Starting Soon:
An Introduction to Managed Aquifer Recharge (MAR) Training

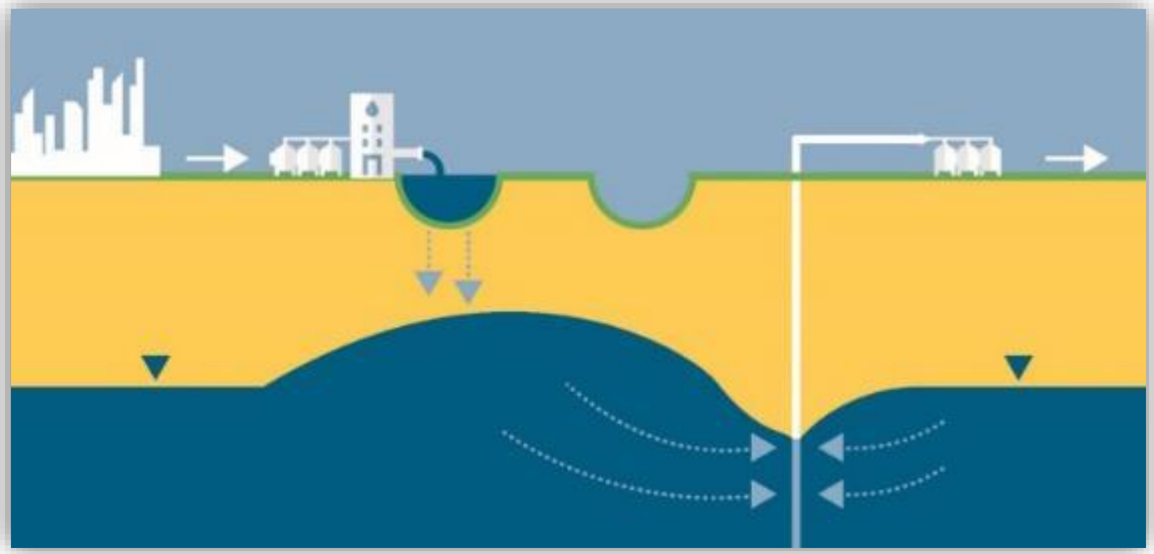
Housekeeping

- This event is being recorded; Event will be available On Demand after the event at the main training page

  https://clu-in.org/conf/itrc/MAR/

- If you have technical difficulties, please use the Q&A Pod to request technical support
- Need confirmation of your participation today?
  - Fill out the online feedback form and check box for confirmation email and certificate

An Introduction to Managed Aquifer Recharge (MAR) (MAR-1, 2023)



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ITRC – Shaping the Future of Regulatory Acceptance

- Host Organization ECOS
- Network - All 50 states, PR, DC
- Federal Partners
  DOE DOD EPA
- ITRC Industry Affiliates Program IAP
- Academia
- Community Stakeholders

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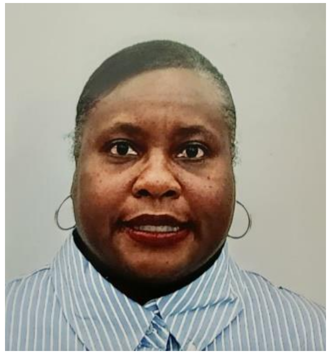
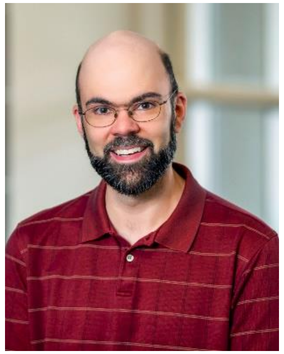
Meet the ITRC Trainers

Kelsey Bufford
Oklahoma DEQ
kelsey.bufford@deq.ok.gov

Guy Sewell
ECU Professor Retired
sewell@mac.com



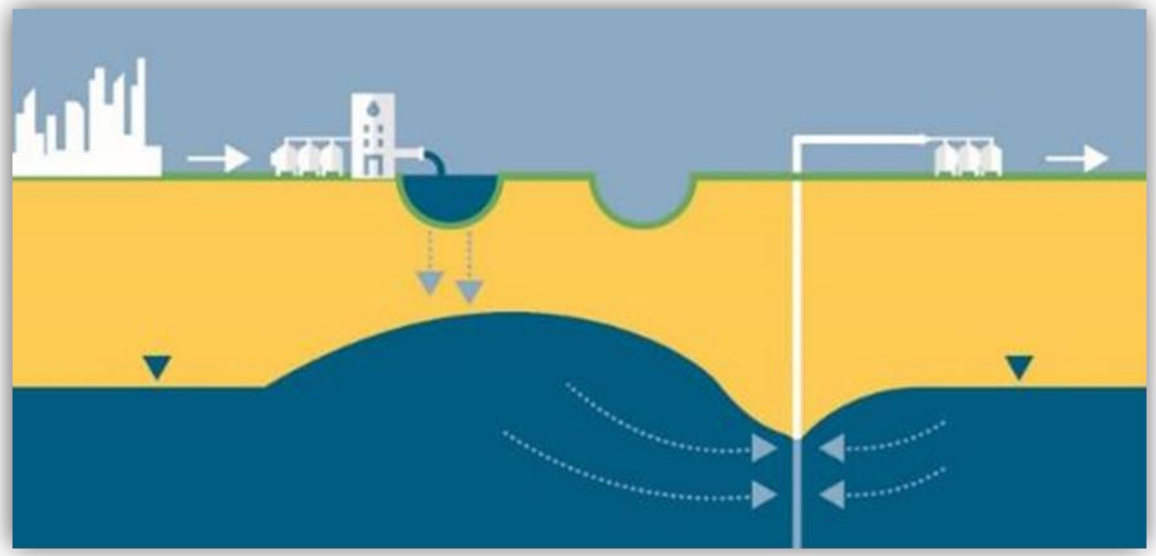
Linda Bowling
US EPA
bowling.linda@epa.gov



Adam Janzen
Barr Engineering Co
ajanzen@barr.com

John Mitsdarfer
Oklahoma DEQ
john.mitsdarfer@deq.ok.gov

Managed Aquifer Recharge (MAR)



What is your level of knowledge/ experience concerning MAR?
a) None
b) Limited
c) Moderate
d) Expert

Poll

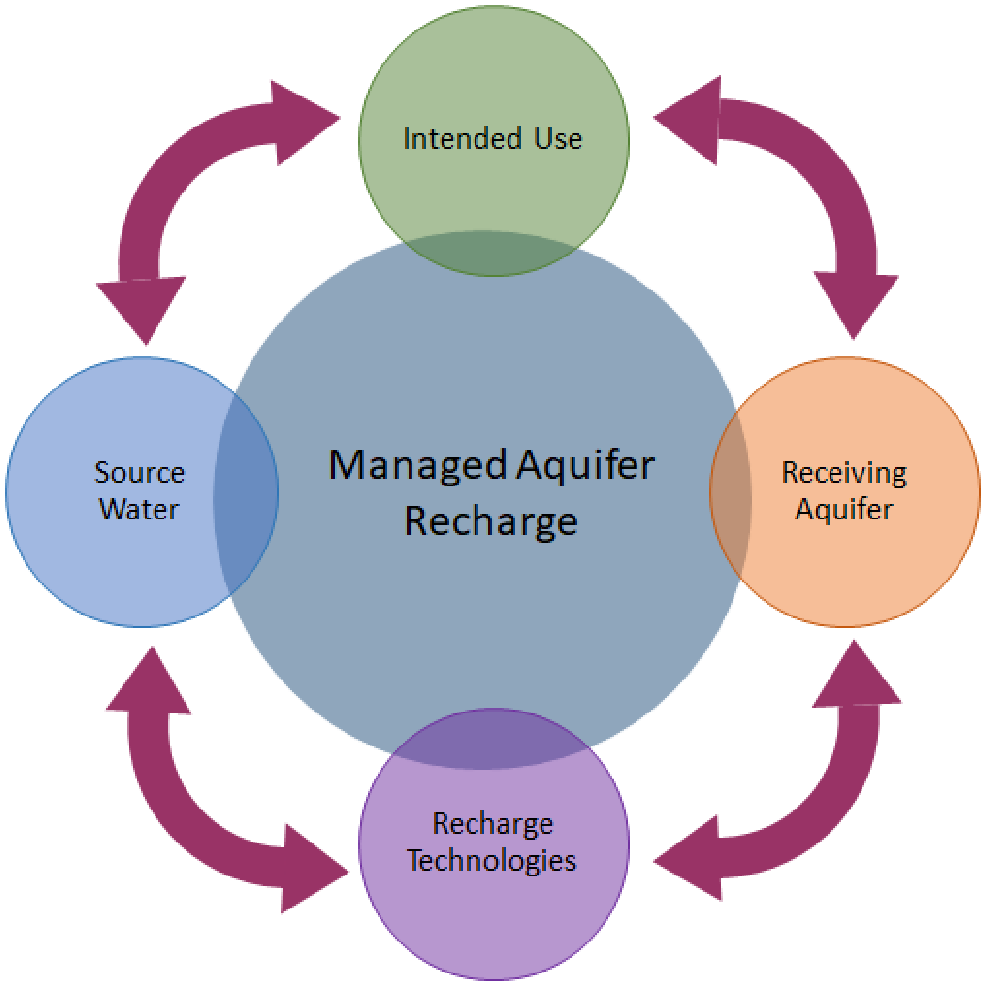
TRAINING OBJECTIVES

- Understand MAR and its applications
- Recognize MAR as a process rather than a technology
- MAR can be widely applied
- MAR's role in the future; addressing water supply resilience and climate impacts

Why MAR?

What is your water challenge?

What do you need to know about source water?



What do you need to know about the Receiving Aquifer?

Which Recharge Technology to select?

MAR Document Figure 1.1 MAR Process Model – Key Elements

Freshwater

Drought

Flooding

Climate Change Impacts by Sector | US EPA
https://www.epa.gov/climateimpacts/climate-change-impacts-sector

Roadmap

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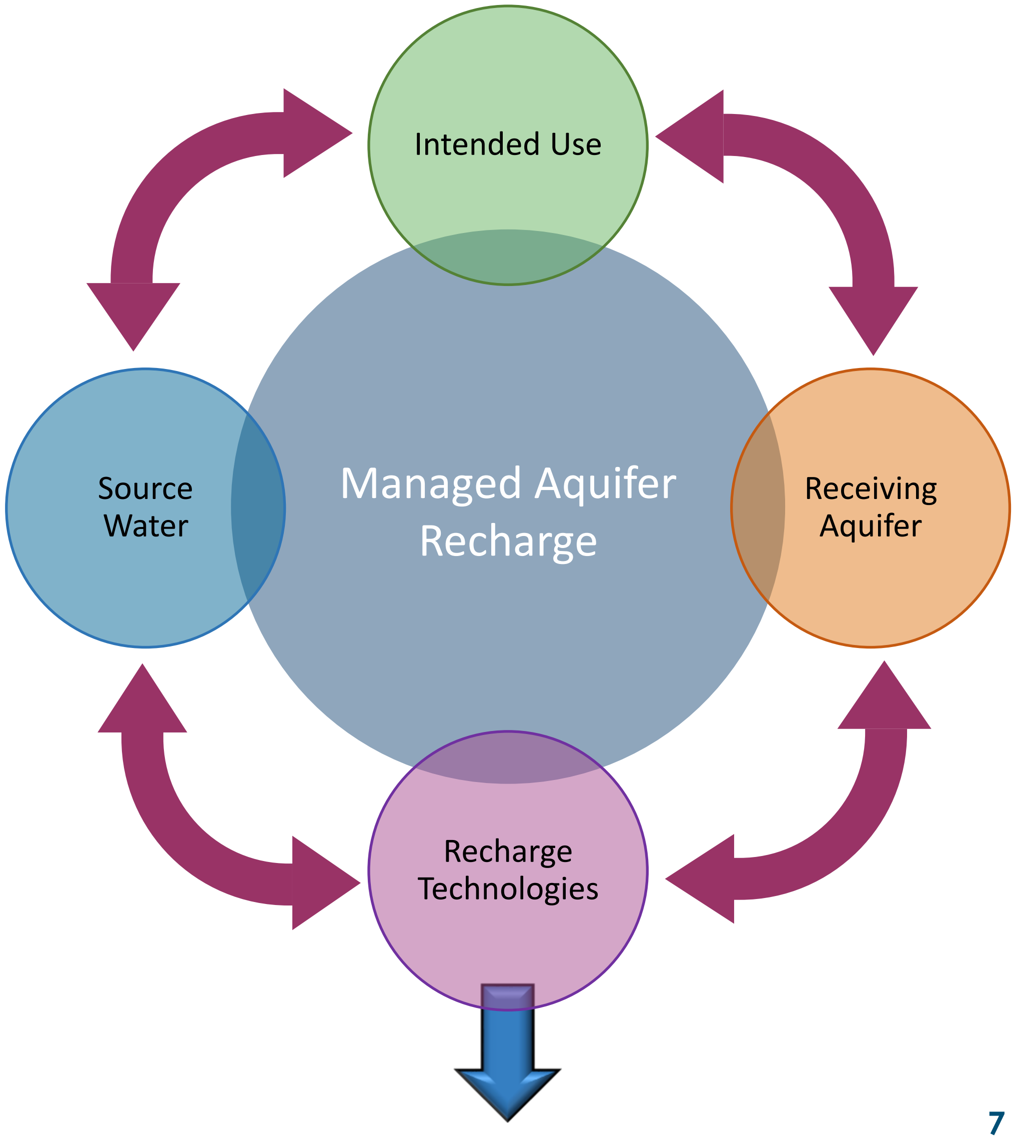
  - How to make it happen?
- Case Study Examples

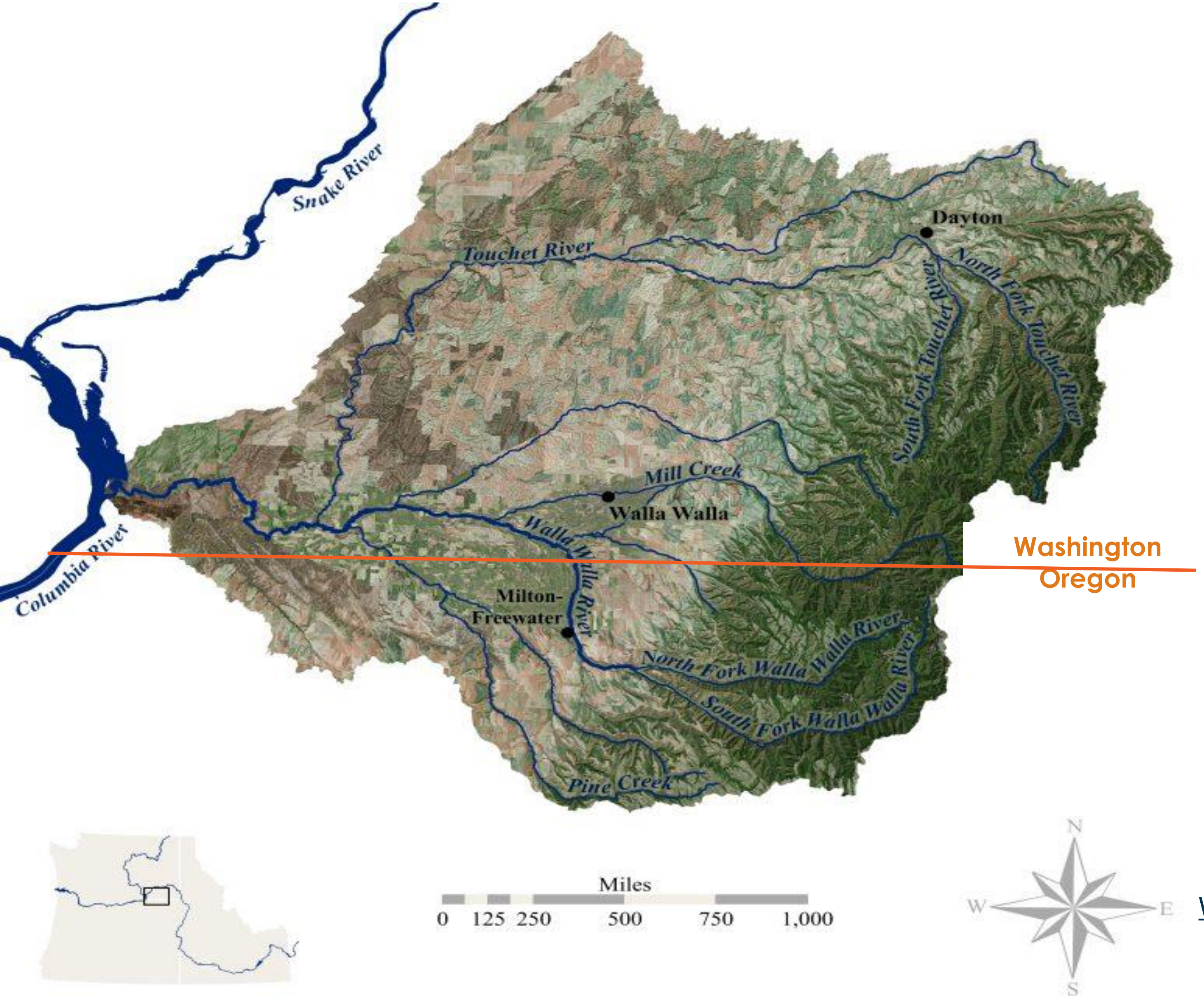


Case Studies

Case Studies!

- 5.1 HRSD Sustainable Water Initiative for Tomorrow (SWIFT) Program; Southeast Virginia
- 5.2 Reduce the Concentration of Naturally Occurring Arsenic and Other Trace Metals in Recovered Water during Aquifer Storage and Recovery (ASR) Operations; Deland, Florida
- 5.3 Seawater Intrusion/Replenishment in Southern Los Angeles County; Southern Los Angeles County, California
- 5.4 San Antonio Water System H2Oaks Center Aquifer Storage and Recovery (ASR) Project; San Antonio, Texas
- 5.5 Salinas Valley Groundwater Basin; Monterey County, California
- 5.6 Idaho's Eastern Snake Plain Aquifer MAR Program; Eastern Snake Plain, Idaho
- 5.7 South Hillsborough Aquifer Recharge Project (Apollo Beach); Hillsborough County, Florida
- 5.8 Mustang Creek Watershed Dry Well Pilot Study; Merced County, California
- 5.9 Walla Walla Basin Watershed; Oregon/Washington
- 5.10 Clark Fork River Basin MAR Modeling; Deer Lodge, Montana
- 5.11 Army Post Road ASR Well; Des Moines, Iowa
- 5.12 South Metro Water Supply Authority Regional ASR Groundwater Model Scope of Work; Aurora, Colorado

Walla Walla Basin Watershed



Located in southeast Washington and northeast Oregon

Covers an area of dry land in the rain shadow of the Cascades

Walla Walla River Basin – CTUIR Fish Habitat Restoration Efforts in the Walla Walla River Basin
https://wallawallariver.org/

Walla Walla Basin Watershed

Case Study 5.9

Water Challenges

- Increase in development caused water levels to drop
- Insufficient stream flows to support aquatic life
- Loss of floodplain function due to channelization and flood control
- Seepage loss from the river to groundwater

MAR CS 5.9 Figure 2. Average gains or losses in flow of a segment of the Walla Walla River; Source: WWBWC (2017)

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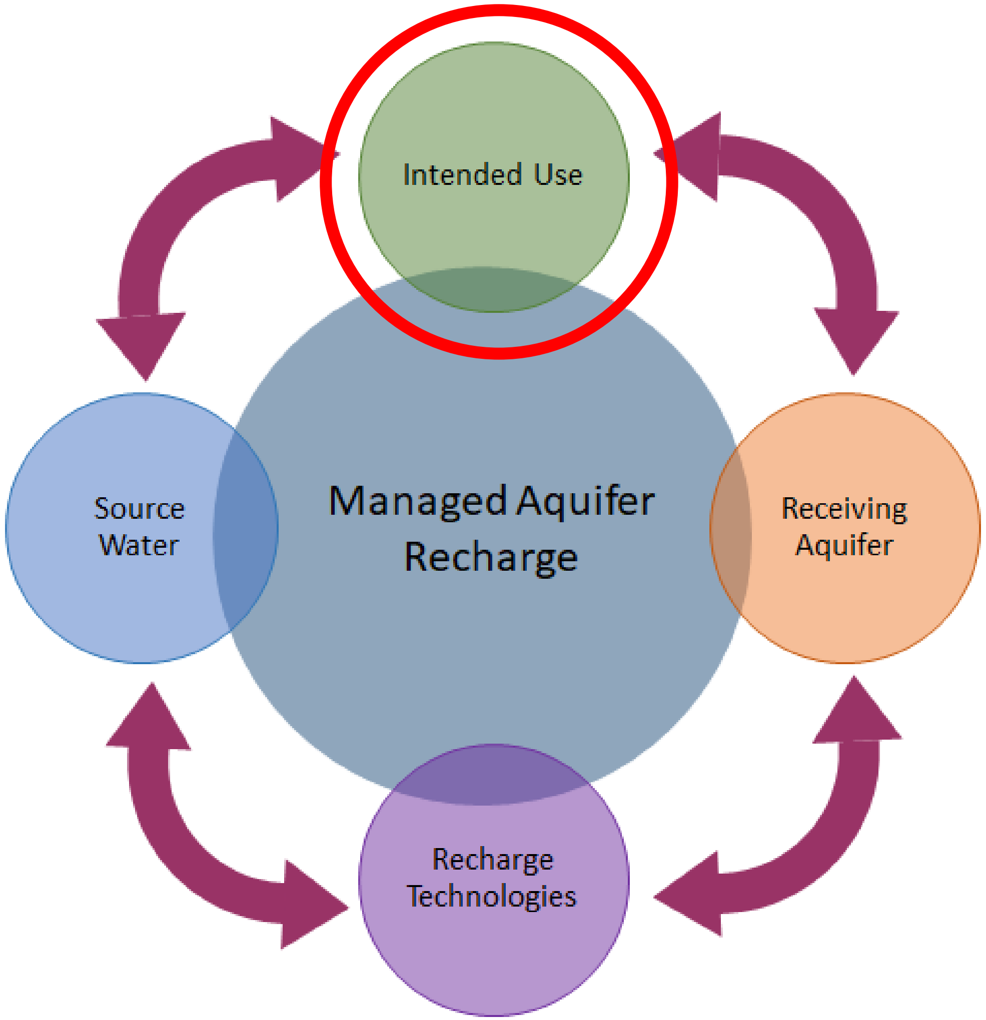


Water Challenges → MAR Solutions

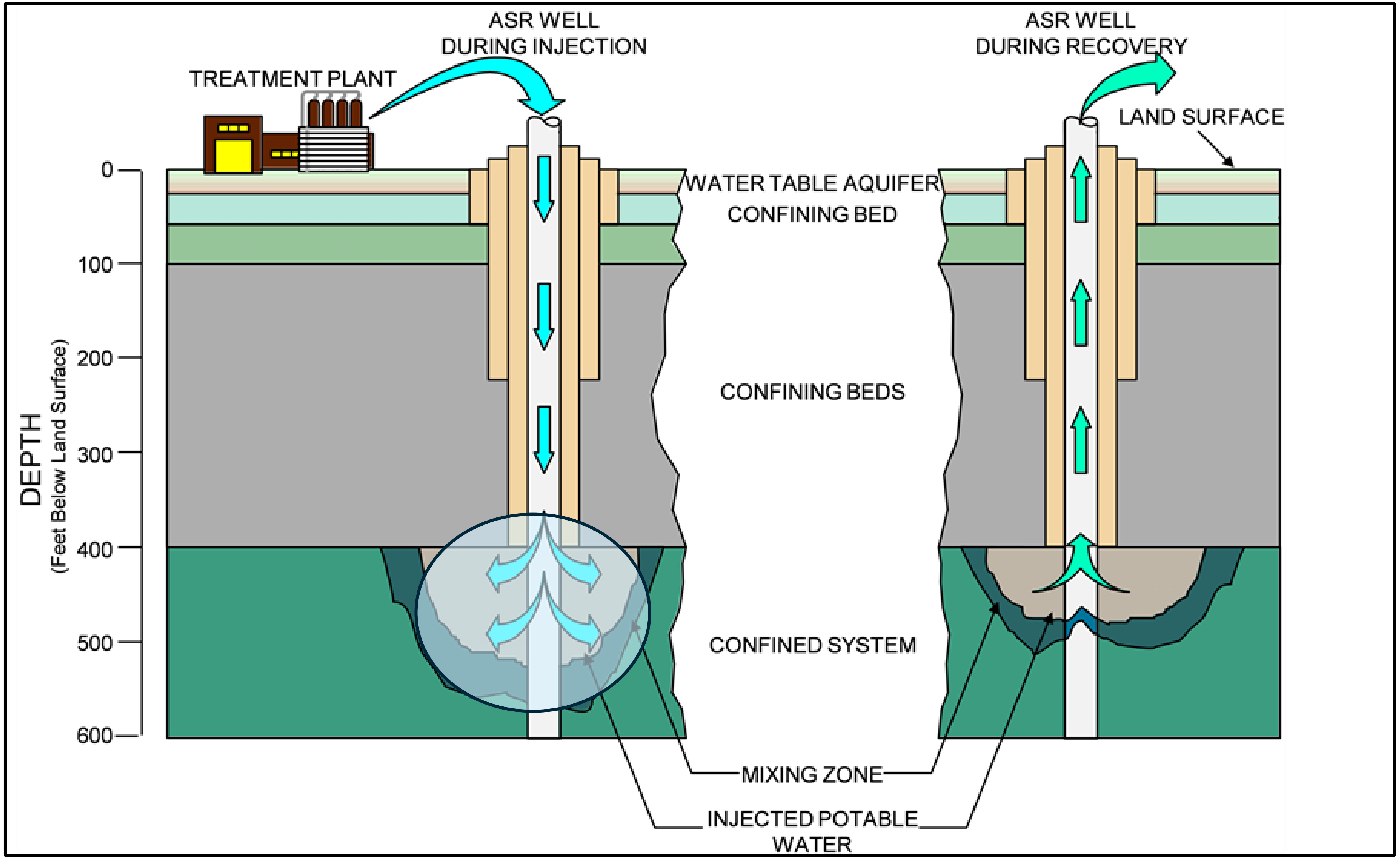
Managed Aquifer Recharge

Water Challenges	MAR Solutions	
Declining Water Supply	Water Supply Resilience (Storage & Recovery)	Section 3.1.1
Poor Groundwater Quality	Improve Groundwater Quality	Section 3.1.2
Saltwater Intrusion	Mitigation Against Saltwater Intrusion	Section 3.1.3
Excess Stormwater Floodwater	Excess Stormwater Management Floodwater	Section 3.1.4 3.1.5
Subsidence	Subsidence Reduction	Section 3.1.6
Impaired Riparian Ecosystems/Reduced Streamflow	Protection of Riparian Ecosystems/Maintenance of Streamflow	Section 3.1.7

Water Supply Resilience (Storage And Recovery)

Case Study 5.4

Sustainability of a long-term water resource

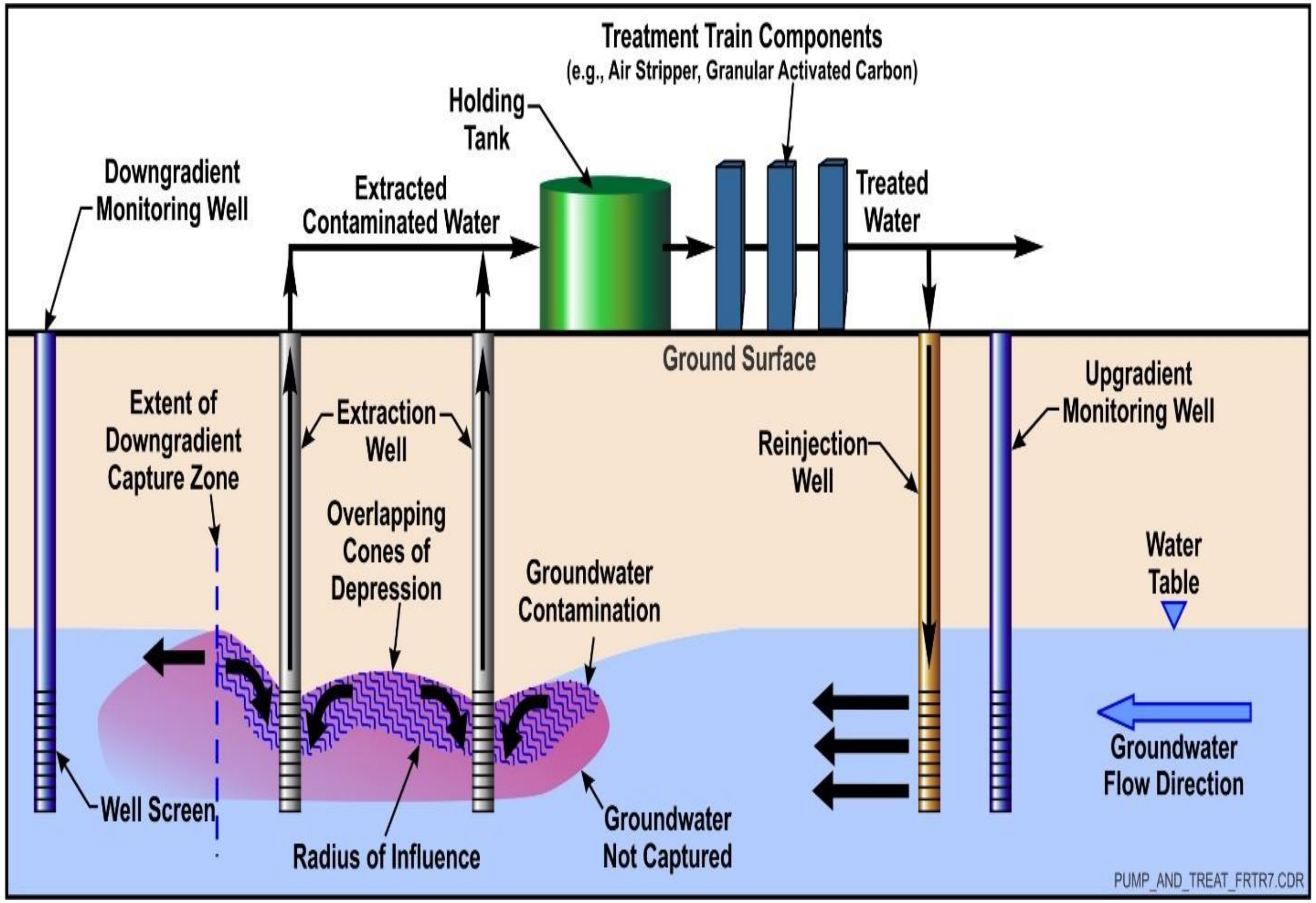


Example: Scottsdale, AZ

Lessons Learned from Aquifer Storage and Recovery (ASR) Systems in the United States (scirp.org)
Journal of Water Resource and Protection - Creative Commons Attribution 4.0 International License

Improve Groundwater Quality

Case Study 5.2



Repurpose treated water

Improve marginal quality water

Increase quantity of available water

[Groundwater Pump and Treat | FRTR Remediation Technologies Screening Matrix]

Courtesy of the Federal Remediation Technologies Roundtable

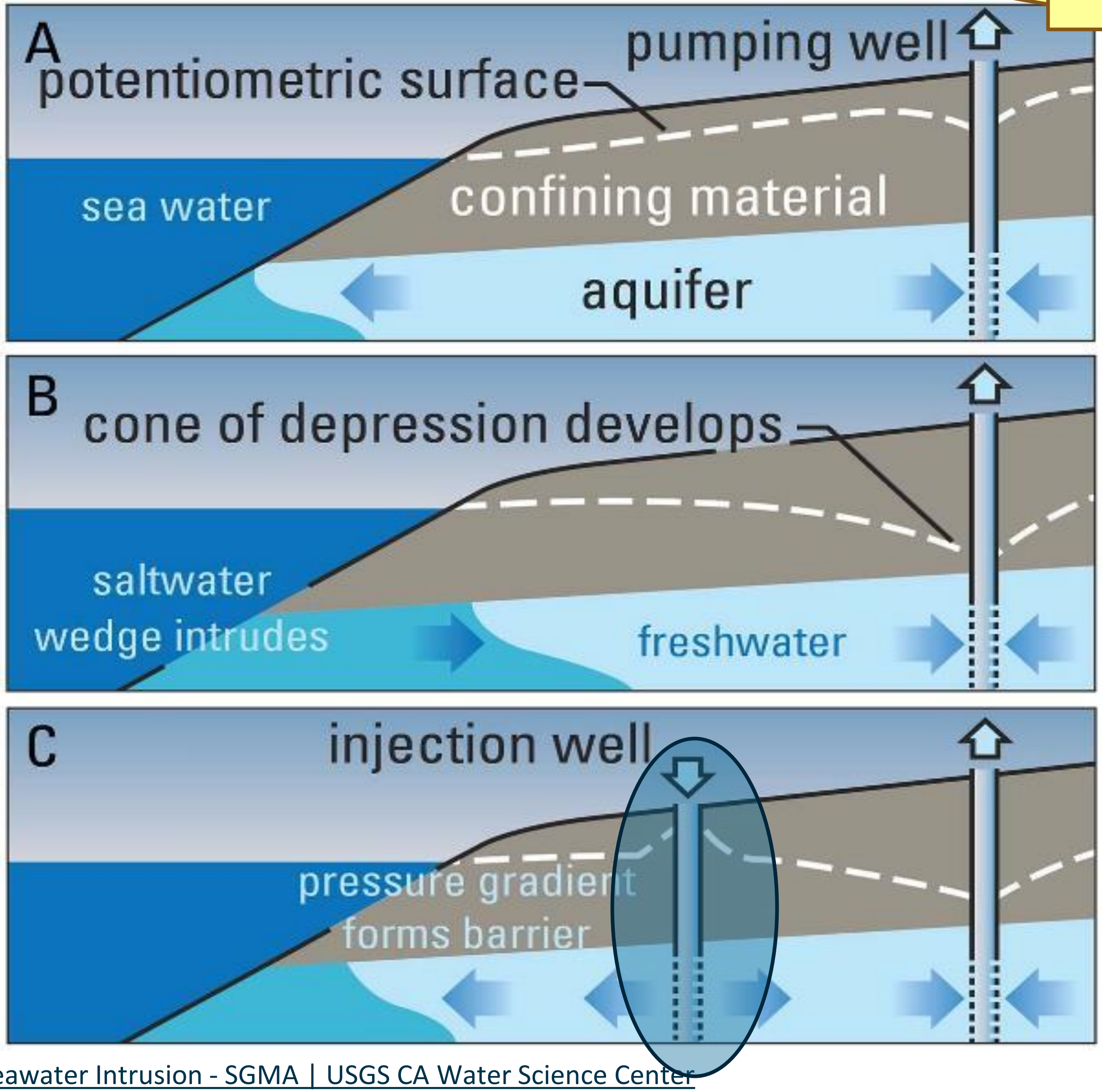
Mitigation Against Saltwater Intrusion

Case Study 5.3

Natural conditions

Pumping the aquifer

Use of MAR to mitigate saltwater intrusion



Seawater Intrusion - SGMA | USGS CA Water Science Center

https://ca.water.usgs.gov/sustainable-groundwater-management/seawater-intrusion-california.html

Flood Water/Excess Stormwater Management

Case Study 5.5

Help reduce flood risk & boost groundwater supplies

Intended Uses:

Increase flows into adjacent streams or rivers

Support agricultural activities

Create bird and terrestrial habitat (Ecosystem Enhancement)

Recharge depleted aquifers

Enhances water supply resilience

Reduces flood risk and increases drought preparedness

Improve water quality

Adapt to climate change

Flood-Managed Aquifer Recharge (Flood-MAR) (ca.gov)
https://water.ca.gov/Programs/All-Programs/Flood-MAR

Subsidence Reduction

Case Study 5.1

Recharge the aquifer to offset recovery of water to slow land subsidence

Land Subsidence in the United States, Fact Sheet 165-00
https://water.usgs.gov/ogw/pubs/fs00165/

Frederick, Maryland

What is a sinkhole? | U.S. Geological Survey (usgs.gov)
https://www.usgs.gov/faqs/what-a-sinkhole#multimedia

Riparian Ecosystems Protection/ Streamflow Maintenance

Case Study 5.6

[Flood-MAR: Harnessing Flood Waters to Advance Sustainable Water Management (ca.gov)](https://water.ca.gov/News/Blog/2018/July-18/Flood-MAR-Harnessing-Flood-Waters-to-Advance-Sustainable-Water-Management)
https://water.ca.gov/News/Blog/2018/July-18/Flood-MAR-Harnessing-Flood-Waters-to-Advance-Sustainable-Water-Management

Benefits:

Increase climate change resilience

Restore water bodies

Protect and improve water quality

Provide fish and wildlife habitats

Store flood waters

Maintain surface water flow during dry periods

Sacramento River Valley, CA

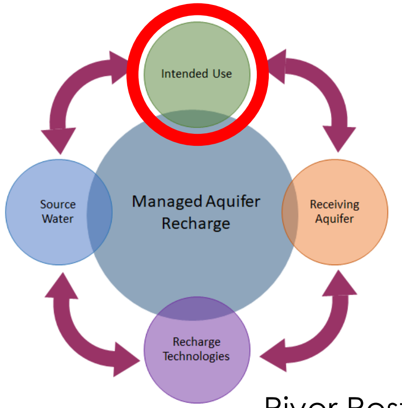
Walla Walla Basin Watershed Example – Intended Uses

Case Study 5.9

Water Supply Resilience

Protection of Riparian Ecosystems

Maintenance of Streamflow



River Restoration in the Walla Walla Basin (arcgis.com)
https://ctuirgis.maps.arcgis.com/apps/MapJournal/index.html?appid=56ee9d323eb94d0bb2ea85ed4e1327e2

Roadmap

- Introduction
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  - What is the problem you need to solve?
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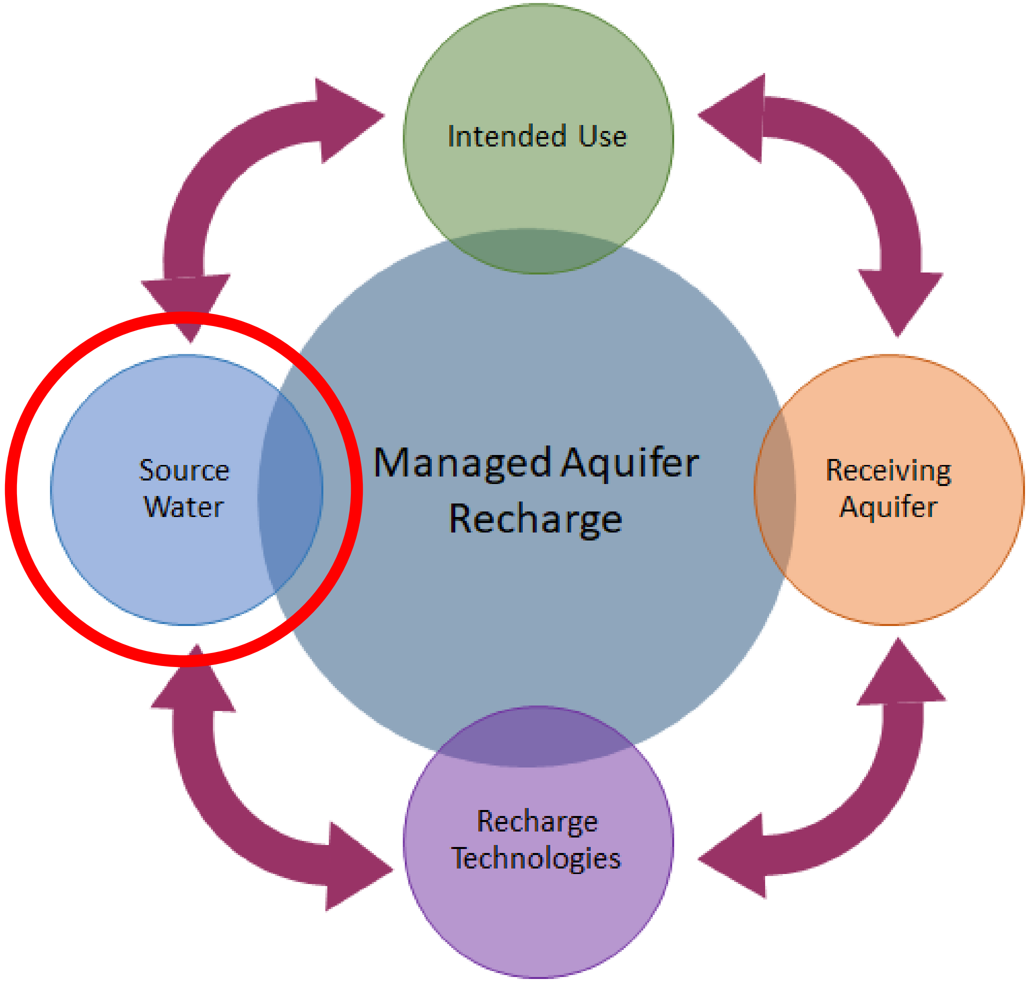


Source Water – Things to Consider

Section 3.2

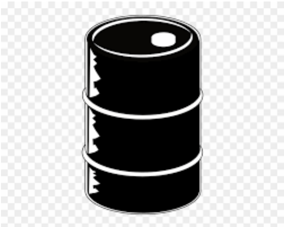
- Origin
- Availability
- Quality Considerations
- Regulatory Issues
- Other?

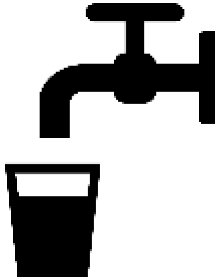
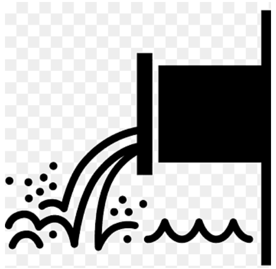
Origin

Many sources of water are available to utilize, each with varying advantages and constraints that need to be considered in the context of specific projects.



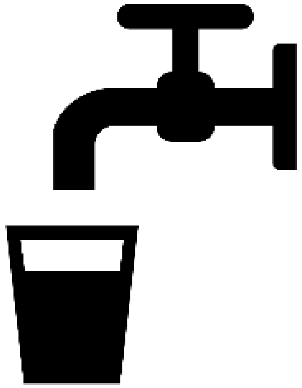


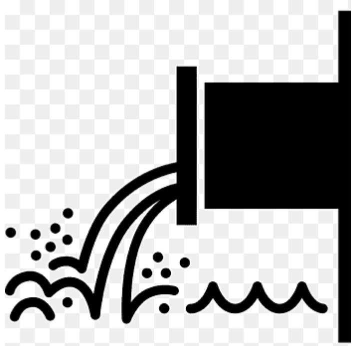



Origin

1. Surface Water
2. Treated Drinking Water
3. Highly Treated Wastewater
4. Captured Water
5. Flood Water





Origin

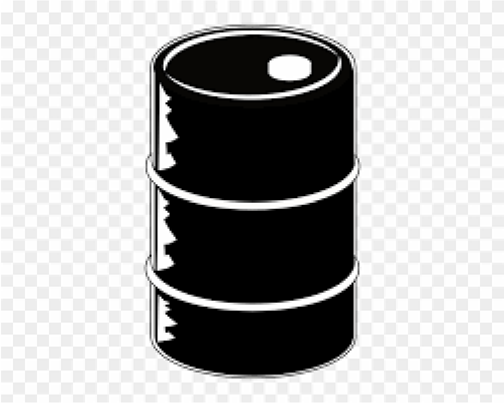
6 Industrial Process Water

7 Agricultural Return Flows

8 Produced Water/ Saline Waters

Origin

9. Dewatering Flows
10. Environmental Remediation Sites
11. Groundwater Transfer



Availability

When considering source waters for MAR projects, a variety issues impact the availability of source waters.

1 Volume and Duration of Flow

$$Q = V/t$$

2 Proximity/Conveyance

3 Ownership/Water Rights

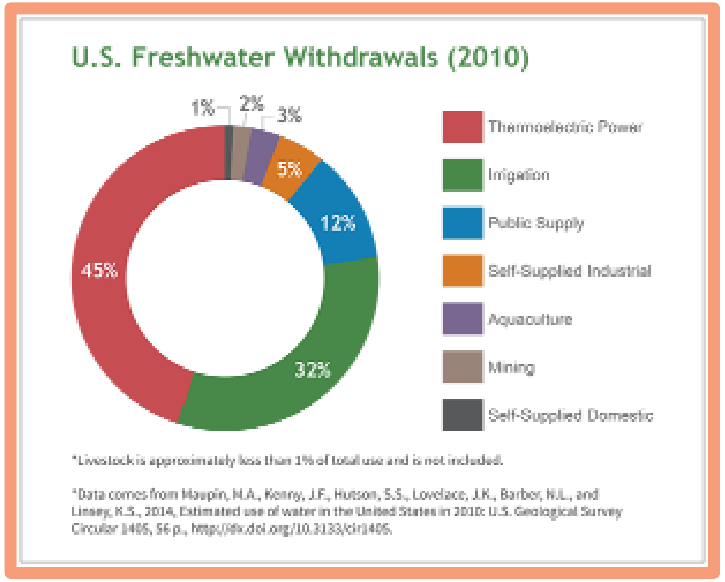
"Whiskey is for drinking; water is for fighting over"

Mark Twain

Availability

When considering source waters for MAR projects, a variety issues impact the availability of source waters.

4 Competing Uses/Stakeholders



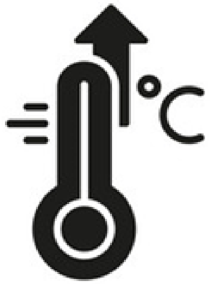
How We Use Water | WaterSense | US EPA
https://19january2021snapshot.epa.gov/watersense/how-we-use-water_.html

5 Regulatory Limitations

Quality Considerations

The physical, chemical, biological, and radiological characteristics of a source water limit both regulatory and economic applicability for MAR.

Physical



- Temperature
- Turbidity
- Total suspended solids (TSS)

Chemical

- Alkalinity
- B…
- D…
- D…
- E… pharmaceutic…, mi…oplastics)
- Inorganic che… …etals, for example, arsenic, i… …adi…
- Major an…s …lfat… cl…ide, nitrate)
- Nutrients
- Oxidation-red… …tial
- Pesticides
- pH
- Salinity
- Sodicity
- Total dissolved solids (TDS)
- Total organic carbon (TOC)
- Volatile organic compounds

Pre-injection Treatment Costs

Biological

- Algae/cyanobacteria
- Bacteria
- Protozoa
- Viruses

Radiological

- Naturally occurring radioactive materials (NORM)

MAR Table 3-1. Typical physical, chemical, biological, & radiological parameters.

Regulatory Issues

Source waters for MAR projects must meet federal and state-specific water quality standards.

- MCLs
- Intended use modifications
- State specific rules
- Receiving ground water quality

See MAR Document Section 2.5 and Section 3.5

Other (Potential) Source Water Issues

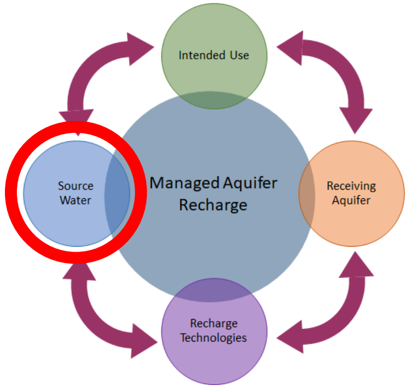
Each MAR project will have unique considerations dependent on location, intended use, and design.

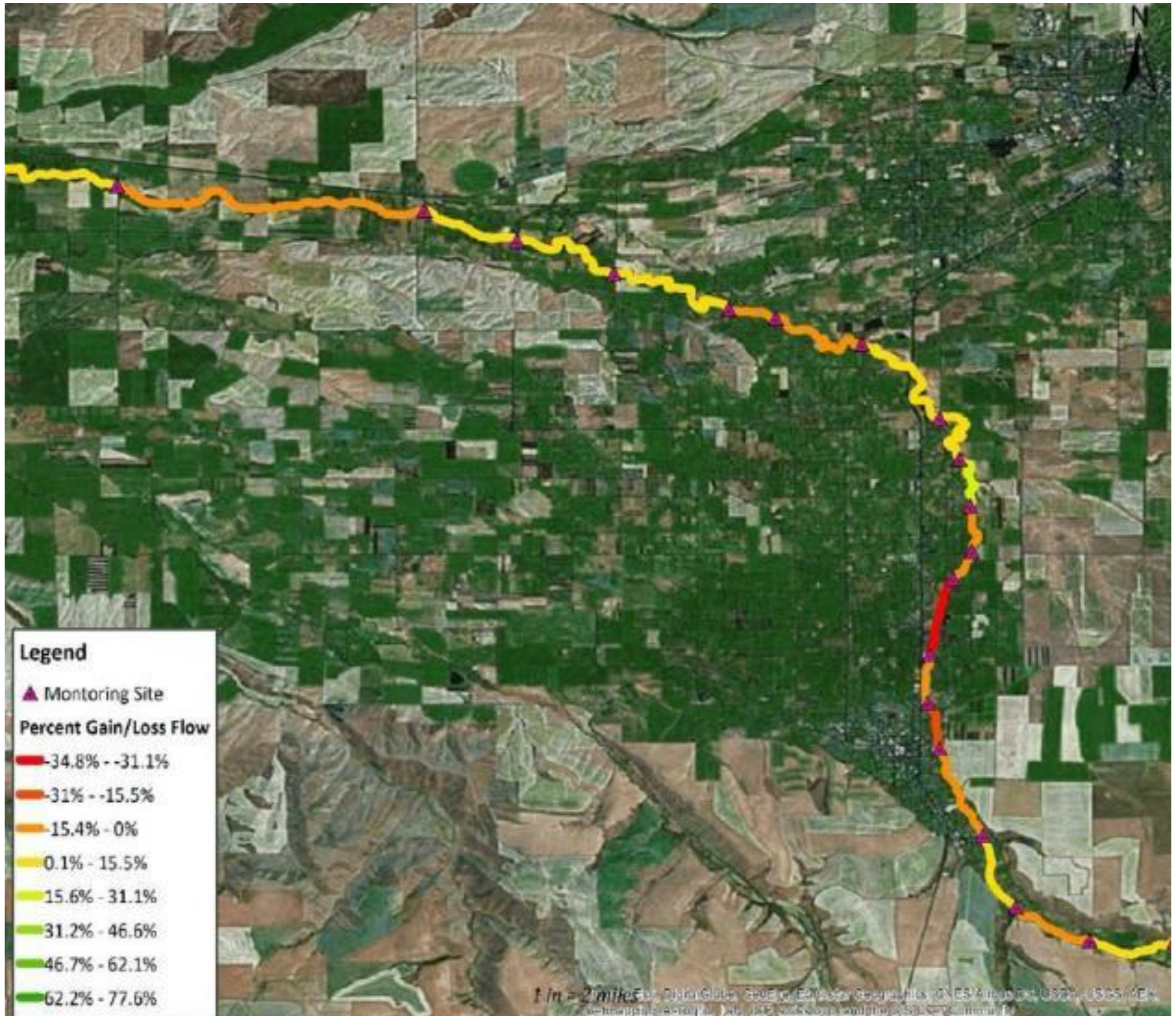
- Public Outreach
- Environmental Justice
- Existing vs Future competing uses
- Ecosystem Impacts
- Climate Change Considerations
- Characterization and Pilot Costs
- Conceptual Model Development
- Economic Considerations

Walla Walla Basin Watershed Example – Source Water

Case Study 5.9

- ✓ Origin
- ✓ Availability
- ✓ Quality Considerations
- ✓ Regulatory Issues
- ✓ Other?





MAR CS 5.9 Figure 2. Average gains or losses in flow of a segment of the Walla Walla River; Source: WWBWC (2017)

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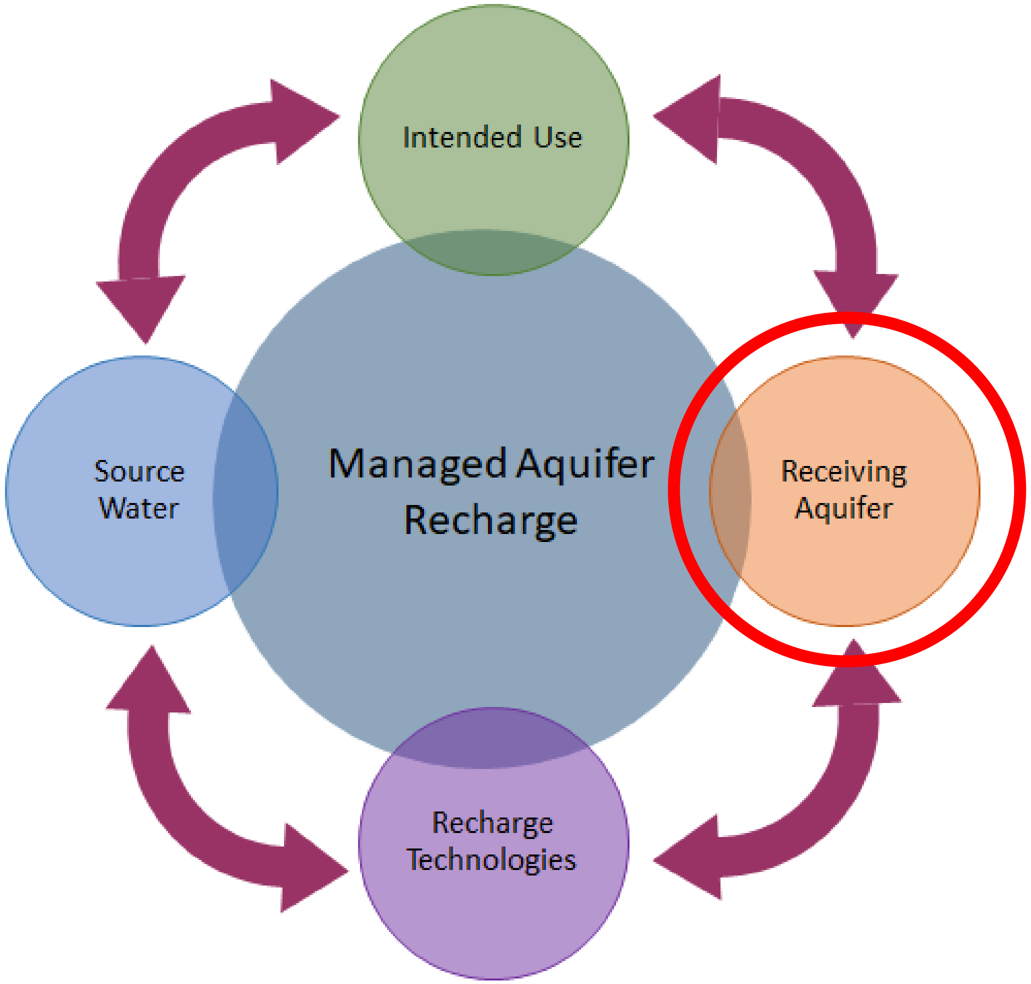
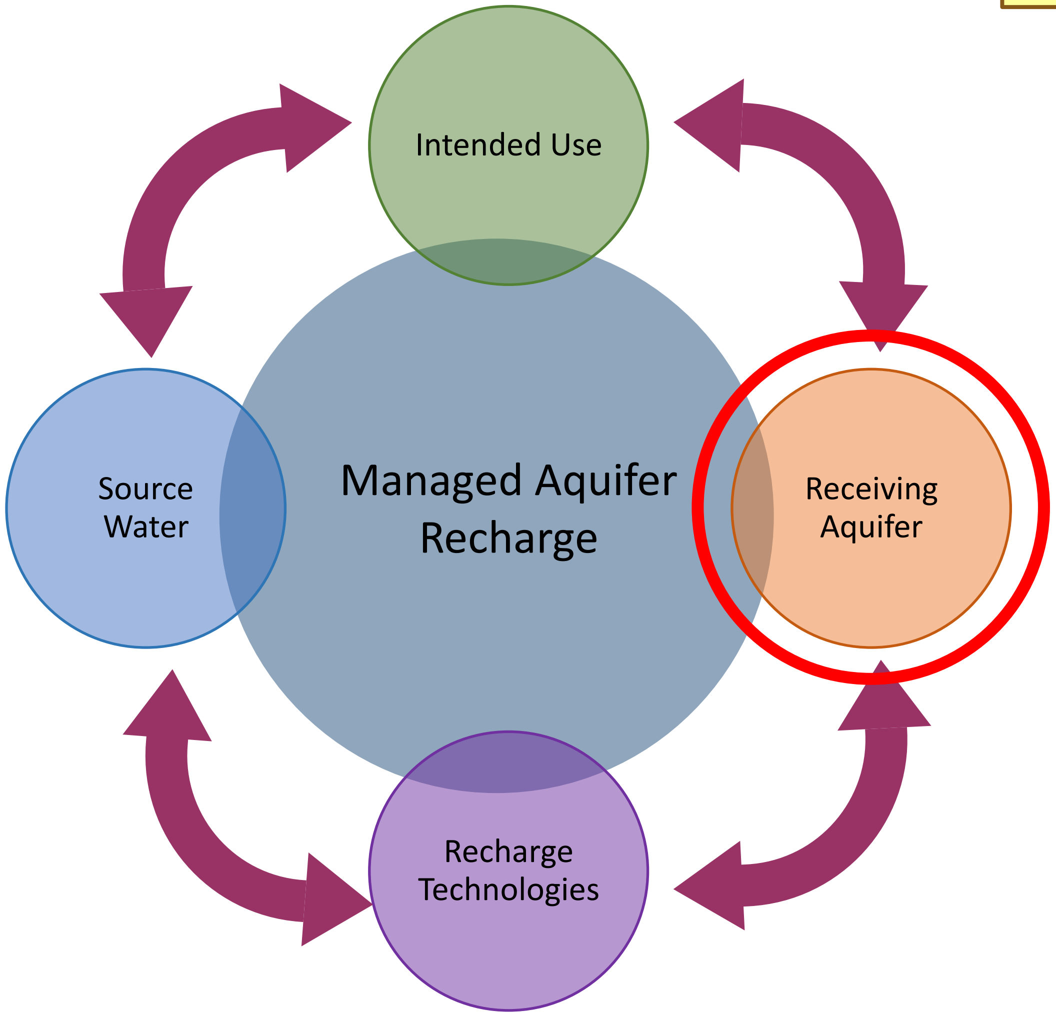


Receiving Aquifer

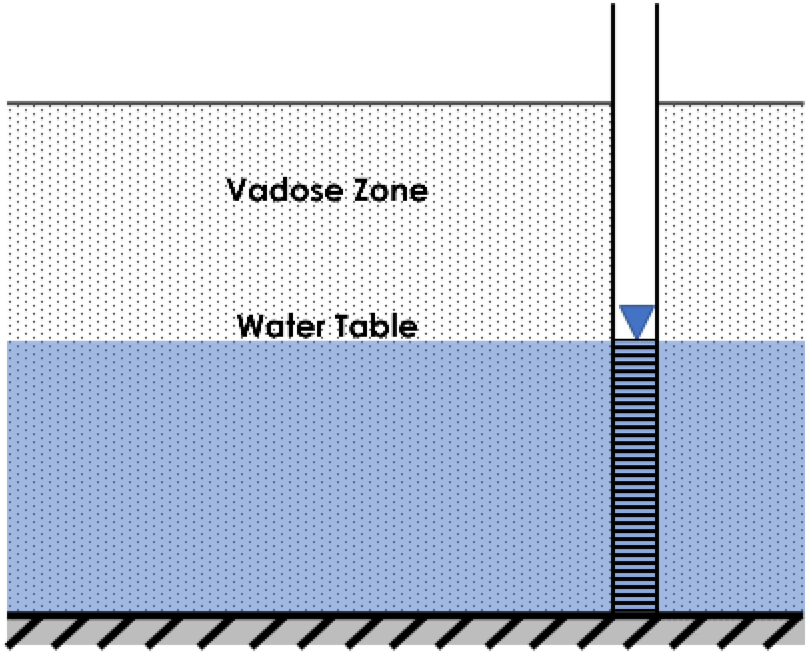
Section 3.3

- Hydrogeologic Setting and Storage Potential
- Site Conditions & Land Use
- Geotechnical Considerations
- Geochemical Compatibility between Source Water and Receiving Aquifer
- Modeling



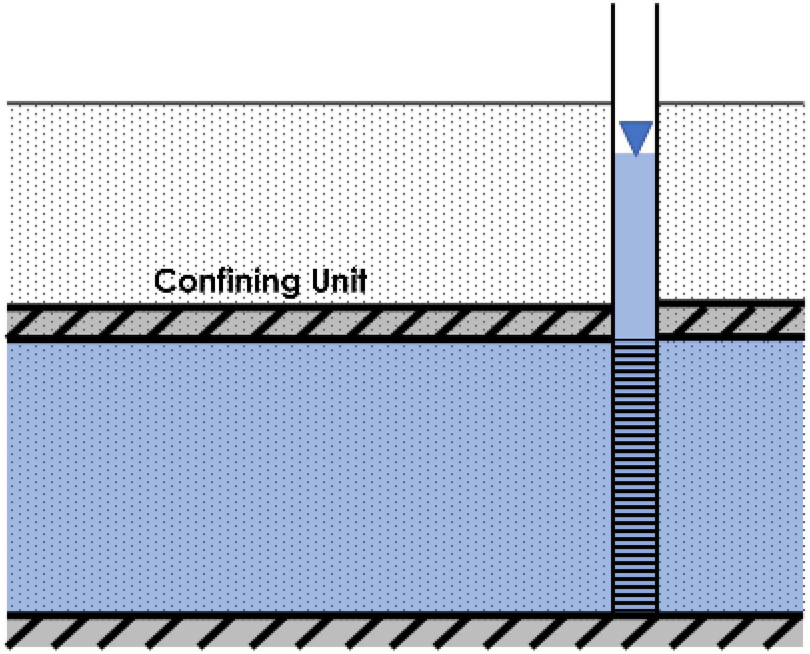
Hydrogeologic Setting

Unconfined Aquifer



Aquifer **can be** recharged via infiltration

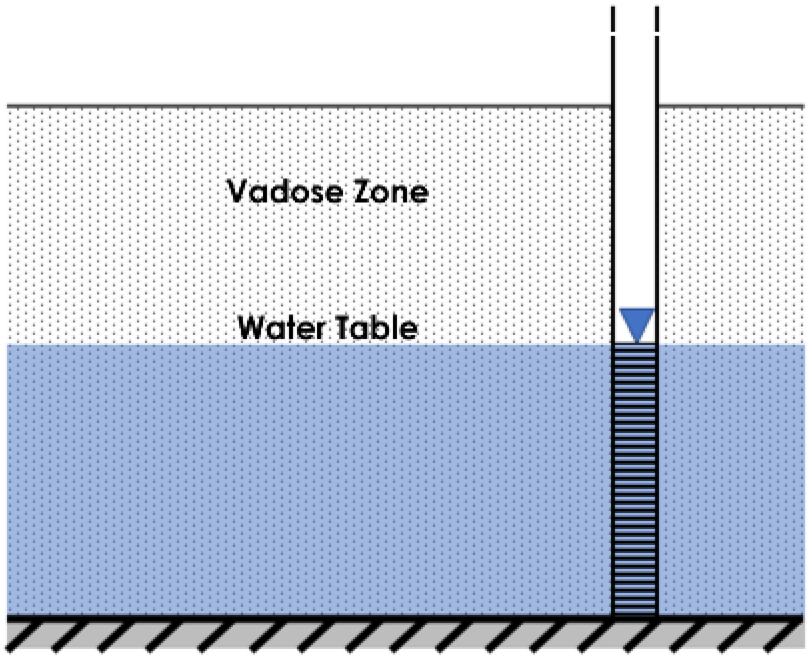
Confined Aquifer



Aquifer ***must be*** recharged via injection

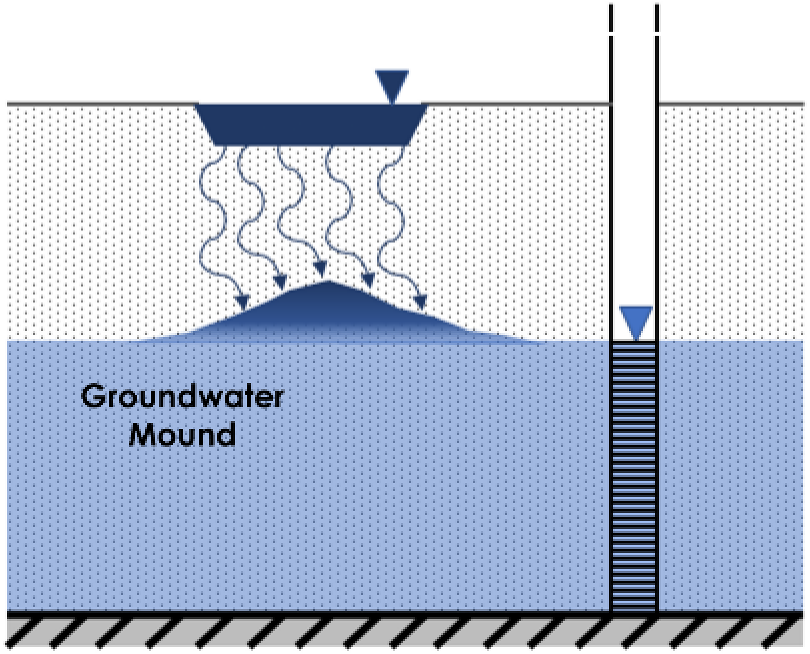
Recharging an Unconfined Aquifer

Unconfined Aquifer



Aquifer can be recharged via infiltration

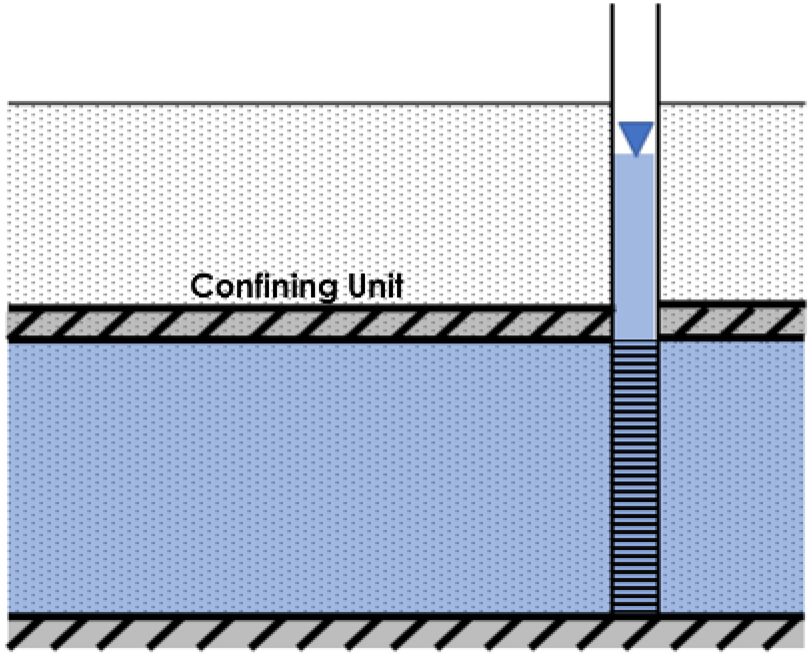
Infiltration Basin



Water stored in groundwater mound that forms in vadose zone

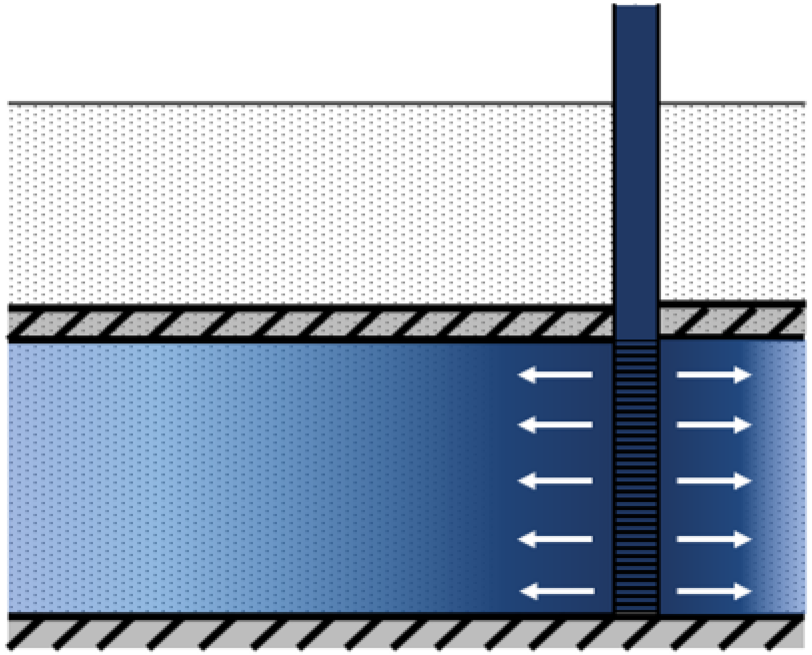
Recharging a Confined Aquifer

Confined Aquifer



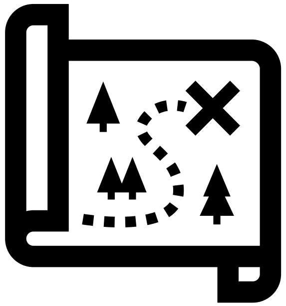
Aquifer must be recharged via injection

Injection Well

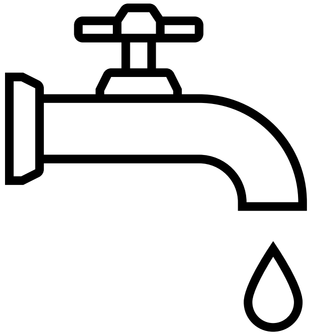


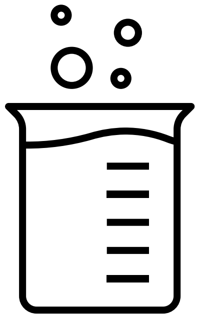
Injected water displaces native groundwater in aquifer

Site Conditions and Land Use

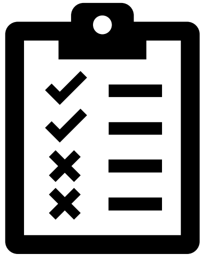


Land availability/competing uses





Water quantity/quality impacts to existing users

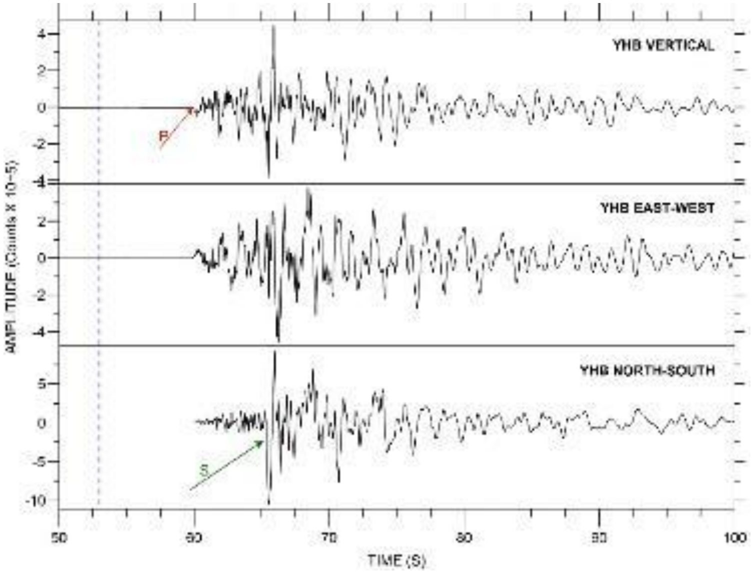


Existing aquifer restrictions

Proximity to known contamination

Geotechnical Considerations

Seismicity



Locating earthquakes in the Yellowstone region | U.S. Geological Survey (usgs.gov) https://www.usgs.gov/observatories/yvo/news/locating-earthquakes-yellowstone-region

Liquefaction

Women in Science - Responding to Ridgecrest, CA earthquake July 2019 | U.S. Geological Survey (usgs.gov) https://www.usgs.gov/media/images/women-science-responding-ridgecrest-ca-earthquake-july-2019-5

Slope Failures

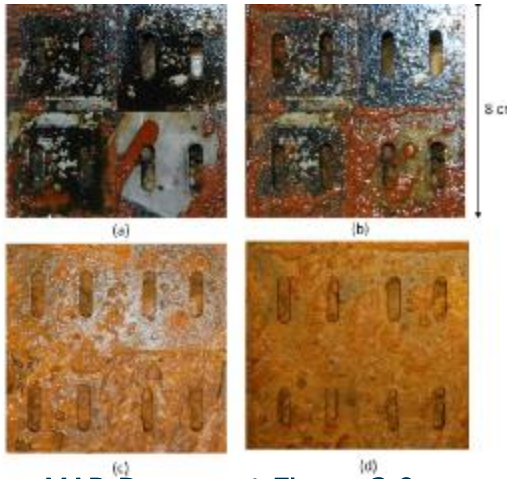
2018 Potter Hill landslide 2, Anchorage, AK | U.S. Geological Survey (usgs.gov) https://www.usgs.gov/media/images/2018-potter-hill-landslide-2-anchorage-ak

Geochemical Compatibility Considerations

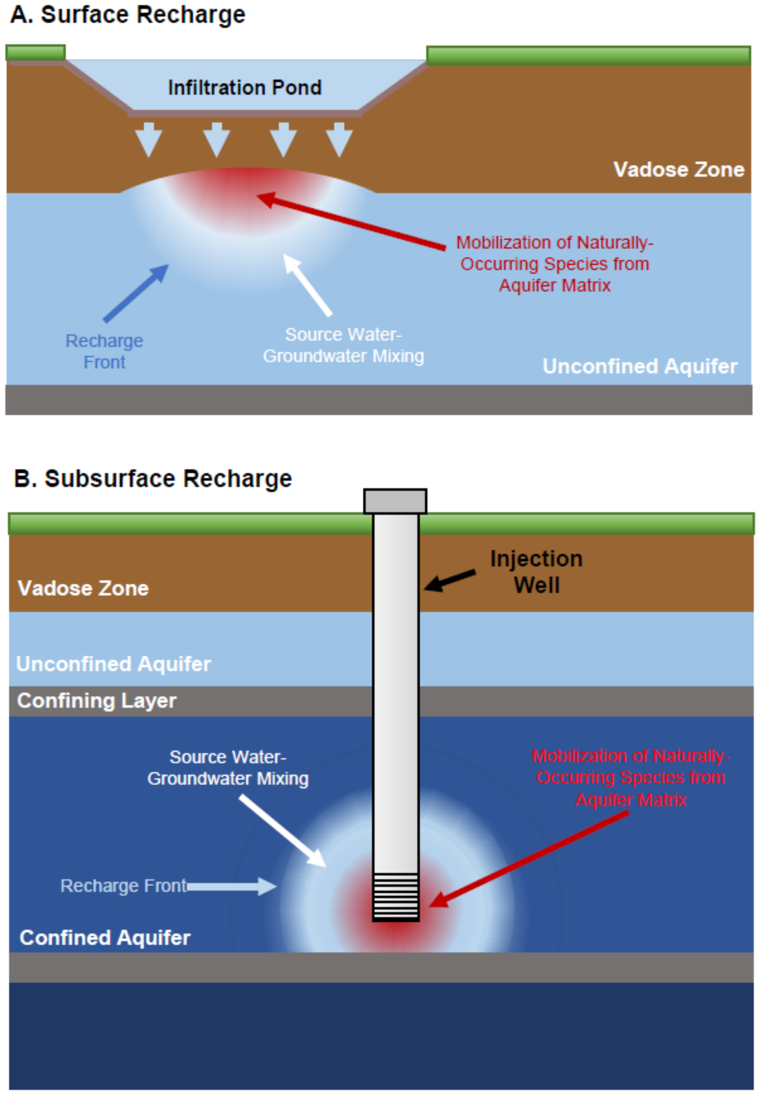
Potential problems:

- Injection well fouling/corrosion
- Aquifer clogging - mineral precipitation
- Aquifer clogging - clay swelling/dispersion
- Dissolution of aquifer matrix
- Mobilization of contaminants (e.g., arsenic)

Important to characterize the chemistry of source water and receiving aquifer



MAR Document Figure 3.9. Example of well screen clogging after (a) 1, (b) 20, (c) 29, and (d) 73 days
Source: Source: Camprovin et al. (2017)



MAR Document Figure 3.7. Geochemical reactions and recharge fronts.
Source: Beth Hoagland, SSPA. Used with Permission

Modeling

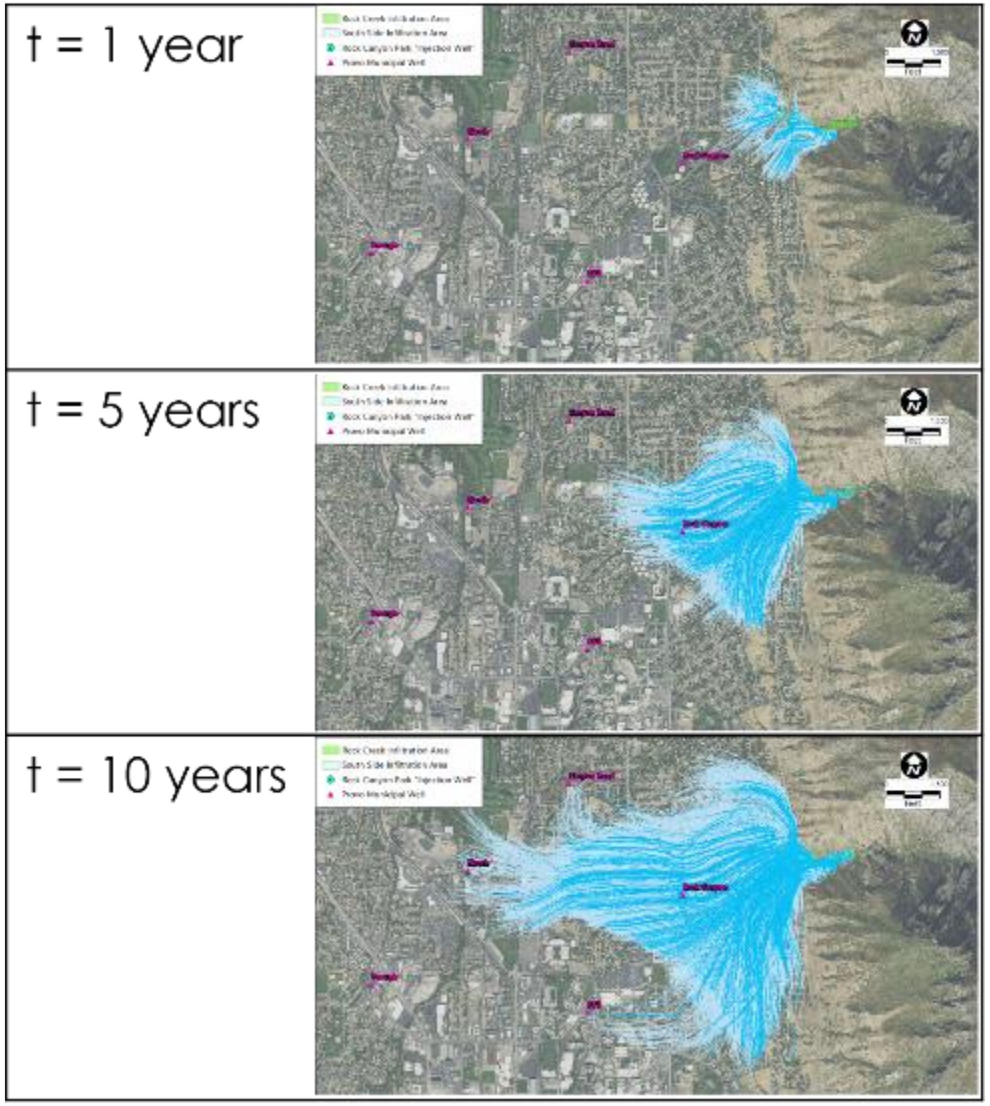
Simulation of future MAR system performance is key to design/permitting

Predictive

Interpretive

Regulatory

Communication



Poll Question

Which of the following is NOT a potential challenge related to the receiving aquifer?

A. Mobilization of naturally-occurring contaminants

B. Artesian conditions

C. Degraded water quality for existing aquifer users

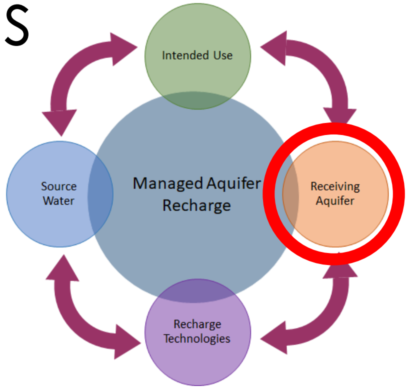
D. Increased risk of liquefaction

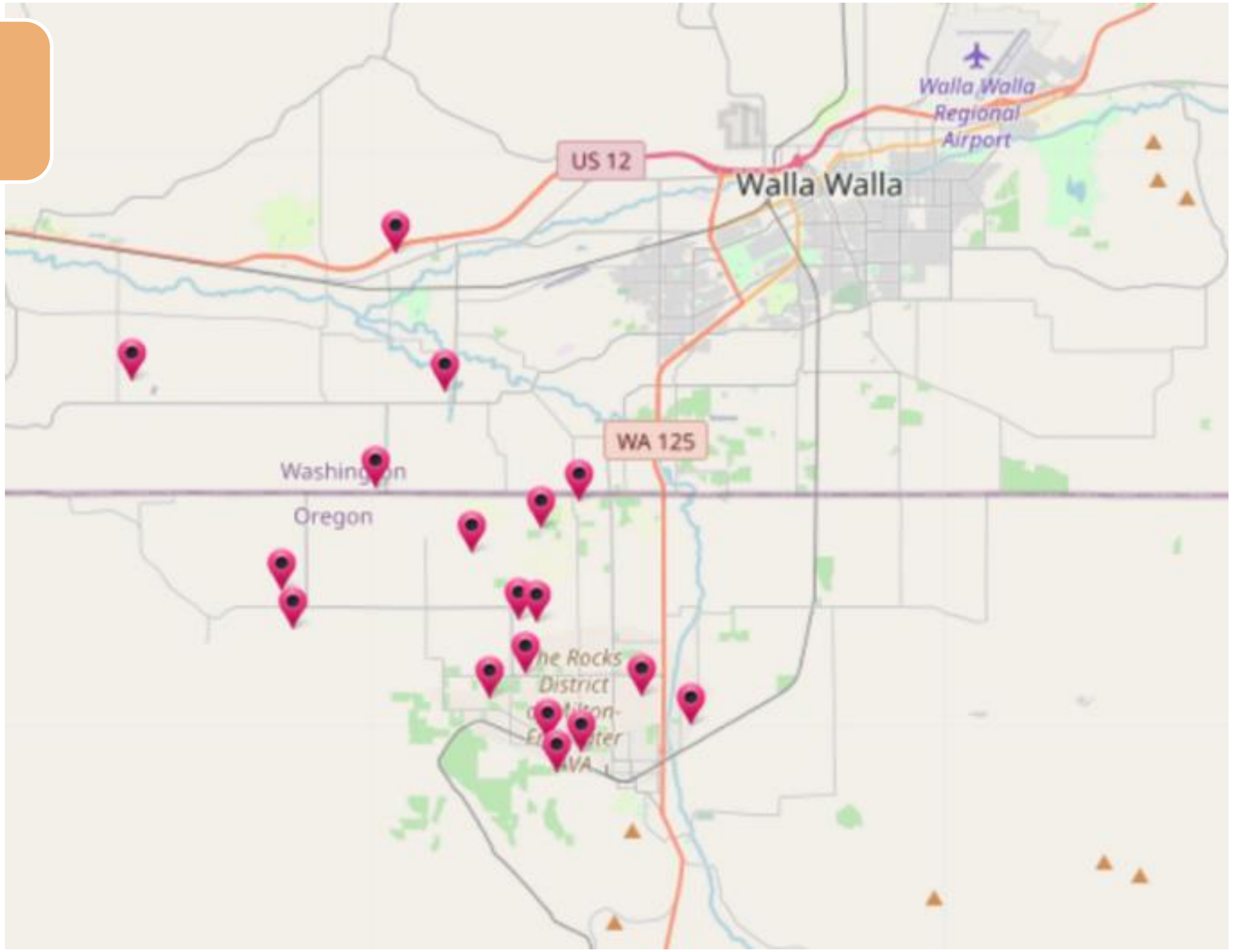
Walla Walla Basin Watershed

Case Study 5.9

RECEIVING AQUIFER

- Alluvial aquifer of the Milton-Freewater alluvial fan
- Unconfined
- High degree of hydraulic connectivity to streams

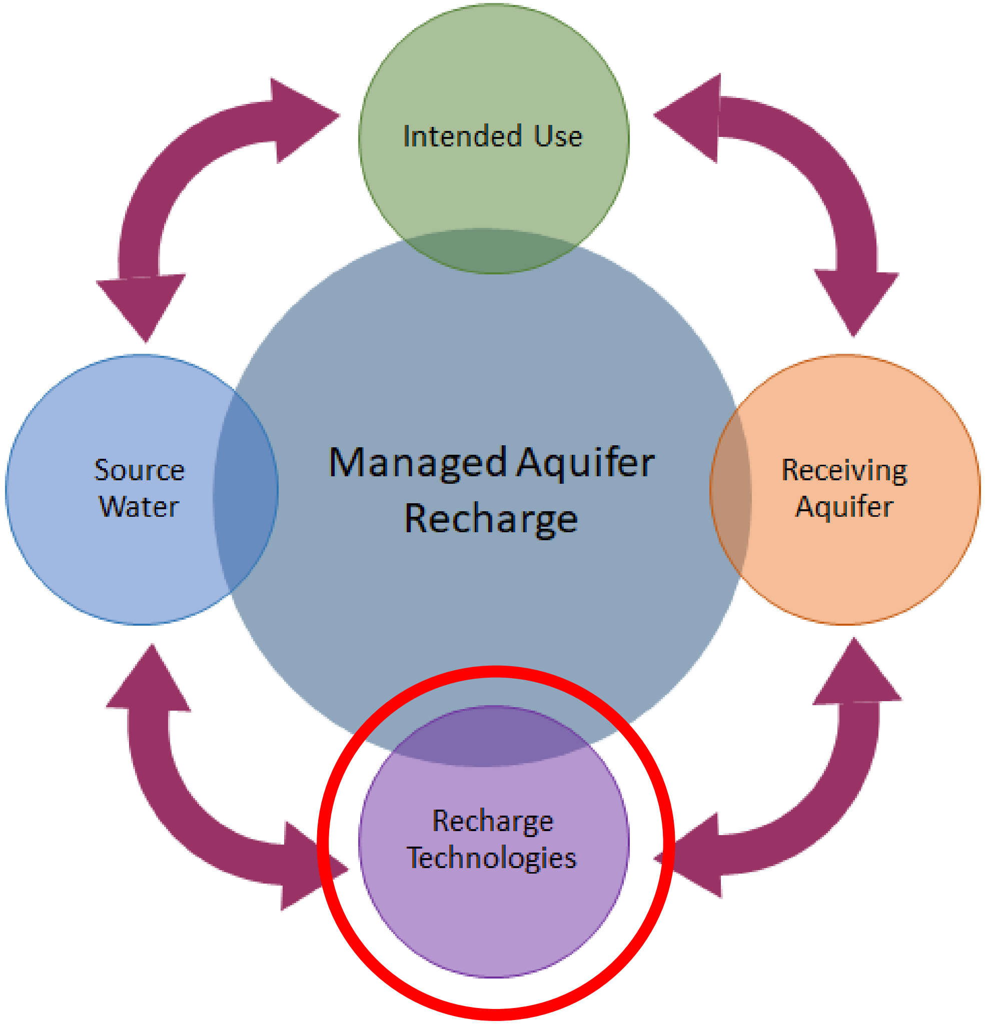




MAR Case Study 5.9 Figure 3. Recharge locations of the WWBWC
Source: WWBWC (2023)

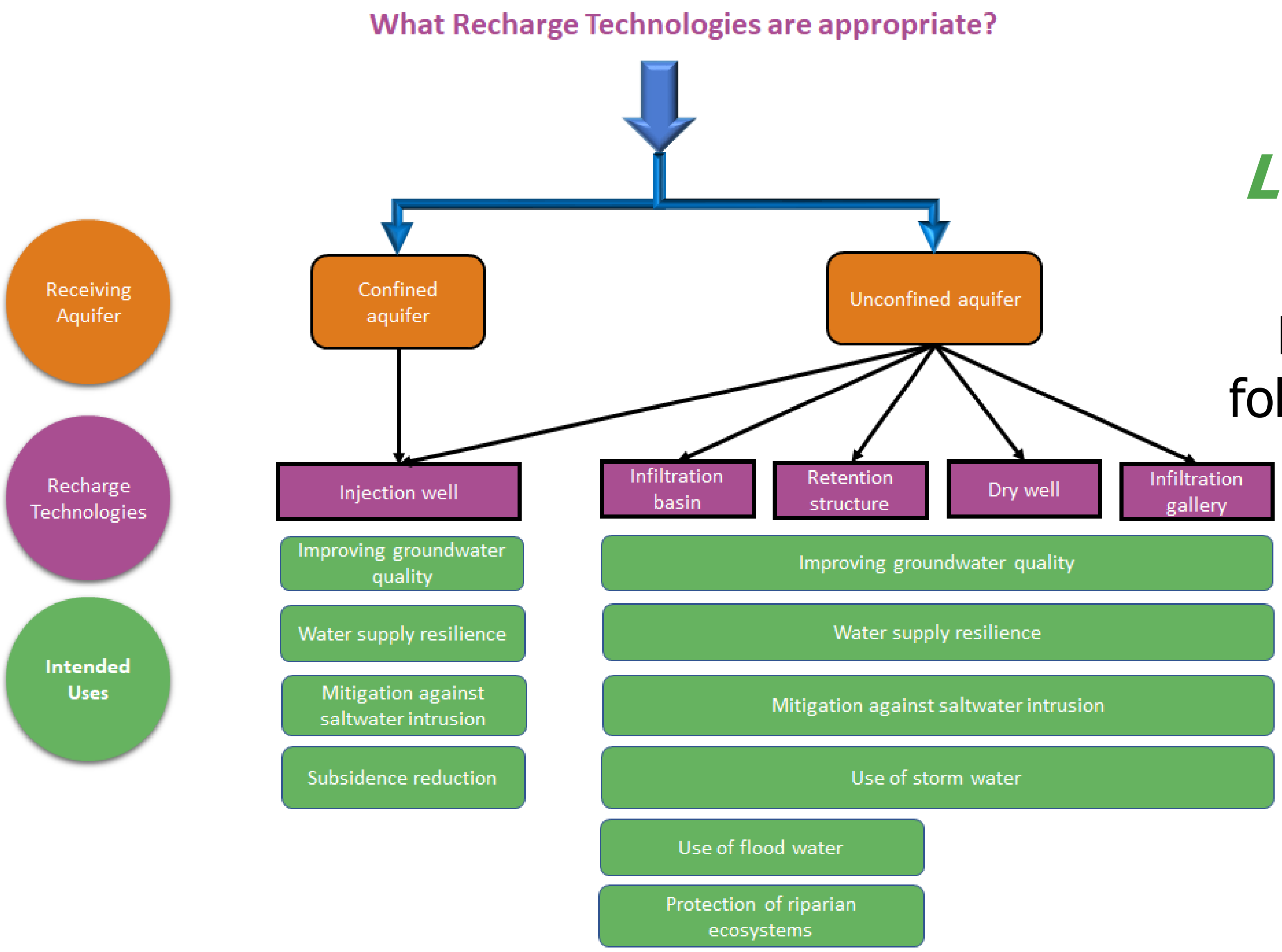
Roadmap

- Section 1 – Introduction
- Section 2 – Intended Use
  - What is the problem you need to solve?
- Section 3 – Source Water
  - What is the source of the solution?
- Section 4 – Receiving Aquifer
  - Where is the problem to be addressed?
- Section 5 – Recharge Technologies
  - How to make it happen?
- Section 6 – Case Study Examples



How to make it happen (Recharge Technologies)

Section 3.4



Let's get it in the ground! But how?

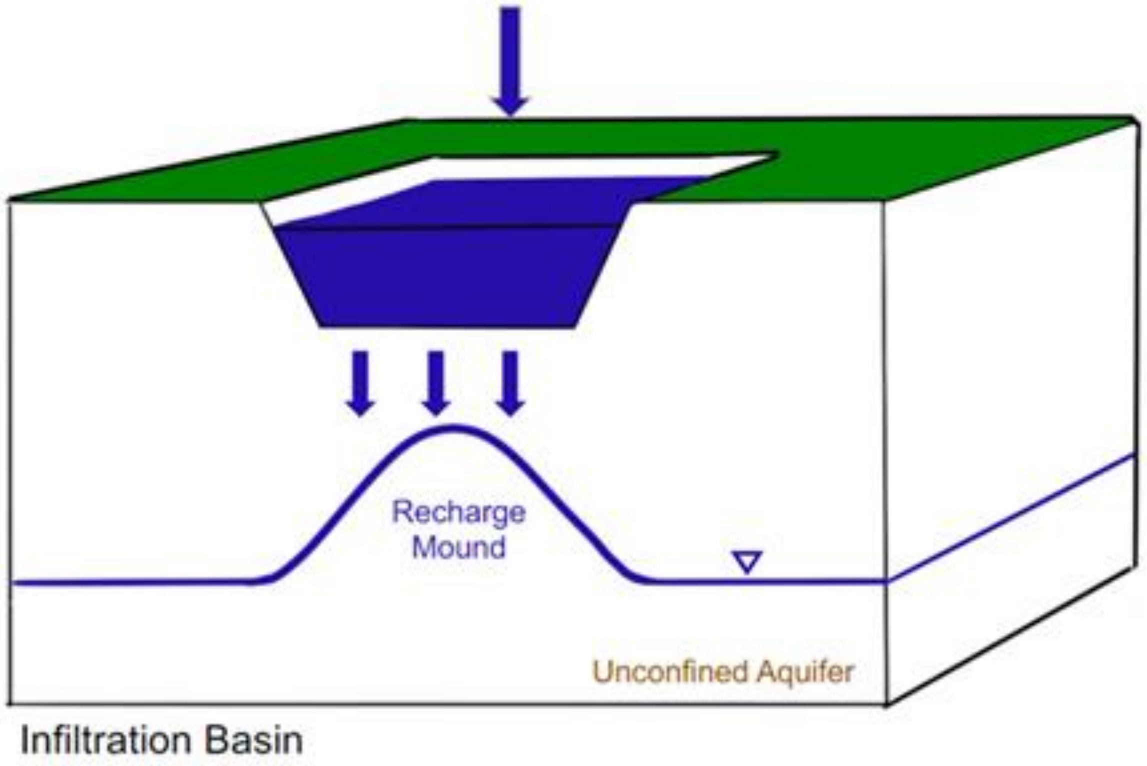
Many methods exist and the following are the most common:

- Injection Wells
- Infiltration Basins
- Retention Structures
- Dry Wells
- Infiltration Galleries

Infiltration Basins

See Case Study 5.9

Surficial ponds used for percolating water into unconfined aquifers



MAR Document Figure 3–2. Infiltration Basin

Pros:

- Cost-effective compared to other technologies
- May provide secondary benefits, such as aquatic habitat for birds
- Lower energy demands

Cons:

- Large footprint
- Prone to clogging
- Only applied to unconfined aquifers

Injection Wells

See Case Study 5.4

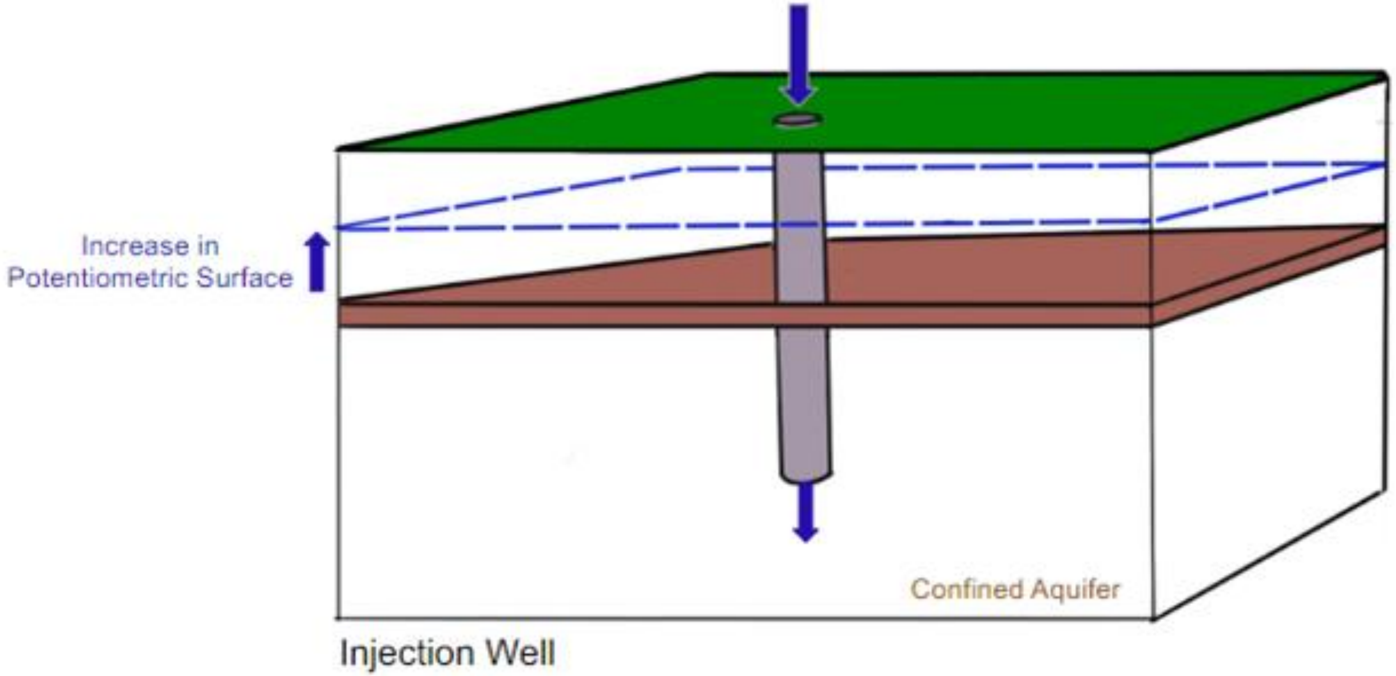
Utilized in confined aquifers or unconfined aquifers with low permeability layers

Pros:

- Flexible orientation (horizontal or vertical installation)
- Requires less land than other MAR technologies

Cons:

- Can be expensive to construct, operate, and maintain (ex. clogging)
- May require pretreatment of source water
- Higher energy demand

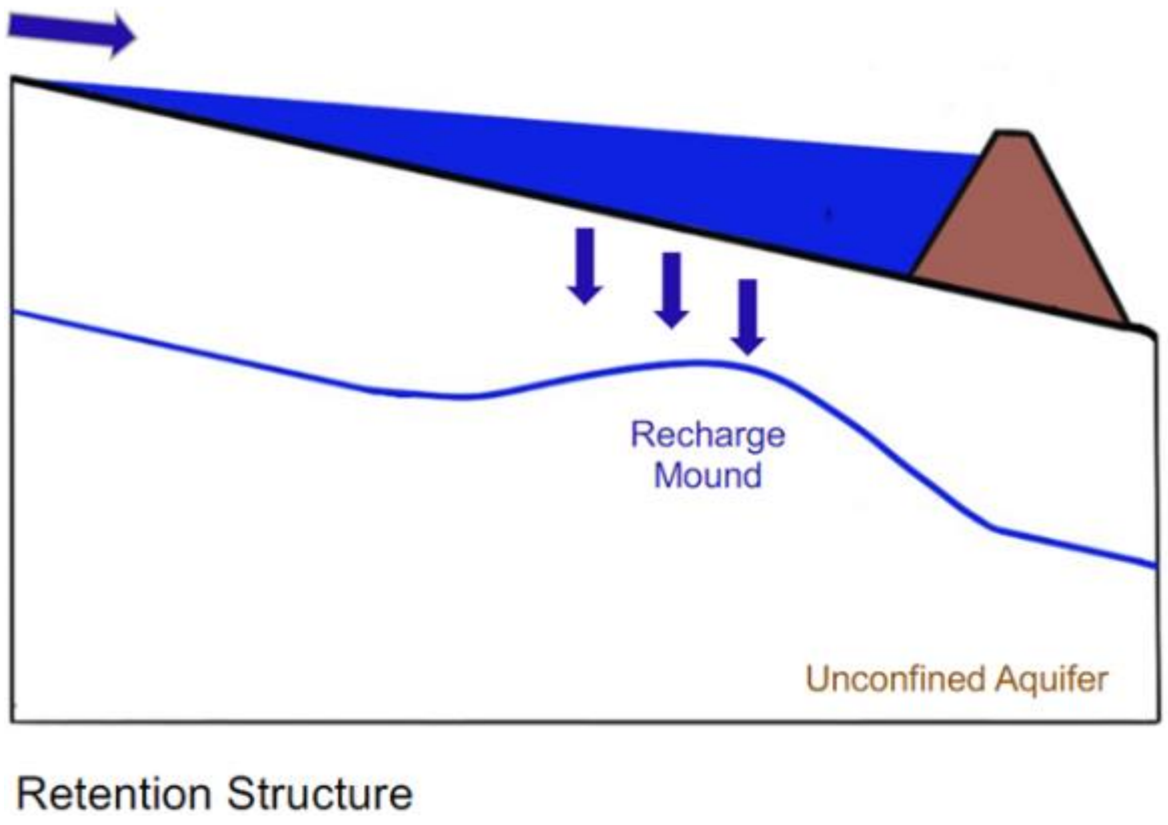


MAR Document Figure 3–4. Injection Well

Retention Structures

See Case Study 5.6

Uses natural features to recharge unconfined aquifers by creating barriers such as dams



MAR Document Figure 3–3. Retention Structure

Pros:

- Can utilize natural features
- Can be cost-effective

Cons:

- Infiltrates only unconfined aquifers
- Relying only on native features can limit where it can be applied

Drywell

See Case Study 5.8

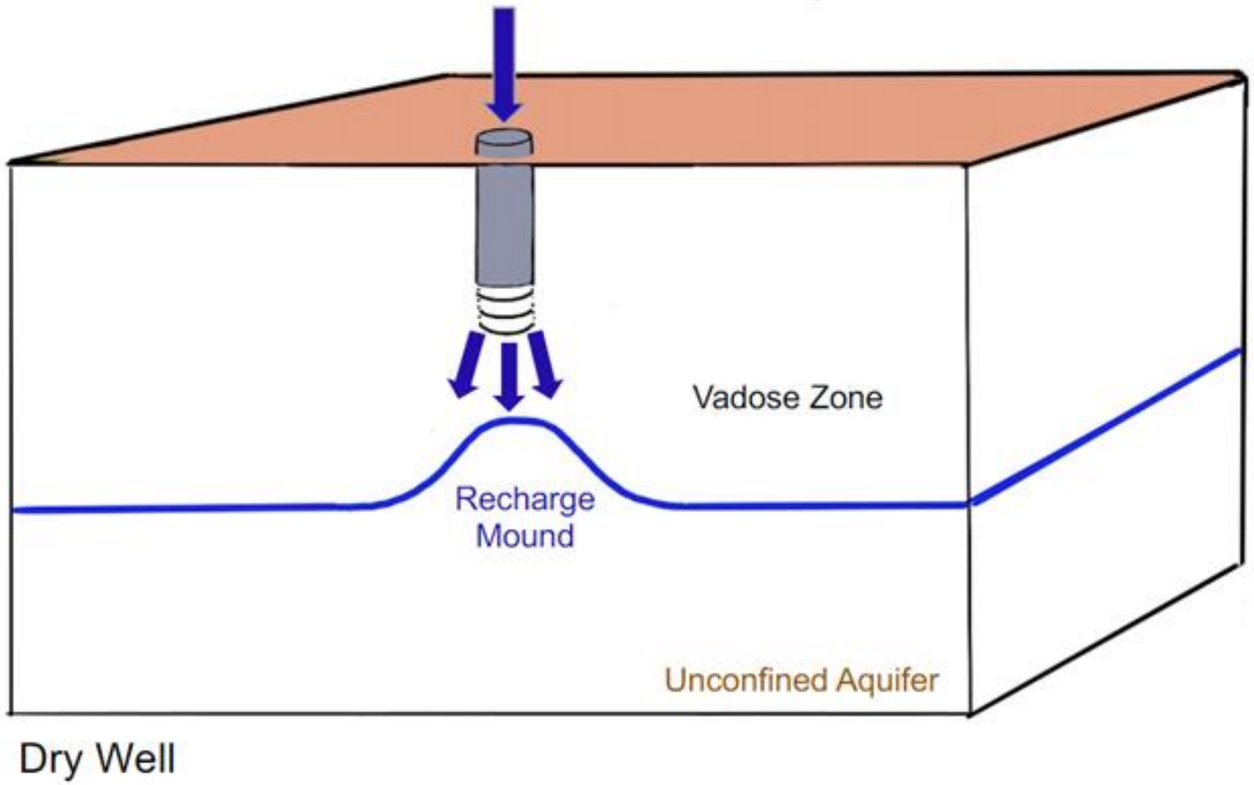
Gravity-fed well typically designed to recharge stormwater into the vadose zone

Pros:

- Smaller footprint than infiltration basins
- Can penetrate low-permeability layers

Cons:

- Recharge capacity dependent on the hydraulic conductivity of surrounding soils (unlike injection wells)

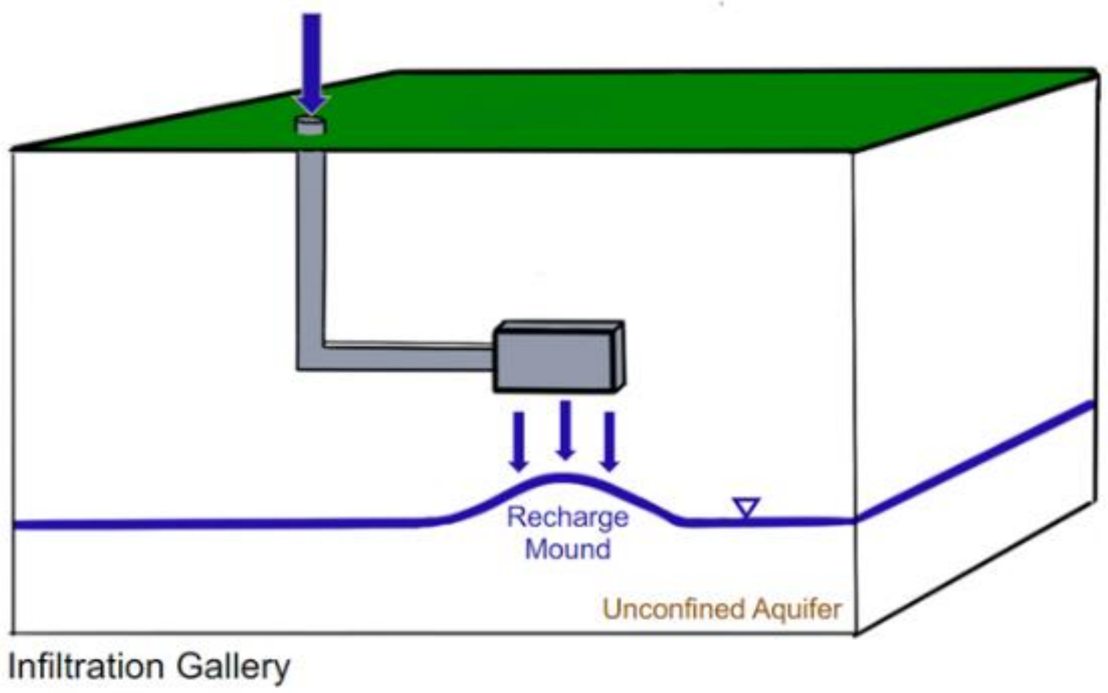


MAR Document Figure 3–5. Dry Well

Infiltration Gallery

See Case Study 5.9

Below-ground structures that allow for rapid infiltration of water through the vadose zone



MAR Document Figure 3–6. Infiltration Gallery

Pros:

- Can be placed at near-surface or deeper depths
- Land above can be developed for other beneficial uses

Cons:

- Subject to clogging
- Susceptible to intrusion of plants

Poll Question

The reasons why injection wells may be the preferred recharge technology are

A. Land is expensive and the water quality requirements are easier

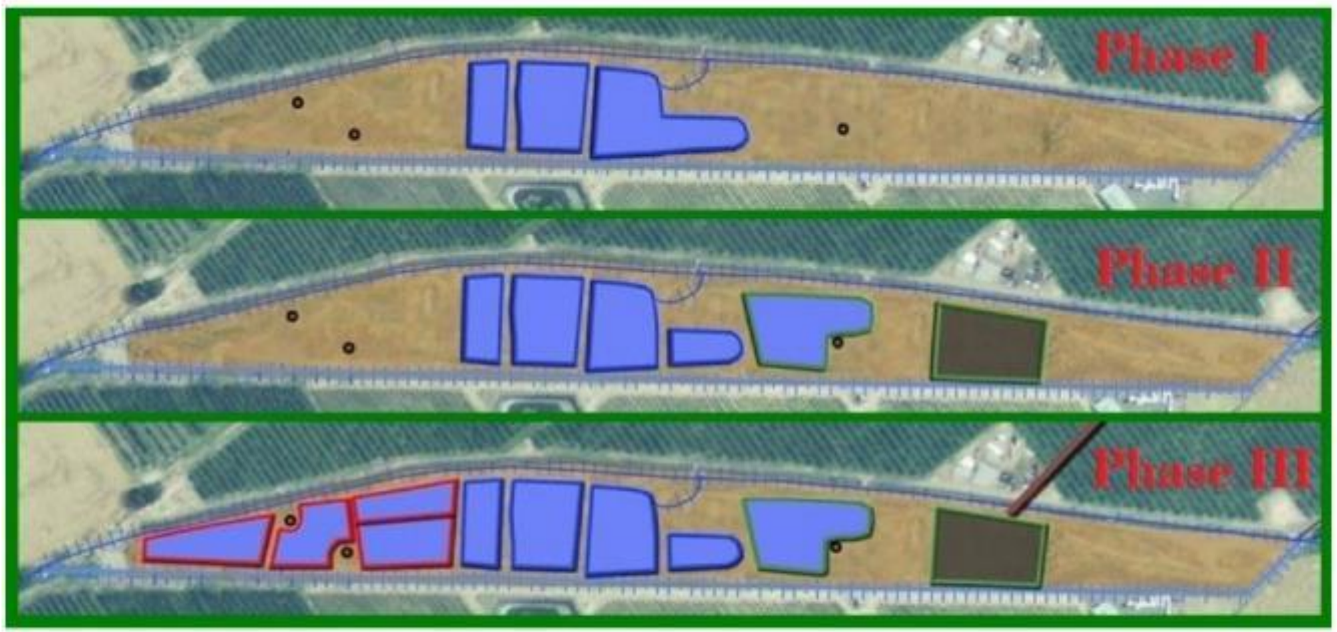
B. Injection wells are inexpensive to build and surface infiltration is too slow

C. The receiving aquifer is confined and the footprint for injection wells is small

D. Injection wells are more likely to win water sustainability awards

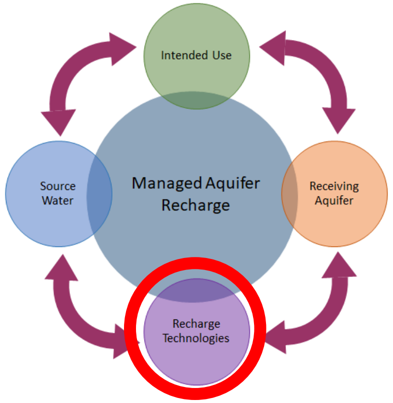
Walla Walla Basin Watershed

Case Study 5.9



MAR Case Study 5.9 Figure 7. Phased approach of MAR at the Johnson site.

Source: WWBWC (2023)



RECHARGE TECHNOLOGIES

- Infiltration Galleries and Basins
  - A total of 19 recharge sites constructed
  - Johnson Recharge site the largest over 51,000 acre-feet since 2004
  - Developed under a phased approach
  - Designed based on cost/benefit analysis of different gallery types

Walla Walla Basin Watershed

Case Study 5.9

▶ INTENDED USE

- Walla Walla River Aquatic Habitat Restoration
- Enhance and improve river and streams

▶ SOURCE WATER

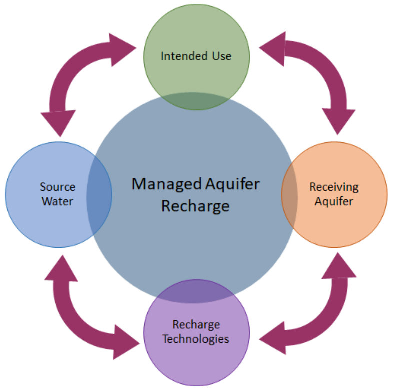
- Walla Walla River

▶ RECEIVING AQUIFER

- Alluvial aquifer of the Milton-Freewater alluvial fan

▶ RECHARGE TECHNOLOGIES

- Infiltration Galleries and Basins



[Walla Walla River Basin – CTUIR Fish Habitat Restoration Efforts in the Walla Walla River Basin]

https://wallawallariver.org/

Walla Walla Basin Watershed

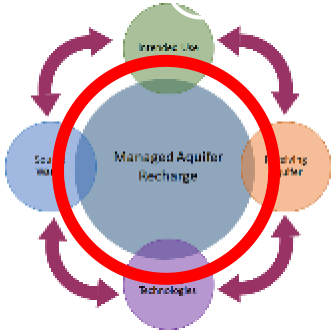
Case Study 5.9

LESSONS LEARNED AND OTHER CONSIDERATIONS

The aquifer maintains a high degree of hydraulic connectivity to streams and rivers; therefore, aquatic habitat restoration would not be possible without incorporating Managed Aquifer Recharge

Consideration of recharge volumes with respect to achieving project success requires realistic timelines

To date, the project goal of recharging 20,000 acre-feet per year has not yet been achieved; but foundational structure exist, which includes stakeholder collaboration within this transboundary watershed

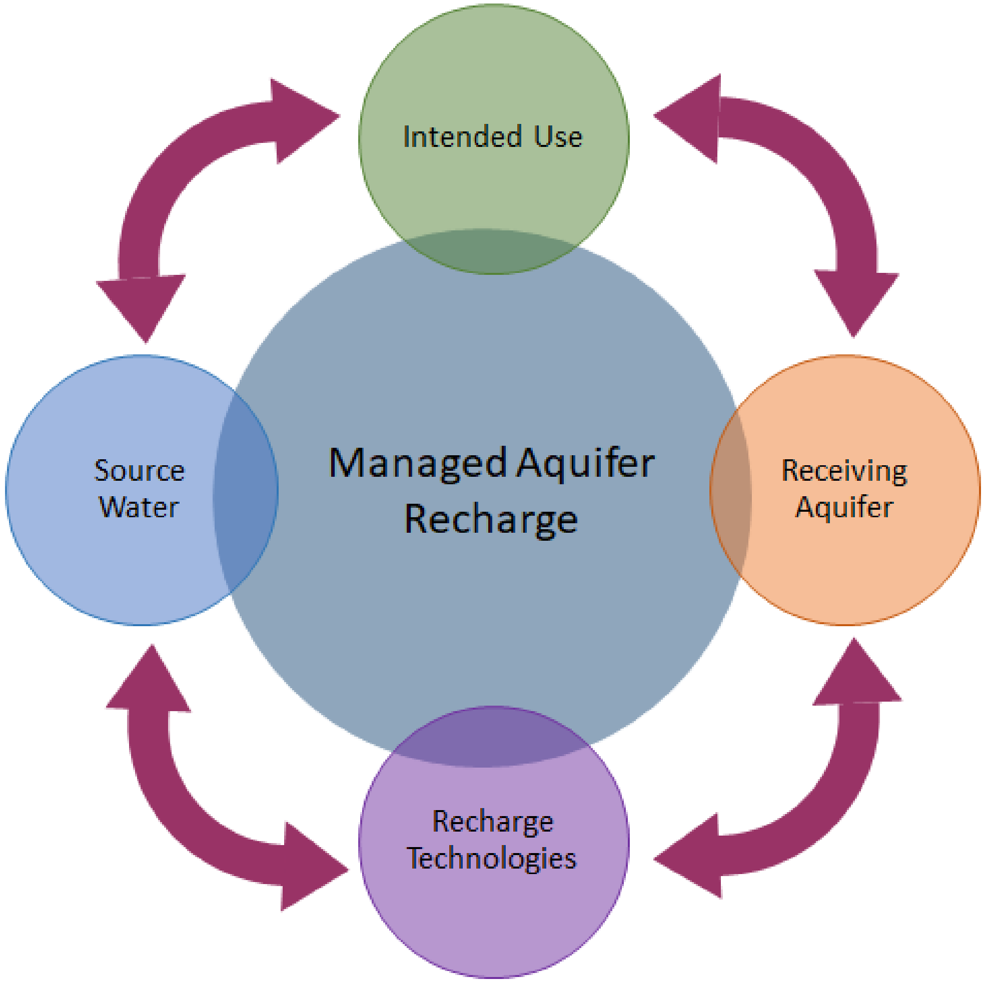


Questions?

Created by Team Member Carrie Ridley

Roadmap

- Introduction
- Intended Use
  - What is the problem you need to solve?
- Source Water
  - What is the source of the solution?
- Receiving Aquifer
  - Where is the problem to be addressed?
- Recharge Technologies
  - How to make it happen?
- Case Study Examples



HRSD Sustainable Water Initiative for Tomorrow (SWIFT) Program

Case Study 5.1

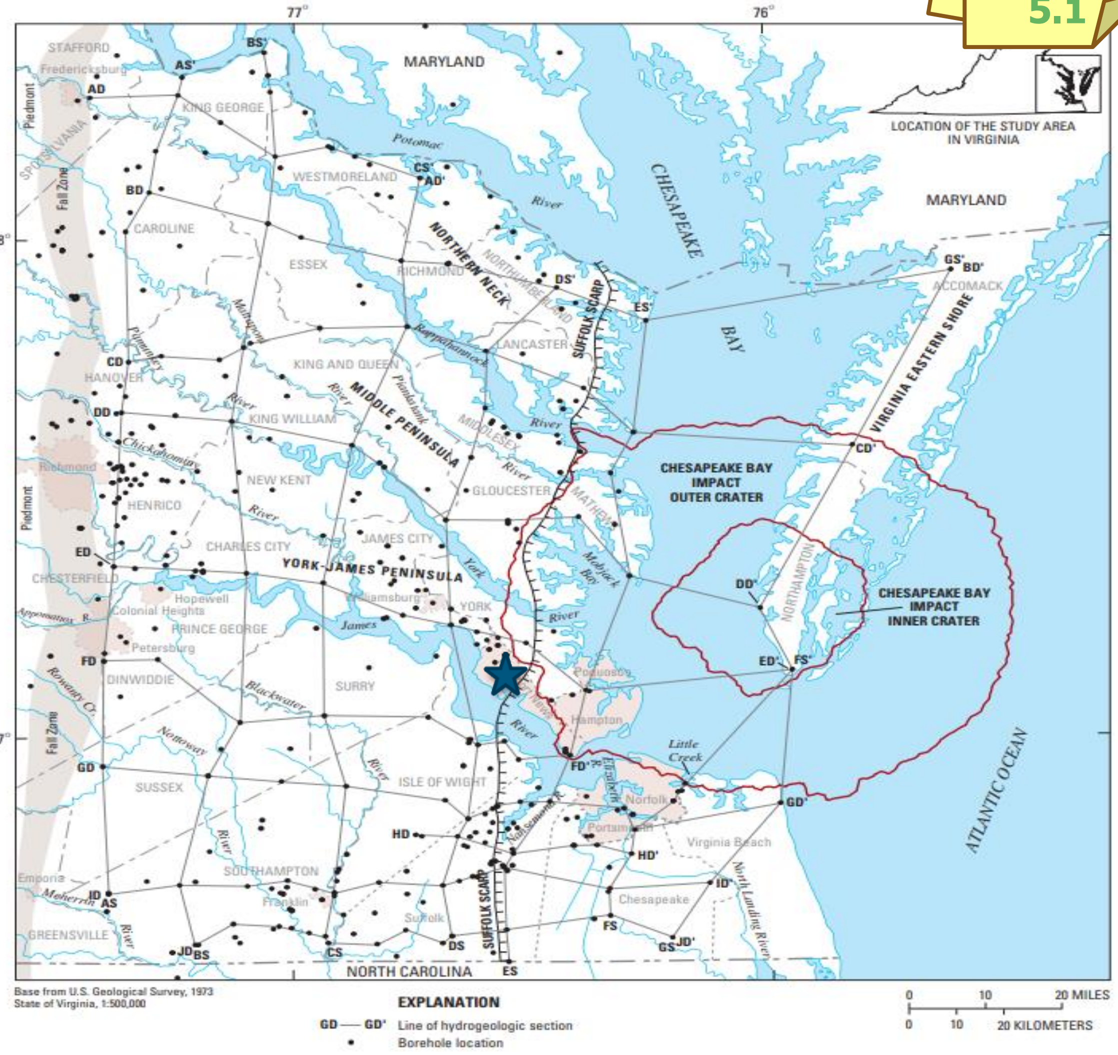
SWIFT Research Center rendering

Screen Capture from https://youtu.be/IO9t1ijr6tw - SWIFT Home | HRSD.com

Sustainable Water Initiative for Tomorrow (SWIFT)

Case Study 5.1

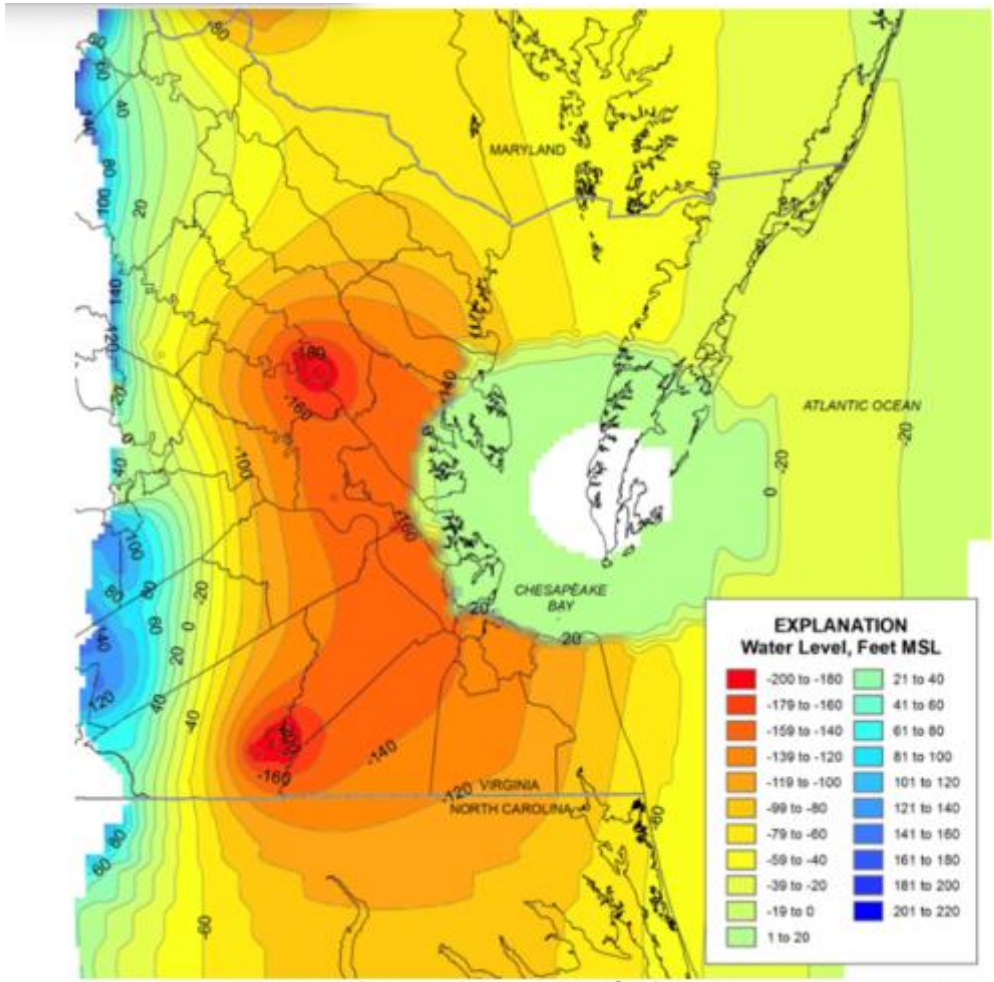
- An innovative water treatment project in Eastern Virginia
  - ✓ Enhance the sustainability of the region's long-term groundwater supply
  - ✓ Protect the Chesapeake Bay
  - ✓ Address sea level rise and saltwater intrusion
- At full-scale, SWIFT will be implemented at up to five of HRSD's* wastewater treatment facilities with a total recharge capacity of up to 100 MGD



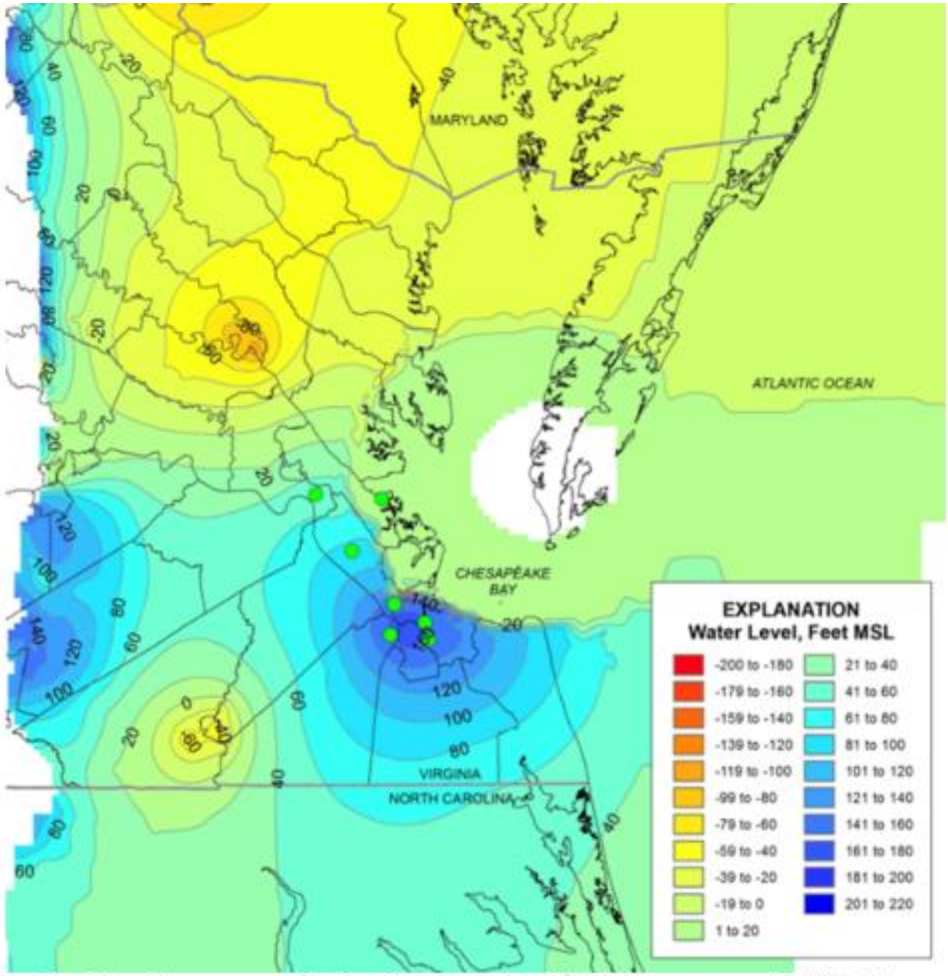
MAR Case Study 5.1 - Figure 1. Location of Virginia's coastal plain.
McFarland and Scott (2006); UpdatedPlate1 (usgs.gov)
https://pubs.usgs.gov/pp/2006/1731/PDF_plates/PP1731plate1.pdf

Eastern Virginia Groundwater Management Area

Case Study 5.1



Predicted pressures in the Potomac Aquifer in 50 years without SWIFT replenishment.



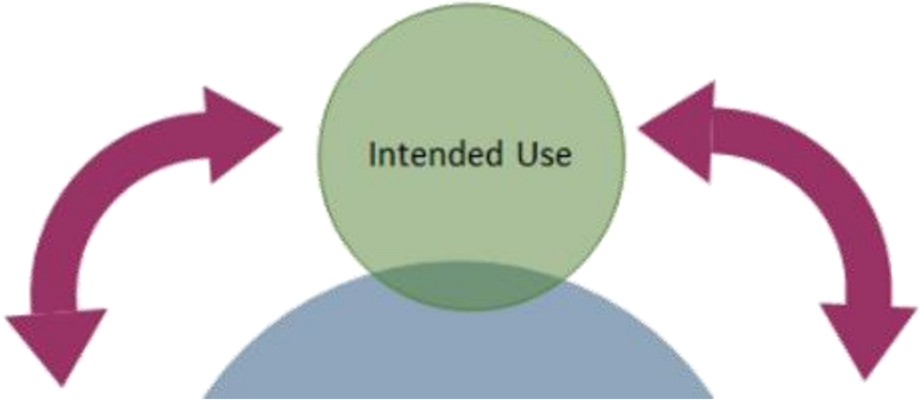
Predicted pressures in the Potomac Aquifer in 50 years with SWIFT replenishment.

The Potomac Aquifer: A Diminishing Resource, HRSD.com
https://www.hrsd.com/swift/potomac-aquifer-diminishing-resource

Intended Use

Case Study 5.1

Help Chesapeake Bay by significantly reducing the amount of nutrients such as nitrogen and phosphorus that HRSD discharges to the James, Elizabeth and York rivers



Replenish dwindling groundwater supplies, allowing this natural resource to remain productive for generations to come

Fight sea level rise by reducing the rate at which land is sinking in Hampton Roads

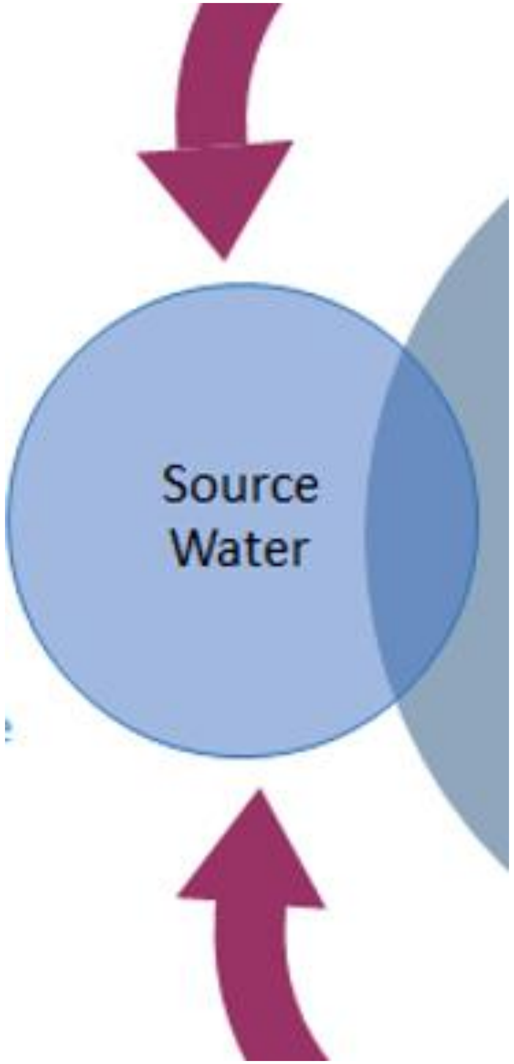
Protect groundwater from saltwater intrusion due to a shrinking aquifer

Support Virginia's economy by providing businesses with the water they need to operate

Source Water Characteristics

Case Study 5.1

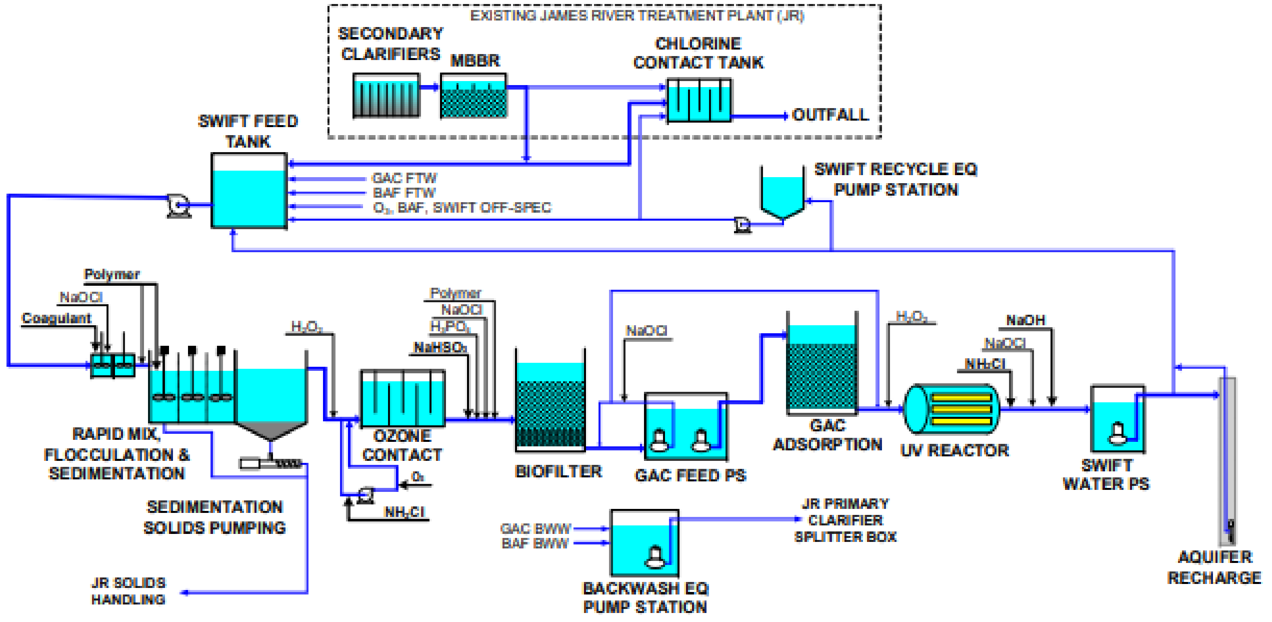
- Highly treated secondary effluent
- Including nitrogen and phosphorous removal
- Treated to drinking water standards
- Tested carbon-based and membrane-based treatments trains.



Source Water

Case Study 5.1

- SWIFT tested two proven drinking water treatment technologies:
  1. Membrane-Based
  2. Carbon-Based Advanced Water Treatment Processes
- Create multiple barriers to remove potential contaminants and pathogens
- Stringently monitored throughout each stage
- Estimated capital cost of $2.0B ($0.055/gallon of capacity)



MAR Case Study 5.1 - Figure 2. James River SWIFT process flow diagram. HRSD Permit Application - Part 2 (epa.gov) https://www.epa.gov/system/files/documents/2022-06/HRSD_Permit_Application_Part2.pdf

Source Water

Case Study 5.1

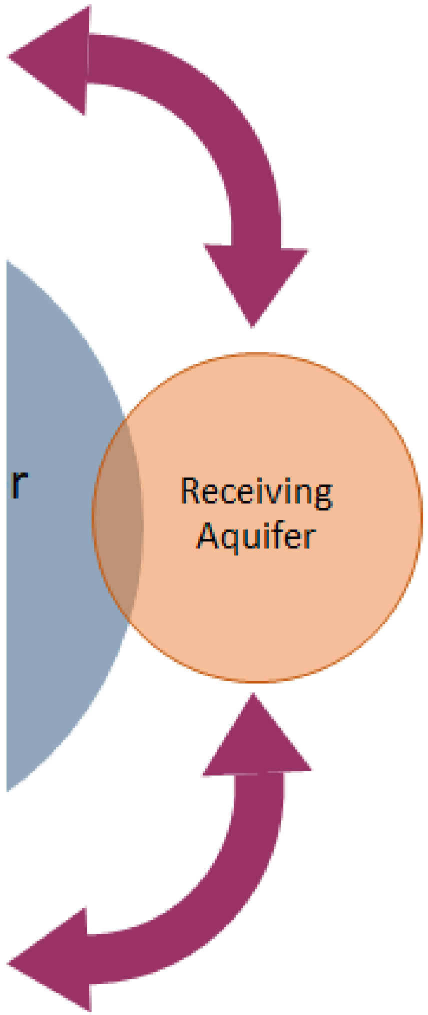
Parameter	Regulatory Limit
USEPA Drinking Water Primary Maximum Contaminant Levels (PMCL)	Meet all PMCL
Total Nitrogen (TN)	5 mg/L Monthly Average; 8 mg/L Max Daily
Turbidity	Individual Filter Effluent (IFE) <0.15 NTU 95% of time and never >0.3 NTU in two consecutive 15-minute measurements
Total Organic Carbon (TOC)	4 mg/L Monthly Average, 5 mg/L Maximum Instantaneous
Total Coliform	<2 CFU/100 mL 95% of collected samples within one calendar month, applied as the 95th percentile
E. Coli	Non-Detect
TDS	No Limit

Receiving Aquifer

Case Study 5.1

Potomac Aquifer System:

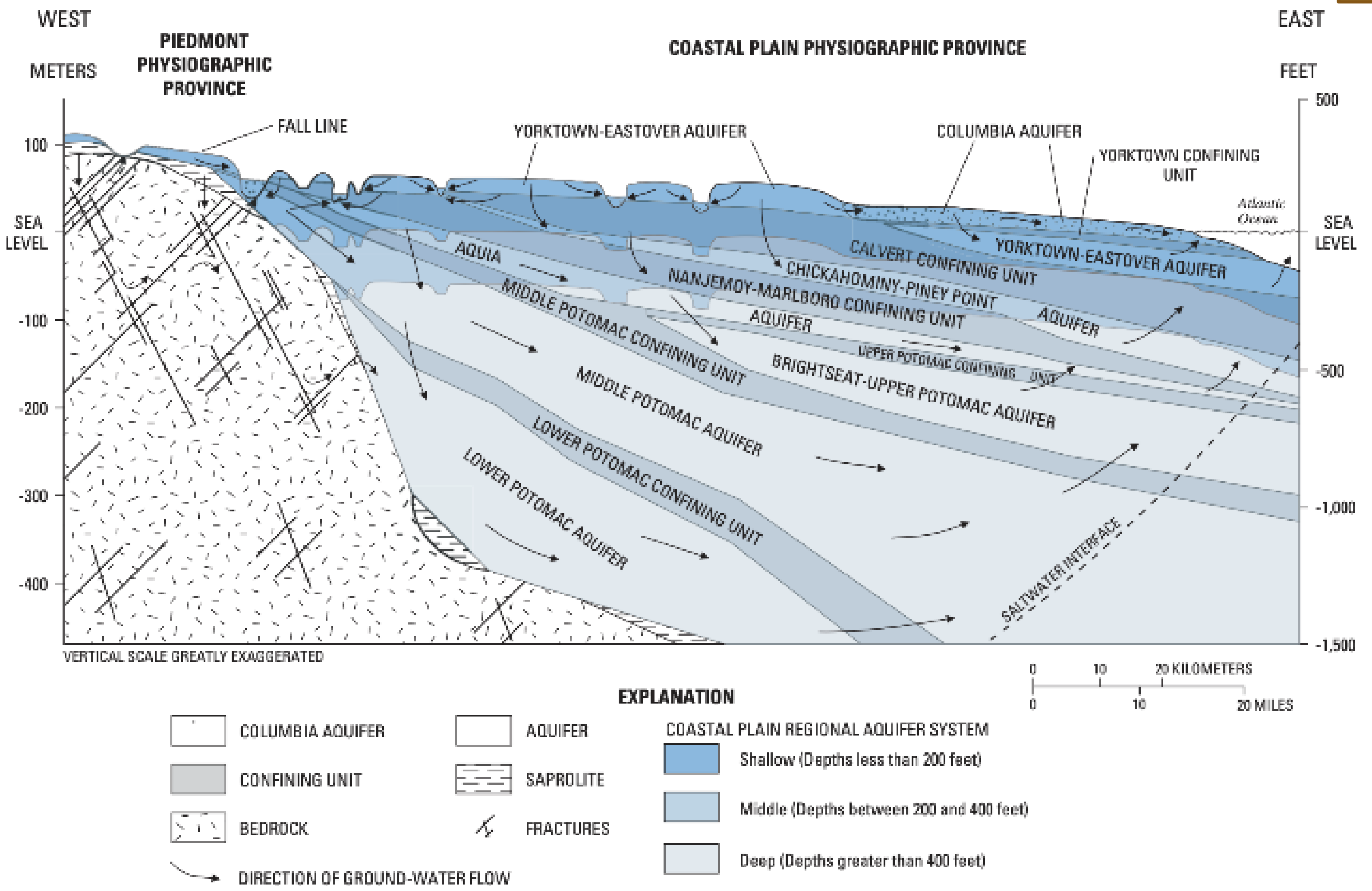
- Largest aquifer several 1000 feet thick
- Confined aquifer with Interbedded clays and sands
- Insufficient ability to recharge naturally
- Contains hundreds of trillions of gallons of pressurized water



Receiving Aquifer Hydrogeologic Setting

Case Study 5.1

- 100 years of water withdrawal has significantly lowered pressure in aquifer
- Aquifer compaction has resulted in land subsidence and increased potential for saltwater contamination

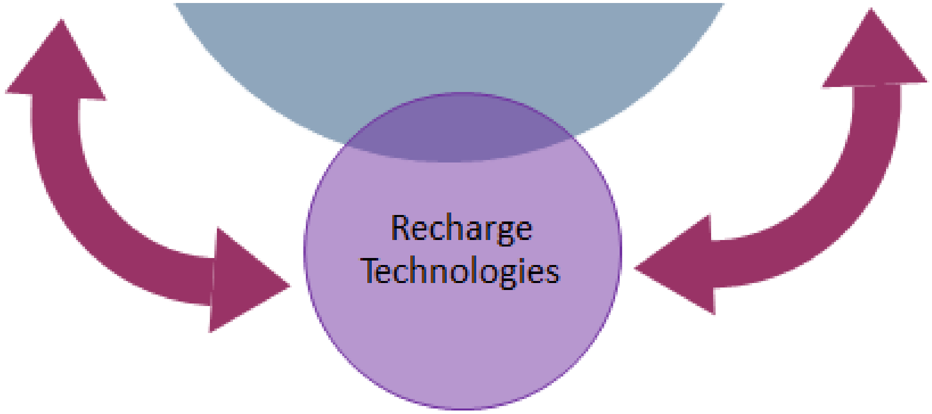


Aquifer Susceptibility in Virginia, 1998-2000. Water-Resources Investigations Report 03-4278, USGS
(https://pubs.usgs.gov/wri/wri034278/wrir03_4278.pdf)

Recharge Technology

Case Study 5.1

Multiscreen Injection Well	Pretreatment of recharge water for compatibility with aquifer matrix	Recharge to multiple units	Injection/flow testing	Backflushing



Recharge Technology

Case Study 5.1

Site Schematic of the SWIFT System

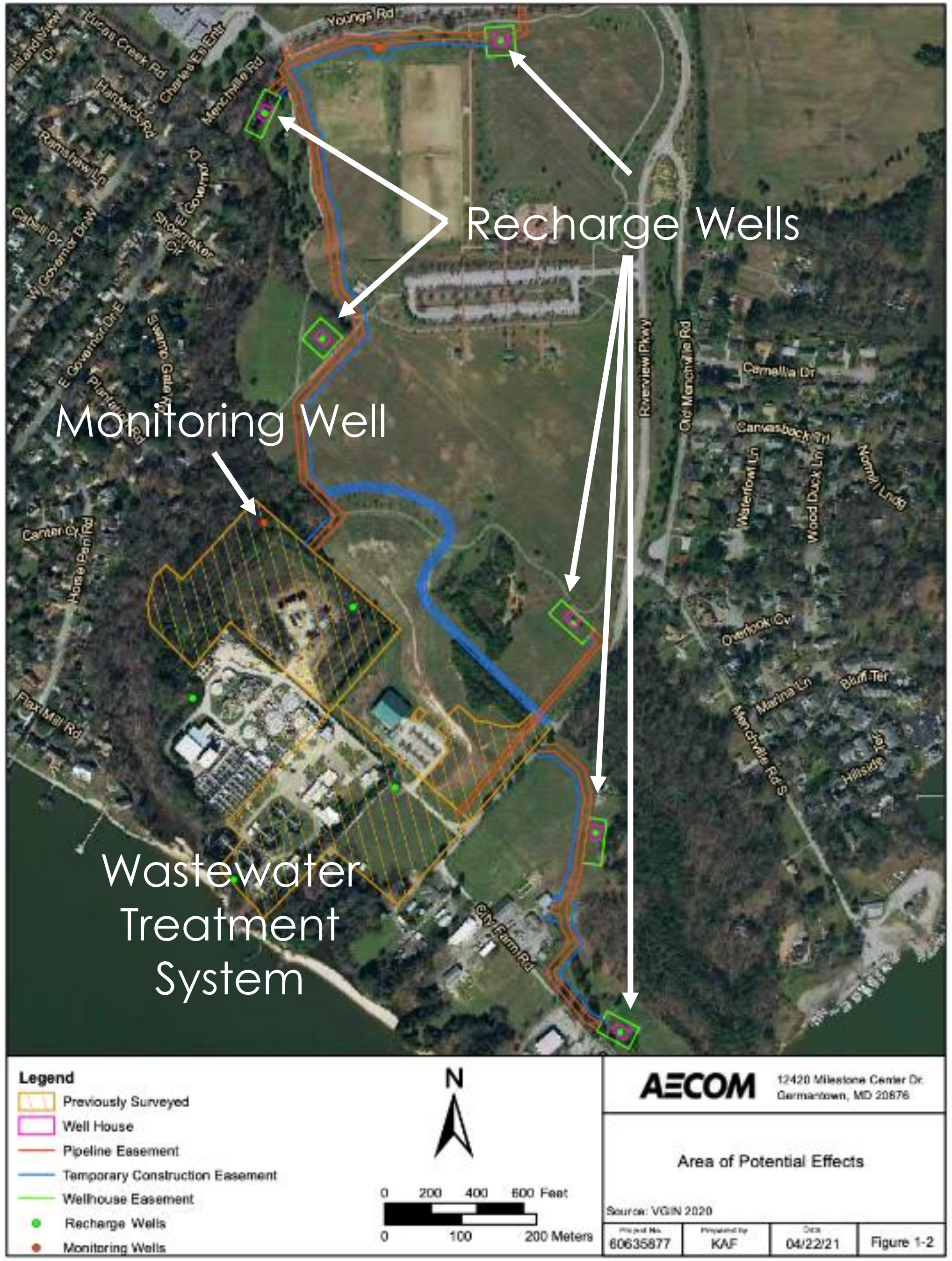
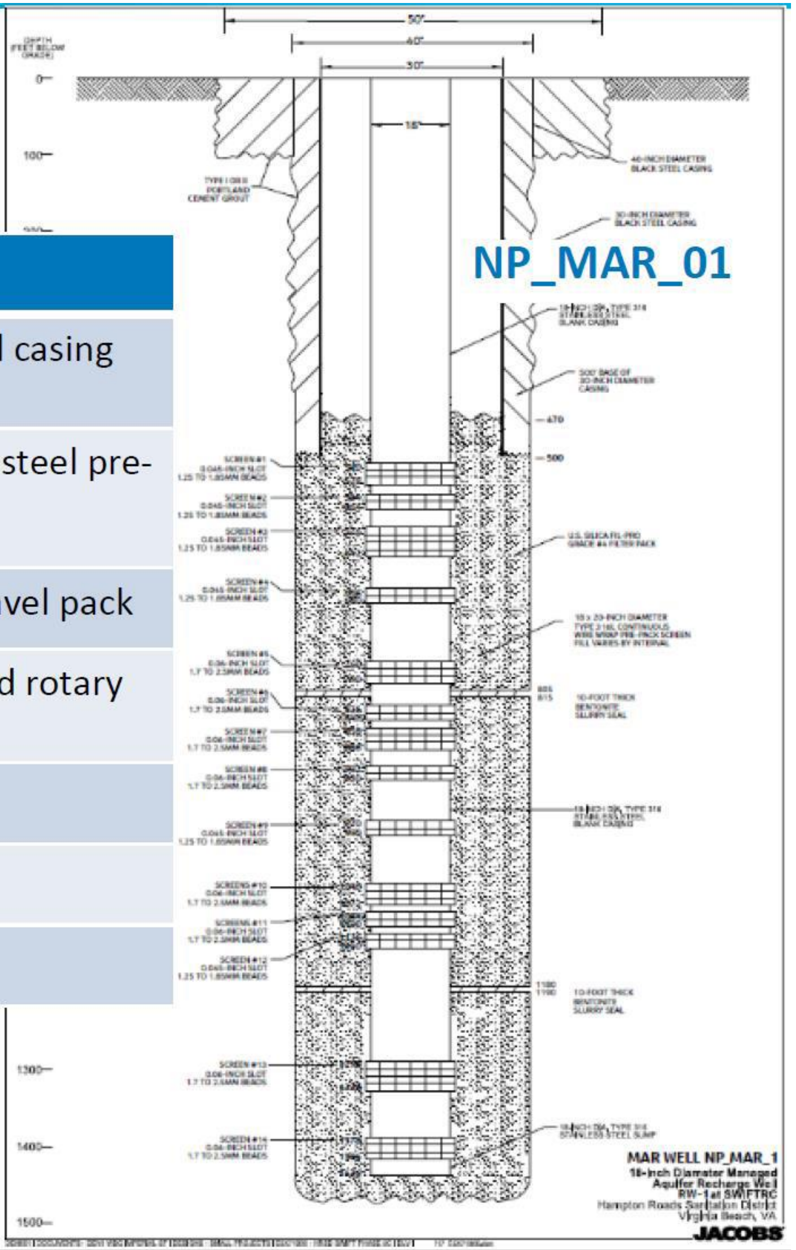


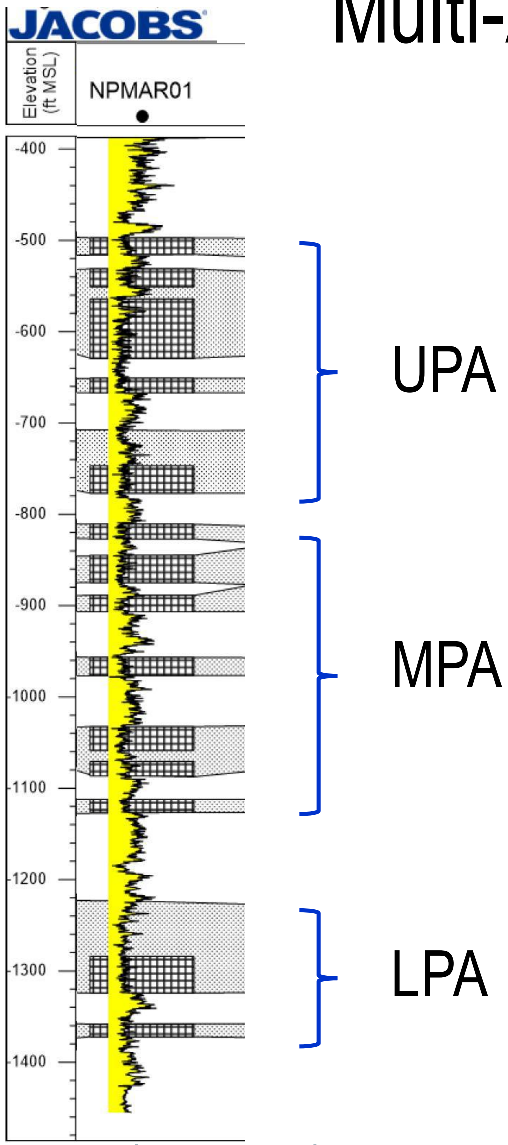
Image Courtesy of AECOM

Case Study 5.1

MAR-01: Multi-Screen, Multi-Aquifer Recharge Well

NP_MAR_01
30” 316L stainless steel casing
18”x20” 316L stainless steel pre-packed screen
Si spherical beads + gravel pack
Reverse circulation mud rotary drilling
Overlap construction
14 screen zones
342’ of screen





March 18, 2022, Potomac Aquifer Recharge Monitoring Laboratory Update Presentation
Mark Widdowson and Gary Schafran, PARML Co-Directors (PowerPoint Presentation (hrpdcva.gov))

HRSD Sustainable Water Initiative for Tomorrow (SWIFT) Program

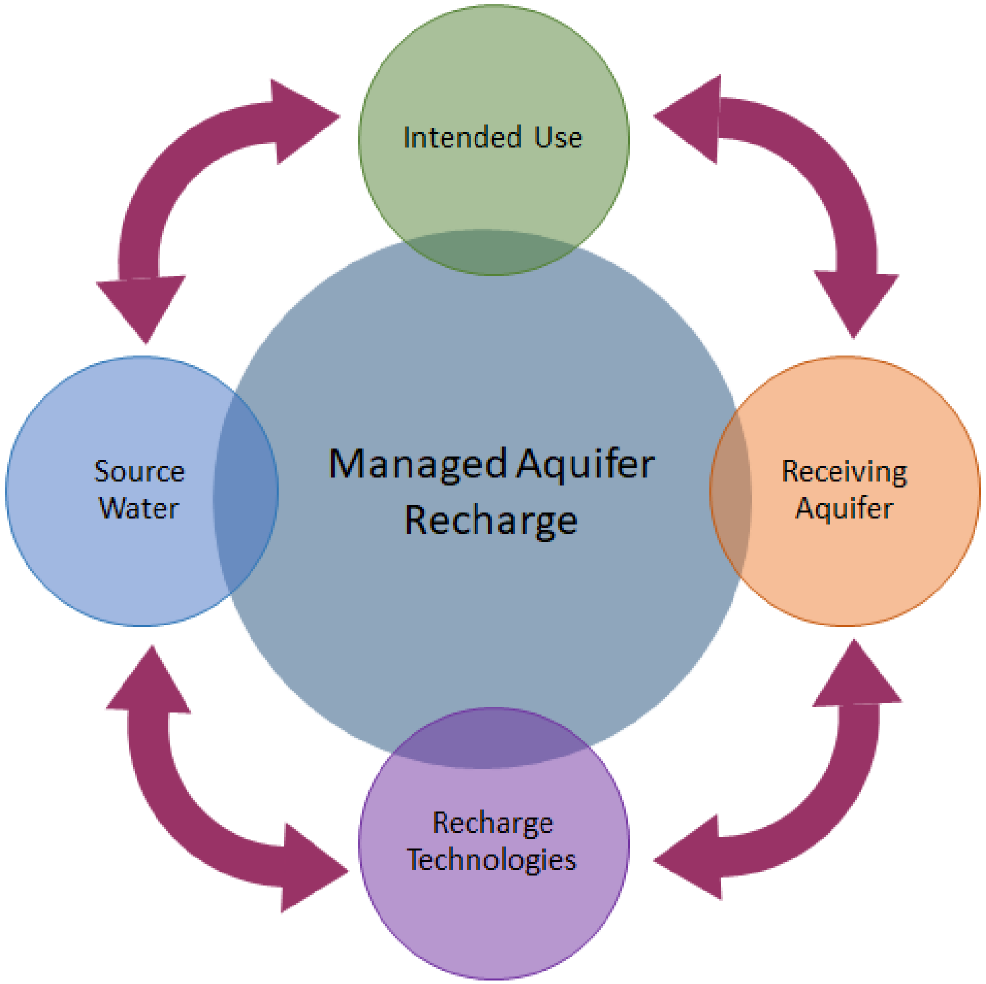
Case Study 5.1

Project Goal: 100M gallons/day by 2026

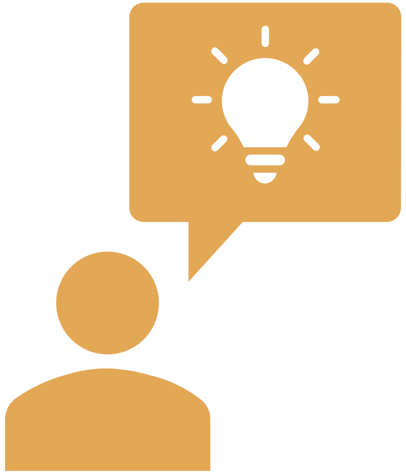
Ongoing Project

Other Consideration? PFAS!

www.hrsd.com/swift



Poll Question



What was the source water component of the SWIFT MAR Project design?

A. Chesapeake Bay water

B. Treated wastewater

C. Desalinated seawater

D. Surface water

Case Study 5.4

San Antonio Water System H2Oaks Center Aquifer Storage and Recovery (ASR) Project

San Antonio Water System

San Antonio H2Oaks ASR Case Study

Case Study 5.4

San Antonio Water System

EDWARDS AQUIFER AUTHORITY

- Obtains most of its water from the Edwards Aquifer
- Does not need its full allocation in wet years

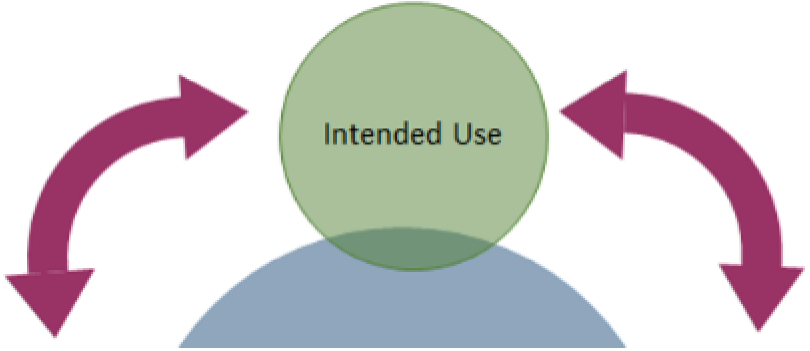
- Regulates withdrawals from the Edwards Aquifer
- Can impose restrictions in drought years

Poll Question

- What should San Antonio do with the excess Edwards Aquifer water available to them in wet years?
  A. Don’t pump it, leave it in in the Edwards Aquifer
  B. Pump it, discharge it into a surface water reservoir
  C. Pump it, inject it into a different aquifer
  D. Pump it, sell it to a different water provider

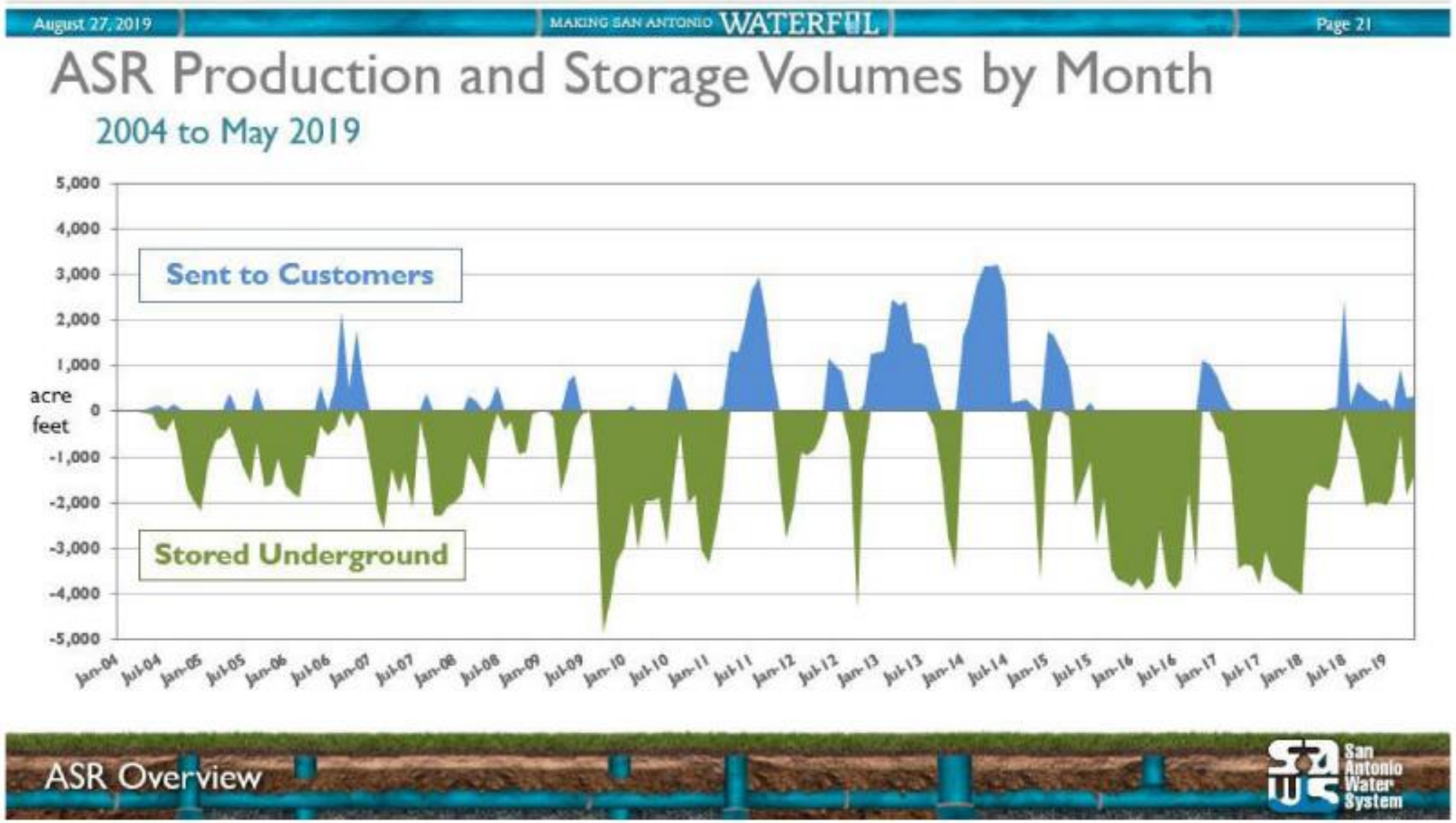
Intended Use

Case Study 5.4



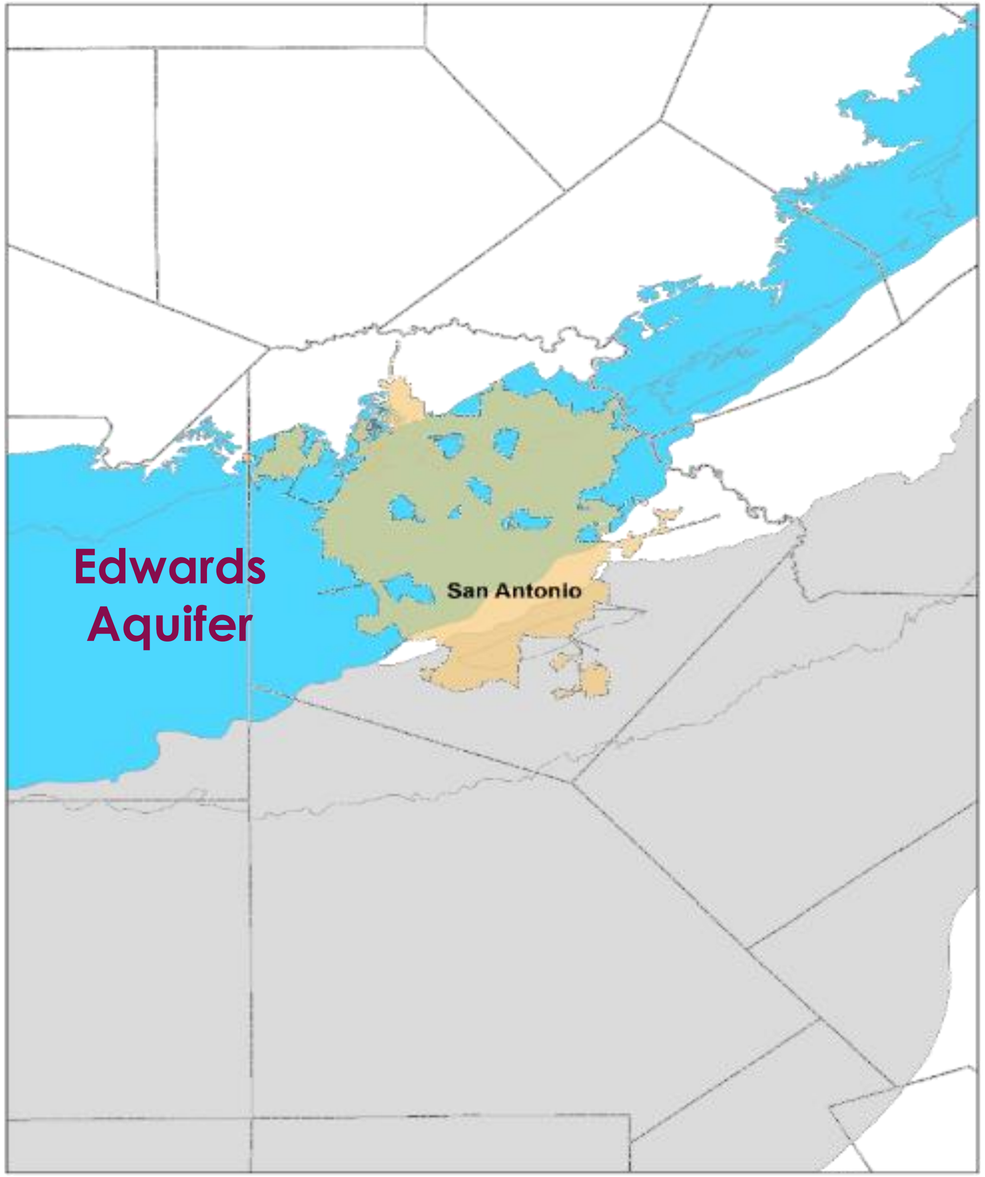
Water Supply Resilience

- Store water during wet years
- Withdraw this water in dry years



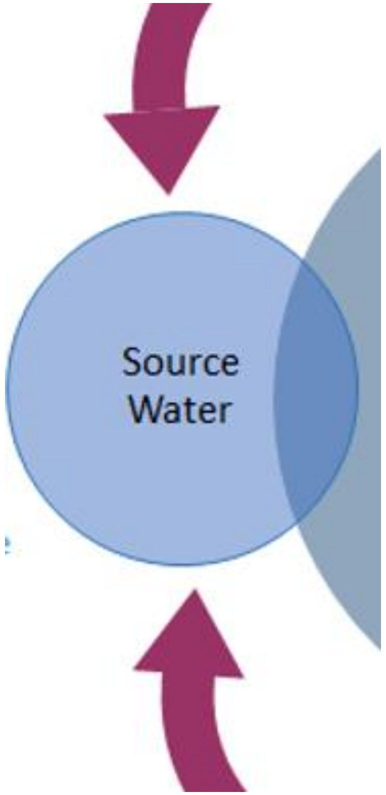
MAR Case Study 5.4 Figure 4. SAWS H2Oaks ASR production and storage volumes by month.
Thompson (2019)

Source Water



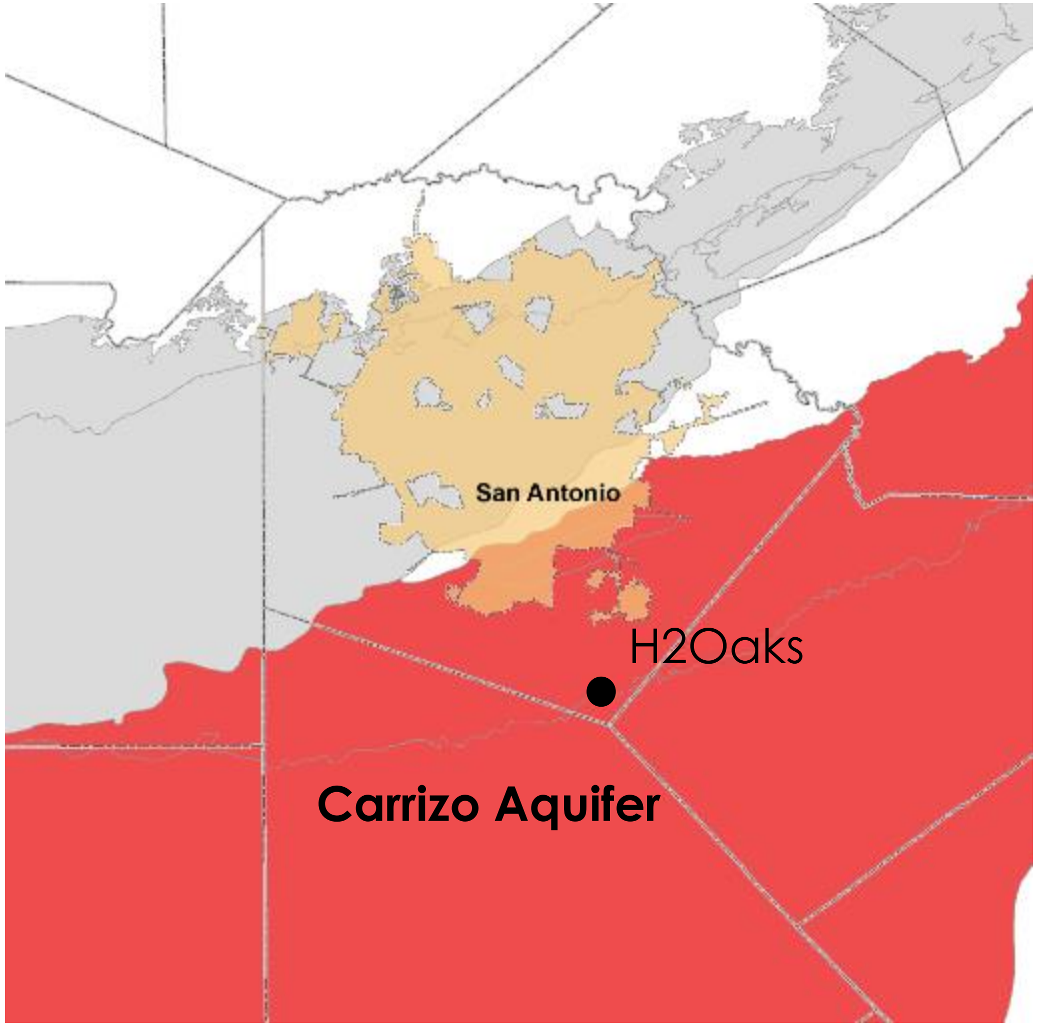
Edwards Aquifer

- Limestone aquifer with karst features
- Close to the surface in San Antonio
- Excellent water quality
- Disinfected prior to injection



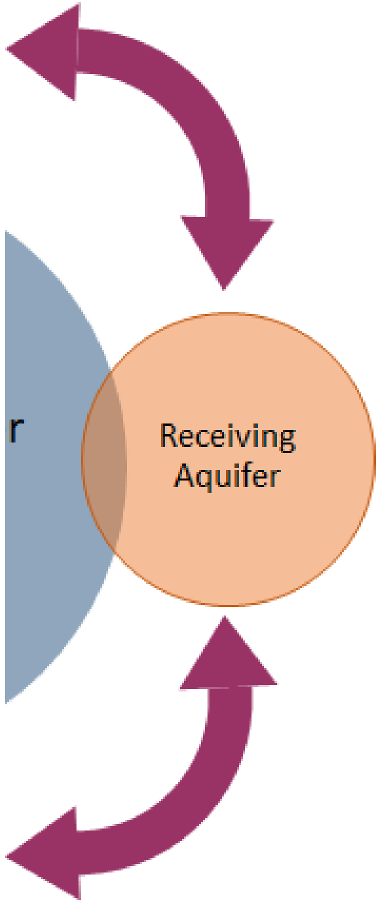
Receiving Aquifer

Case Study 5.4



Carrizo Aquifer

- Confined sandstone aquifer
- 400 to 700 feet deep
- Marginal water quality
  - pH = 5.5
  - High dissolved solids, iron, and manganese

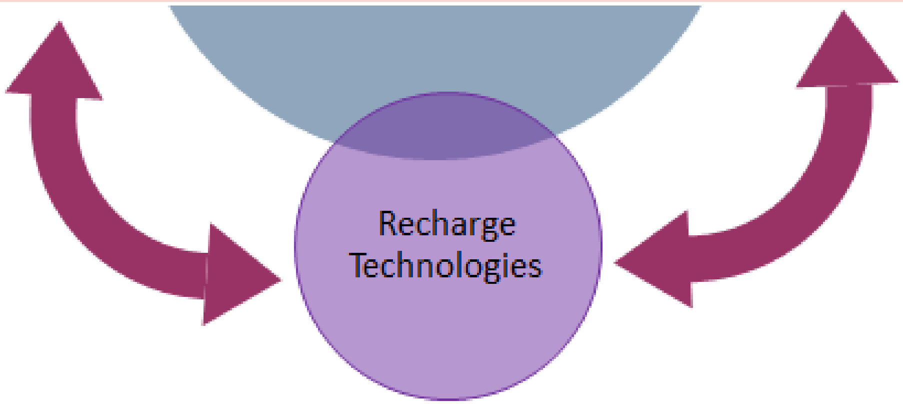


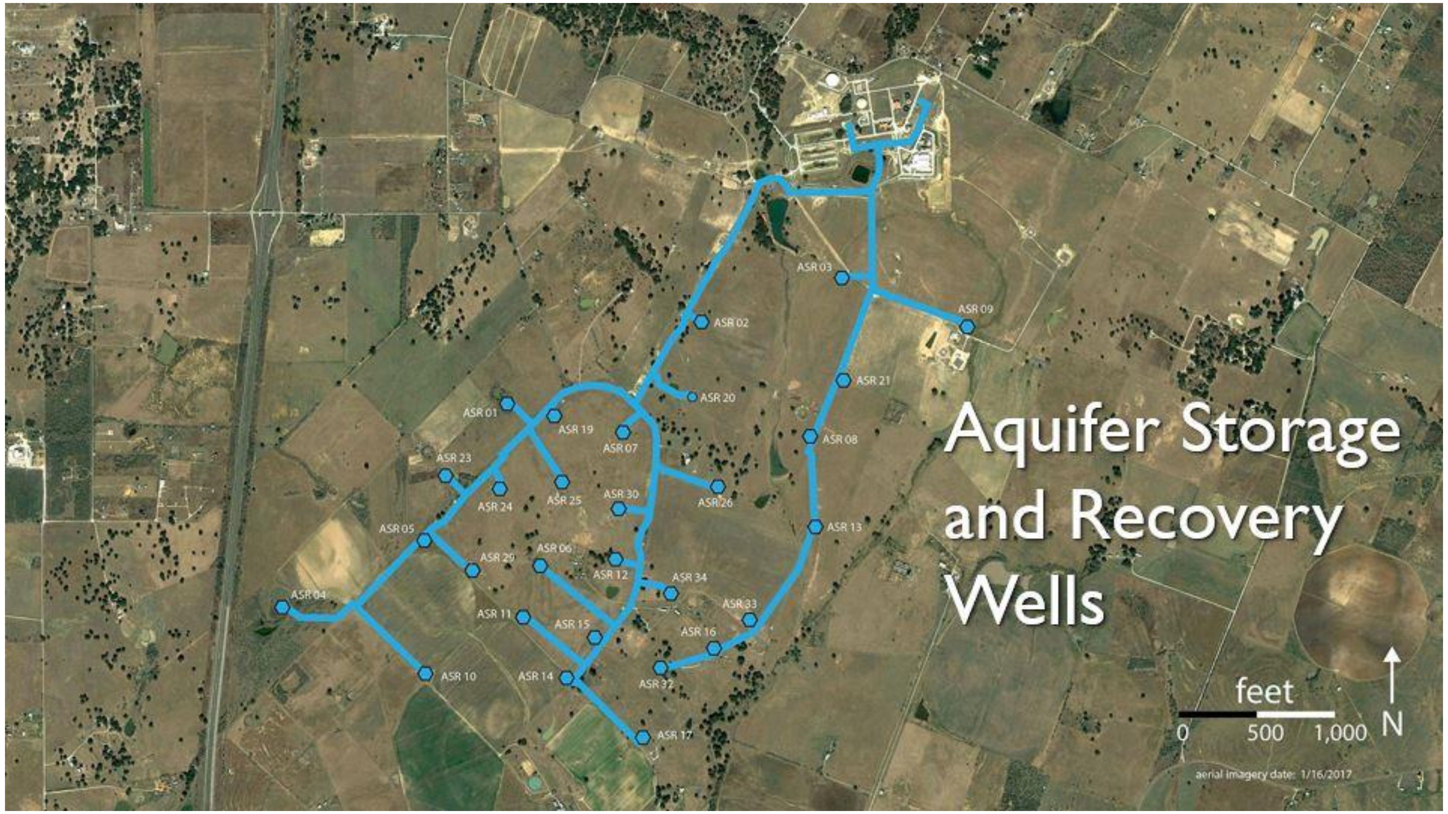
Recharge Technology

Case Study 5.4

ASR Wells

- 29 ASR wells
- Injection capacity of 74 mgd
- Land available for agricultural uses
- Addressed corrosion of well casings and screens





MAR Case Study 5.4 Figure 2. SAWS H2Oaks ASR well fields.
Source: Morrison (2022)

Lessons Learned – Stakeholder Engagement

Case Study 5.4

Water quantity/quality concerns from existing Carrizo users

→

Agreement between SAWS and Evergreen Underground Water Conservation District

→

Monitoring and Mitigation Plan

San Antonio H2Oaks ASR Case Study

Case Study 5.4

WATER SOURCE AT A GLANCE	PROJECT	HOUSEHOLDS SERVED	WATER DISTRIBUTED IN 2022	% OF WATER DISTRIBUTED IN 2022	WATER STORED IN 2022	TOTAL AMOUNT STORED END OF 2022
Edwards Aquifer water stored in Carrizo	Aquifer Storage Recovery	59,500	14,900 AF	4.4%	11,600 AF	189,000 AF

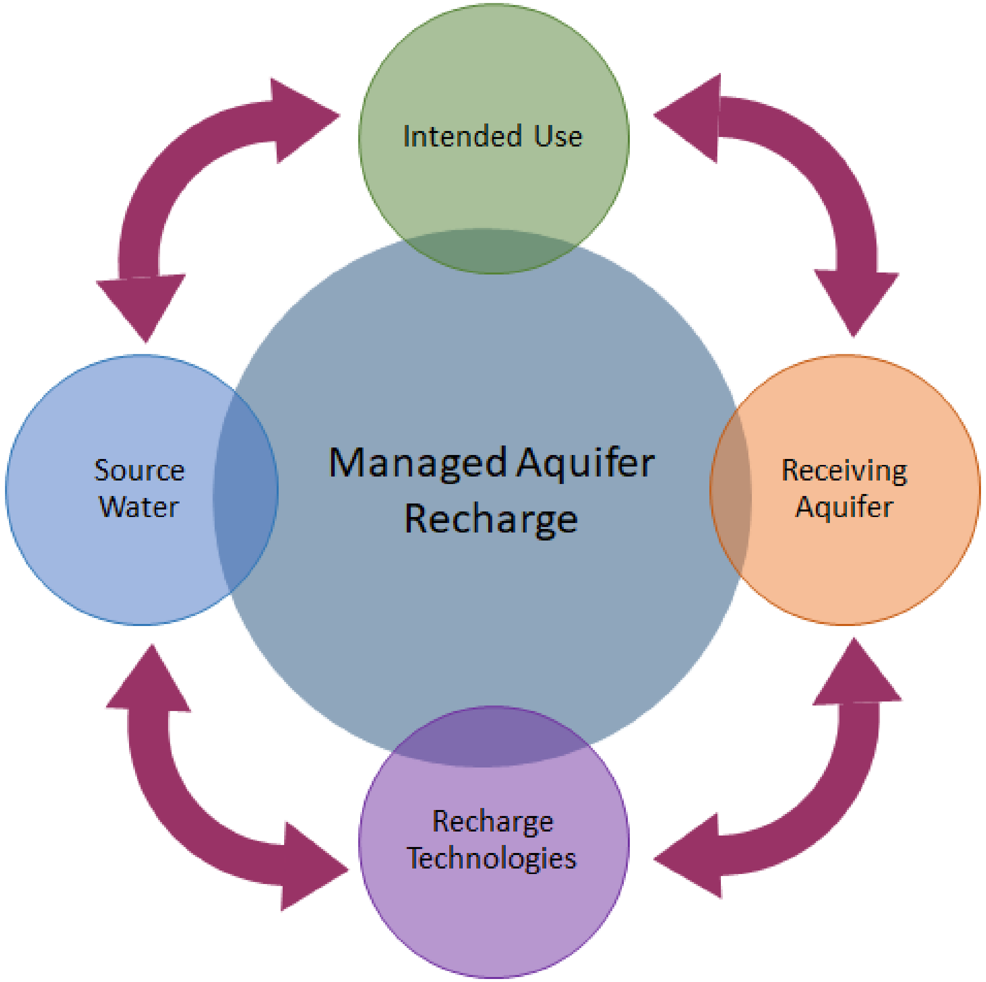
San Antonio Water System Aquifer Storage and Recovery
Aquifer Storage & Recovery - San Antonio Water System (saws.org)
https://www.saws.org/your-water/management-sources/aquifer-storage-recovery/

Poll Question

- Which of these was a concession made by SAWS to existing users of the Carrizo Aquifer?
  - A. Treated wastewater cannot be used as source water
  - B. No native Carrizo groundwater may be extracted
  - C. SAWS must replace all private wells with public supply
  - D. H2Oaks was annexed into the Evergreen Underground Water Conservation District

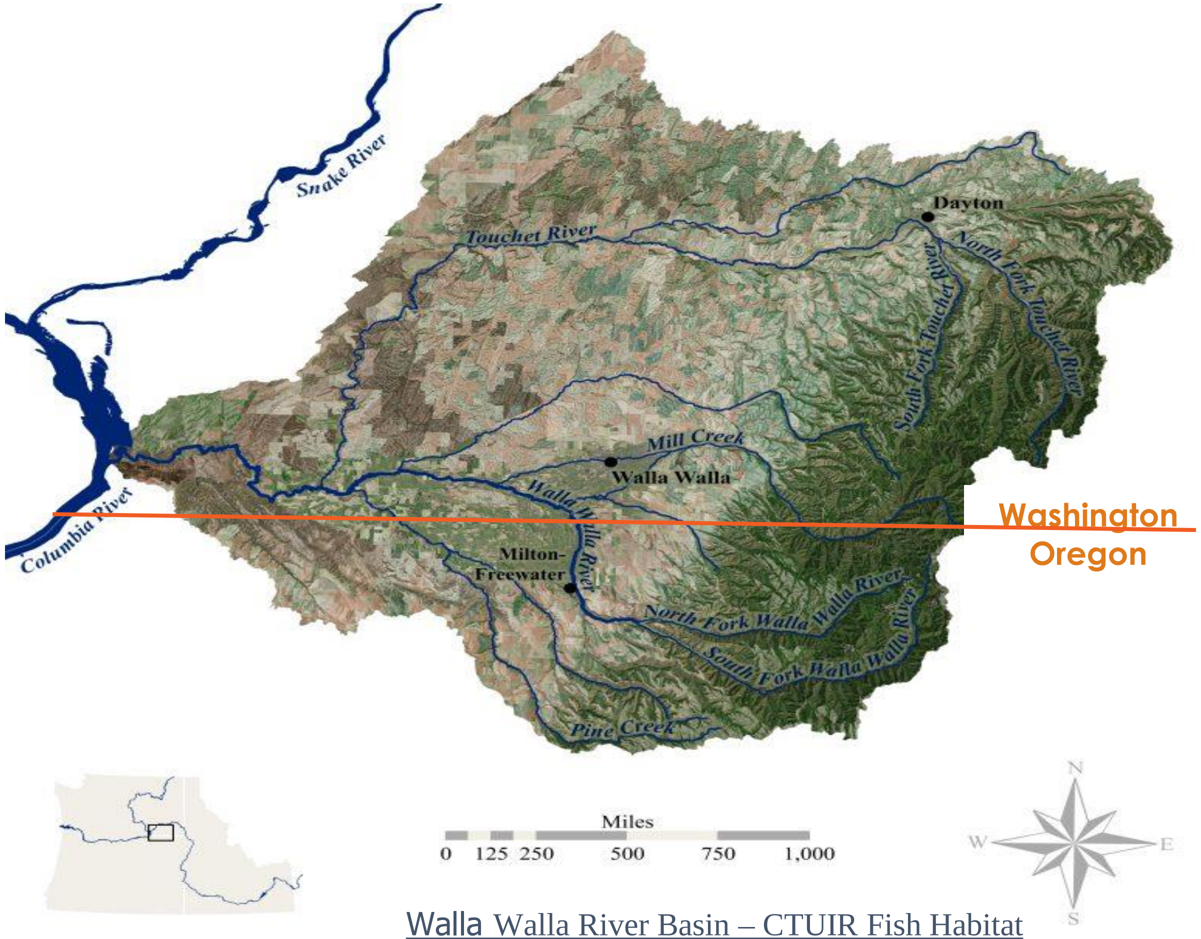
What did we learn today?

- MAR is a PROCESS: not a formula or linear flowchart
- WIDELY APPLIED to all types of aquifers: unconsolidated sediments, floodplains, crystalline or karst bedrock
- Future of MAR is now, addressing WATER SUPPLY RESILIENCE



MAR Recap

MAR Case Study Figure 6. The Johnson Aquifer recharge site.
Source: WWBWC (2023).



Walla Walla River Basin – CTUIR Fish Habitat Restoration Efforts in the Walla Walla River Basin
https://wallawallariver.org/

MAR Recap

- Head to the Guidance Document and find:
  - Section 2.0: Project Planning
    - Stakeholder Engagement
    - Regulatory Considerations
    - Permitting
  - Section 3.6: Data & Modeling
  - Appendix B: Water Quality Parameters
  - Appendix C: State, Territory & Tribal Regulatory Contacts

Access the MAR Document at: https://mar-1.itrcweb.org

Questions

ITRC Managed Aquifer Recharge (MAR) Guidance Document mar-1.itrcweb.org

Certificate of Completion https://clu-in.org/conf/itrc/mar/
(emailed after you complete the Feedback Form)