RECLAMATION

Managing Water in the West

Missouri River Basin Depletions

November 2013

U.S. Department of the Interior
Bureau of Reclamation

Objectives

- Bureau of Reclamation Missouri River basin depletion terminology
- Past Missouri River basin depletion studies
- Current depletion calculations
- Sources of data
- Reclamation’s use of historic and present level depletions

RECLAMATION

RECLAMATION

Terminology

•Depletion: A loss of water from a surface water system resulting from a man induced activity.

•Crop Irrigation Requirement: The additional water, supplied by irrigation, needed to supplement the effective precipitation to adequately grow a given crop to maturity.

•Diversion Requirement: The amount of water diverted from a surface water source (stream) to satisfy the crop irrigation requirement and conveyance losses.

RECLAMATION

Terminology Continued

- Return Flow: The portion of the water diverted for a beneficial use that returns to the stream for potential future diversion or in-stream uses.

- Consumptive Use: Amount of water loss from the system through irrigated crops by evapotranspiration.

RECLAMATION

Terminology Continued

- Historic Depletions: Estimated amount of water depleted from the system from 1929 to 2007

- Present Level Depletions: Estimated amount of water that would be depleted monthly since 1929 based on current level of development

RECLAMATION

Background

- Monthly
- Surface Water
- Large Scale
- Theoretical

RECLAMATION

Past Depletion Studies

- 1982 Missouri Basin States Association (MBSA) Study
  - Also known as Missouri River Basin Commission
  - Study was from 1977-1982
  - All Missouri basin states, 10 federal agencies
  - Basis for all of Reclamation's Missouri River basin depletion studies after 1982

- 1999 Missouri River Depletion Study for U.S. Army Corps of Engineers Flood Frequency Analysis
  - Depletions for 1898 to 1996

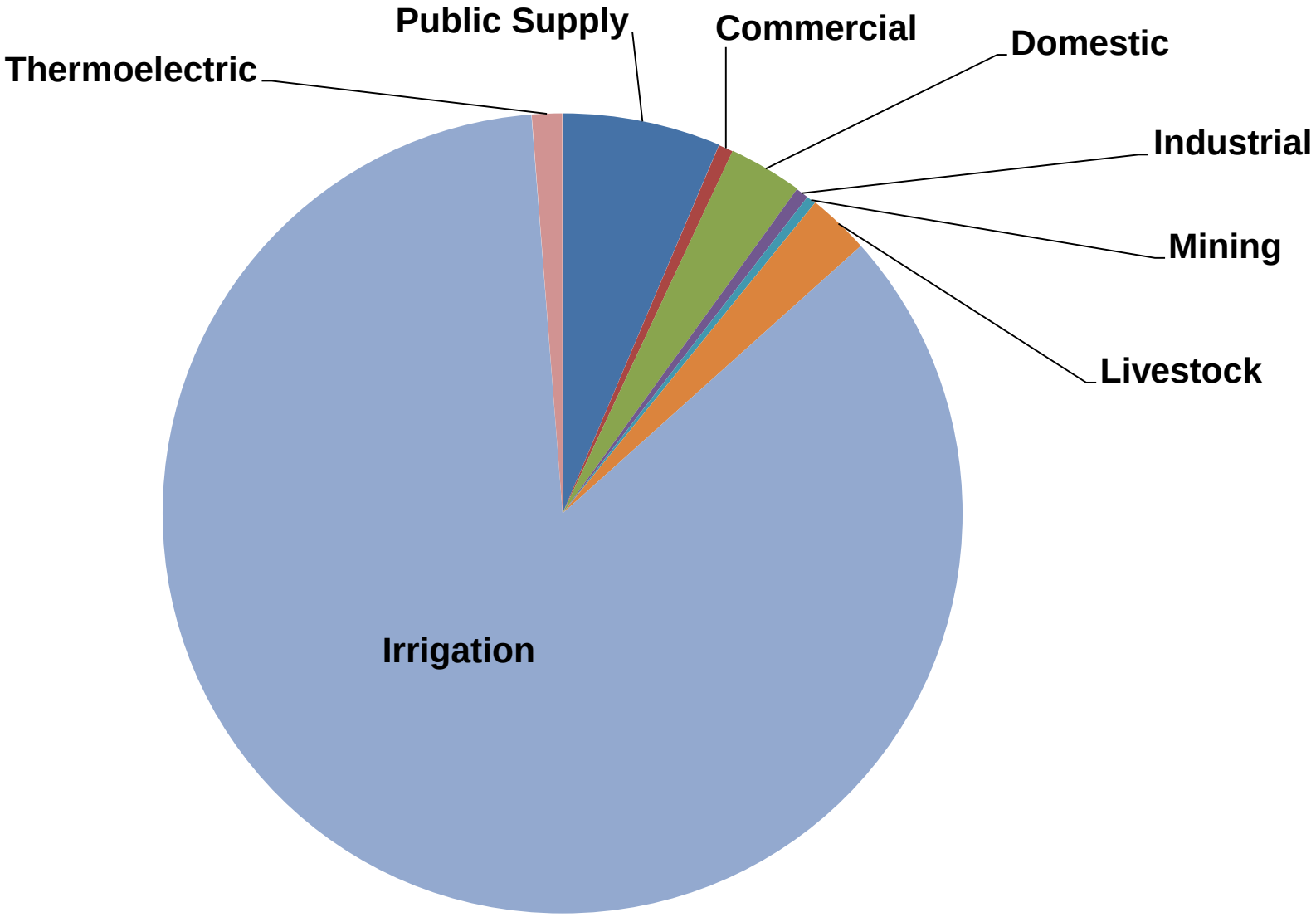
- 2005 Study to Determine the Historic and Present-Level Streamflow Depletions in the Missouri River Basin 1929 to 2002

RECLAMATION

Depletion Categories

- Irrigated agriculture
- Public surface water supply
- Reclamation reservoir holdouts
- Basin transfers

RECLAMATION



1995 USGS Water Use Data

RECLAMATION

Main Components to the Depletion Calculations

- Depletion data and calculations are currently maintained in a Microsoft Access Database
- Depletions calculated monthly 1929 to 2007
- Depletions are calculated by Hydrologic Unit (HUC)
- Depletions are updated every 5 years
  - Next update through 2012 (Update occur in 2014)
  - Schedule based on availability of Ag Census data

RECLAMATION

Missouri River Basin HUC Map

RECLAMATION

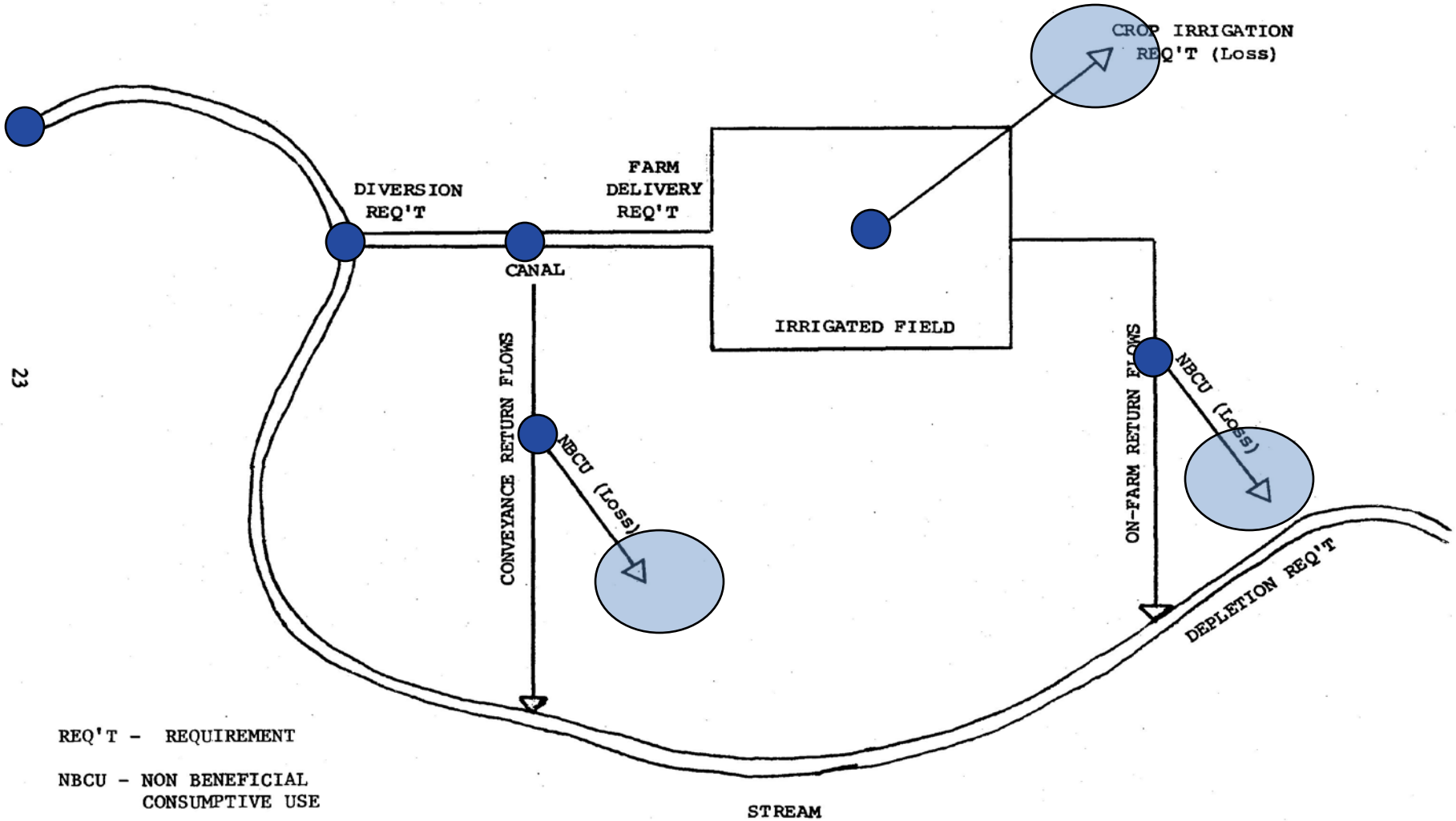
Irrigated Agriculture Depletions

- Depletions are calculated for each HUC

- Data required
  - Irrigated acres
  - Crop types and crop data (plant, cover, and harvest dates)
  - Temperature, precipitation, and solar data
  - Irrigation practices
  - Types of conveyance system
  - Return flow pattern
  - Percent of water supply from groundwater and surface water

RECLAMATION

FIGURE 4
SURFACE IRRIGATION DEPLETION DIAGRAM

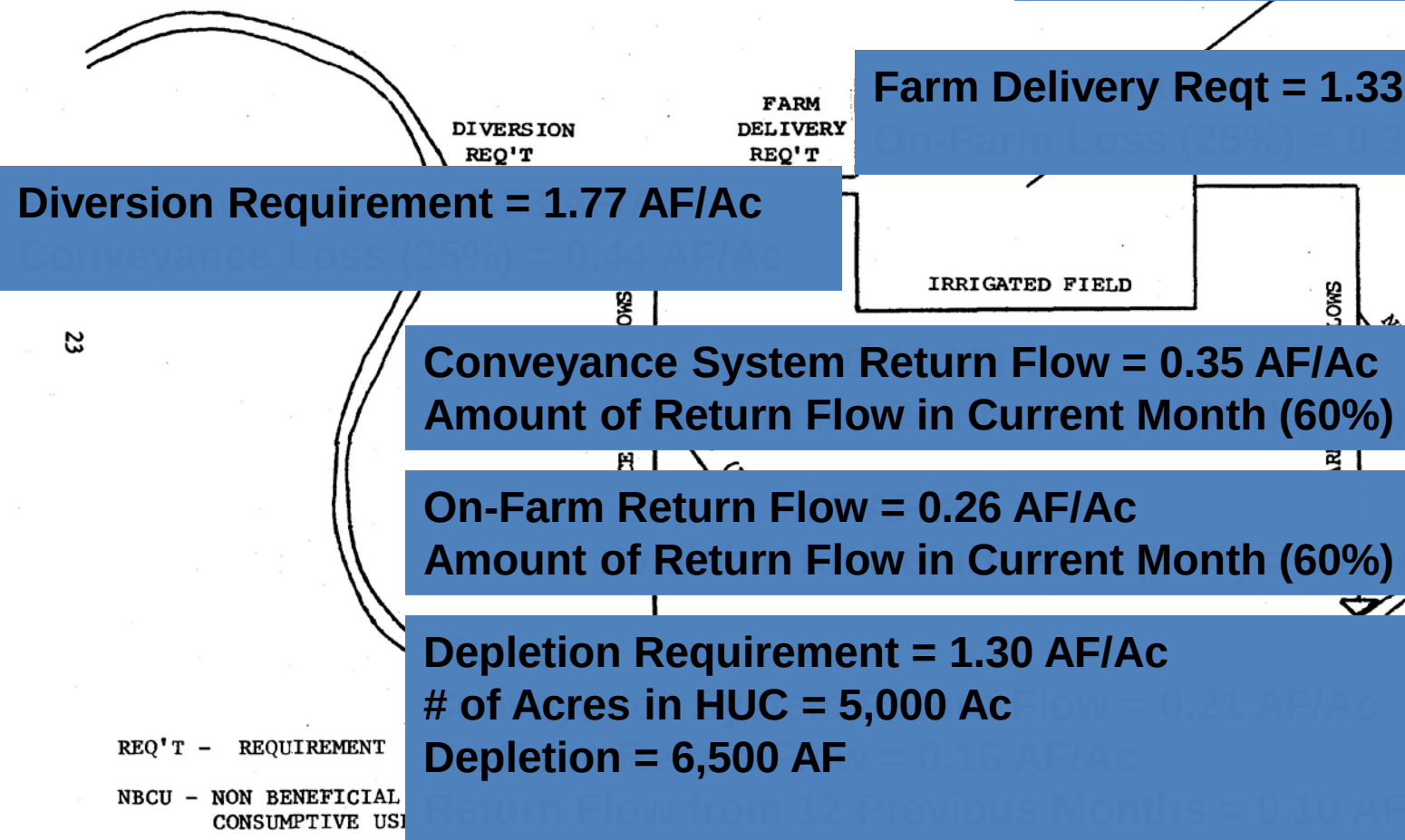


REQ'T - REQUIREMENT

NBCU - NON BENEFICIAL CONSUMPTIVE USE

RECLAMATION

FIGURE 4
SURFACE IRRIGATION DEPLETION DIAGRAM



CIR = 1.0 AF/Ac

Farm Delivery Reqt = 1.33 AF/Ac
On-Farm Loss (25%) = 0.33 AF/Ac

Diversion Requirement = 1.77 AF/Ac
Conveyance Loss (25%) = 0.44 AF/Ac

Conveyance System Return Flow = 0.35 AF/Ac
Amount of Return Flow in Current Month (60%) = 0.21 AF/Ac

On-Farm Return Flow = 0.26 AF/Ac
Amount of Return Flow in Current Month (60%) = 0.16 AF/Ac

Depletion Requirement = 1.30 AF/Ac
# of Acres in HUC = 5,000 Ac
Depletion = 6,500 AF

Flow = 0.21 AF/Ac
= 0.16 AF/Ac
Return Flow from 12 Previous Months = 0.10 AF/Ac
Depletion Requirement = 1.30 AF/Ac

Irrigated Agriculture Depletions Data Sources

- Irrigated agriculture acreage data comes from Ag Census Data
  - Collected every 5 years by Department of Ag
  - Data by county
  - Interpolate to get annual data

RECLAMATION

Irrigated Agriculture Depletions Data Sources Continued

- On-farm irrigation system
  - MBSA Study (1978 NRCS Surveys)
- On-farm and conveyance system efficiencies
  - Data comes from MBSA Study

RECLAMATION

Irrigated Agriculture Depletions Data Sources Continued

- Return flows
  - Data from MBSA Study

- Crop Data
  - Crop Types: MBSA Study, 1978 NRCS Surveys
  - MBSA Study and NRCS Crop Irrigation Guides
    - Planting dates
    - Cover dates
    - Harvest dates
    - Cutting dates

RECLAMATION

Irrigated Agriculture Depletions Data Sources Continued

- Groundwater and surface water distribution
  - MBSA Study

- Temperature and Precipitation Data
  - Data from climate stations
    - Station selection criteria included period of record and centrally located in HUC
  - Missing or incomplete data from climate stations
    - EarthInfo
    - National Climate Data Center (NCDC)

RECLAMATION

Irrigated Agriculture Depletions Data Sources Continued

- Solar Radiation
  - Climate stations
  - Average monthly values when there is no data

- Crop Irrigation Requirement
  - Two methods: Blaney-Criddle and Jensen-Haise
  - Same methods from the MBSA Study

RECLAMATION

Public Water Supply Depletions

PWSD =
HUC Population *
% Served by Surface Water *
Average Water Use per Capita *
% for Monthly Distribution *
0.37

<u>Example</u>
PWSD = (10,000 people)(0.70)(0.2 AF/person/year)(0.10)(0.37)
PWSD = 51.8 acre-feet

RECLAMATION

Public Water Supply Depletions Continued

- Population
  - Data from U.S. Census Bureau
  - Linear interpolation for non-census years
- Percent served by surface water supply
  - Average of 1985, 1990, 1995 USGS Water Use Reports
- Per Capita Water Use
  - Average of 1985, 1990, 1995 USGS Water Use Reports

RECLAMATION

Public Water Supply Depletions Continued

- Monthly Distribution

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
3	3	6	7	10	13	18	15	11	8	3	3	100

  - Percentages from MBSA Study

- Consumptive Use Factor (0.37)
  - 37% of the water diverted is consumed
  - 63% returns to surface water supply
  - MT DNRC Report

RECLAMATION

Reservoir Holdouts

- Water stored in a reservoir or lost to evaporation
- Only Calculate Holdouts for Reclamation Reservoirs
- Data comes from Reclamation's Hydromet Data System

RECLAMATION

Reservoir Holdouts Continued

Canyon Ferry Reservoir

Estimated Storage Impacts to Streamflow

Month Index		RES070 Hydromet Retrieval: Computed Inflow (AF.IN)	Total Discharge (AF.QD)	EOM Stor (AF.EOM)	Forebay Elevation (FB.EOM)	Computed EOM Area (acres)	Computed Reservoir Evap (AF)	Monthly Storage Change (AF)	Storage Impact (AF)	Storage Impact (KAF)
2	Feb-53	205700		0	0	0	0			
3	Mar-53	221400	29752	54018	3675	2685	78	54018	54096	54.096
4	Apr-53	275943	249435	80525	3683	4115	262	26507	26769	26.769
5	May-53	299694	237090	143129	3694	5792	459	62604	63063	63.063
6	Jun-53	921751	343688	721188	3749	16081	2233	578059	580292	580.292
7	Jul-53	301083	254065	768206	3752	16995	3371	47018	50389	50.389
8	Aug-53	166928	162482	772651	3752	17081	4254	4445	8699	8.699
9	Sep-53	207855	142850	837656	3755	18346	3360	65005	68365	68.365
10	Oct-53	268748	209484	896920	3759	19627	2072	59264	61336	61.336

PEVT from Basins 4 for Townsend

Location	MT248324
Constituent	PEVT
Constituent	PEVT (inches)
1953/02	0.537
1953/03	1.03
1953/04	1.49
1953/05	2.42
1953/06	3.57
1953/07	4.85
1953/08	3.7
1953/09	2.12
1953/10	1.18

RECLAMATION

Reservoir Holdouts Continued

- Present-level impacts are premised on the condition that current reservoir conditions existed from 1929 to current.

- The median of the monthly historic storage impacts are used to approximate the present-level impacts for periods between 1929 and current when reservoirs did not exist.

- The median monthly impact is based on historic data, but adjusted to remove the first year or several months of storage data when reservoir was initially filled.

RECLAMATION

Basin Diversions

- Colorado River Basin into South Platte Basin
  - Adams Tunnel
  - Roberts Tunnel
  - Moffat Tunnel
  - Grand River Ditch
  - Berthoud Pass Ditch

- North Platte River Basin into South Platte Basin
  - Laramie-Poudre Tunnel
  - Michigan Ditch

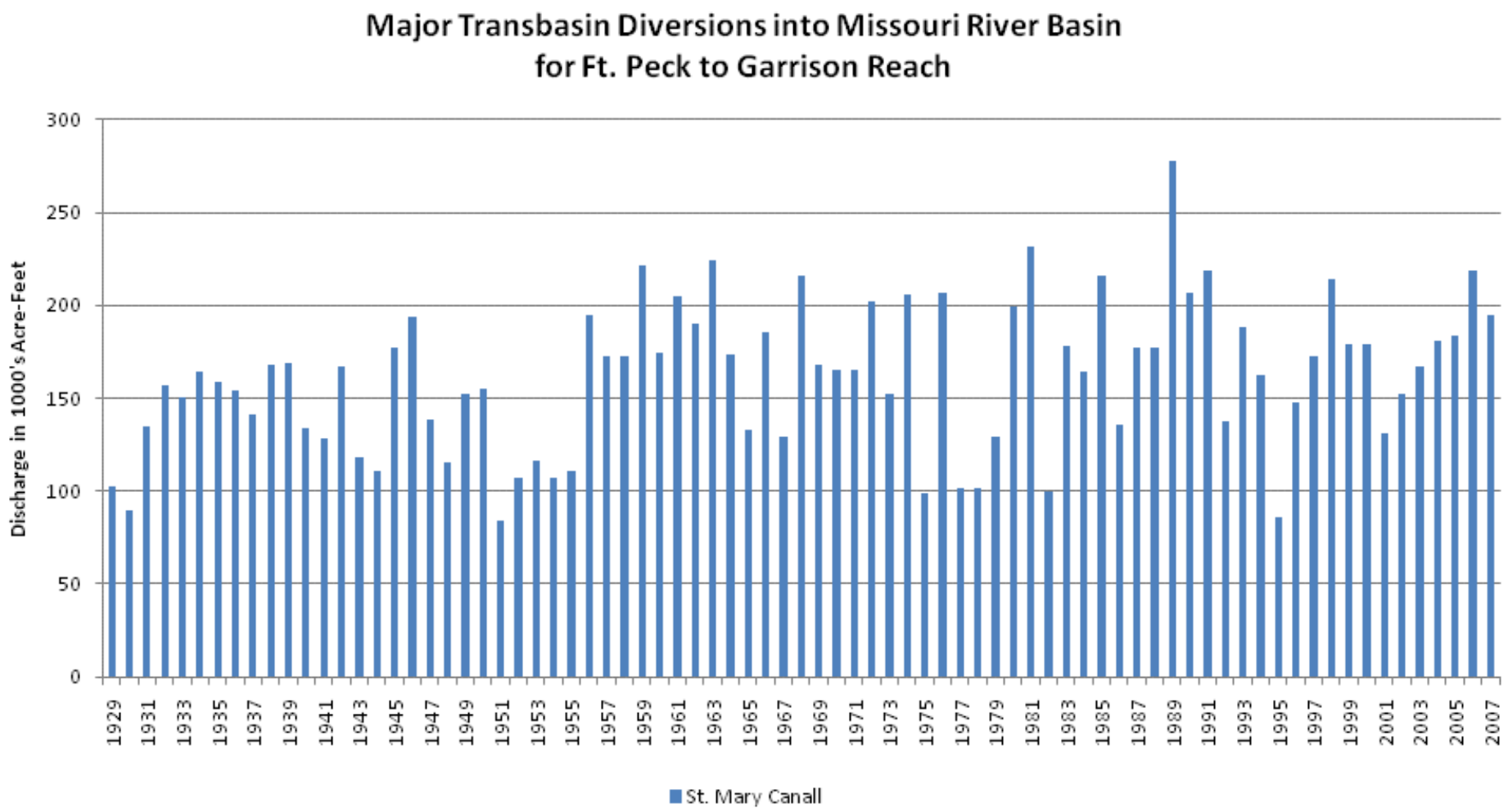
RECLAMATION

Basin Diversions Continued

- Arkansas River Basin into South Platte Basin
  - Aurora Homestake Pipeline
- Hudson Bay Basin to Milk River Basin
  - St. Mary Canal
- Tracks the quantity of water diverted each month
- Data comes from
  - Colorado Decision Support System
  - South Platte Decision Support System Memo
  - USGS NWIS
  - Reclamation AOPs
  - Hydromet Data System

RECLAMATION

Basin Diversions Continued



RECLAMATION

Historic Depletions and Present Level Depletions

- Historic Depletions: Estimated amount of water depleted from the system from 1929 to 2007, given in acre-feet by month.

- Present Level Depletions: Estimated amount of water that would be depleted since 1929 based on current level of development, given in acre-feet by month.

- Natural Flow: Gage data plus historic depletions

RECLAMATION

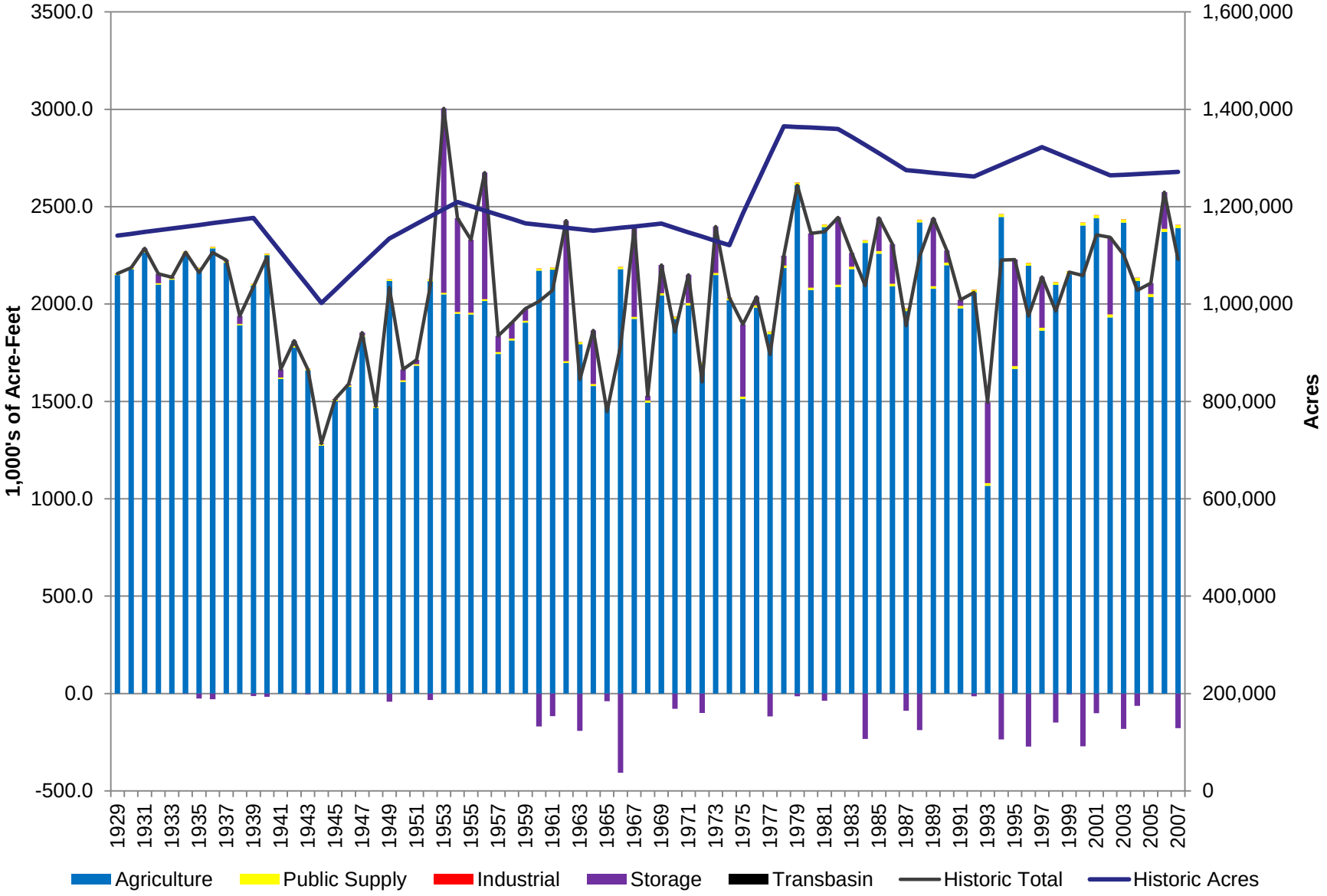
Future and Specific Project Analysis

- Using the same methodologies, calculate depletions from anticipated future projects

- Using projected population growth from U.S. Census Bureau and state projections, estimate additional public surface water supply and industrial water supply depletions

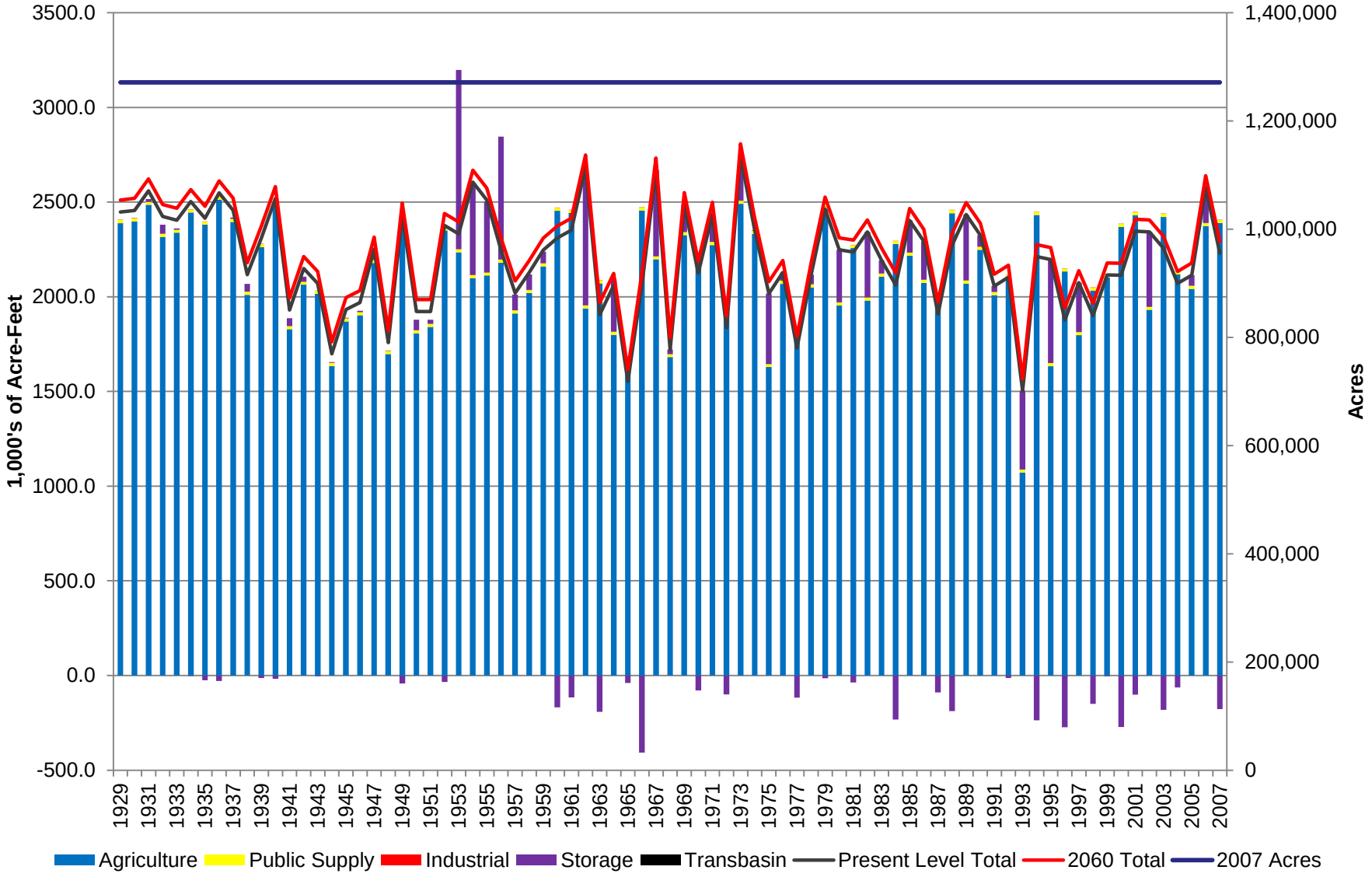
RECLAMATION

Above Fort Peck: Annual Historic Depletions



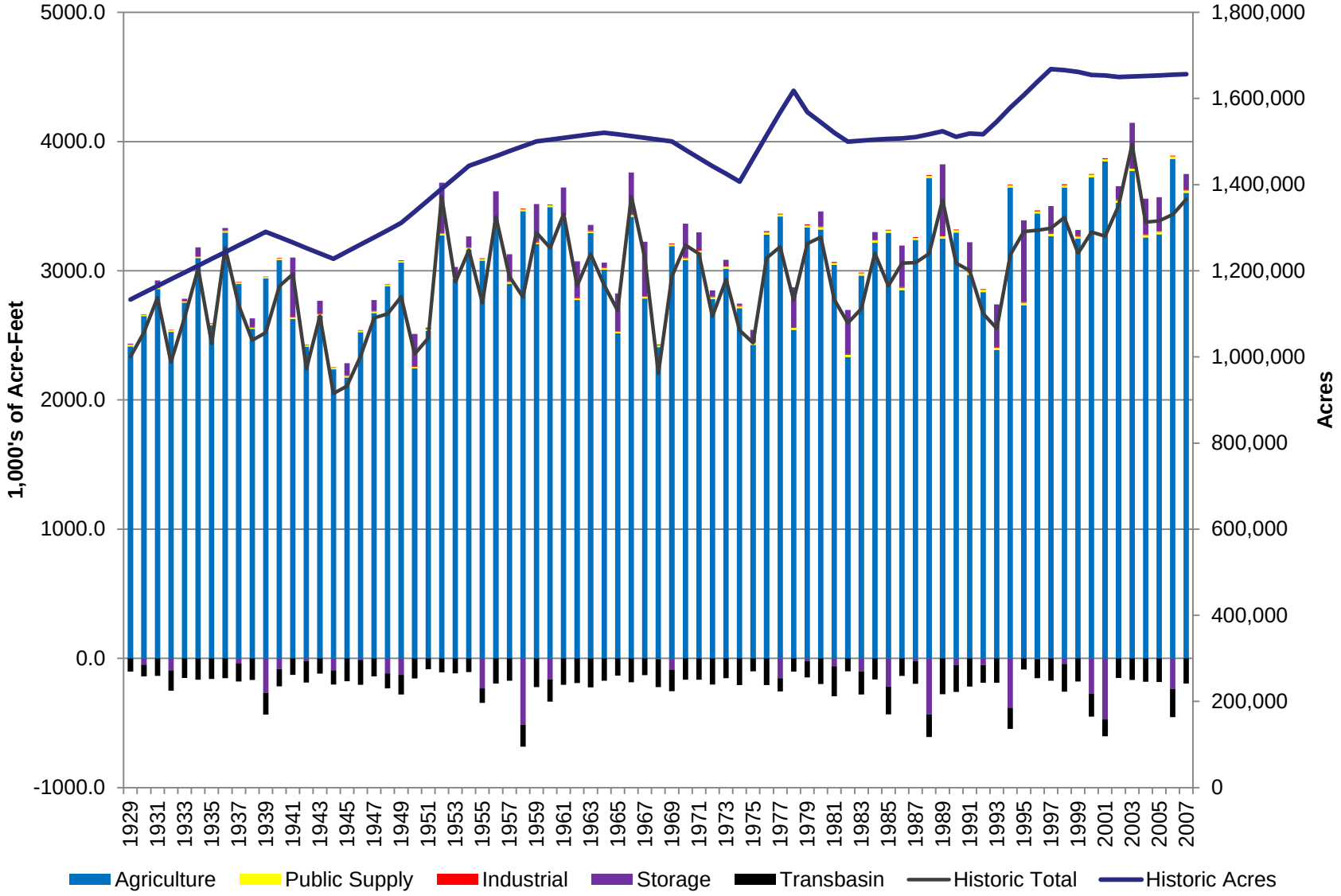
RECLAMATION

Above Fort Peck: Annual Present Level Depletions



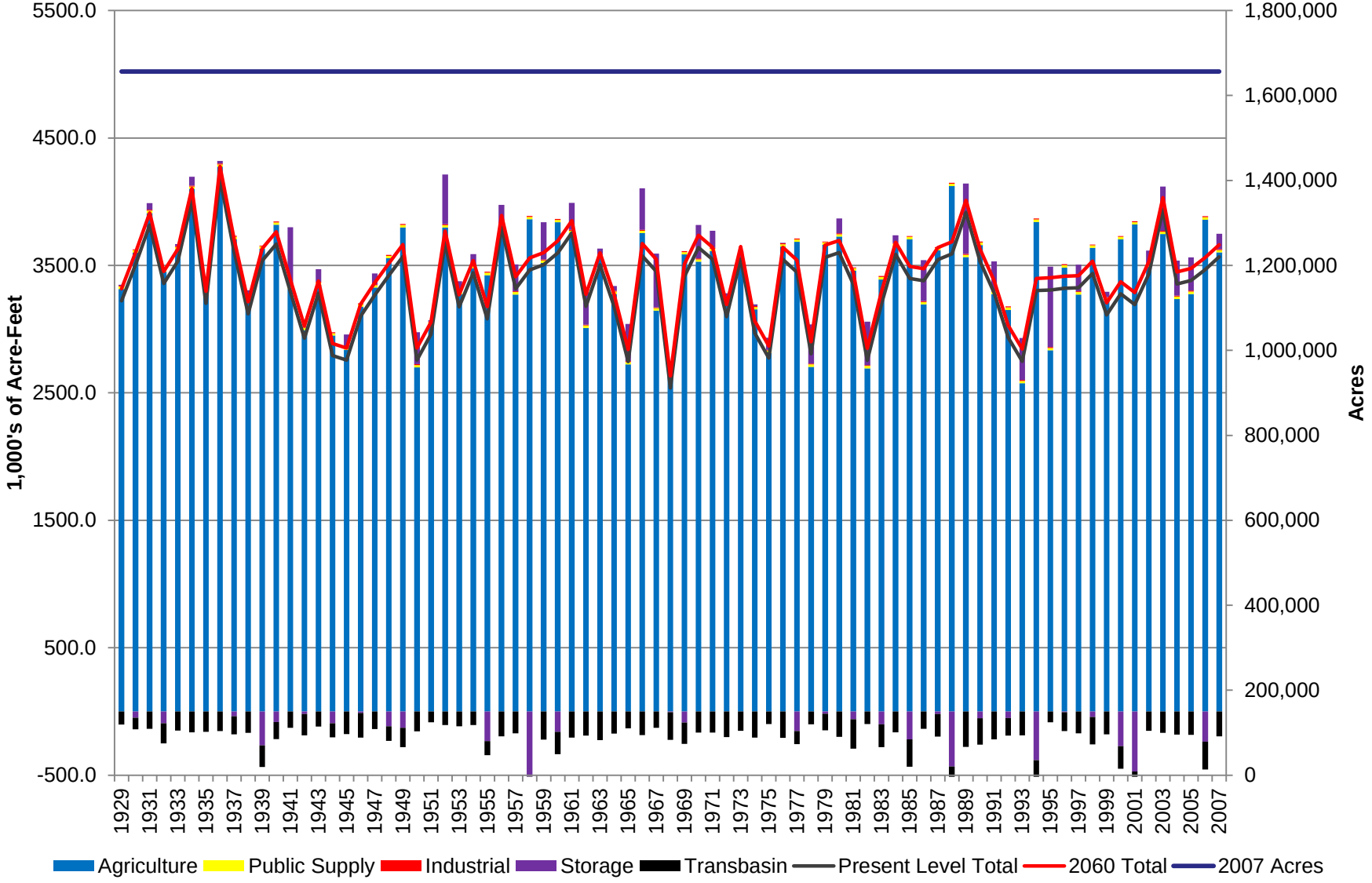
RECLAMATION

Fort Peck to Garrison: Annual Historic Depletions



RECLAMATION

Fort Peck to Garrison: Present Level Depletions



RECLAMATION

Questions

RECLAMATION