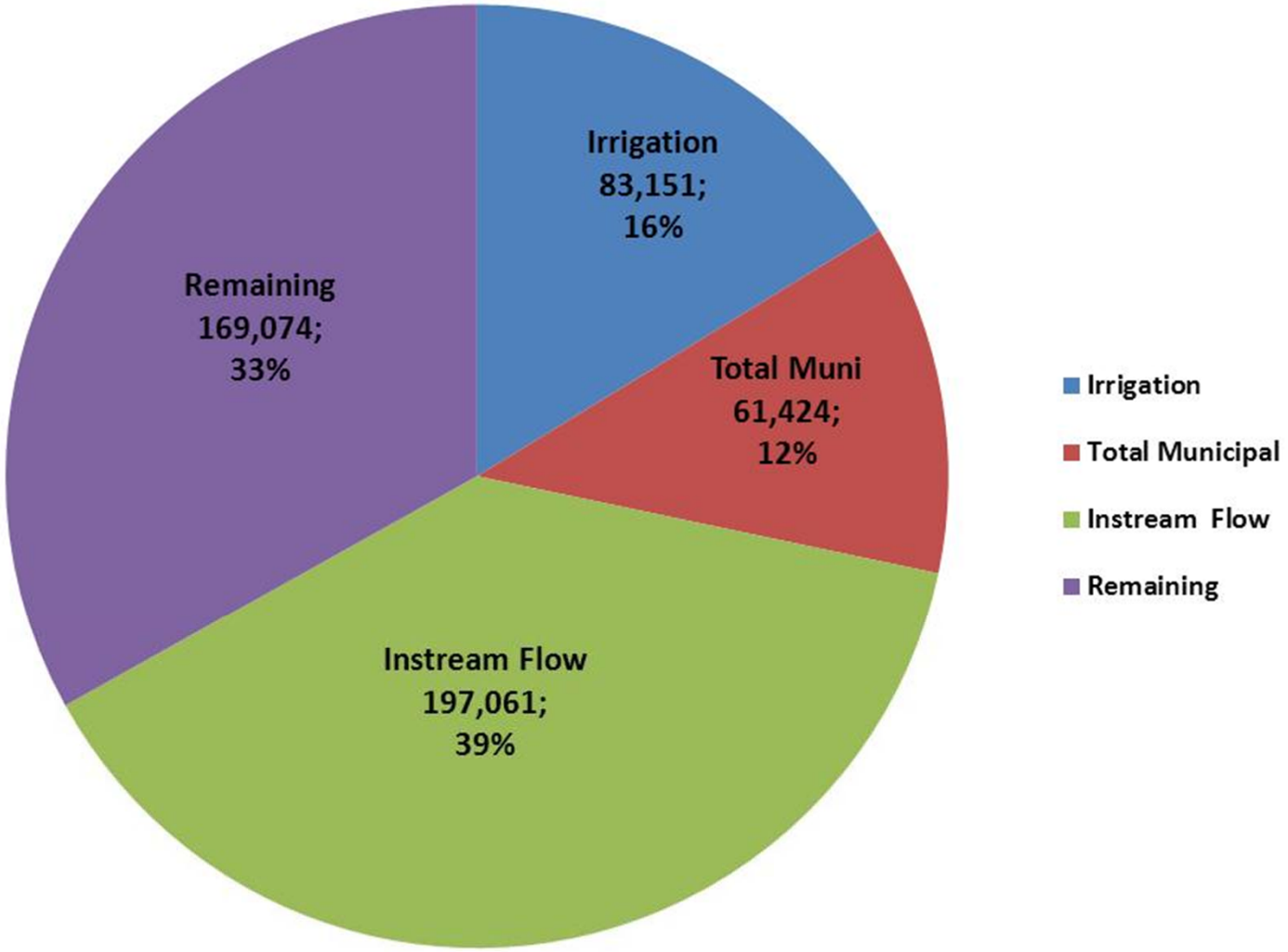

Water Uses and Remaining Water Supply
(Elkhorn Basin, Irrigation Season)
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Acre-ft
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Municipal
Remaining
Instream Flows
Other Irrigation

2004-2007 Average Values Elkhorn Basin Irrigation Season




Water Uses and Remaining Water Supply
(Lower Platte Basin, Irrigation Season)
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Acre-ft
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
Municipal
Remaining
Instream Flows
Other Irrigation

2004-2007 Average Values Lower Platte Basin Irrigation Season



Summary of Water Budget

- Approximately 15% - 20% irrigation depletion
- Approximately 33% - 50% instream flow
- Approximately 19% - 26% LPPD hydropower (55%-78% total)
- Typically less than 1% municipal (except Lower Platte 7% - 12%)
- “Remaining” water supply ranged from 5% - 37%

Summary of Water Budgets

- Total water budget guide for developing tools but limited in application
- Transient streamflow water budget most useful for integrated water management
- Assessments of current and future projected “remaining” streamflow water supply (excess flow report)

*Modeling Group meeting, Thurs. 1-5pm East Campus

Questions?

Jesse Bradley, P.G.
Integrated Water Management Coordinator
Nebraska Department of Natural Resources
301 Centennial Mall South, 4th Floor
Lincoln, NE 68509-4676

402-471-0586
Jesse.Bradley@nebraska.gov