Eastern Snake Plain Aquifer Water Budget

Presentation to the
Idaho Water Resource Board
ESPA Management Plan
Advisory Committee

5 June 2007

Idaho Water Resources Research Institute
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Outline

- Overview of Water Budget
- Relative Magnitudes
- Uncertainty
- Individual Detail
  - calculation methods
  - data sources
- Questions

Goezins – Goezouts = Change in Storage

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- Percolation from irrigation
- Seepage from Snake River
- Canal leakage
- Seepage from other streams
- Percolation from precipitation
- Underflow from tributary basins
- Percolation from septic systems

- Discharge to springs
- Discharge to Snake River
- Discharge to non-Snake water bodies
- Pumping from wells
- Phreatophytes

Goezins – Goezouts = Change in Storage

- Percolation from irrigation
- **Seepage from Snake River**
- Canal leakage
- Seepage from other streams
- Percolation from precipitation
- Underflow from tributary basins
- Percolation from septic systems

- **Discharge to springs**
- **Discharge to Snake River**
- Discharge to non-Snake water bodies
- Pumping from wells
- Phreatophytes

"Net Recharge" + **Targets** =

Change in Storage

Targets

- Seepage from Snake River
- Discharge to Snake River
- Discharge to Springs

“Net Recharge”

- Some components combined for convenience:

•Percolation from irrigation
•Canal leakage
•Seepage from other streams
•Percolation from precipitation
•Underflow from tributary basins
•Percolation from septic systems
•Discharge to non-Snake water bodies
•Pumping from wells
•Phreatophytes

→

•Perched-river seepage
•Tributary underflow
•Fixed-point pumping
•Offsite pumping
•Non-irrigated-lands recharge
•Canal leakage
•Irrigated lands calculation
  •Precipitation
  •Irrigation entities
  •Diversions & Returns
  •Irrigated lands
  •Evapotranspiration

Relative magnitudes from draft report.

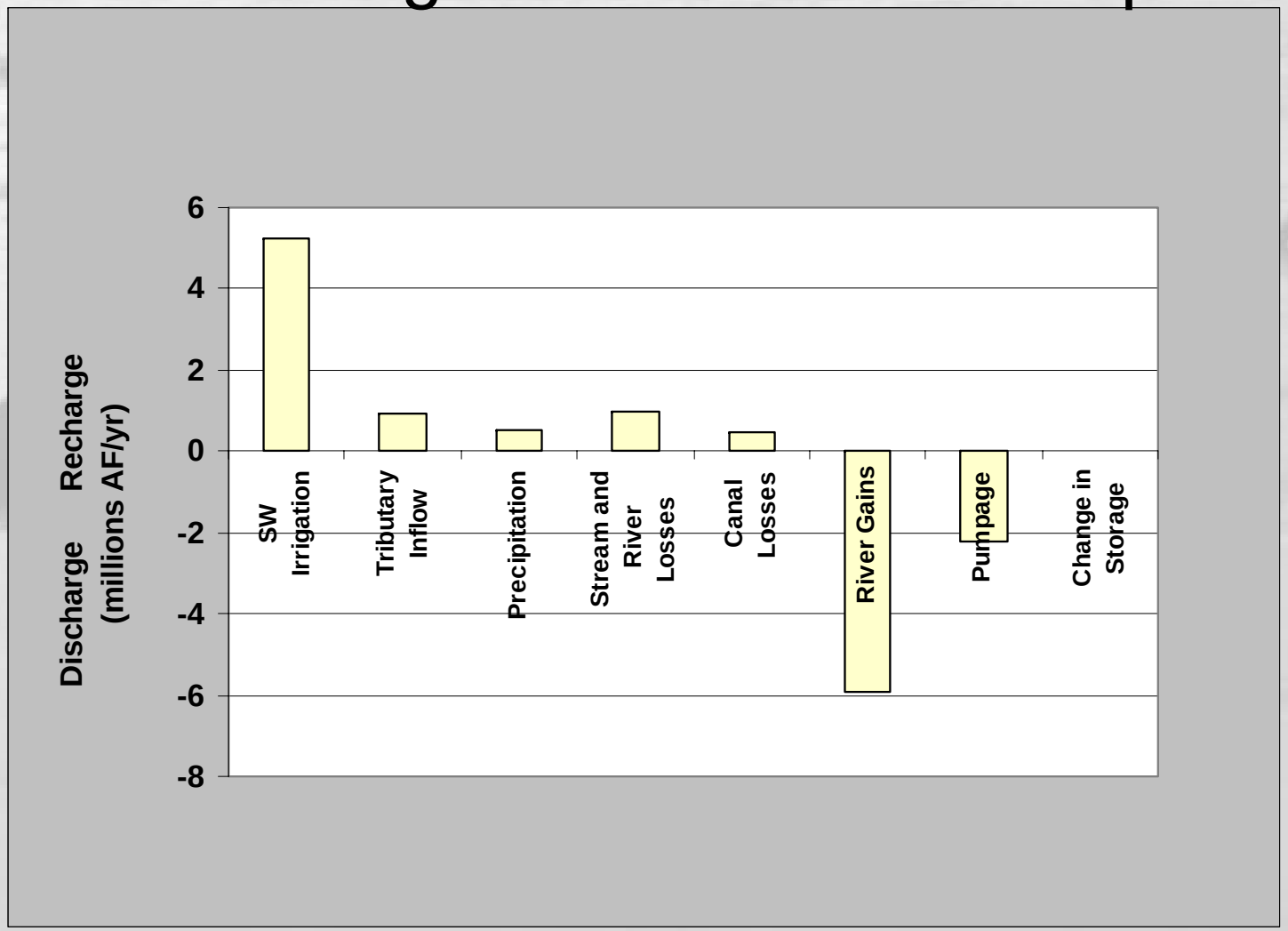


Figure 42. Bar graph of the components of recharge for steady state model.

Uncertainty (From old "Base Case" Scenario)

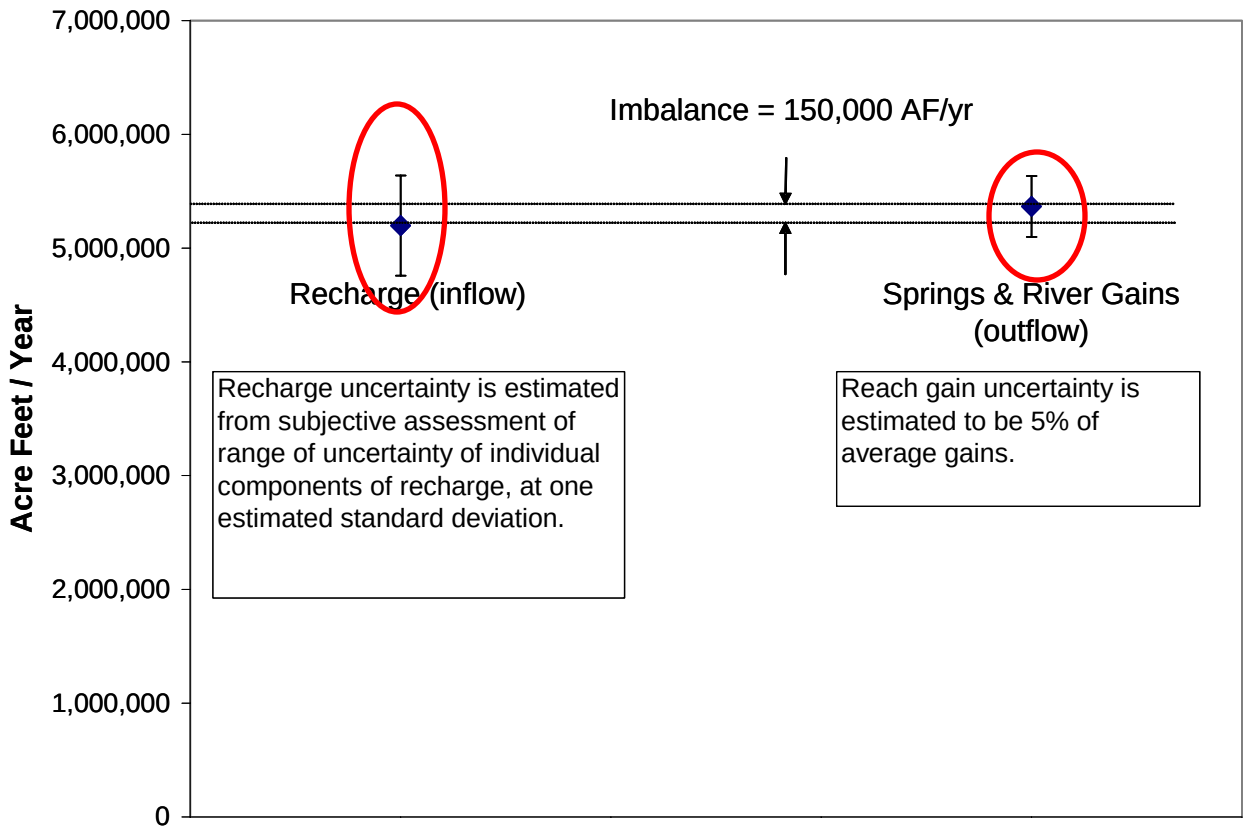
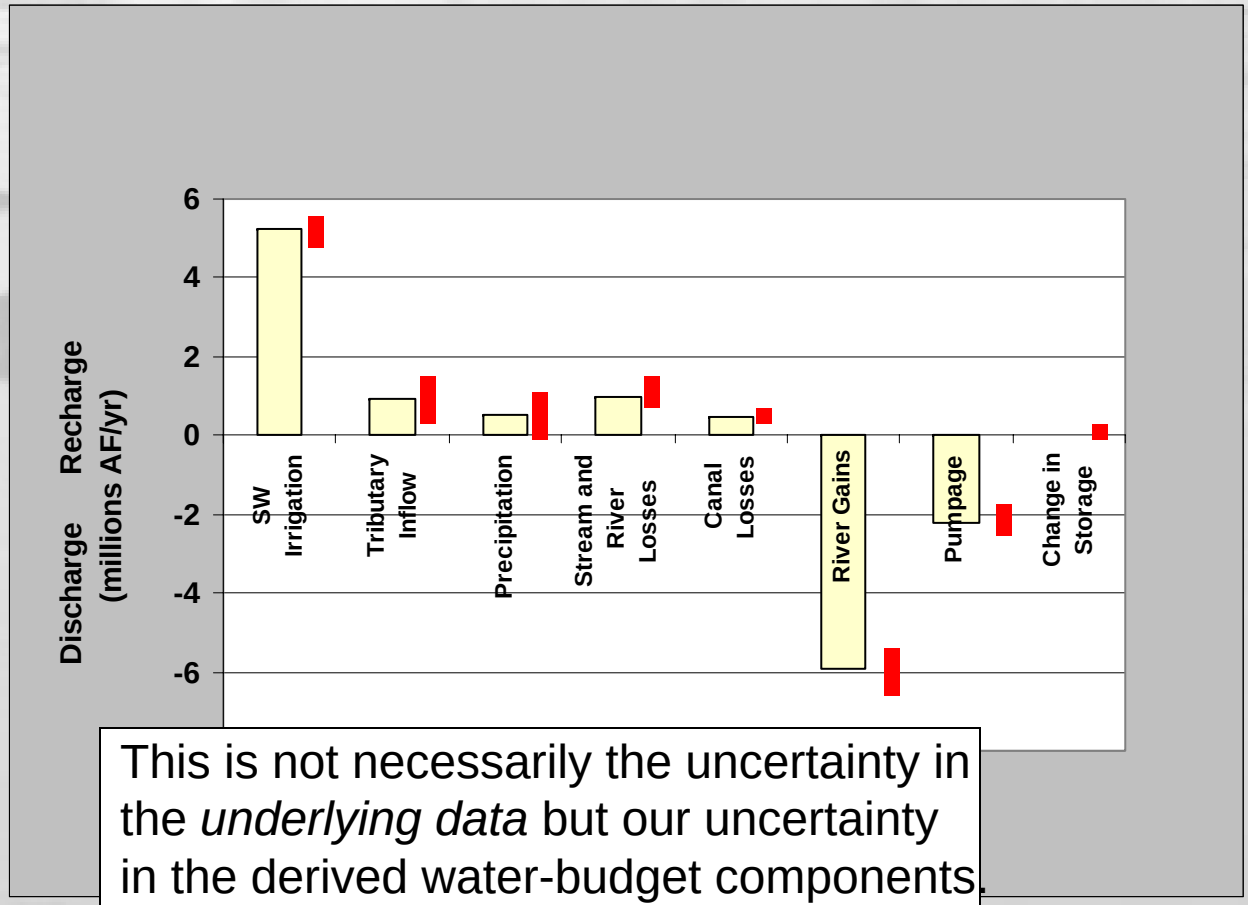


Figure 3. Recharge Uncertainty Estimates Relative to 22-year Average Recharge and Discharge (ESPAM v1.1)

Uncertainty (Qualitative Assessment by Component)



This is not necessarily the uncertainty in the *underlying data* but our uncertainty in the derived water-budget components.

The length of the bars is conceptual and not based on formal quantification.

Calculation and Data Details

Data

Gory Details

Perched River Seepage

Tributary Underflow

Fixed-Point Pumping

Offsite Pumping

Non-Irr Recharge

Canal Seepage

Irrigation (long)

Irrigation (short)

Snake Reach Gains

Snake Reach Losses

Spring Discharge

Questions?

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(Animation Break)

Targets - Snake River Gains/Losses

- Individual reach water budget

  Surface Goezins – Surface Goezouts = Net to Aquifer

  – Goezins: Upstream gage, tributary inflows, SW irrigation return flows
  – Goezouts: Downstream gage, SW diversions

(Animation Break)

Targets - Springs

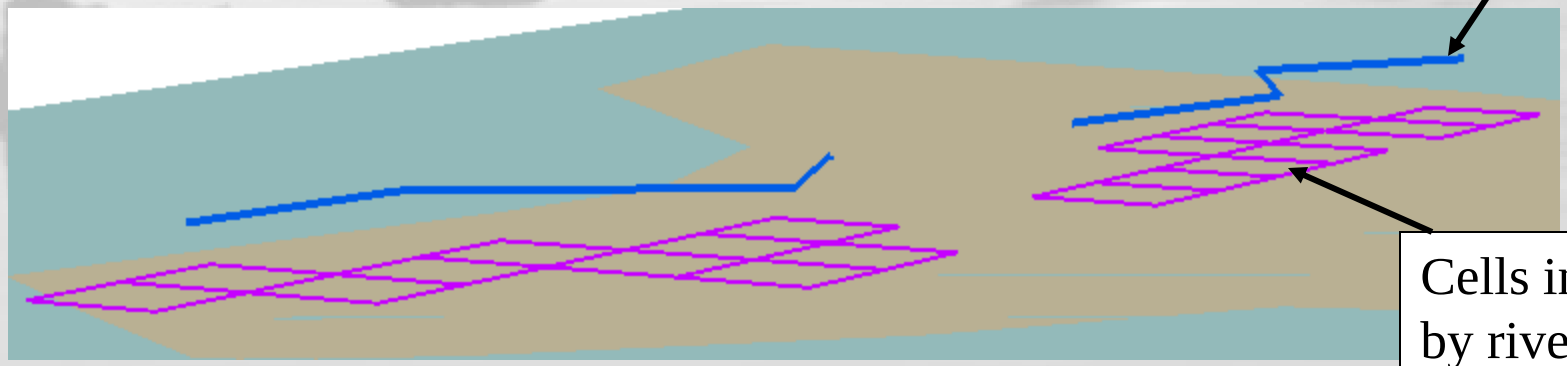
- Entire reach: Kjelstrom method
  - compatible w/ gage records
  - confirmed w/ Covington & Weaver
- partial-reach targets also used in calibration but these are incomplete for water-budget purposes

(Animation Break)

Perched River Reaches Relationship

Overhead view

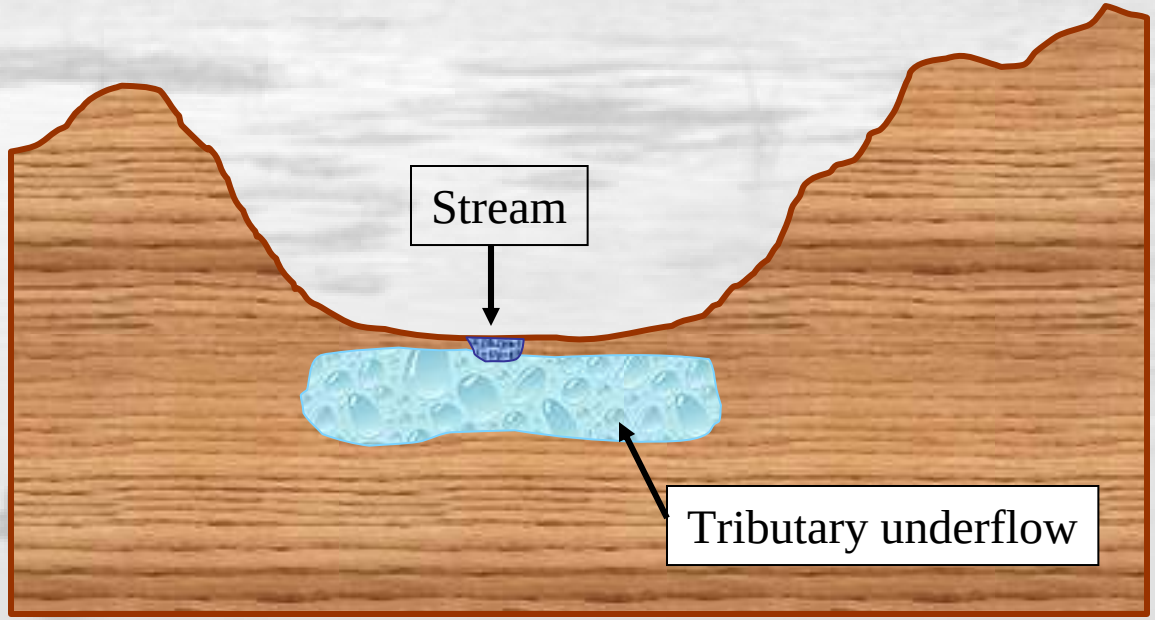
3D view

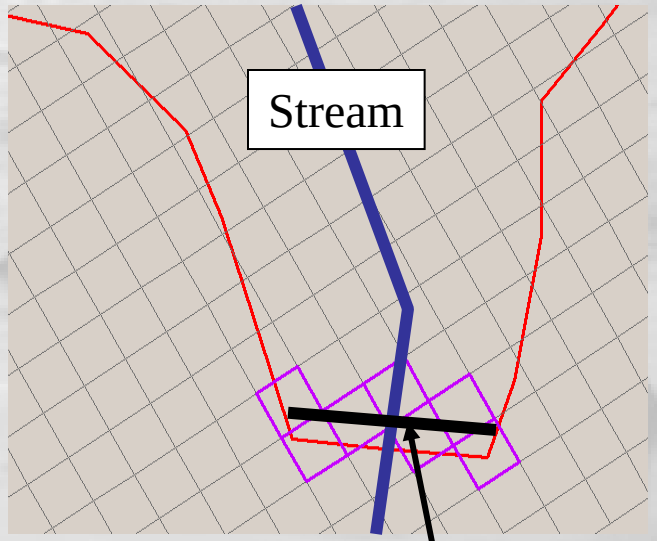


•Seepage from perched rivers (not Snake River) estimated from USGS gage records

(Animation Break)

Tributary Underflow Relationship





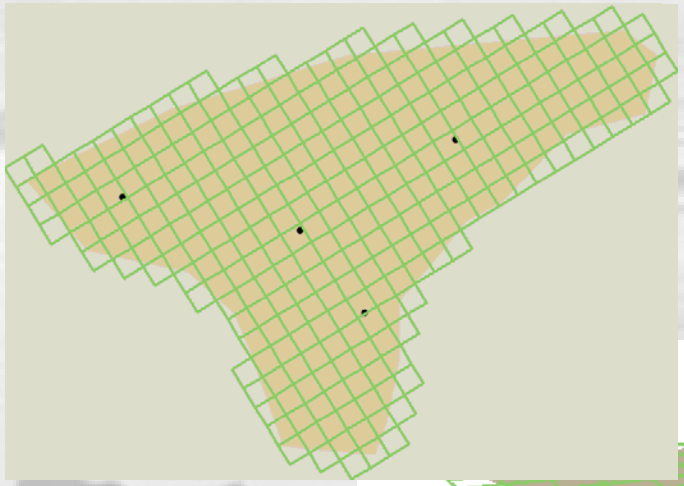
GIS line identifying tributary underflow

- Total volume estimated from prior studies
  - based on water-budget analysis
  - confirmed w/ “sense-check” recalculation
- Annual variation scaled from Silver Creek

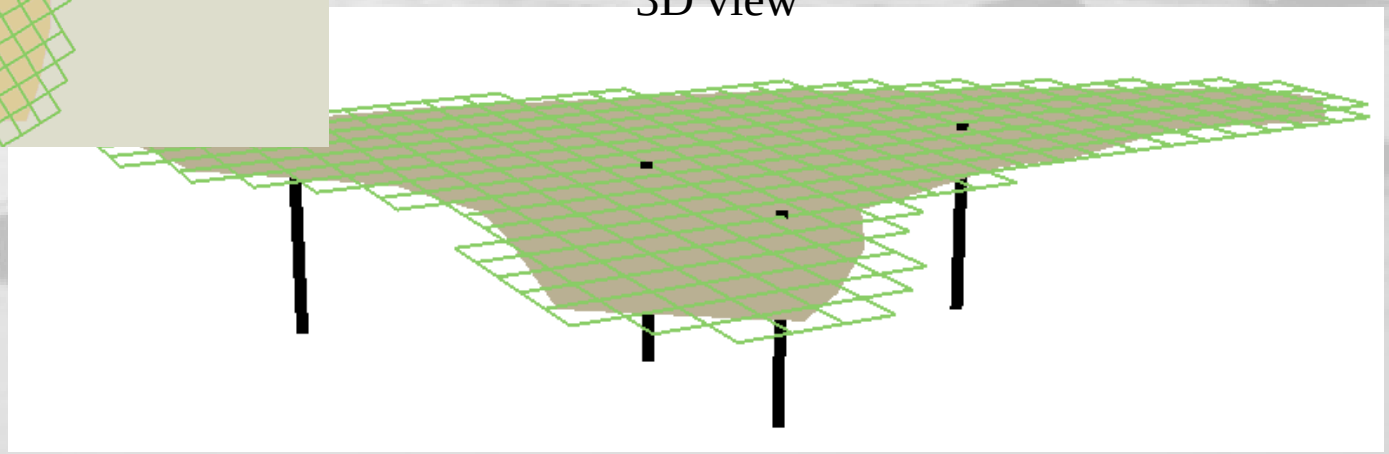
(Animation Break)

Fixed Point Sources and Withdrawals Relationship

Overhead view



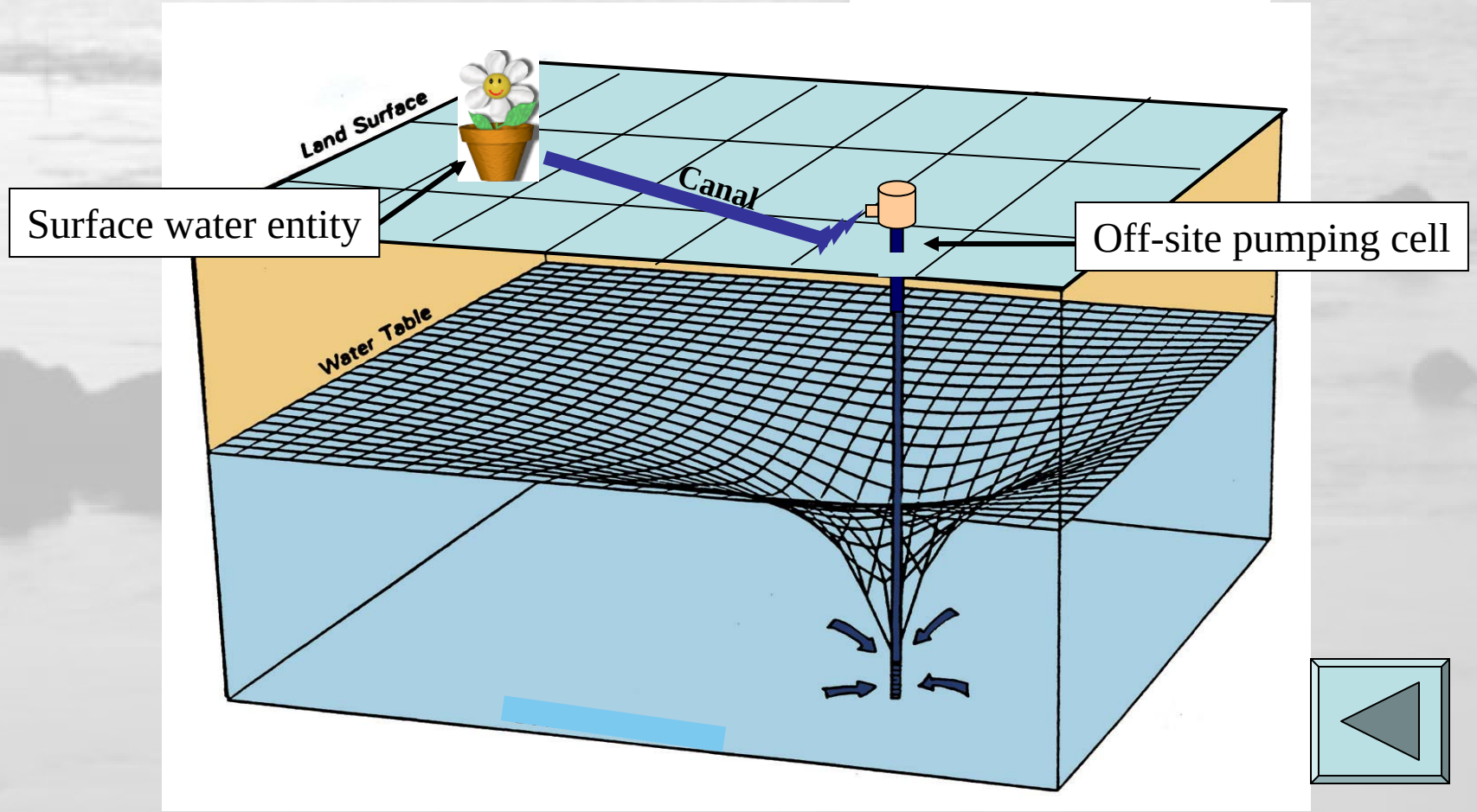
3D view



- Withdrawal (negative) or Recharge (positive) independent of other calculations
- Used for upper-valley exchange wells
- Used for corrections
  - wetlands
  - Richfield tract

(Animation Break)

Off-site Groundwater Pumping Relationship

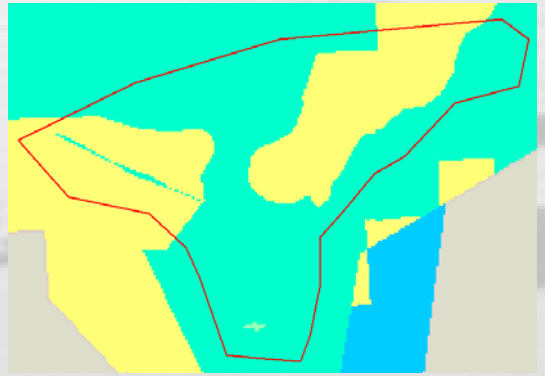


- Withdrawal (negative) where the well is located
- Volume is added to canal-co diversions for irrigation calculations
- Used for Jefferson Irr, Monteview CC, Producers CC

(Animation Break)

Recharge on Non-irrigated Lands Relationship

Non-irrigated recharge GIS raster



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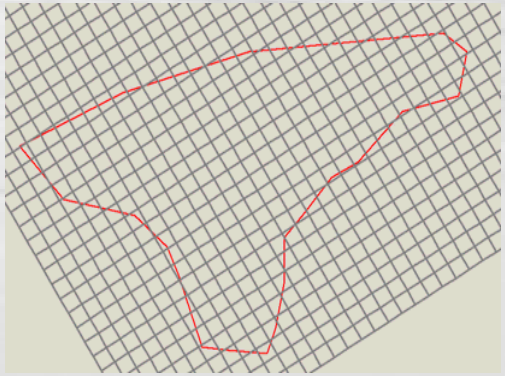
Grid cells



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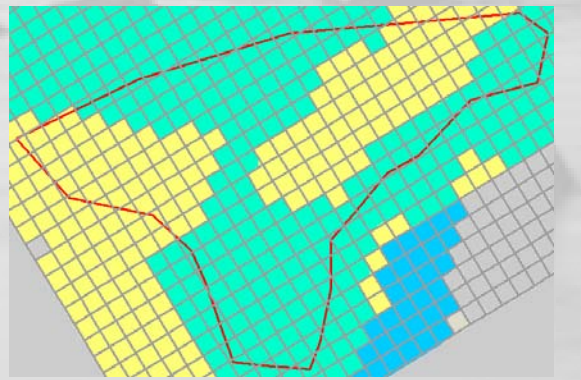
Amount of recharge depth for each grid cell

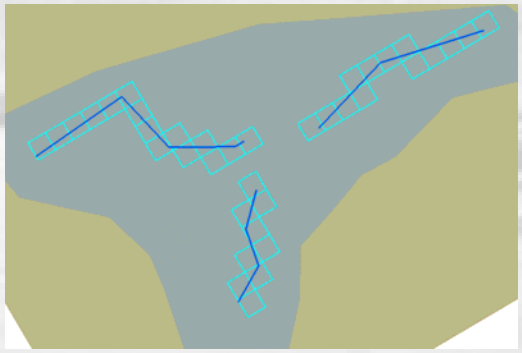


- Depth of recharge calculated from precipitation
- Calculation depends on general soil type
- Non-irrigated recharge is calculated for every cell but was only used on non-irrigated lands
- Wetlands, dryfarms and cities were also represented in this data set

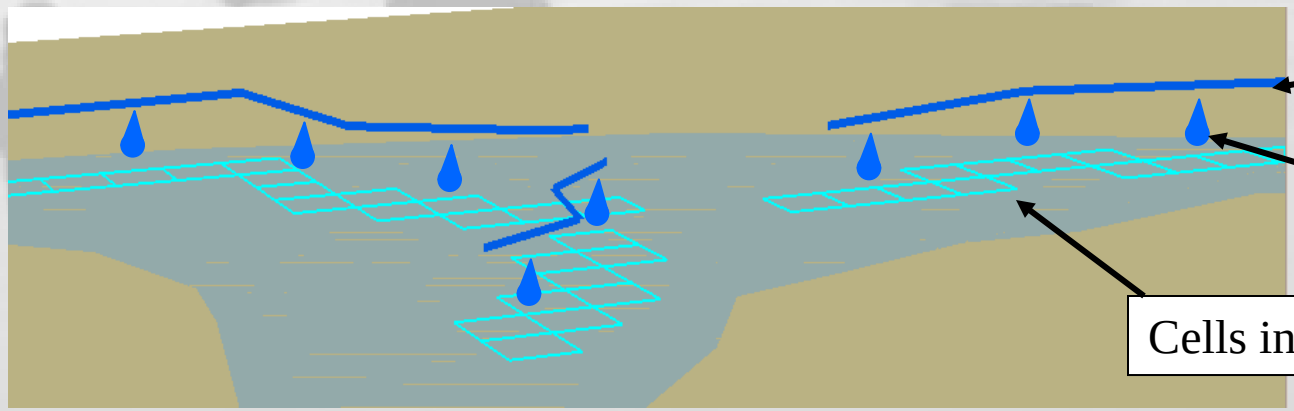
(Animation Break)

Canal seepage relationship

Overhead view



3D view



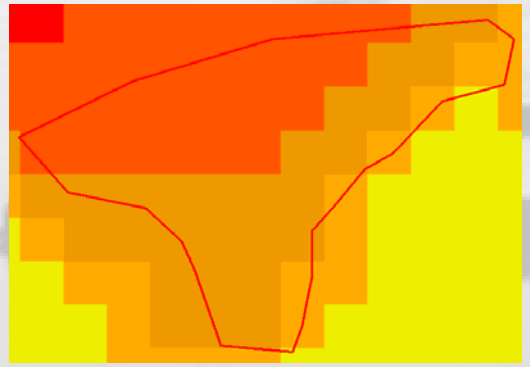
- For largest leaky canals, seepage is estimated as a fraction of diversions
- For other canals, seepage is implicitly part of irrigation percolation calculation

(Animation Break)

The next several slides illustrate calculation of irrigation impacts

Precipitation Relationship

Precipitation
GIS raster



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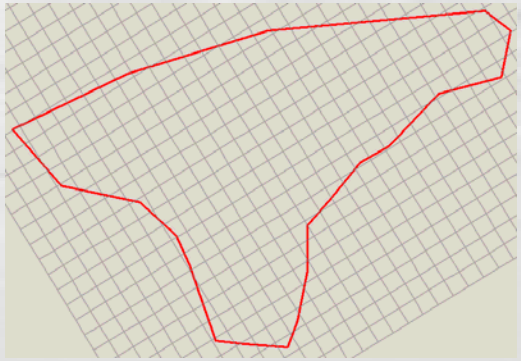
Grid cells



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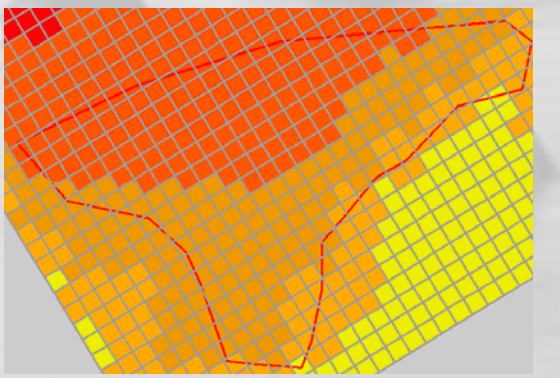
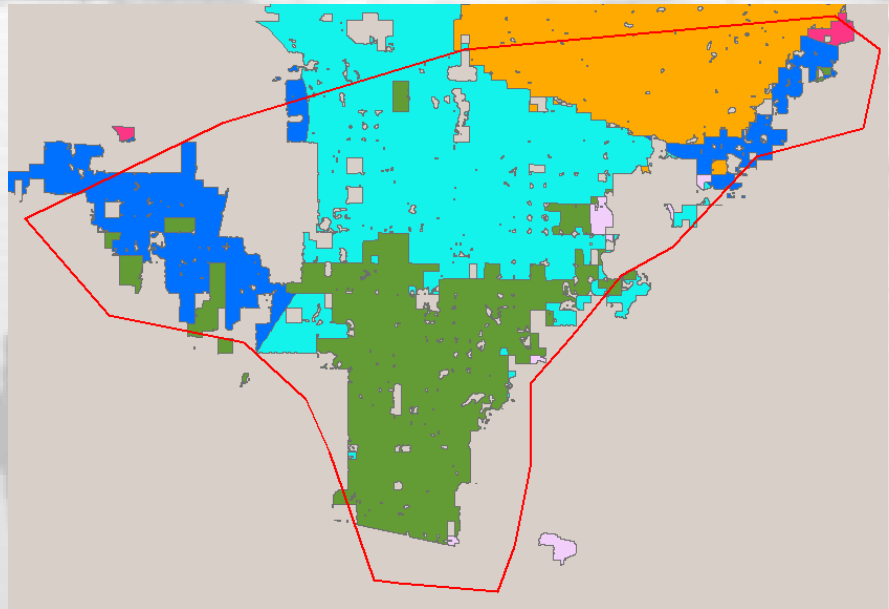
Amount of precipitation
depth for each grid cell



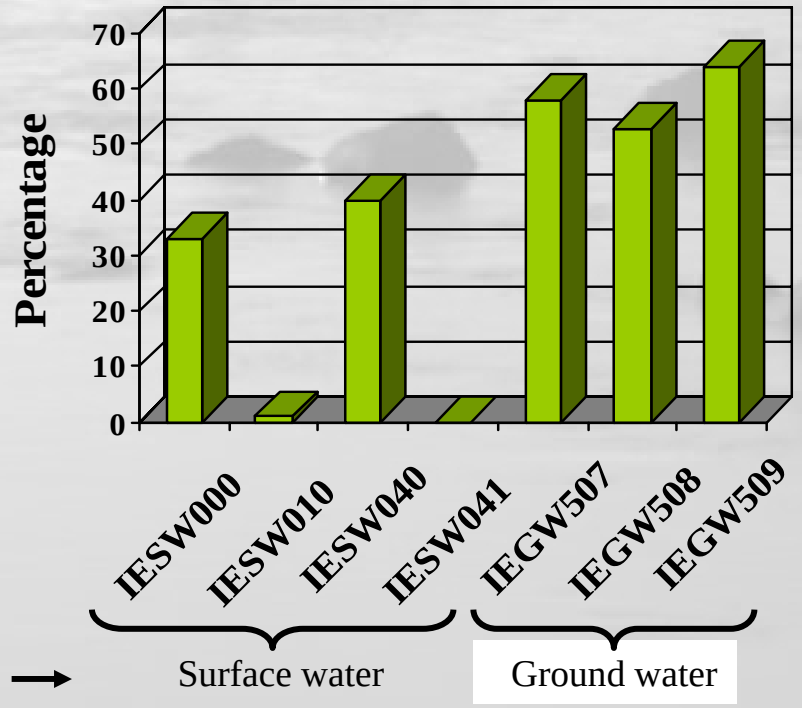
- PRISM precipitation data from Oregon State University
- “Departures from Normal” from NOAA
- Precipitation is applied as an input in irrigation calculations

Irrigation Entities Relationship

Spatial relationship will be represented in .iar analysis



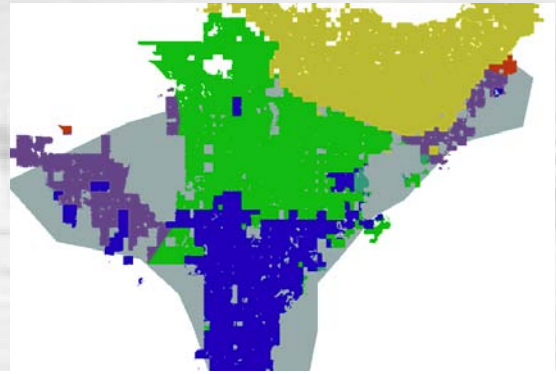
Percentage of entity that uses sprinkler

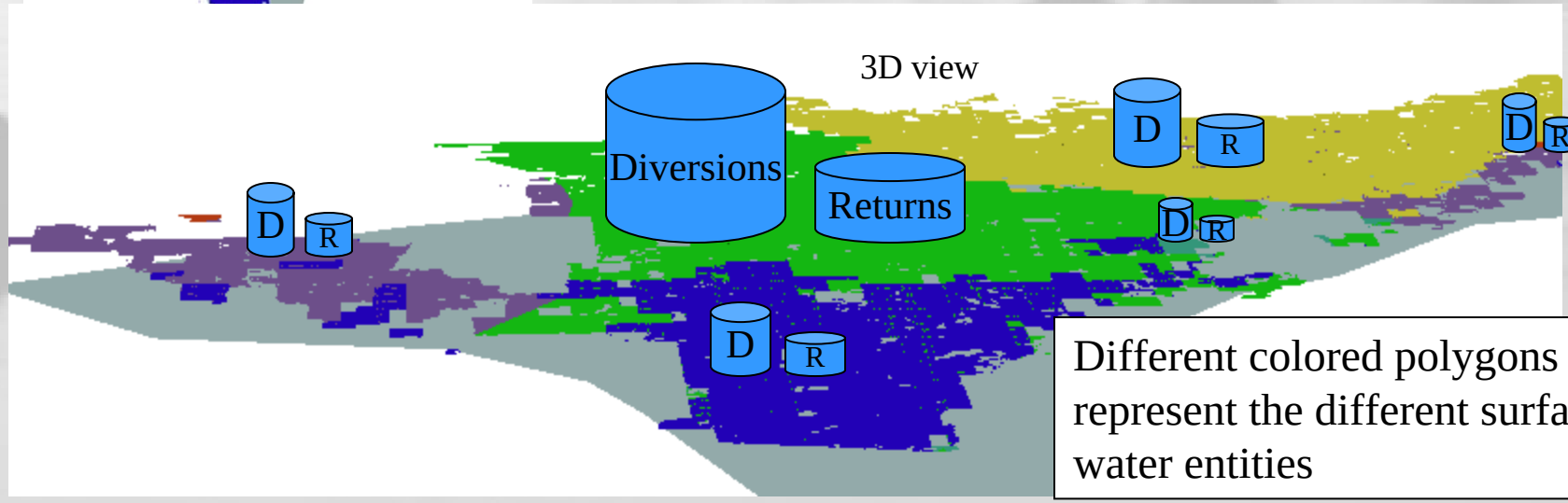


- An “entity” is a block of irrigated lands with similar characteristics
- Source of water is identified as surface or ground water
- Surface-water entities are associated w/ diversions & returns
- Percentage of sprinkler use for each period is shown

Diversions and Returns Relationship

Overhead view

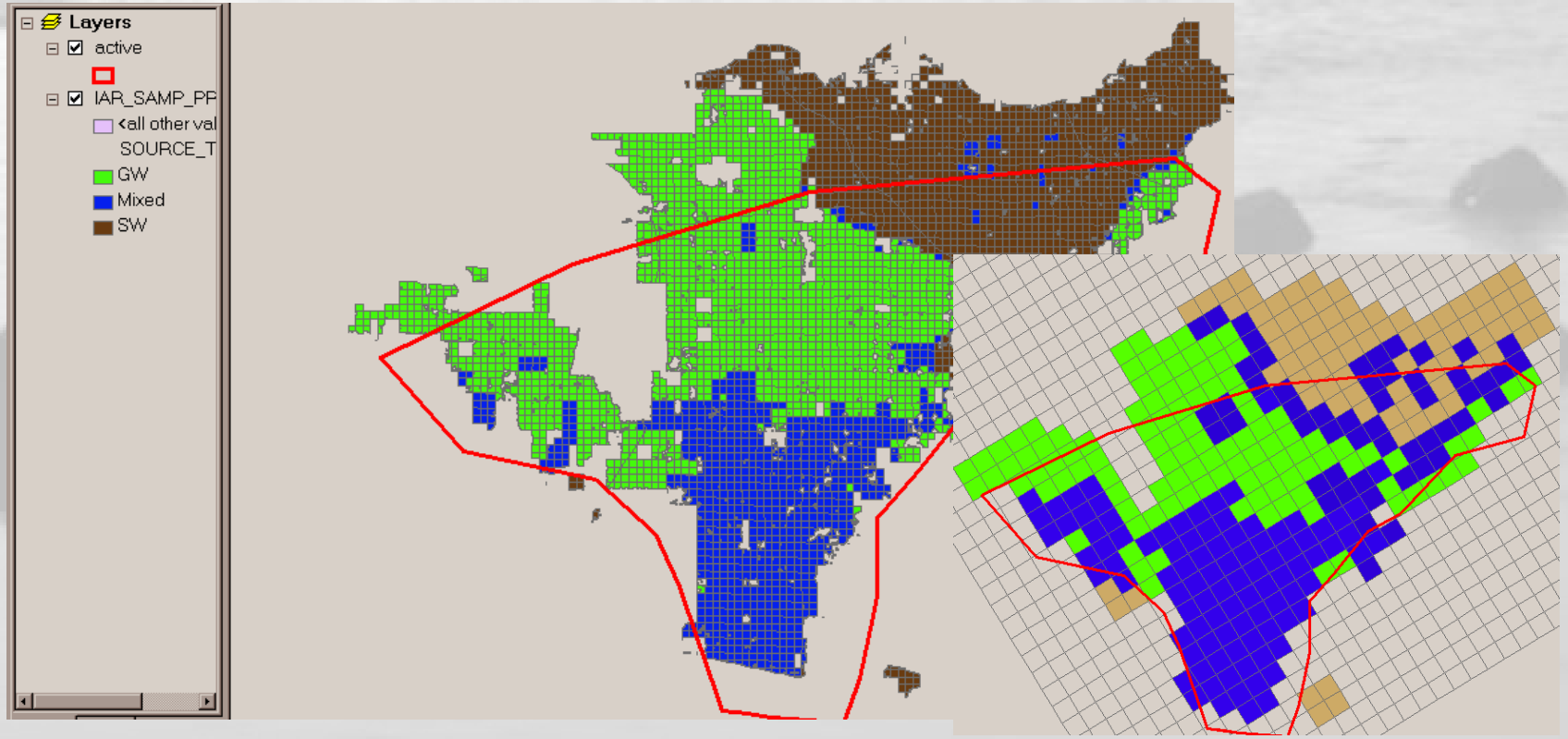




Different colored polygons represent the different surface water entities

- Volumes of diversions and returns are represented for each surface water entity
- (Diversion – Returns) = net application, used in irrigation calculations

Irrigated Agriculture Relationship



- GIS maps of irrigated agriculture were obtained from satellite images (1980, 2000) and aerial photos (1987-1992)
- Water-rights & Adjudication data identified water source

Irrigation Discount Relationship

Nominal irrigated polygon

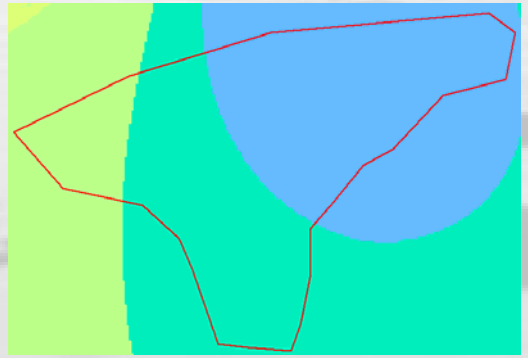
Actual irrigated polygon

$$1 - \left(\frac{\text{Actual}}{\text{Nominal}}\right) = \text{Reduction for non-irrigated inclusions}$$

- Because not all the area in a nominal polygon is irrigated a reduction proportion is applied for non-irrigated areas
- Different reduction factors can be applied for sprinkler and gravity non-irrigated areas

Irrigated Lands Evapotranspiration Relationship

Evapotranspiration GIS raster



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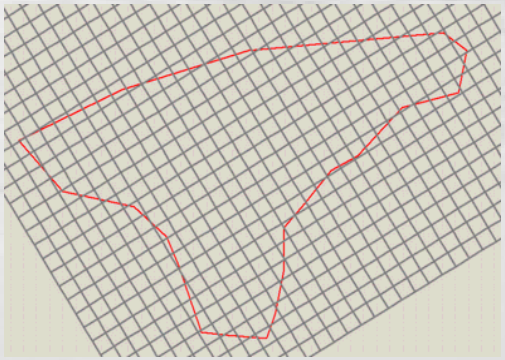
Grid cells



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Amount of evapotranspiration for each grid cell

- Evapotranspiration =
  Reference ET x Crop Coefficient
- Reference ET from weather-station calculations
- Crop coefficient from U of I “Allen Brockway” report
- Coefficients applied according to crop mix from USDA/ Idaho Ag Statistics Service annual reports

Calculation of Net Extraction Due to GW Irrigation

- Stress = (Precipitation – (ET x Adj))
  - If ET is bigger than precip (typical) this is negative
  - Negative means water from the aquifer
- Calculation is performed for each 1-mile cell that has GW-irrigated lands

Calculation of Net Recharge Due To SW Irrigation

- Stress = (Diversions + Offsite – Canal leakage – Return flows + Precipitation – (ET x Adj))
  - If ET is bigger than supply (unusual) this is negative
  - Negative means water from the aquifer
  - Without a well, this is impossible; corrections applied in “fixed point” data set
- Calculation is performed for each 1-mile cell that has SW-irrigated lands

Calculation of Net Impact with Mixed-source Irrigation

- Stress = (GW calculation x GW fraction) + (SW calculation x SW fraction)
  - Sometimes negative, sometimes positive
  - Errors in fraction only change spatial distribution, not total net stress
- Calculation is performed for each 1-mile cell that has Mixed-source lands

(Animation Break)

Data Sources

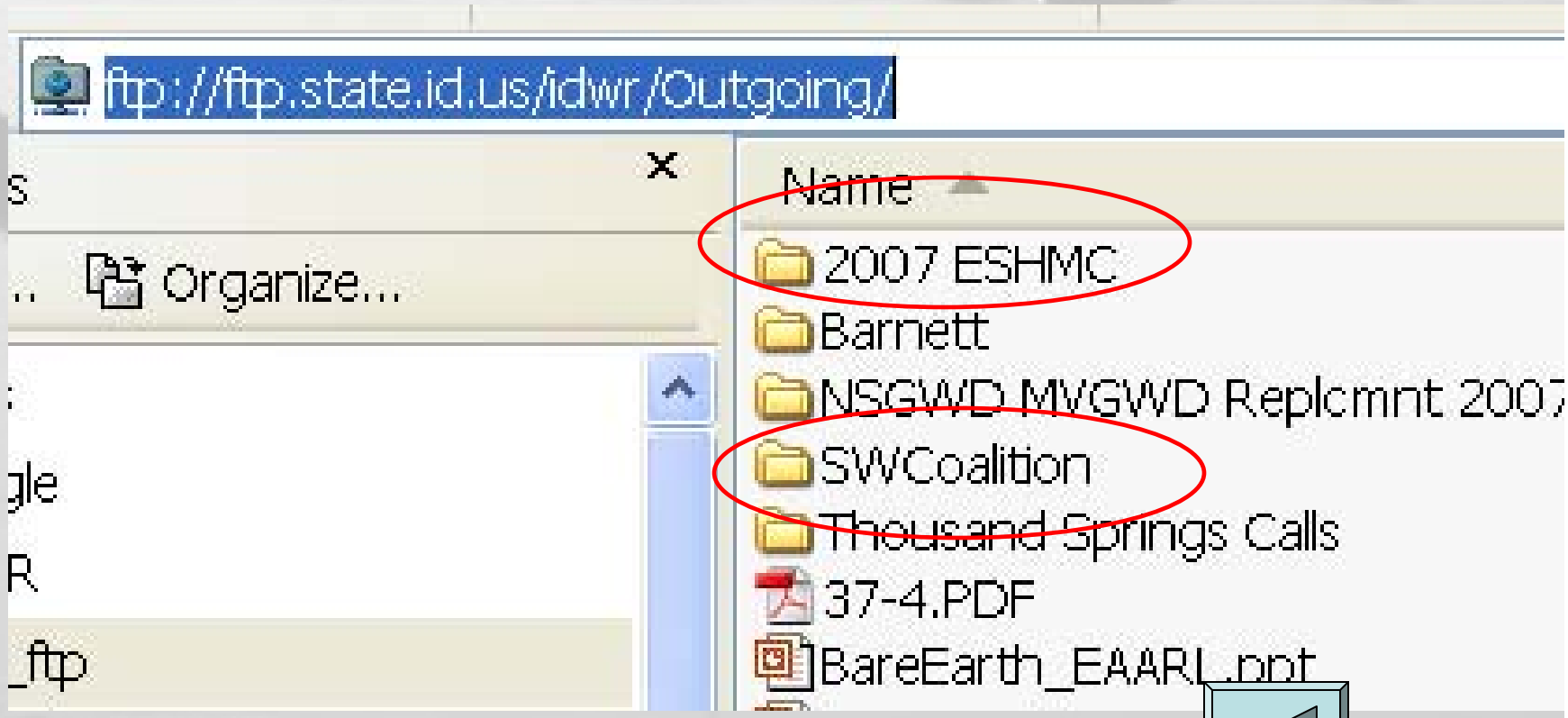
(Animation Break)

Where to Find Gory Details

- web search: “IWRRI Idaho Falls Water Budget Reports”

More Gory Details

- Go to "**ftp://ftp.state.id.us/idwr/Outgoing/**"



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