Harney Basin Groundwater Budget

U.S. Geological Survey and Oregon Water Resources Department
Harney Groundwater Study Advisory Committee Meeting, 12/12/2019

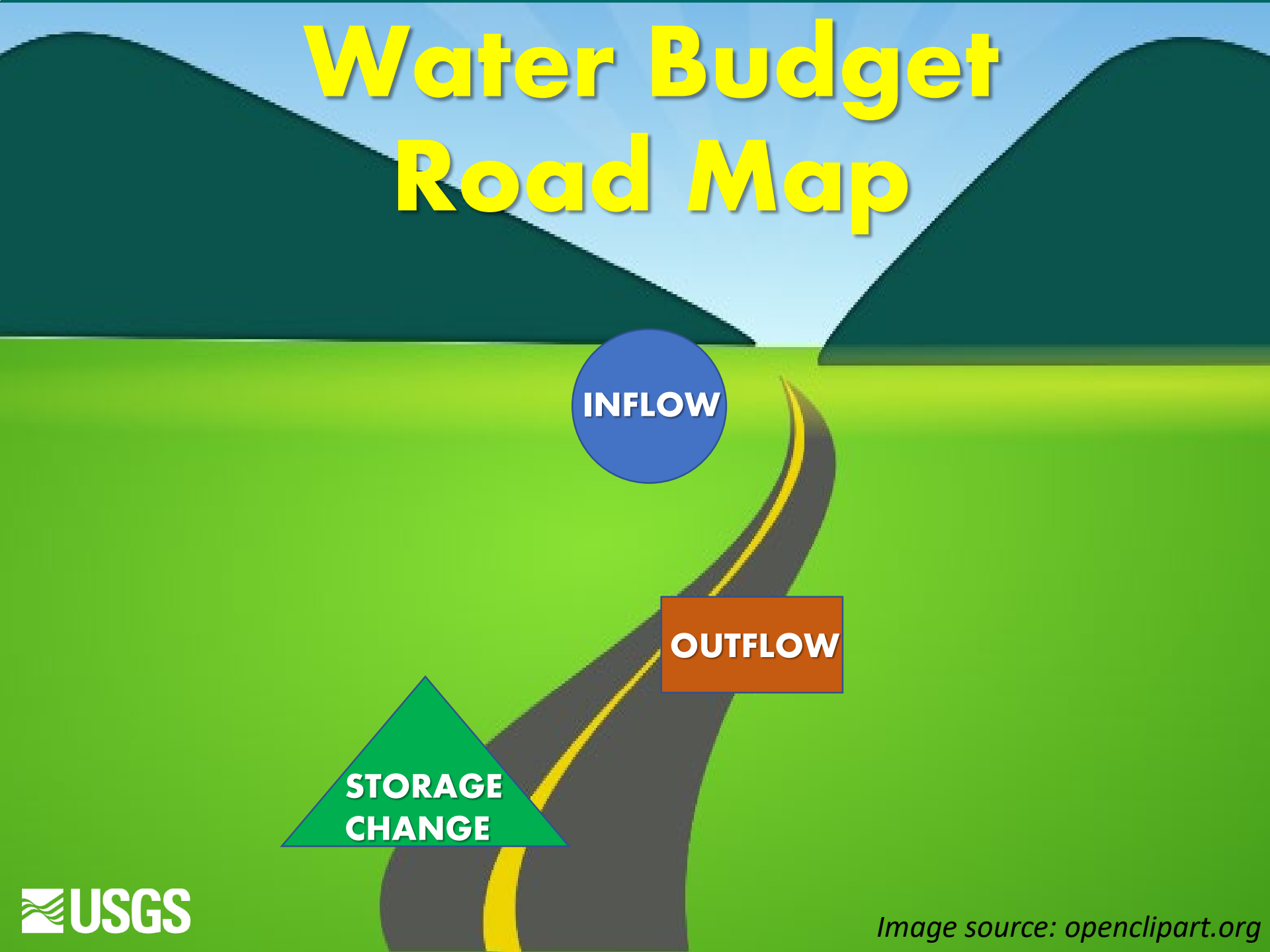
U.S. Department of the Interior
U.S. Geological Survey

Outline

- Background – just a little
- Whole enchilada
- Recharge – where and how
- Change in storage

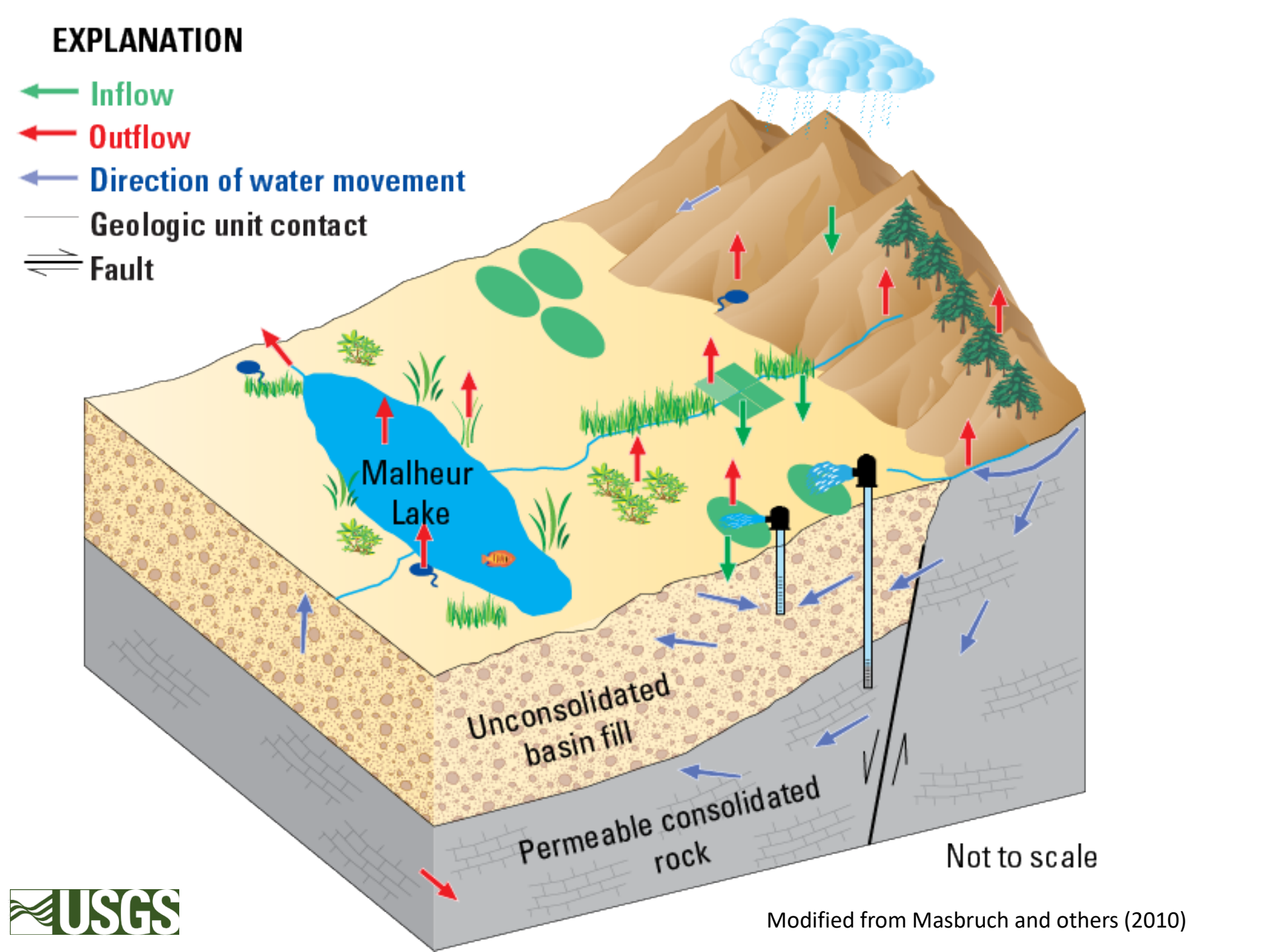
USGS

Water Budget Road Map



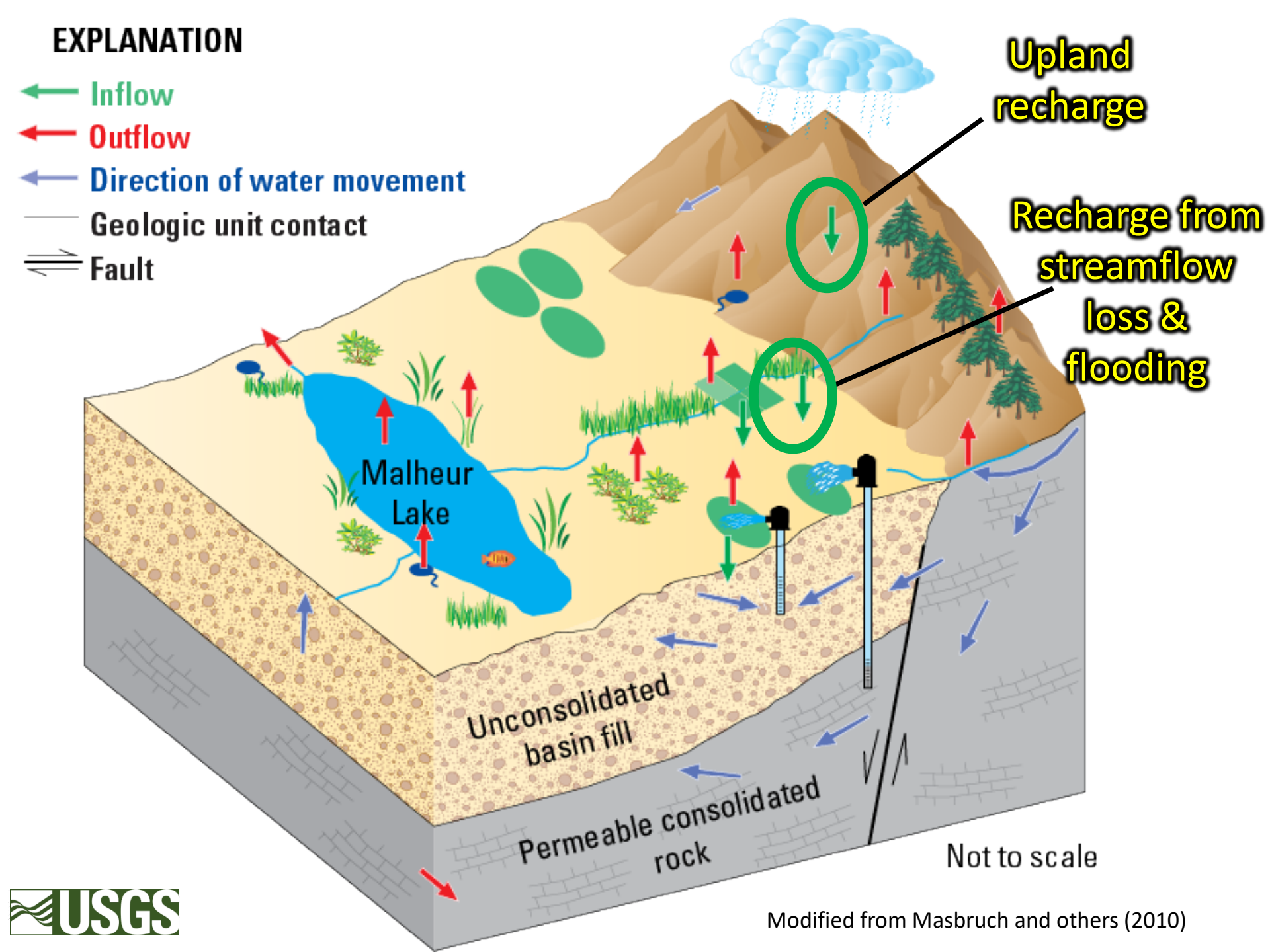
USGS

Image source: openclipart.org



USGS

Modified from Masbruch and others (2010)



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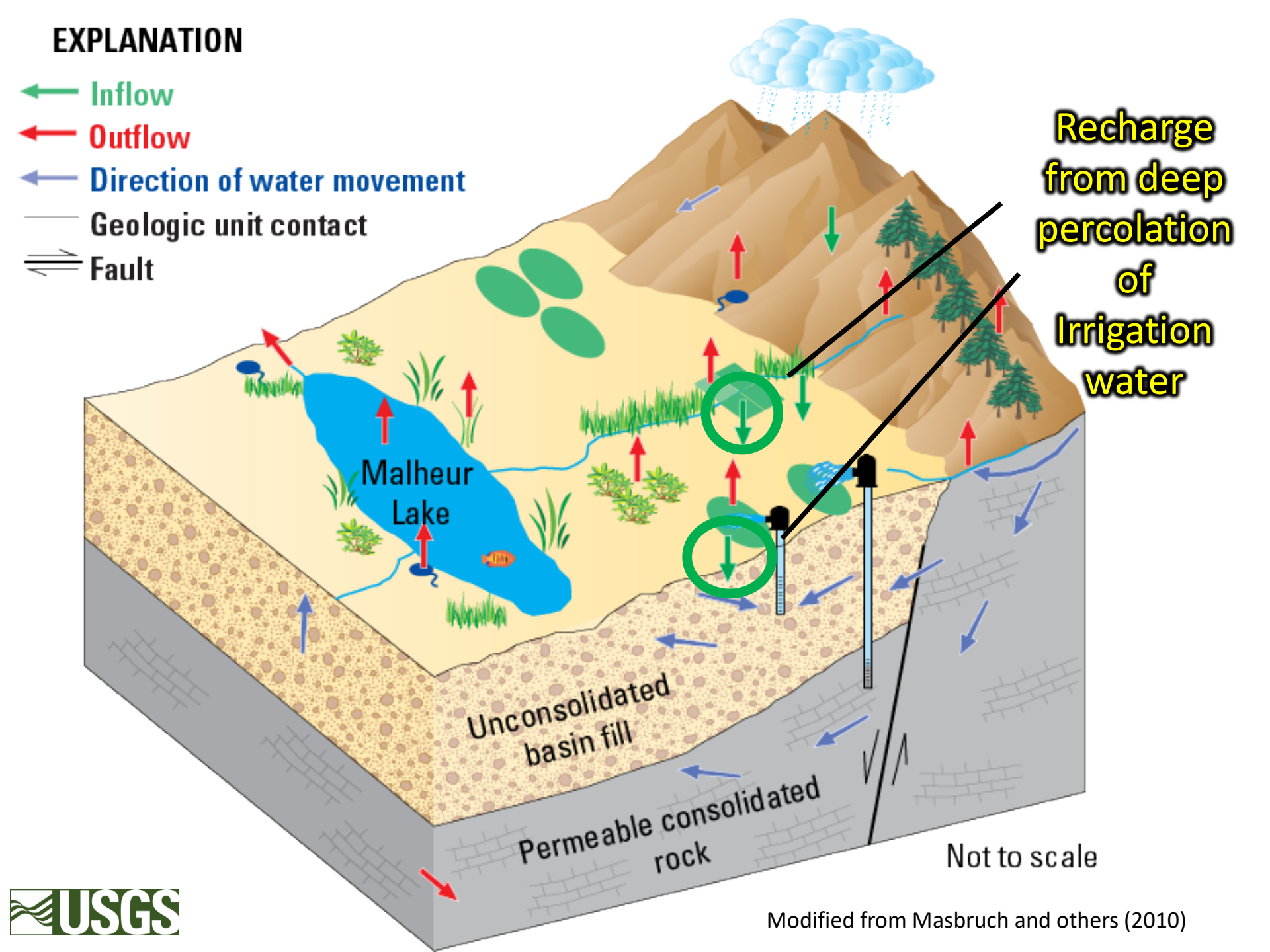

USGS

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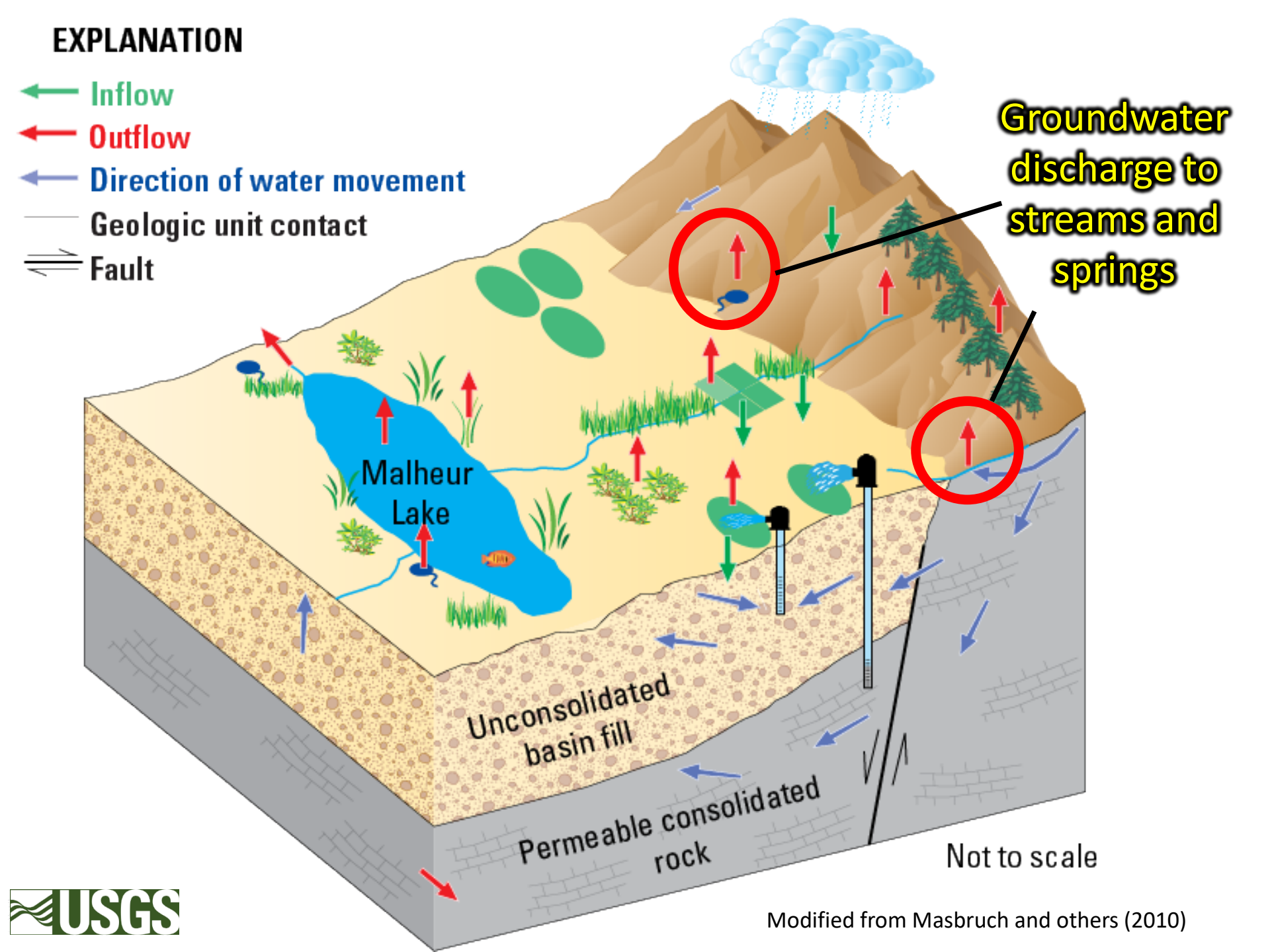

USGS

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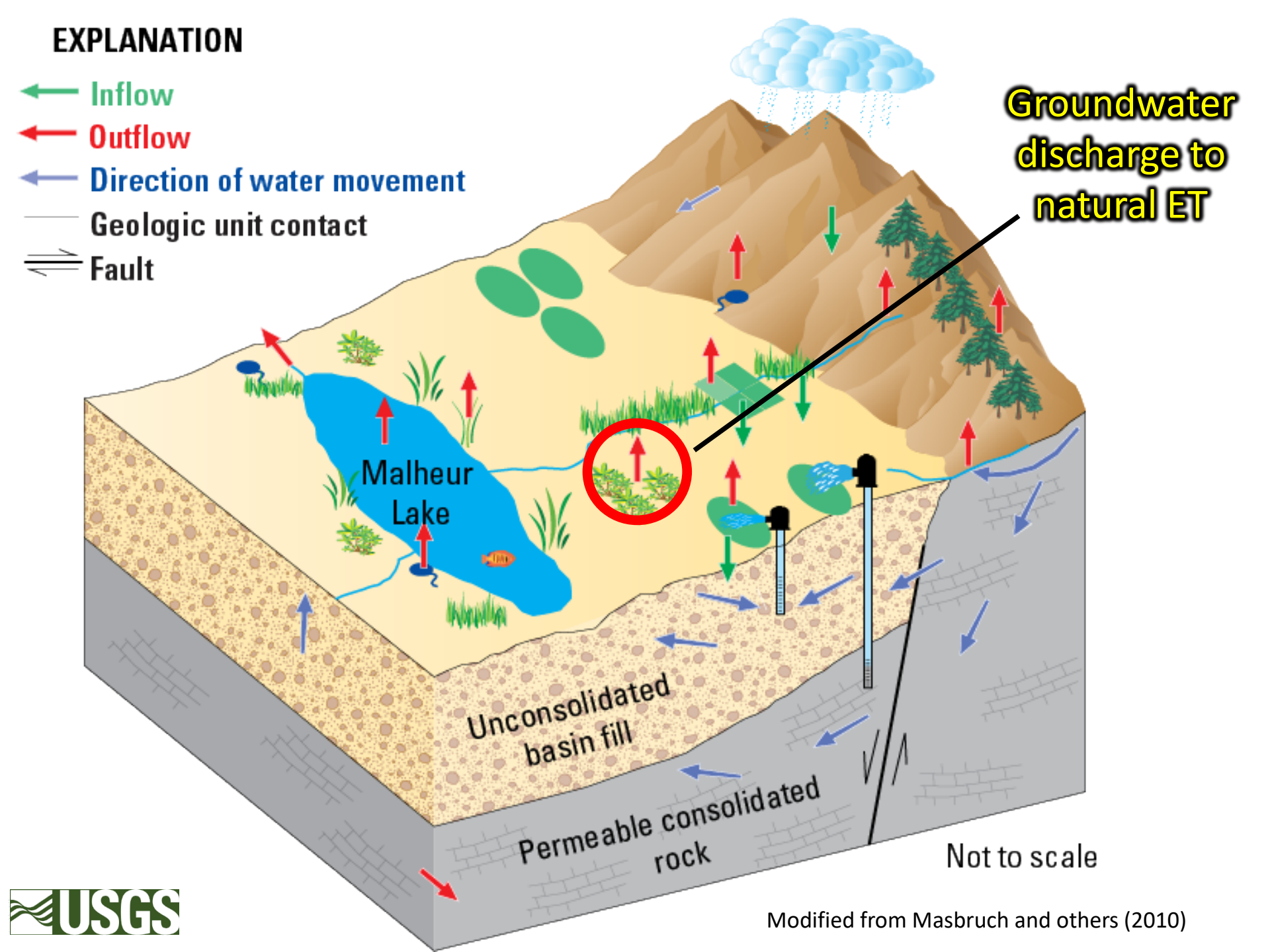

USGS

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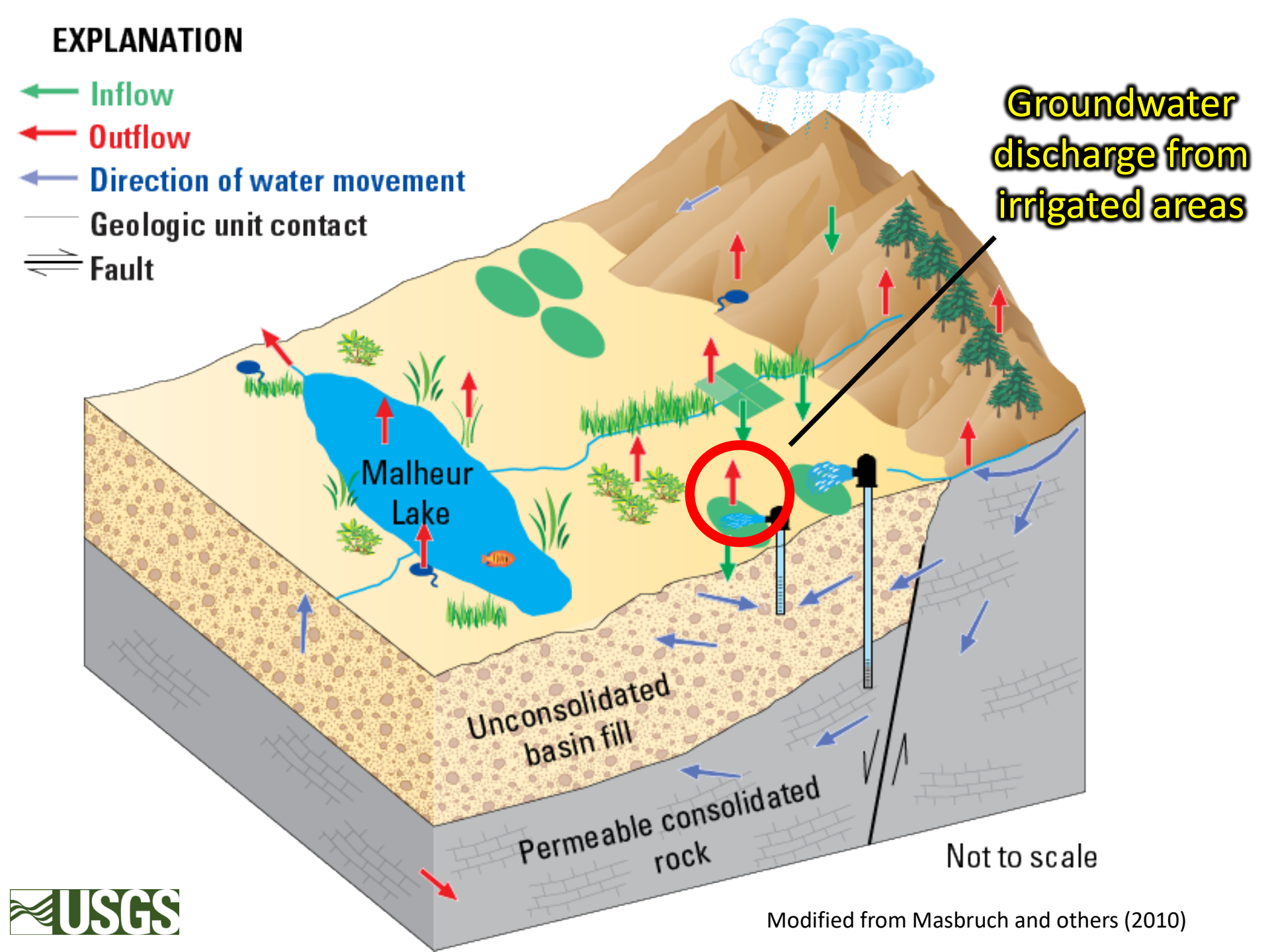

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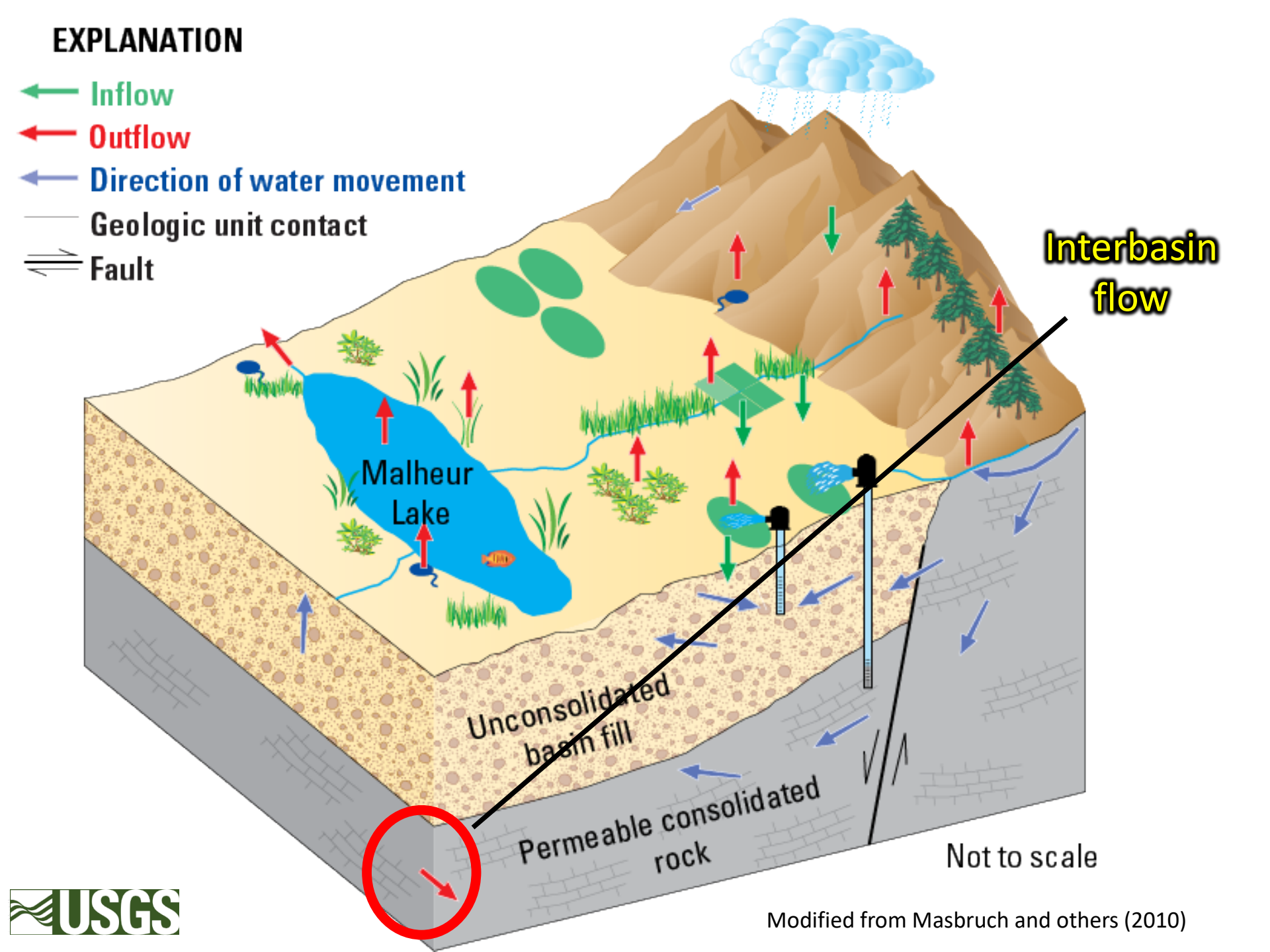


USGS

Modified from Masbruch and others (2010)

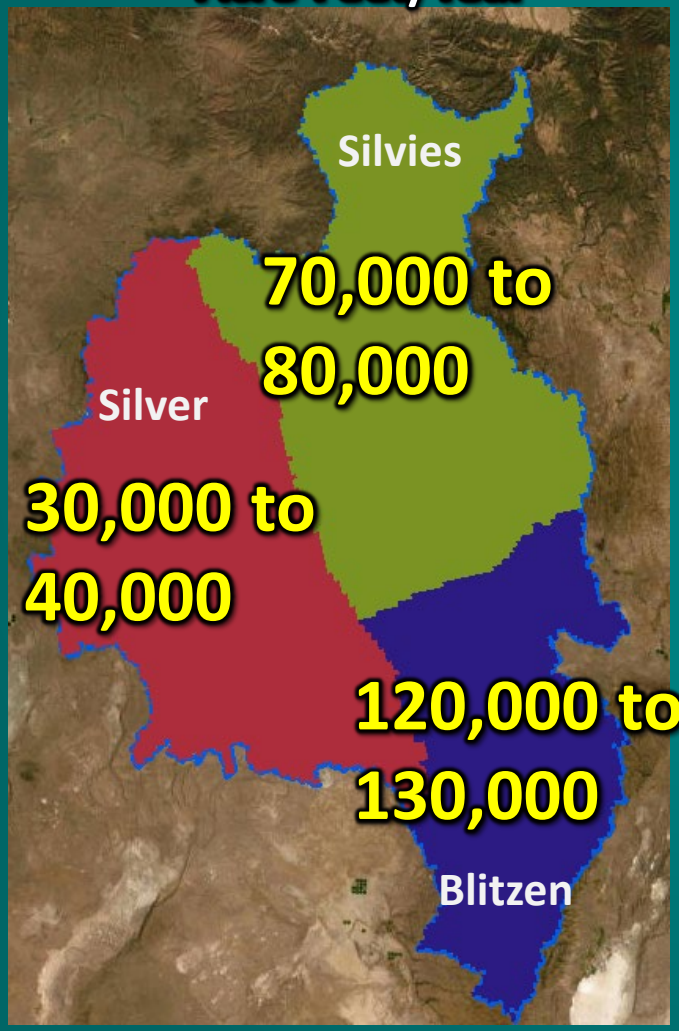
Net Recharge & Net Discharge

- In some areas groundwater recharge and groundwater discharge are recycled back into the groundwater system
  - Example –
    - Precipitation recharges groundwater in uplands
    - Discharges as stream baseflow downslope
    - Reenters as recharge near the base of the mountains
    - Discharges as ET or springflow on the valley floor
- Net recharge and discharge represent the amount lost from the system, NOT recycled back into groundwater

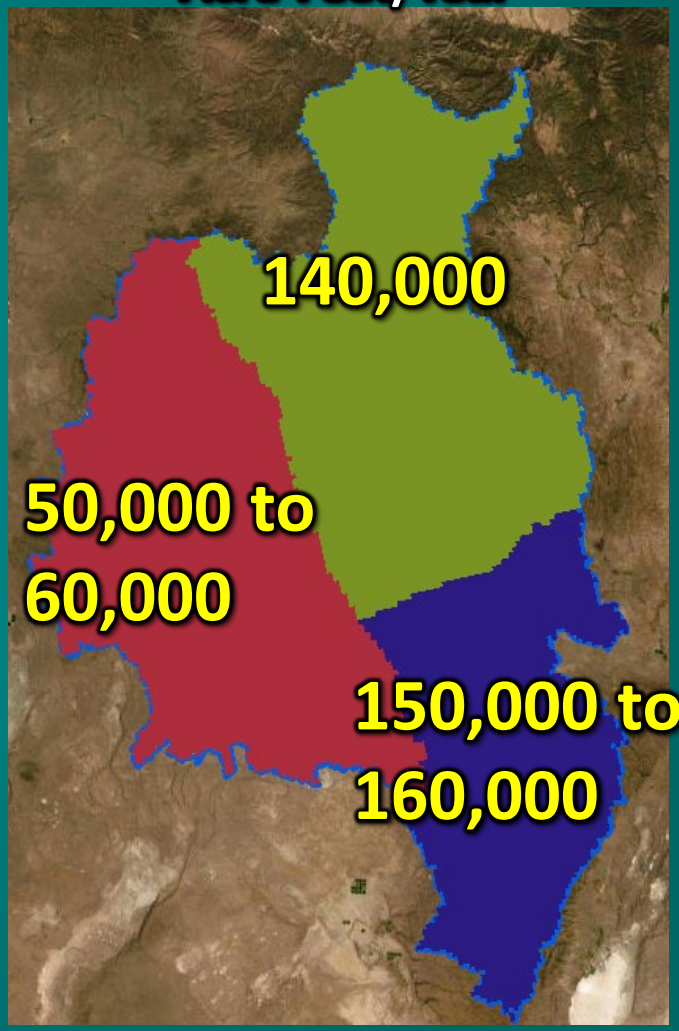
USGS

Current Water-Budget Estimates

RECHARGE = 220,000 to 250,000 Acre-Feet/Year

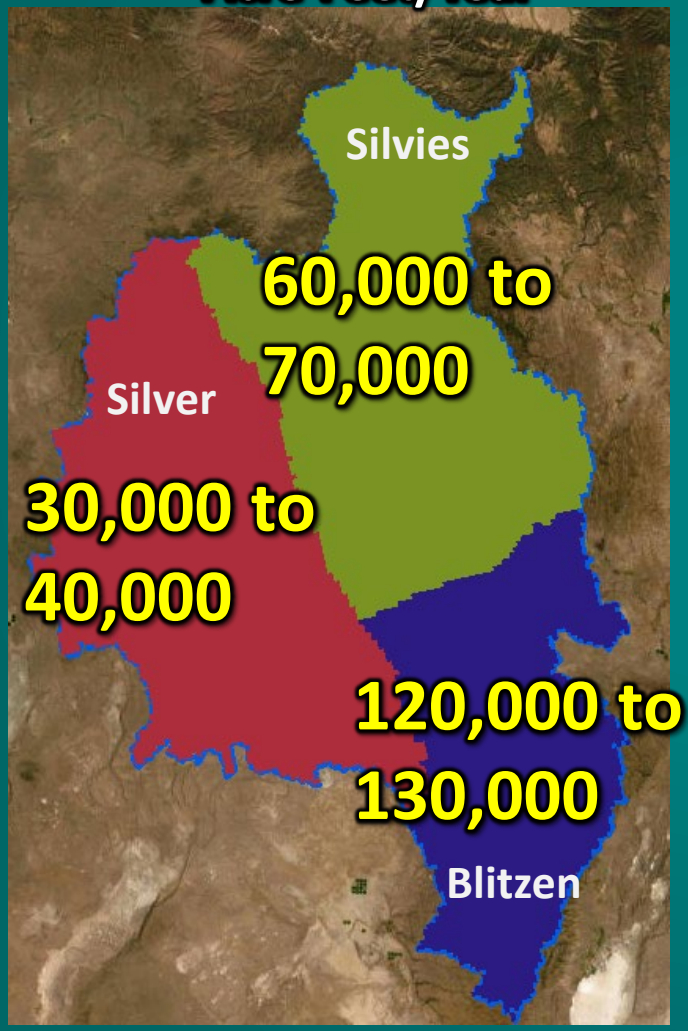


DISCHARGE = 340,000 to 370,000 Acre-Feet/Year

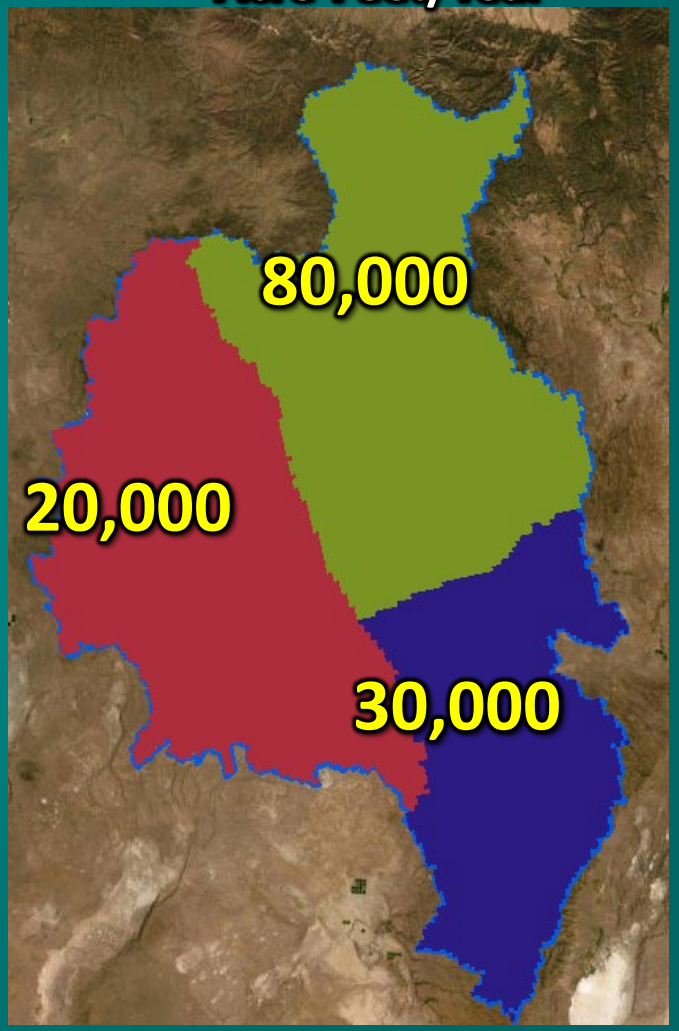


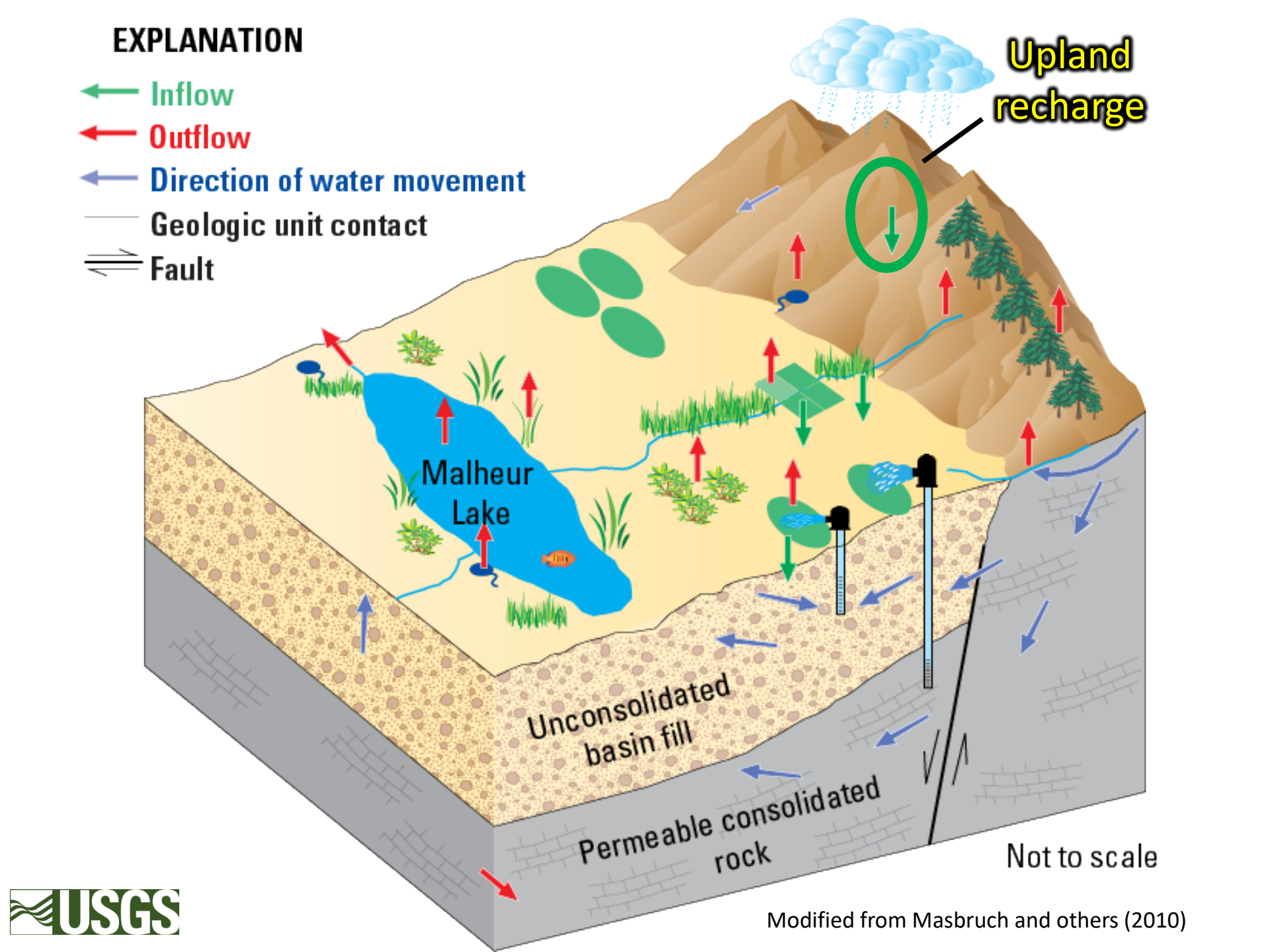
Current Discharge Estimates

Natural-ish = 210,000 to 240,000 Acre-Feet/Year



Irrigation = 130,000 Acre-Feet/Year





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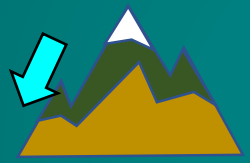
Modified from Masbruch and others (2010)

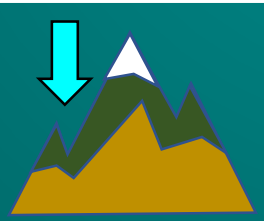
Upland Recharge

Soil Water Balance (SWB)[1] method

Precipitation 

− Runoff 

− ET 

= Upland recharge 

[1]Westenbroek and others (2010)

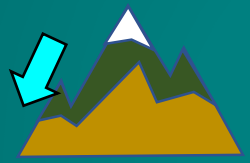
Precipitation image from openclipart.org

USGS

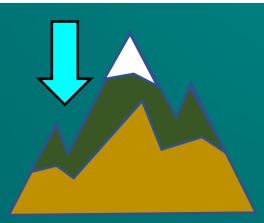
Upland Recharge

Soil Water Balance (SWB)[1] method

Precipitation 

− Runoff 

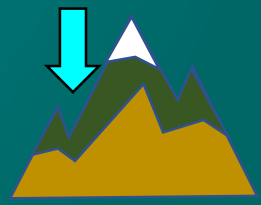
− ET 

= Upland recharge 

Discharge balance

Natural discharge

− Recharge from streamflow loss and flooding 

= Upland recharge 

[1]Westenbroek and others (2010)

Precipitation image from openclipart.org

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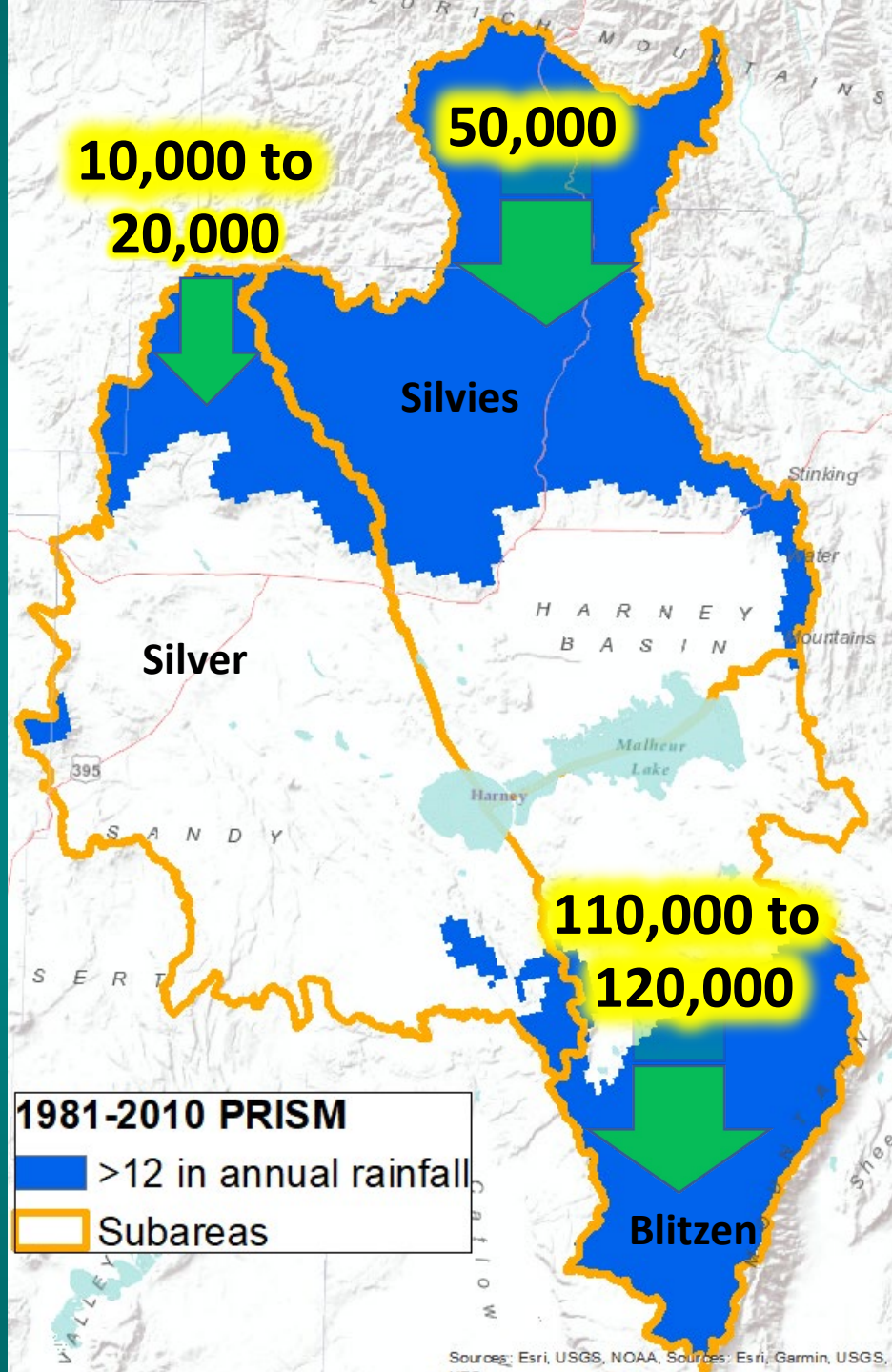
Upland Recharge (1981-2016)

- Total recharge

170,000 – 190,000 acre-ft/year



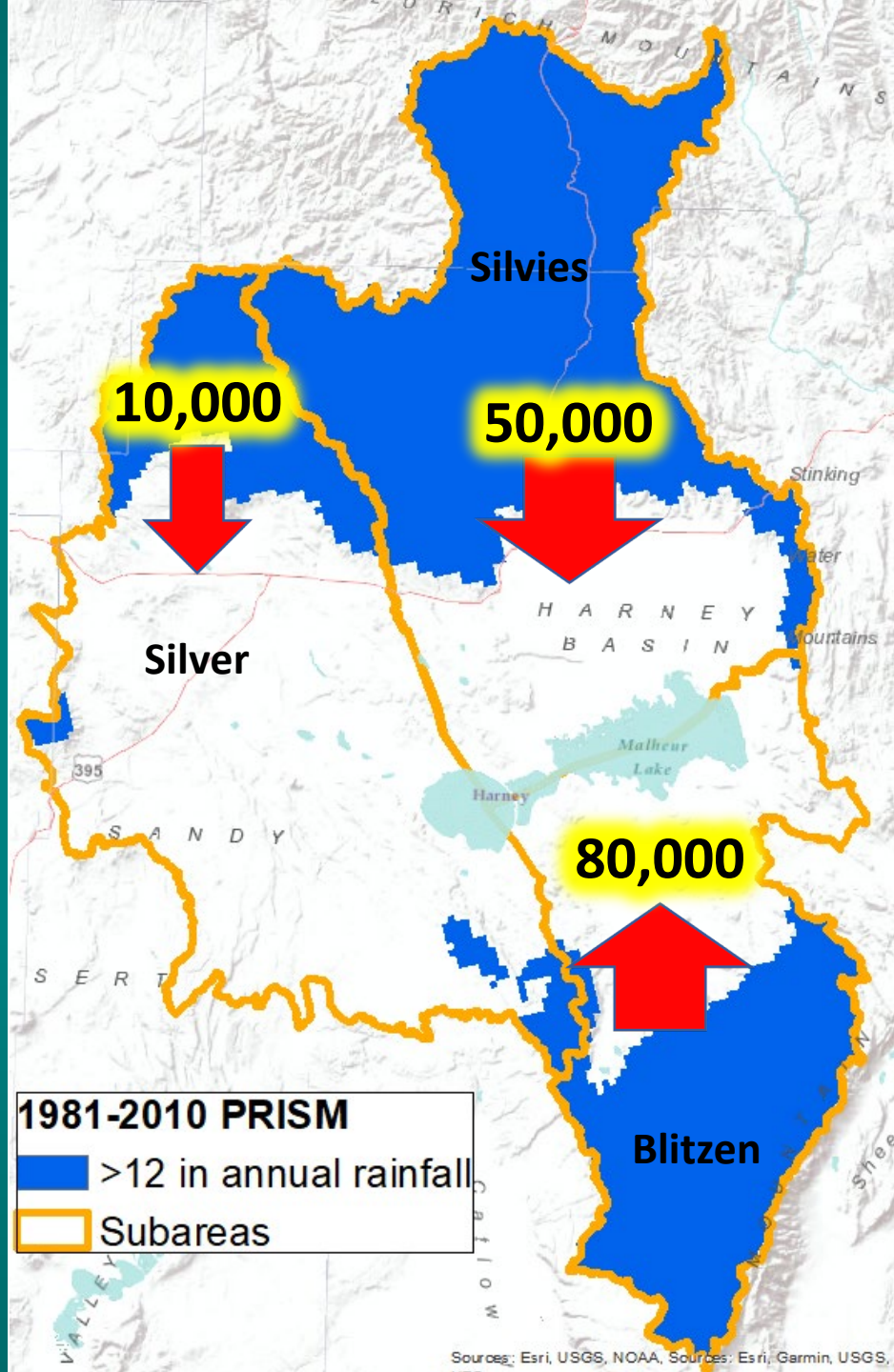
Upland Recharge (1981-2016)

- Upland baseflow & springflow

140,000 acre-ft/year

- Silvies and Silver baseflow is recycled as recharge down slope (streamflow & flooding)

- Blitzen baseflow is not recycled as recharge

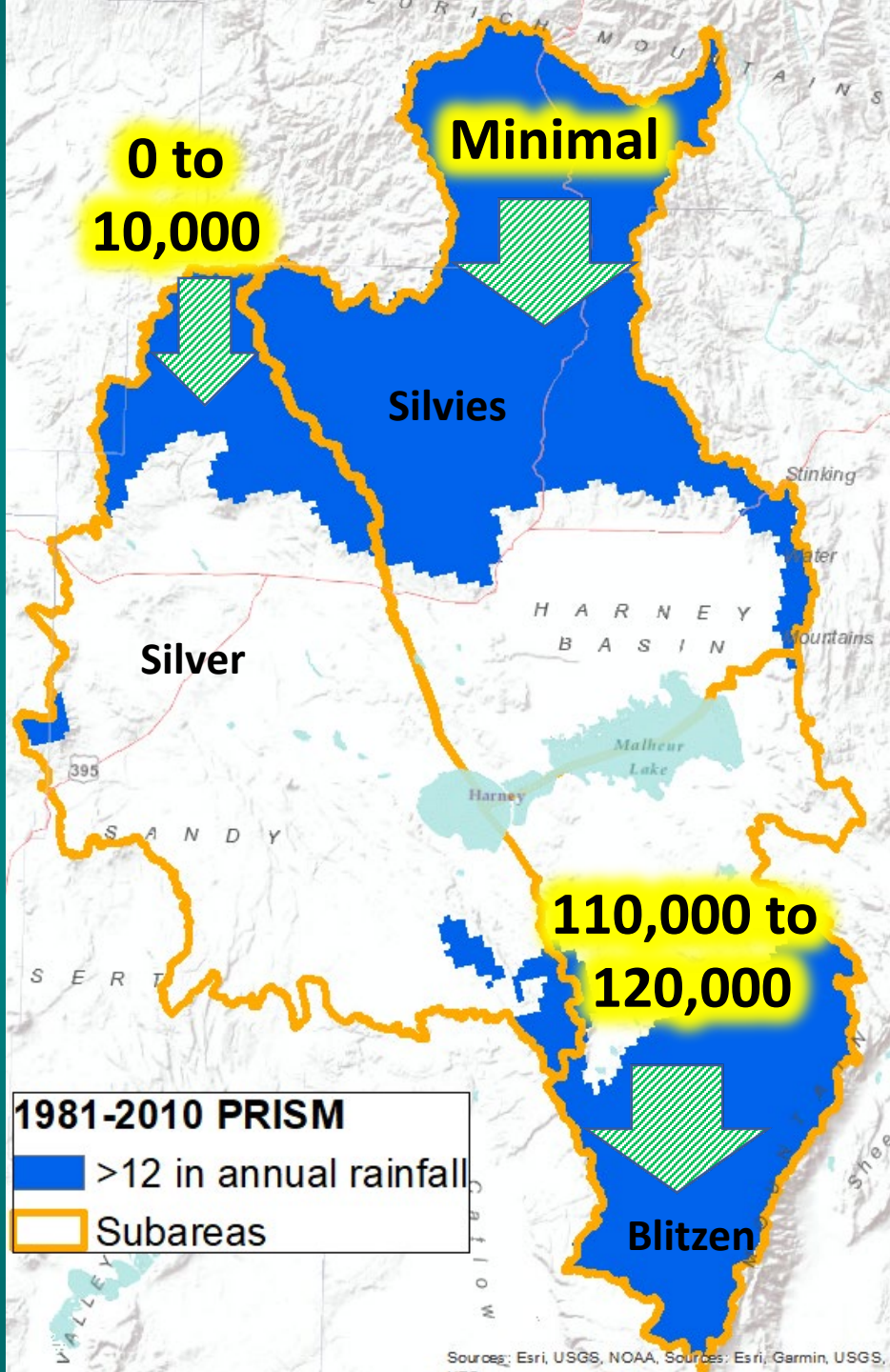


Upland Recharge (1981-2016)

- **Net upland recharge**

110,000 – 130,000 acre-ft/year

- Represents amount of upland recharge that does not recycle back as recharge downslope



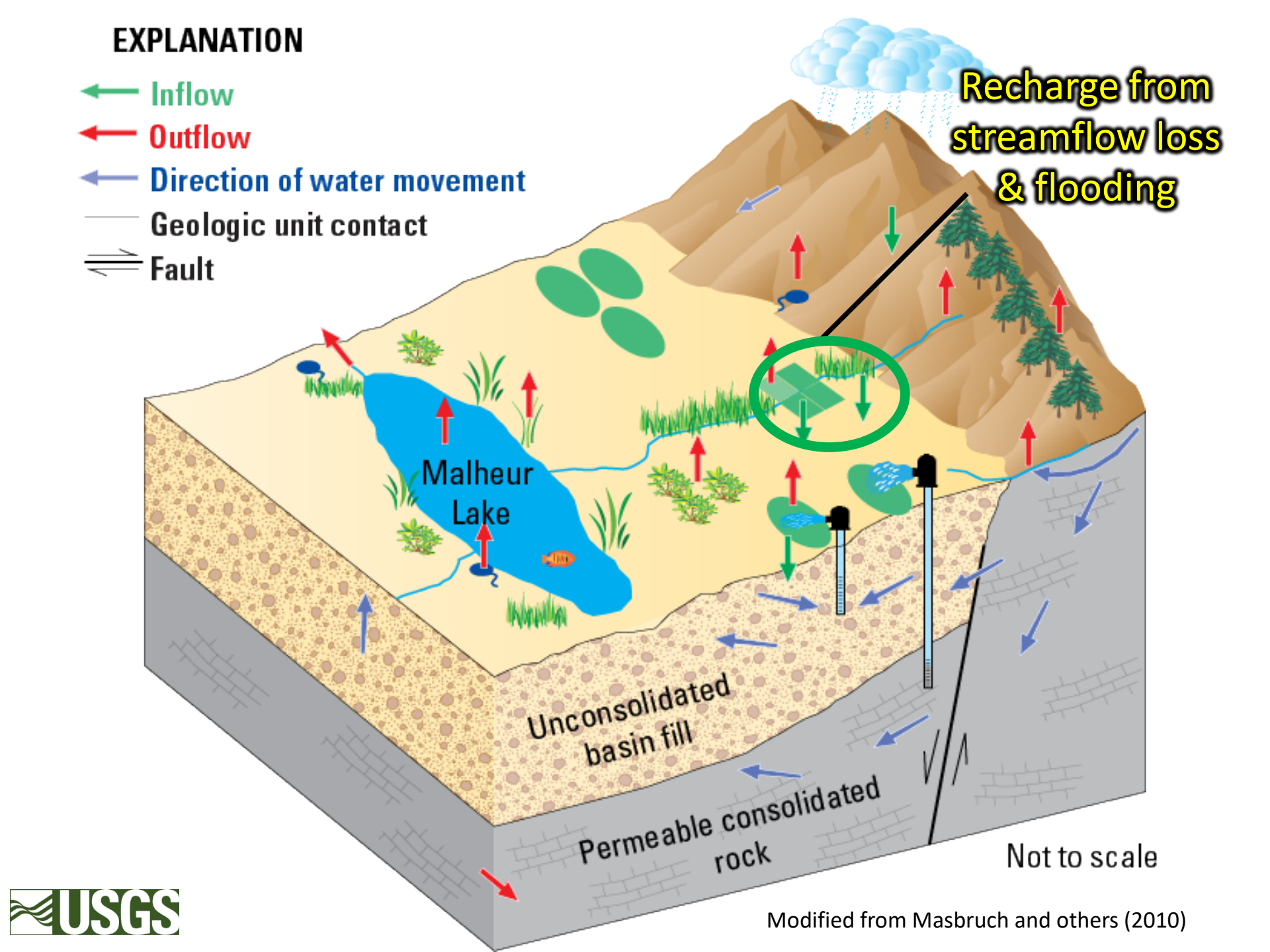
Upland Recharge (1981-2016)

in Acre-Feet/Year

Total upland recharge = 170,000 – 190,000

- Baseflow from uplands (Silvies & Silver) = 60,000

Net upland recharge ~ 110,000 – 130,000

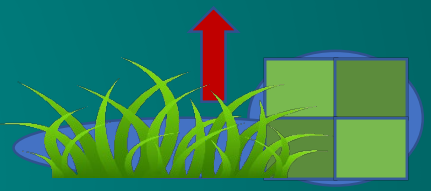


Modified from Masbruch and others (2010)

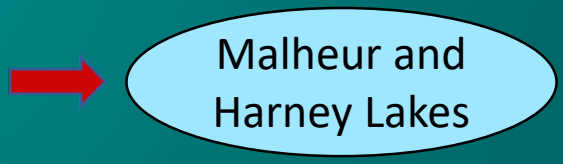
Recharge from Streamflow loss and Flooding

Streamflow from uplands

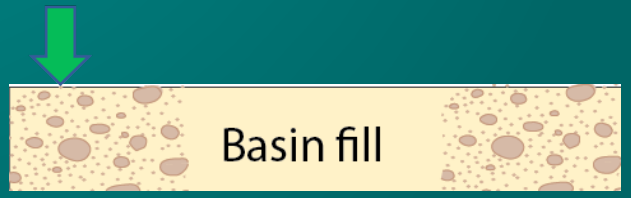
– ET from surface-water flooding and irrigation



– Streamflow to lakes



Basin-fill recharge



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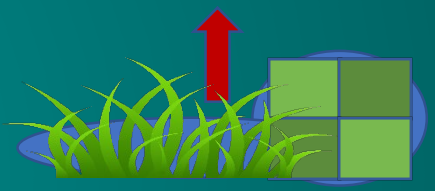
Recharge from Streamflow loss and Flooding

Streamflow from uplands

Rivers and streams

– ET from surface-water flooding and irrigation



– Streamflow to lakes

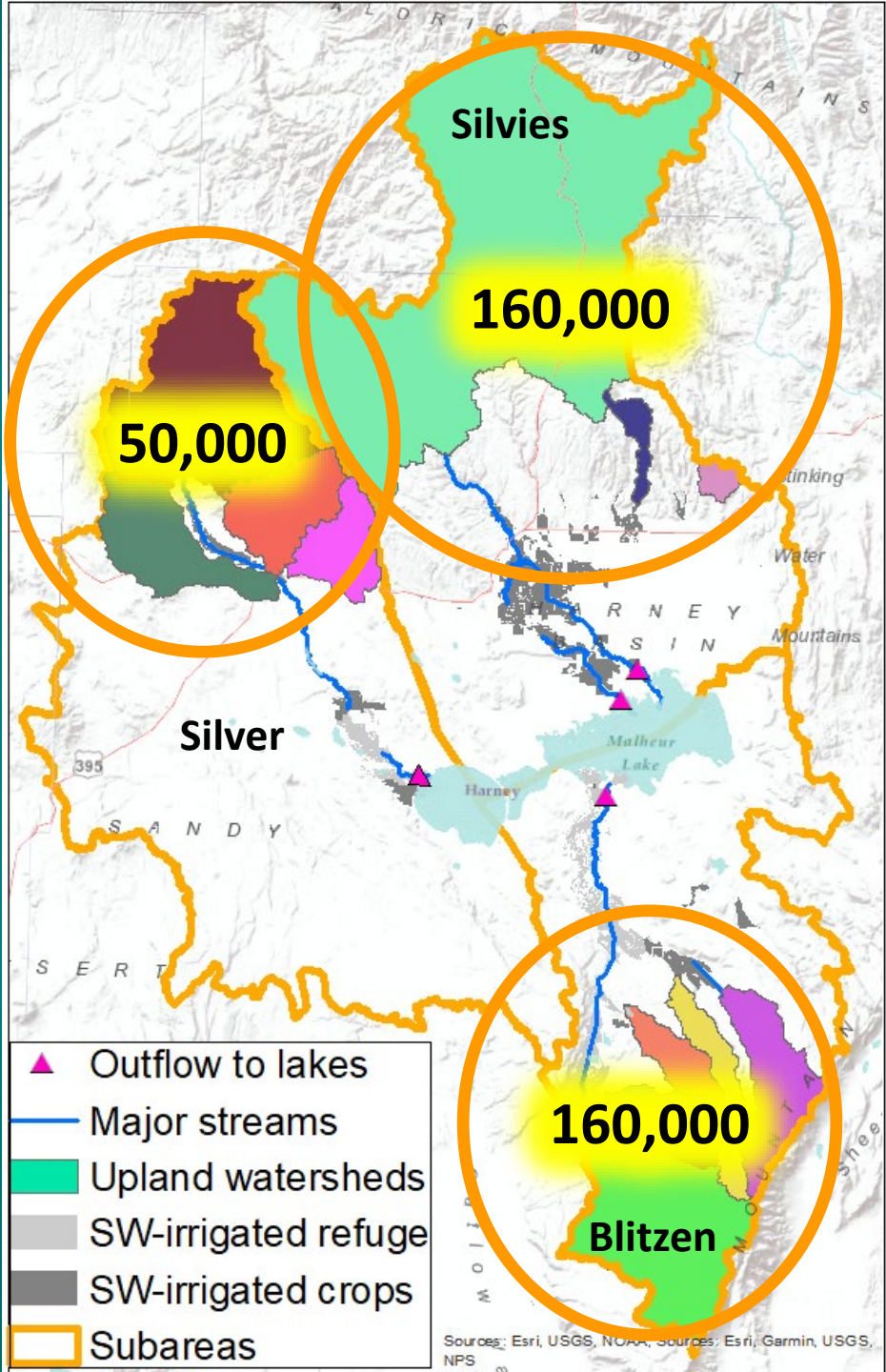
Malheur and Harney Lakes

Includes deep percolation from surface-water irrigation

USGS

Recharge from Streamflow loss and Flooding (1981-2016)

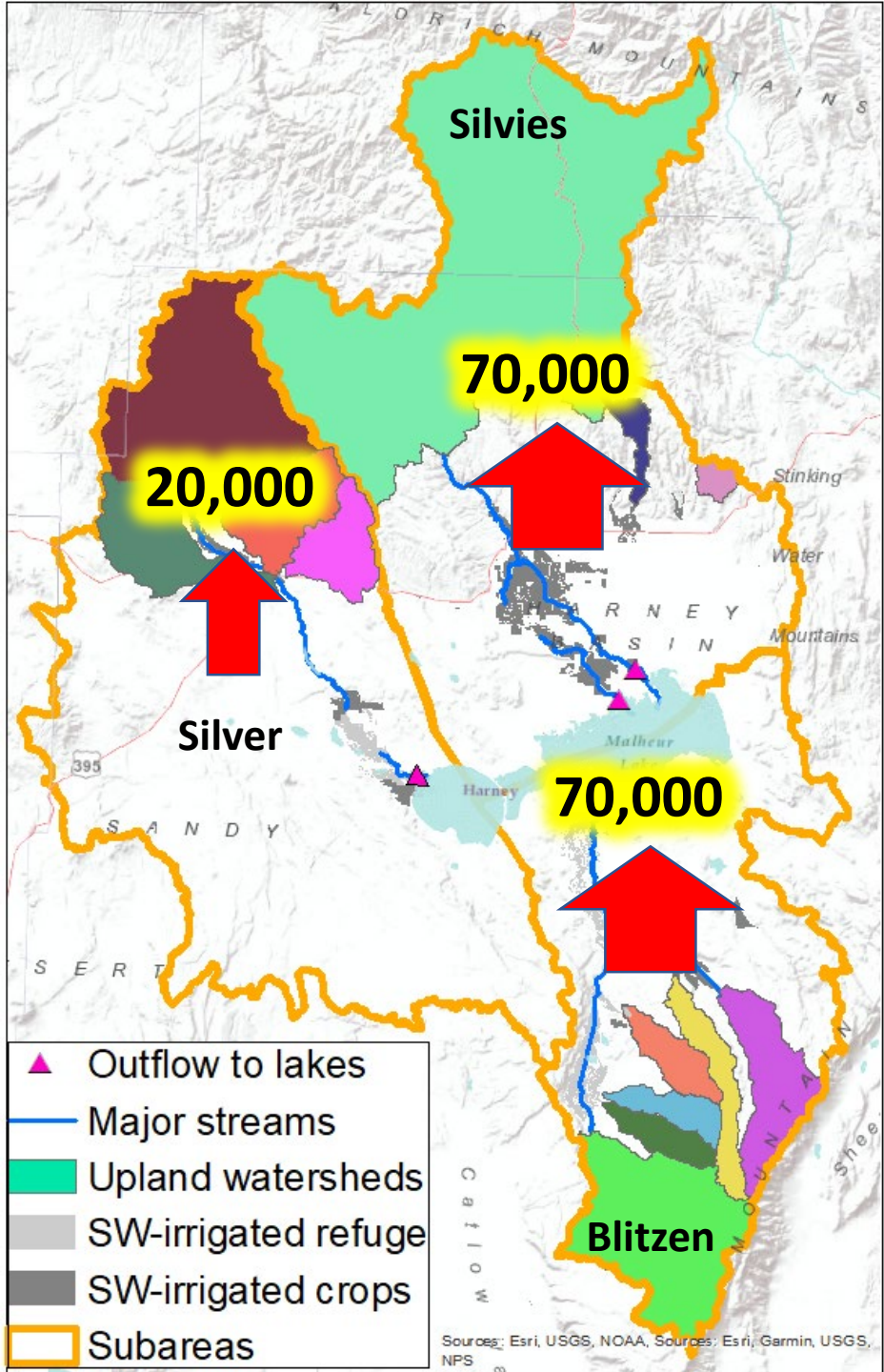
- Upland streamflow = **370,000** acre-feet/year
- Includes upland springs



Recharge from Streamflow loss and Flooding (1981-2016)

- ET from SW flooding, irrigation, and open water (moon reservoir)

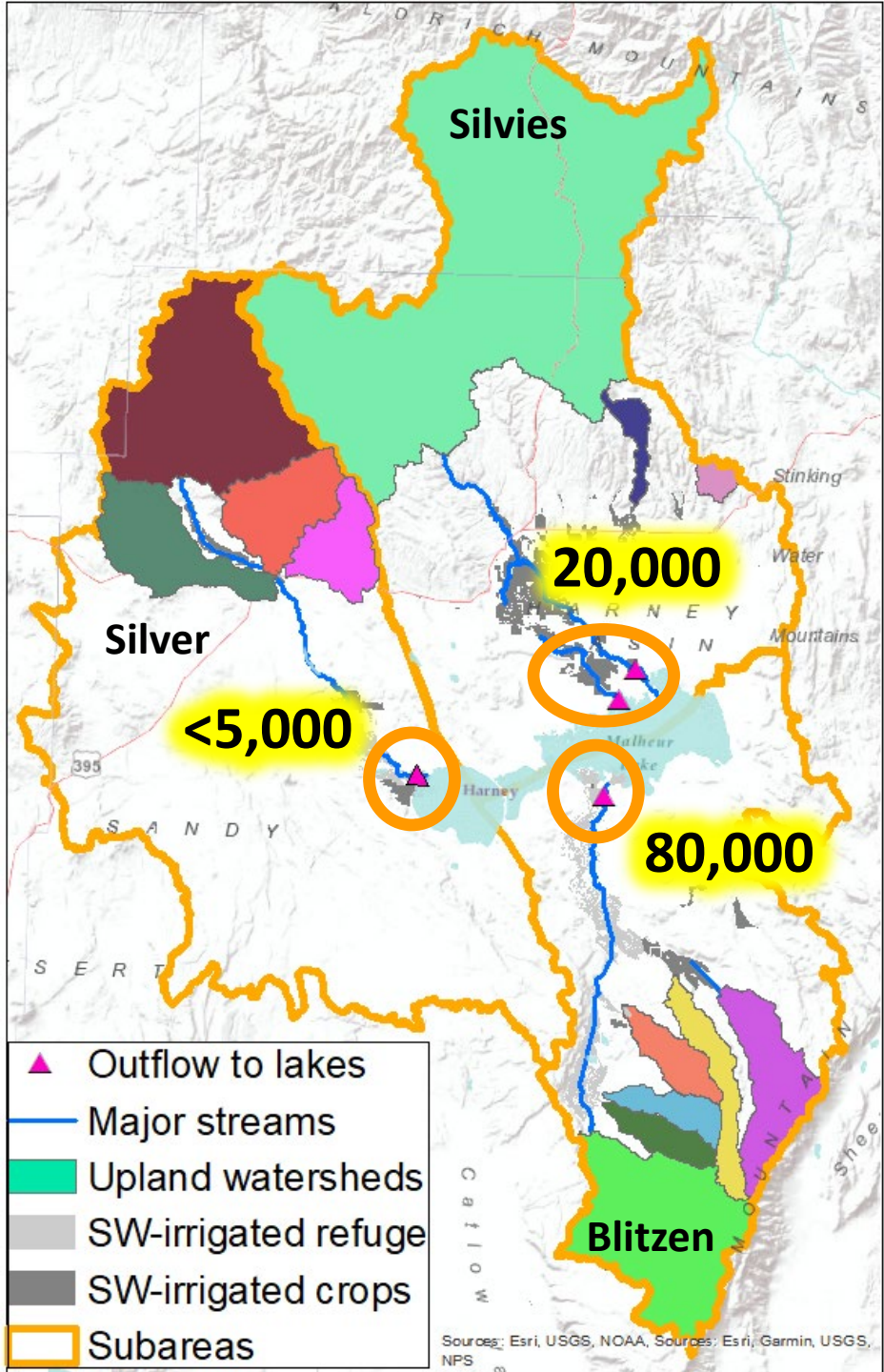
160,000 acre-feet/year



Recharge from Streamflow loss and Flooding (1981-2016)

- Streamflow to lakes

<105,000 acre-ft/year

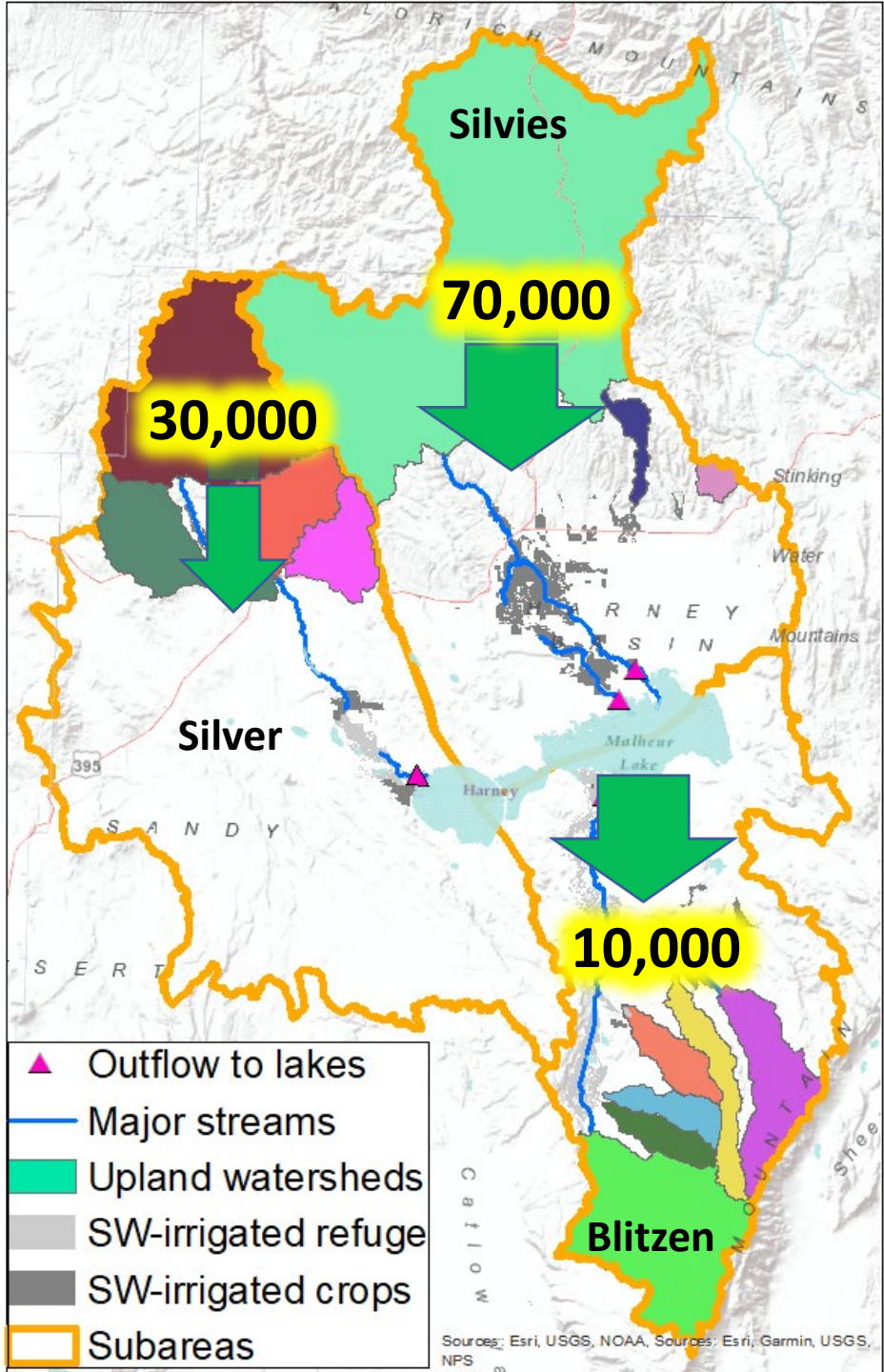


Recharge from Streamflow loss and Flooding (1981-2016)

- Recharge

~110,000 acre-feet/year

- Silvies area – equal to natural discharge
- Silver area – 60 to 80% of natural discharge
- Blitzen area – small fraction of natural discharge



USGS Unpublished data, subject to revision. Do not cite.

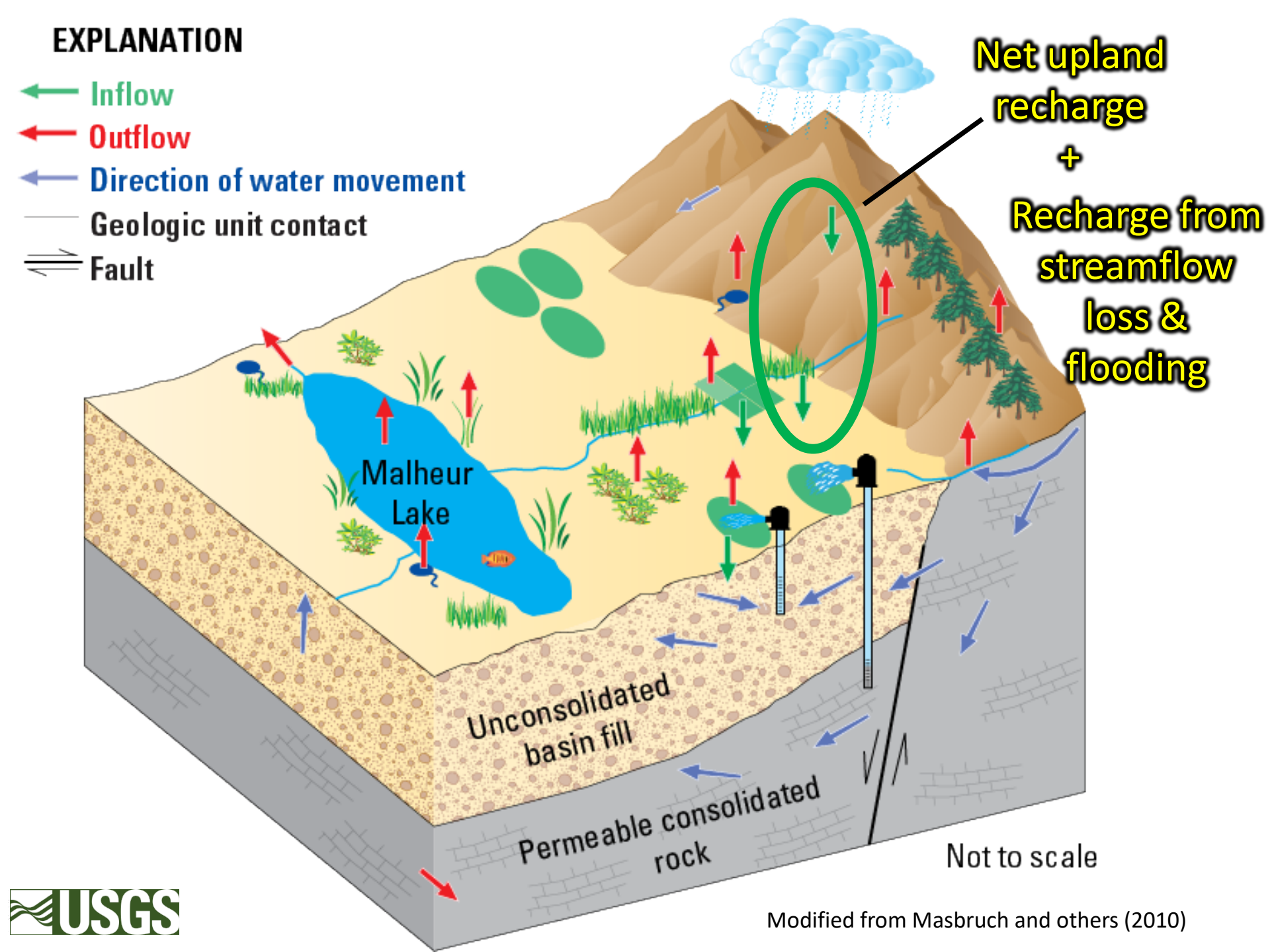
Recharge from Streamflow Loss and Flooding (1981-2016)

in Acre-Feet/Year

Total upland streamflow = 370,000

- ET from flooding, irrigation, open water = 160,000
- Streamflow to lakes = 100,000

Basin fill recharge ~ 110,000



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Modified from Masbruch and others (2010)

Net Basin Recharge – Additional Approach

Harney Empirical Method[2]

Precipitation  × Harney-basin recharge coefficient

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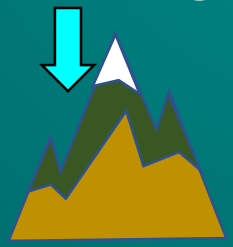
= Net upland recharge  + Streamflow loss & flooding 

[2]Modified Maxey-Eakin approach (Halford and Plume, 2011)

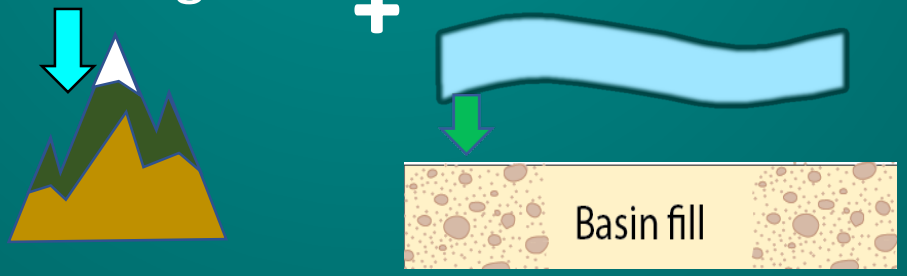
USGS

Net Basin Recharge – Additional Approach

Harney Empirical Method[2]

Precipitation × Harney-basin recharge coefficient

= Net upland recharge + Streamflow loss & flooding



Adjusted to match natural net discharge

[2]Modified Maxey-Eakin approach (Halford and Plume, 2011)

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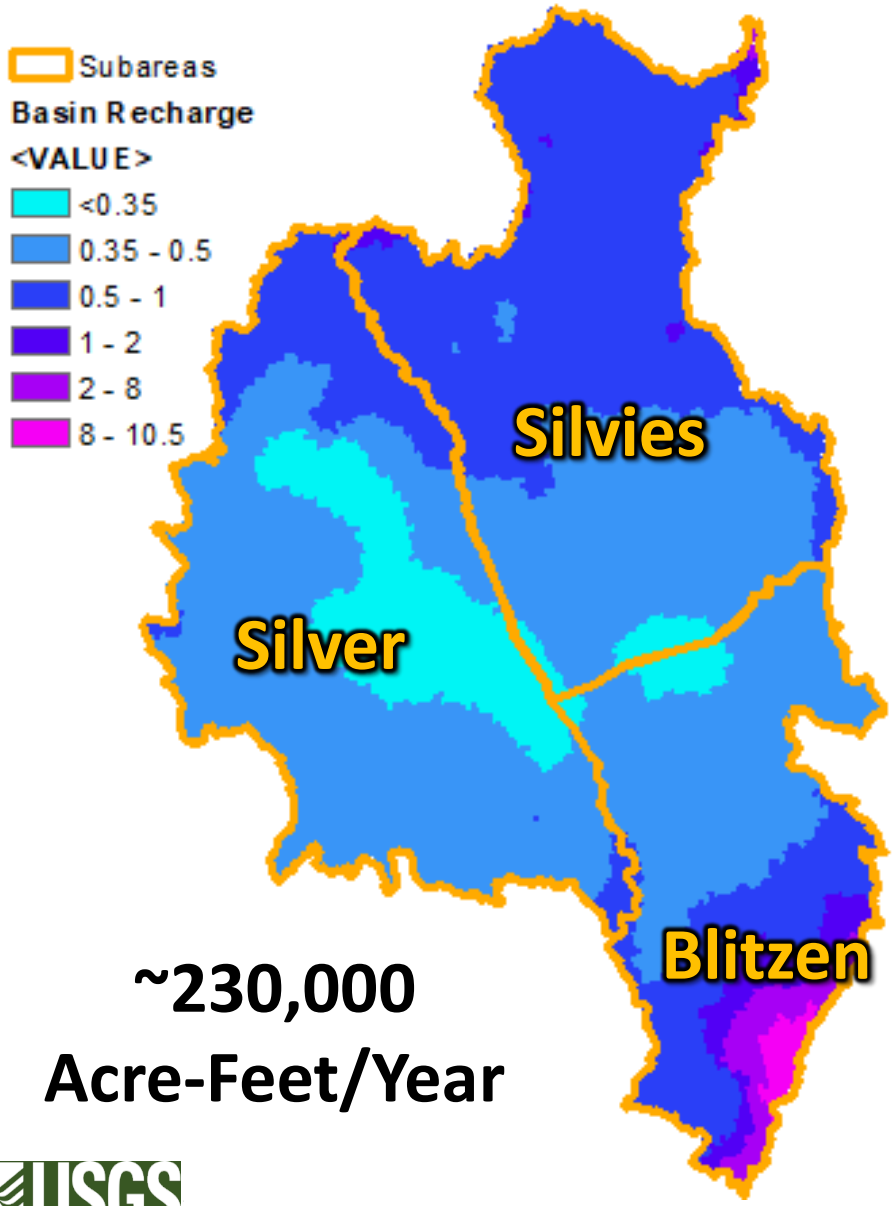
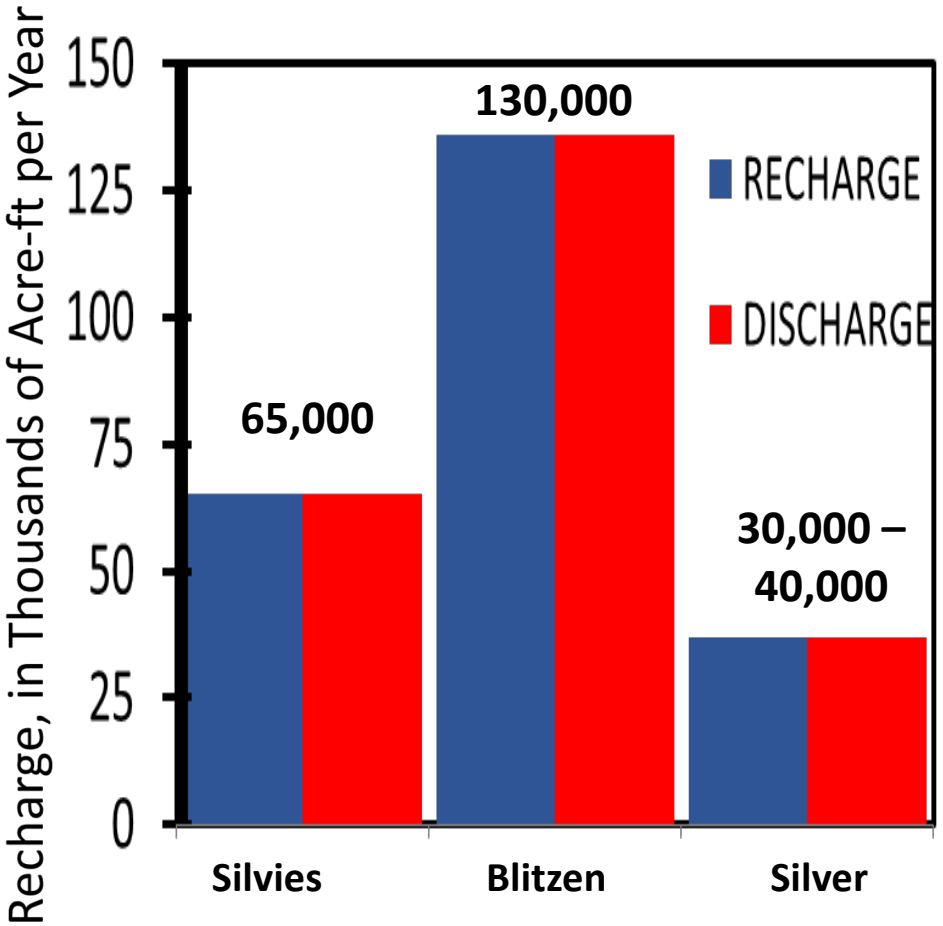
Net Recharge – Harney Empirical Method



~230,000 Acre-Feet/Year



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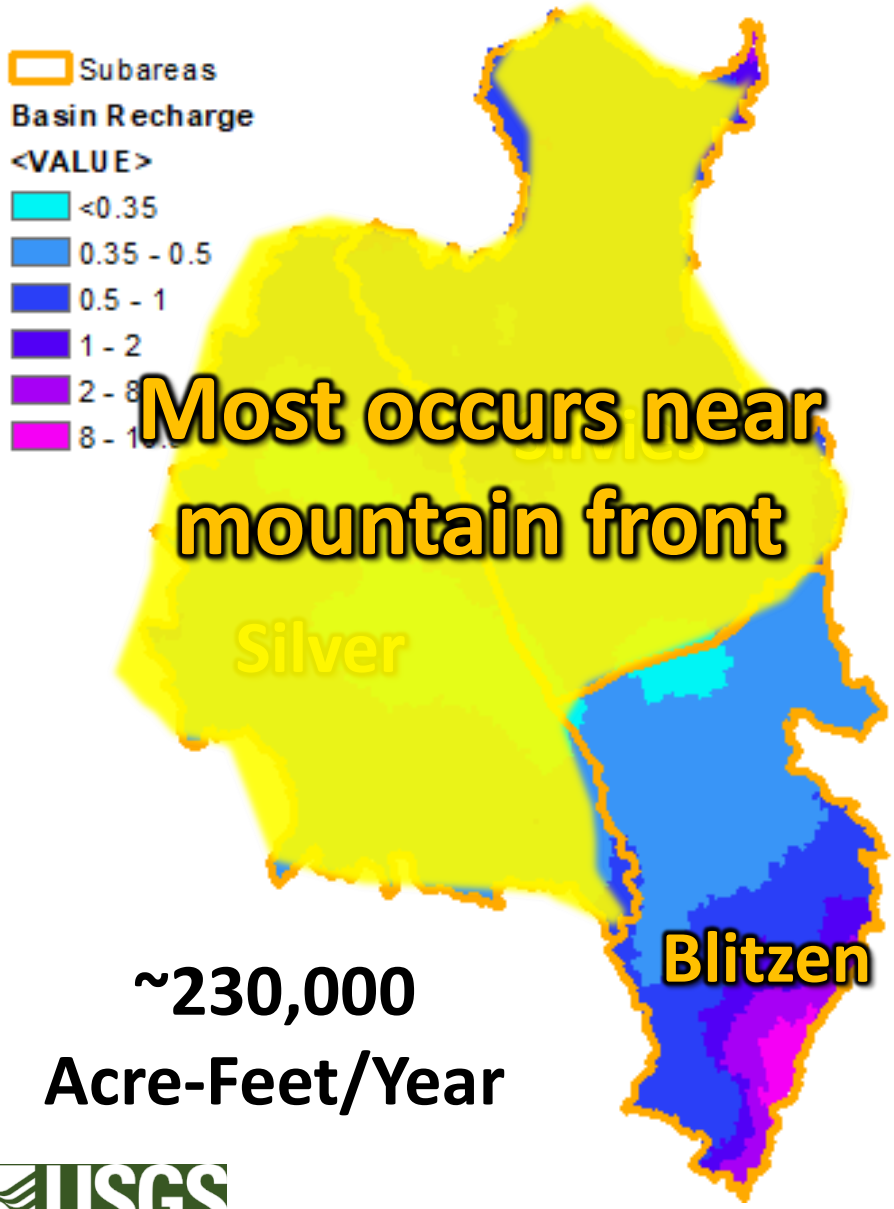
Unpublished data, subject to revision. Do not cite.

Net Recharge – Harney Empirical Method



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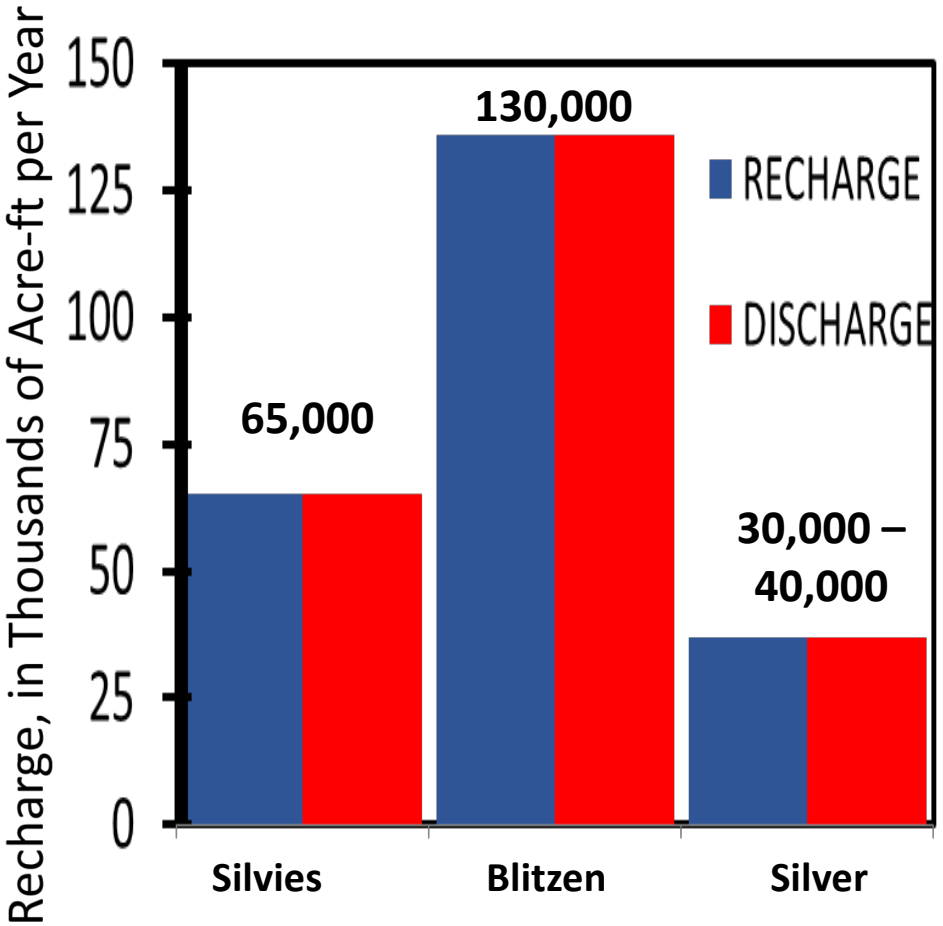

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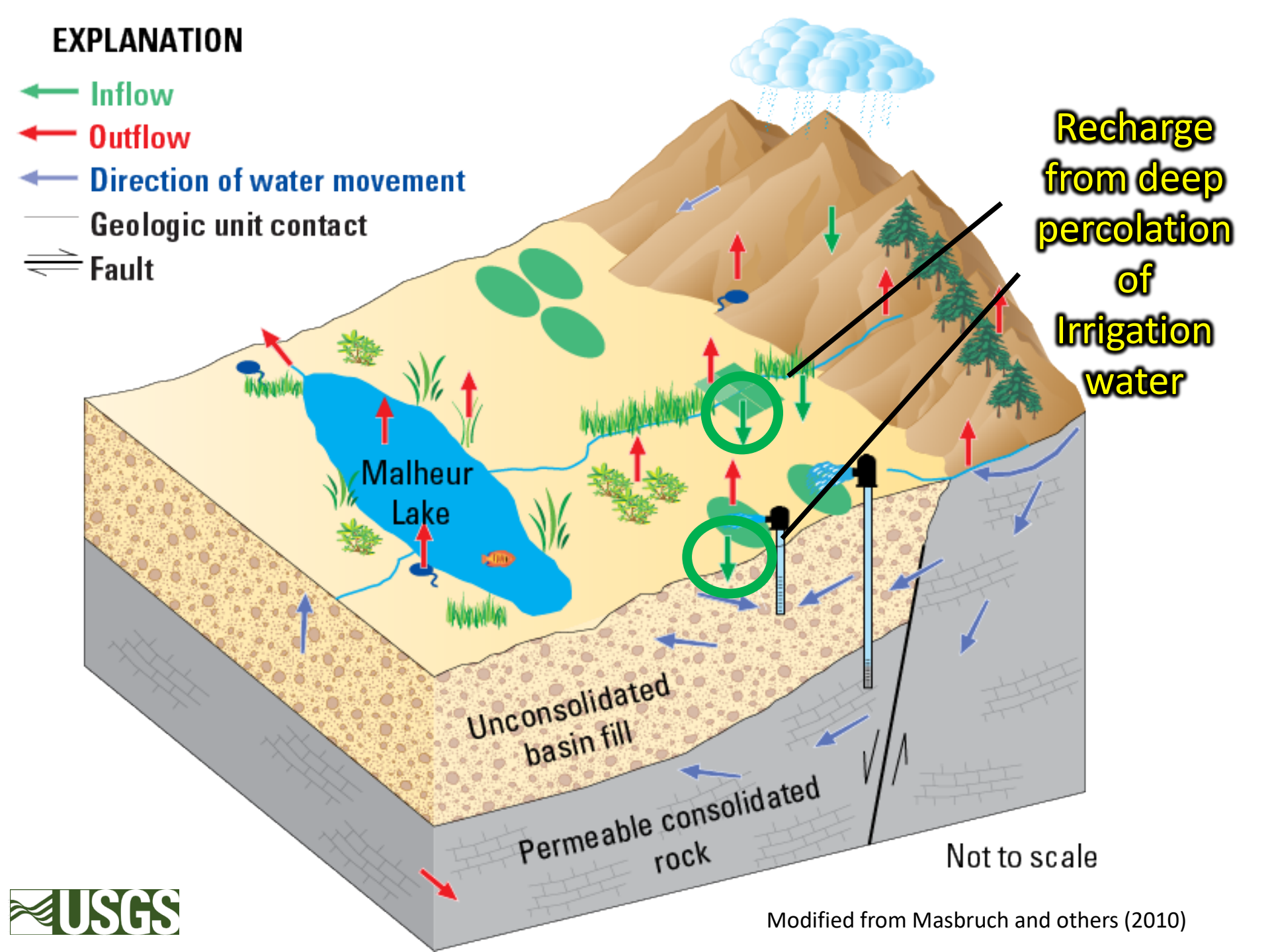

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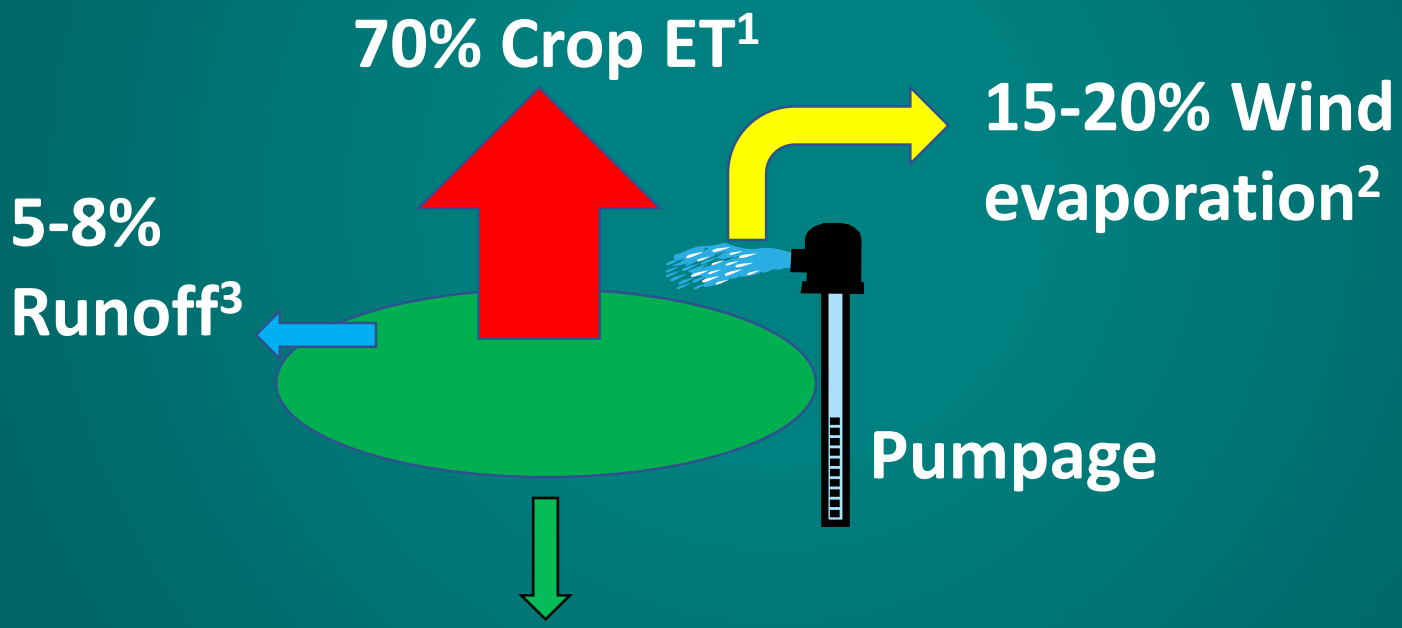
Modified from Masbruch and others (2010)

Recharge from Deep Percolation of Irrigation Water

GW-irrigated fields



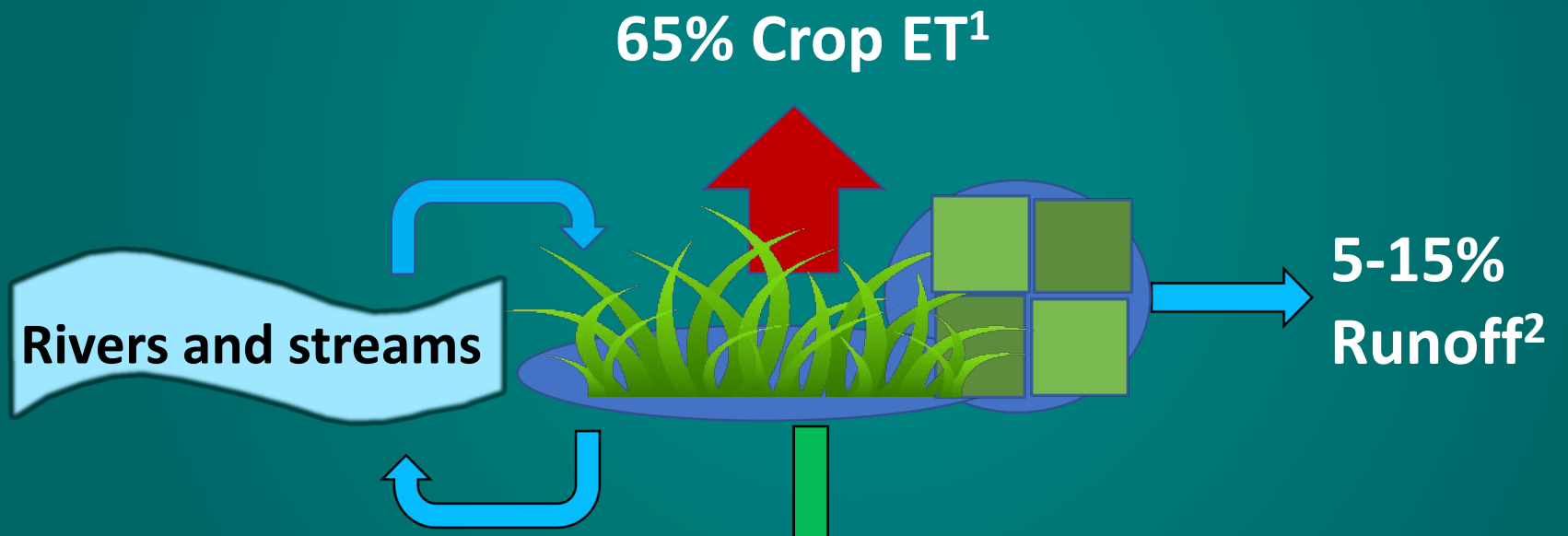
[1] Comparison of pumpage records and crop ET
[2] Published reports
[3] Split the difference (10-15%)

USGS

Unpublished data, subject to revision. Do not cite.

Recharge from Deep Percolation of Irrigation Water

SW-irrigated fields



[1]Published reports
[2]Split the difference (35%)

USGS

Recharge from Deep Percolation of Irrigation Water

in Acre-Feet/Year

Groundwater fields <10,000

+ Surface-water fields ~ 10,000 to 30,000

Total ~ 20,000 to 40,000

Net Recharge – Basin Wide (1981-2016)

in Acre-Feet/Year

Net upland recharge ~ 110,000 – 130,000

+ Recharge streamflow loss & flooding ~ 110,000

+ Recharge from deep percolation* ~ <10,000

Basin fill recharge ~ 220,000 – 250,000

*Value from primary groundwater-irrigated fields only

USGS

Full Basin Groundwater Budget

in Acre-Feet/Year

NET RECHARGE = 220,000 to 250,000

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NET DISCHARGE = 340,000 to 370,000

- Natural*ish* = 210,000 to 240,000
- Irrigation = 130,000
- Municipal and domestic use = 4,000

=

BALANCE = -130,000 to -120,000 AFY

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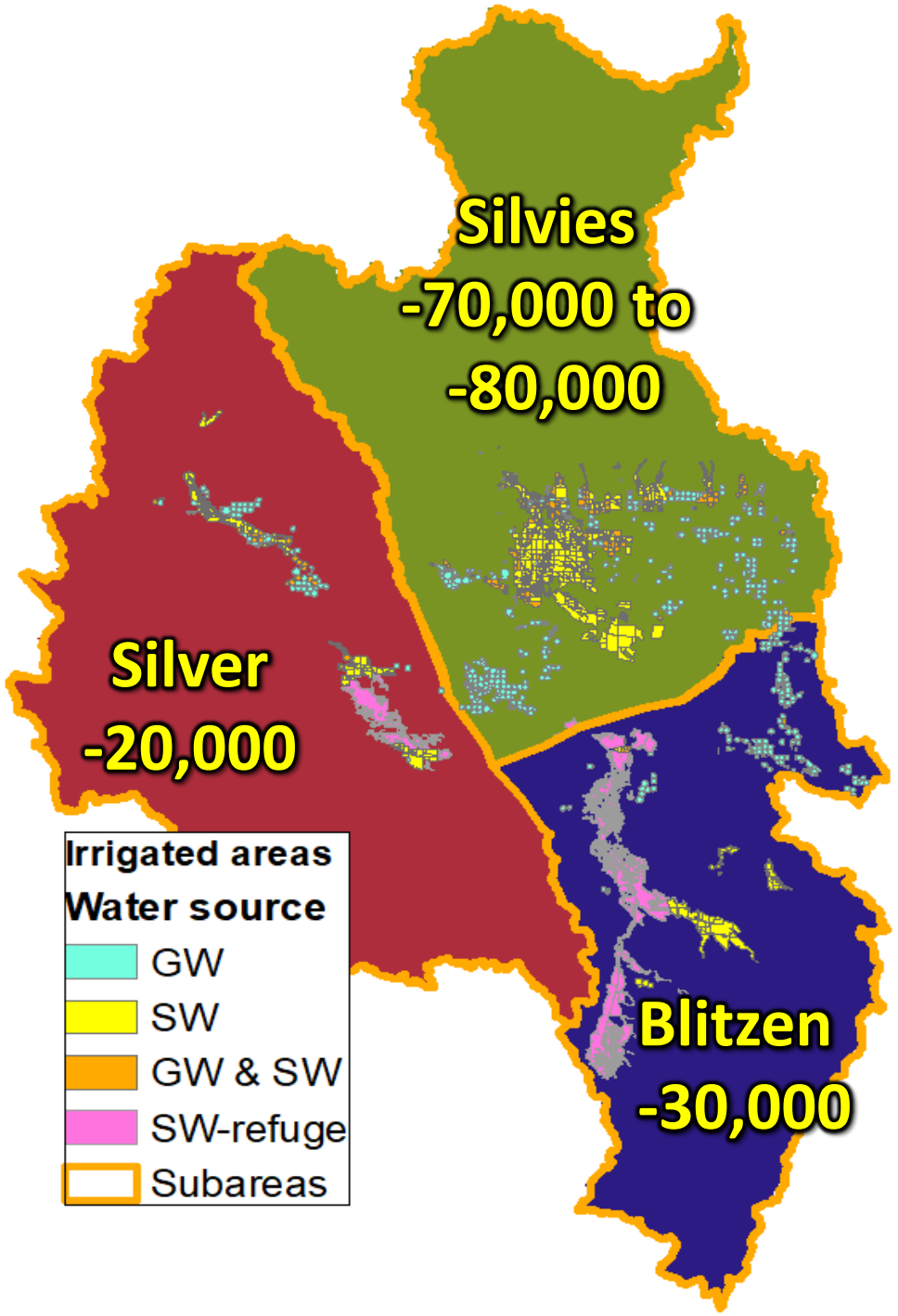
Change in Groundwater Storage

Total = -130,000 to -120,000 Acre-feet/year

Recharge ≈ natural discharge

Excess discharge from depletion of GW storage

Depletion of GW storage supported by declining GW levels



USGS

References

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- Westenbroek, S.M., Kelson, V.A., Dripps, W.R., Hunt, R.J., and Bradbury,K.R., 2010, SWB—A modified Thornthwaite-Mather Soil-Water-Balance code for estimating groundwater recharge: U.S. Geological Survey Techniques and Methods 6–A31, 60 p. Available online at: https://pubs.usgs.gov/tm/tm6-a31/.

USGS