Northeast flank of Mauna Kea, Hawaii

Groundwater Resources Program

Groundwater Availability in Hawaii Volcanic-Rock Aquifers

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USGS
science for a changing world
U.S. Department of the Interior
U.S. Geological Survey

First Annual Joint Hawaii State Water Conference
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Lihue, Wailuku, Honolulu, Kailua-Kona, and Hilo

Overview

- Objectives: assess current condition, reconstruct the past, provide tools and information for the future
- Federally funded
- Uses/complements cooperative work USGS does with State and County

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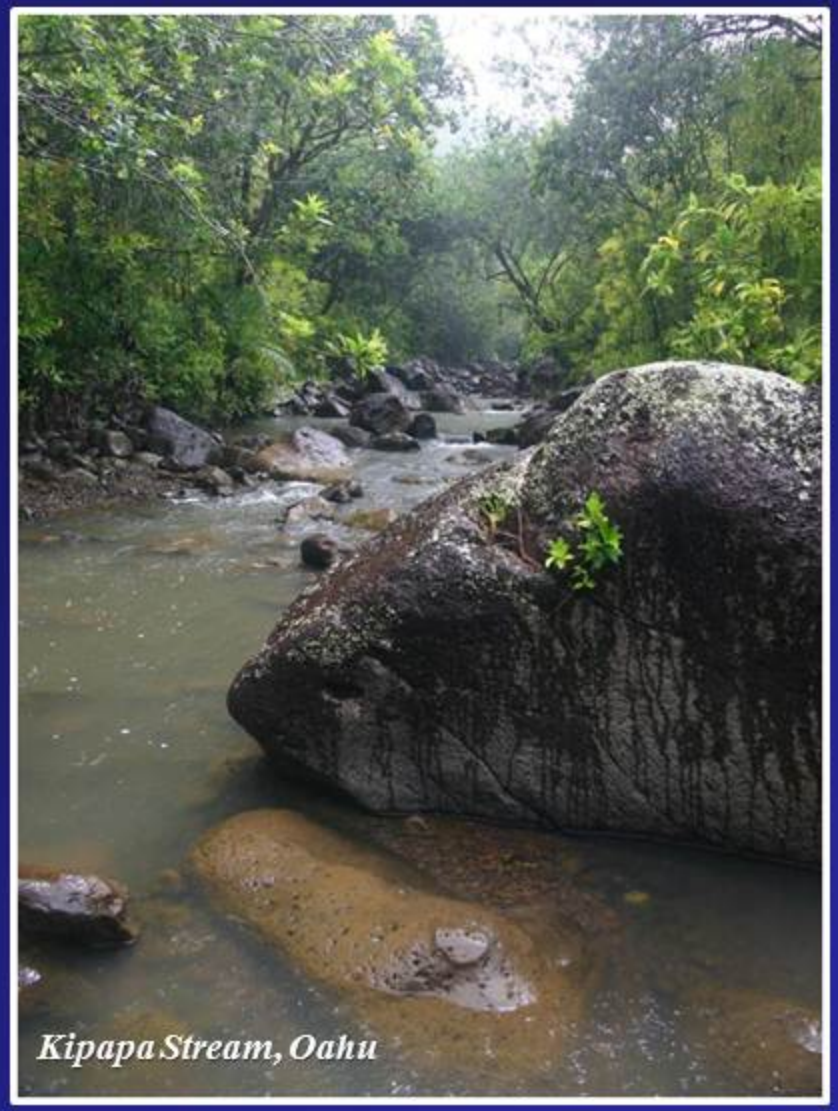
Water Mission of the USGS

- Provide information to manage, protect, and enhance the Nation's water resources
- Address water-related hazards
- Provide information that is reliable, impartial, and timely
- Do science, not regulate or manage



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USGS Water Programs

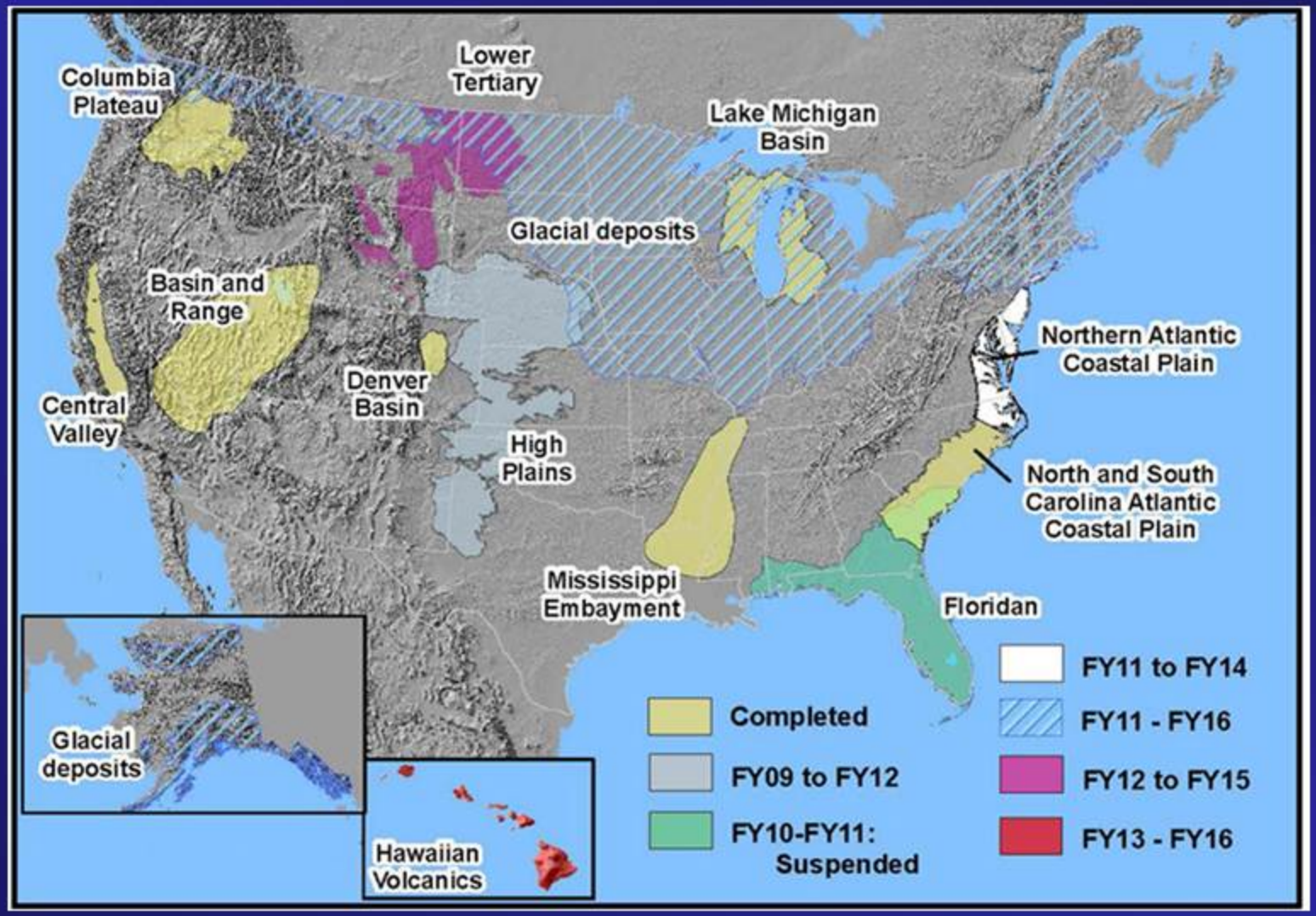
COOPERATIVE WATER PROGRAM

- Joint funding – USGS shares costs with State and County
- Meets specific management and planning needs
- Data collection & hydrologic investigations

GROUNDWATER RESOURCES PROGRAM

- Federally funded
- Quantifies groundwater at regional and national scales
- Uses/complements information from the Cooperative Water Program
- Major current activity – study groundwater availability of principal regional aquifers in US

Principal Regional Aquifers in the Nation



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Hawaii Aquifers

Wells in Lihue, Kauai

Provide much of the freshwater taken for human use

- Drinking water
- Diverse industries – agriculture, tourism, military
- Traditional and cultural uses

Supports stream and coastal ecosystems

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Groundwater Resources Program

Hawaii Volcanic-Rock Aquifer Study

Active lava flow, Kilauea, Big Island

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Objectives

- Document current condition of the Hawaii volcanic-rock aquifers
- Determine effect of human activities
- Develop tools to assess responses to future stresses
- Evaluate adequacy of current data networks

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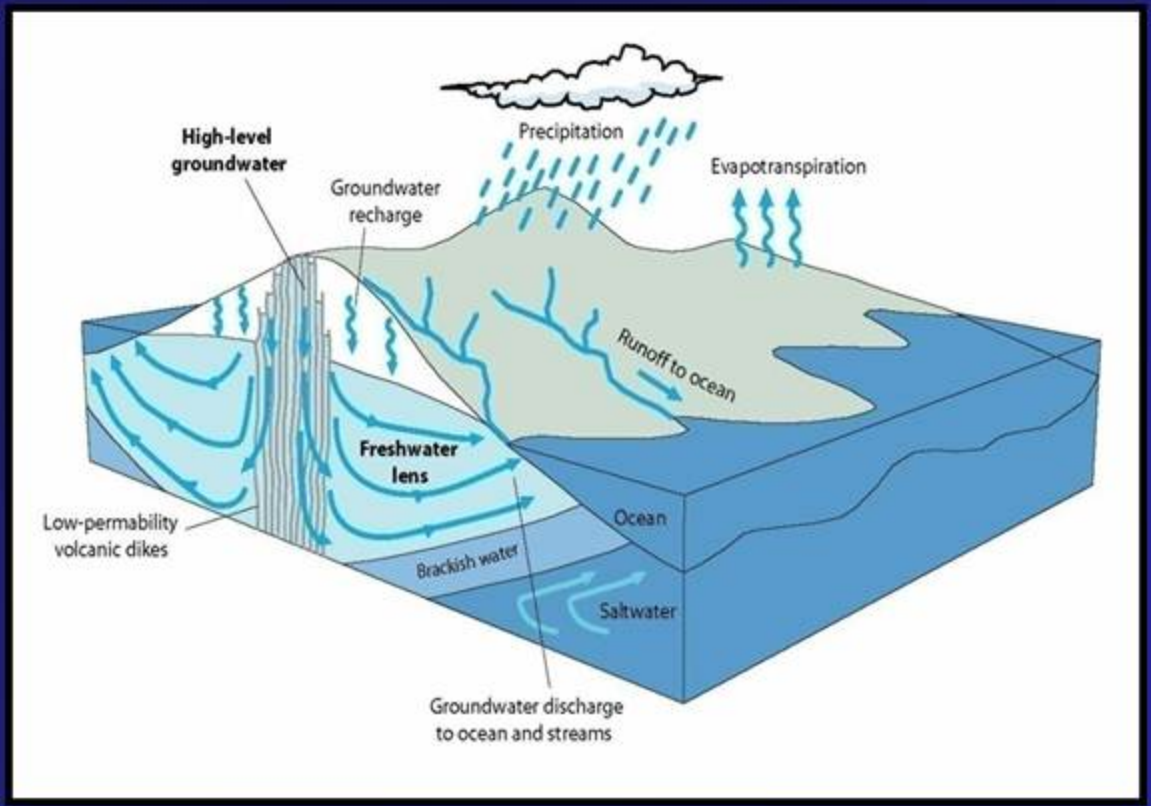
Hawaii Differs from Other Study Areas

- Separate islands, not a contiguous aquifer
- Saltwater surrounds, underlies fresh groundwater
- Limited capacity to store fresh groundwater
- Sharp contrasts in climate within each island
- Sharp contrasts in geology and hydrology within each island



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Hawaii Included in USGS National Groundwater Assessments Since Early 20th Century

1923 – Described large production from Honolulu basalt aquifers

1963 – Described high extraction rate for population size

1978 – Described abundant groundwater, but also problems with seawater intrusion

1980s-90s – USGS Regional Aquifer System Analysis (RASA)

- Access to new computer-based tools: Numerical groundwater modeling, Geographic Information System (GIS)
- Limited to Oahu

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Need for Updated Groundwater Assessment

Lihue basin, eastern Kauai

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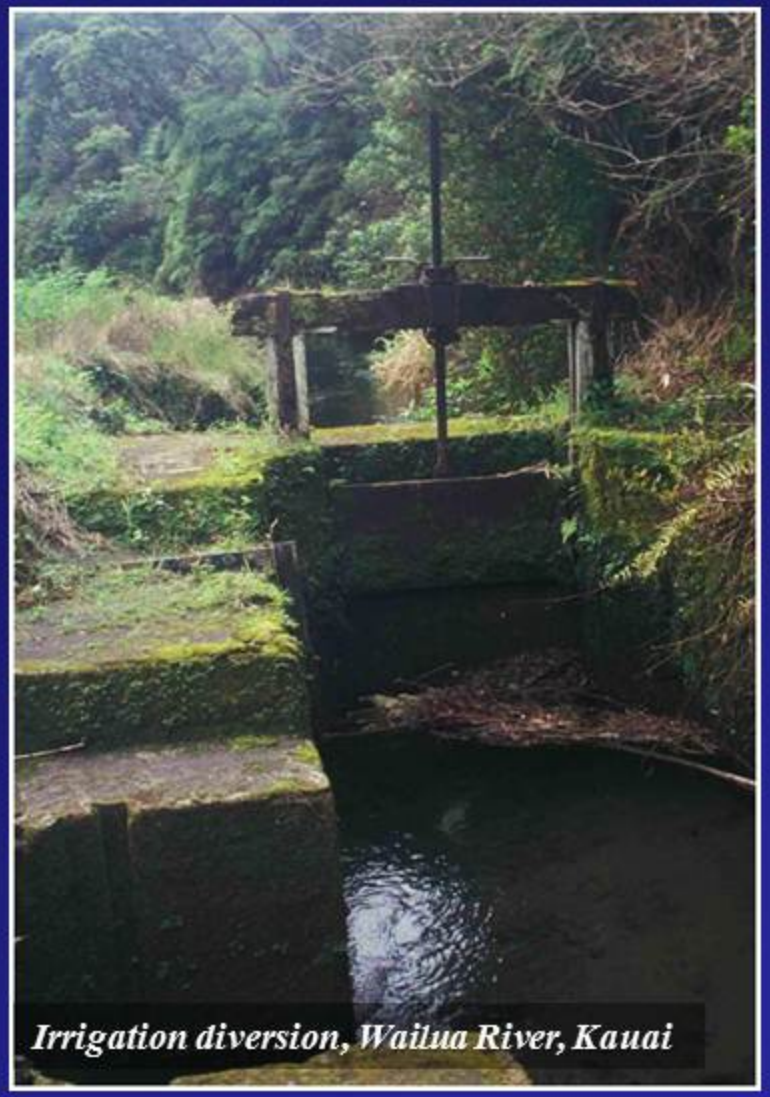
Factors Impacting Groundwater are Changing

- Population growth – 1.11 million in 1990; 1.36 million in 2010
- Land-use changes have altered the groundwater budget
- Climate change effects detected in rainfall and stream base flow records
- Native forests reduced; replaced by invasive plants



Irrigation diversion, Wailua River, Kauai

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Improved Technologies

Groundwater models

Recharge assessment

Geologic & hydrologic surveying

Faster, more powerful computers

Passive seismic survey, northern Oahu

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New Information

New subsurface data

Revised state-wide geologic maps

Revised, higher-resolution rainfall maps

Numerous hydrologic studies since last assessment

- Not all Hawaii aquifers fit conventional concepts

Monitor-well drilling and testing, Lihue, Kauai

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Study Approach
Northwest coast of Maui
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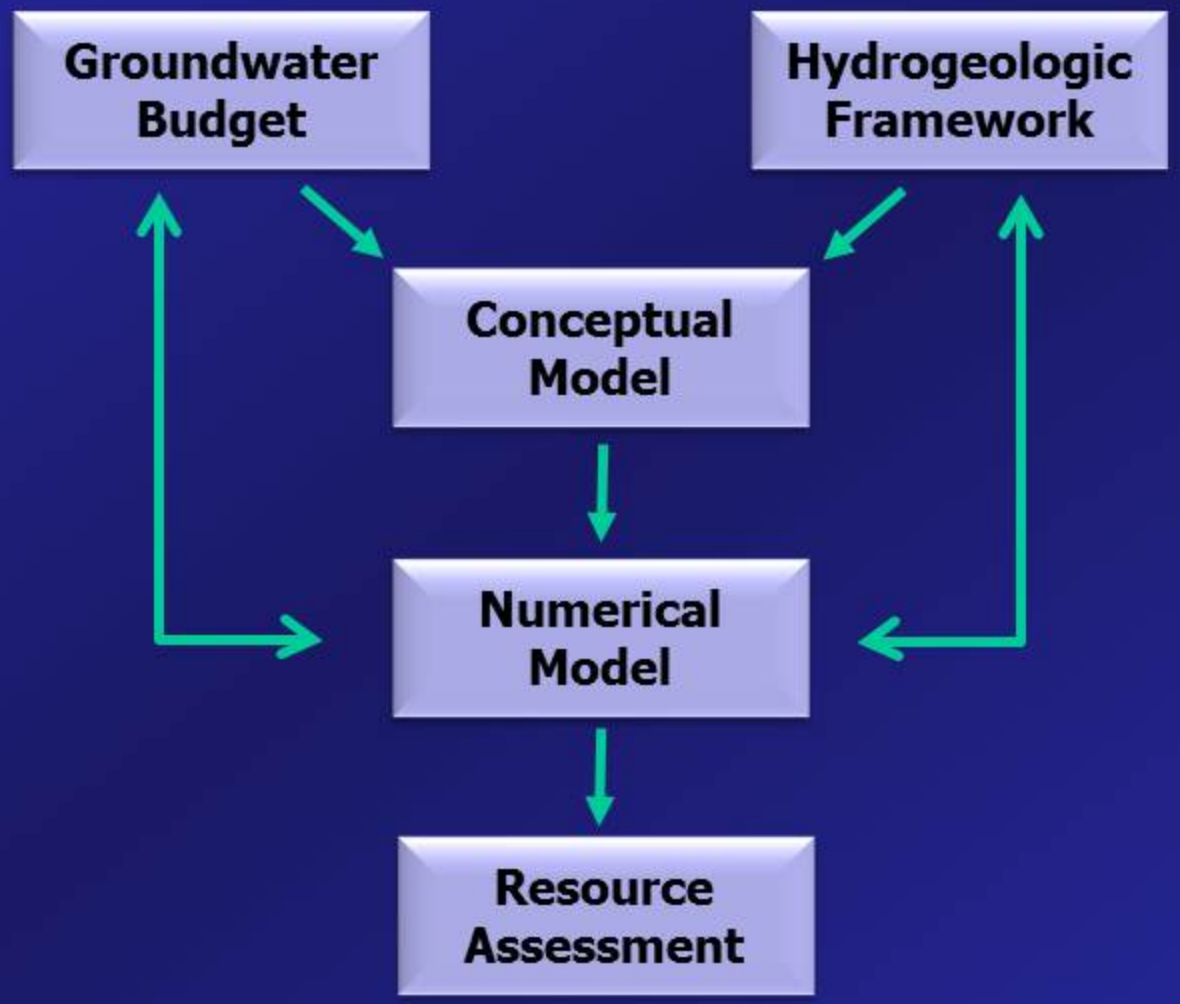
Study Elements



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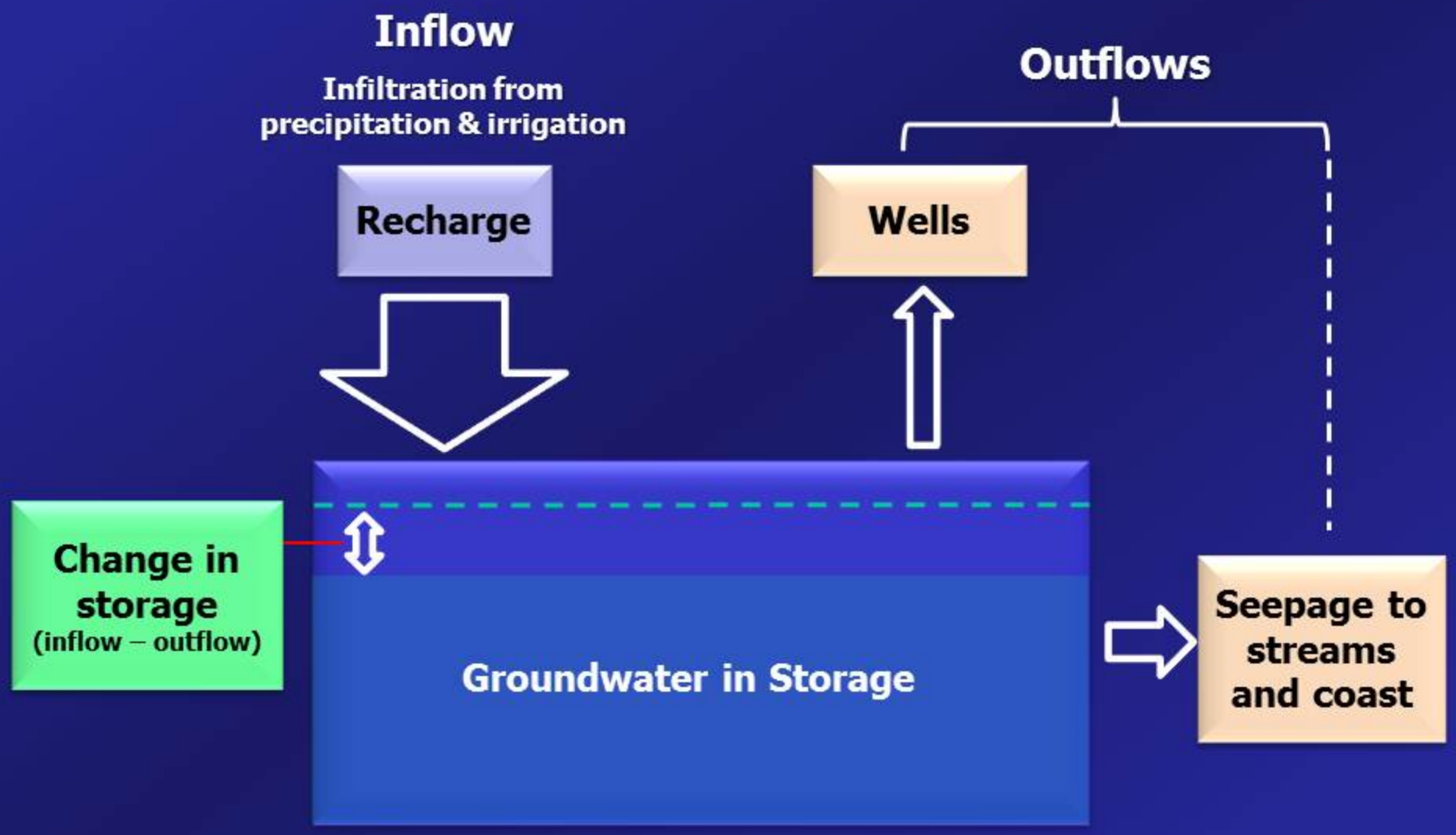
Groundwater Budget



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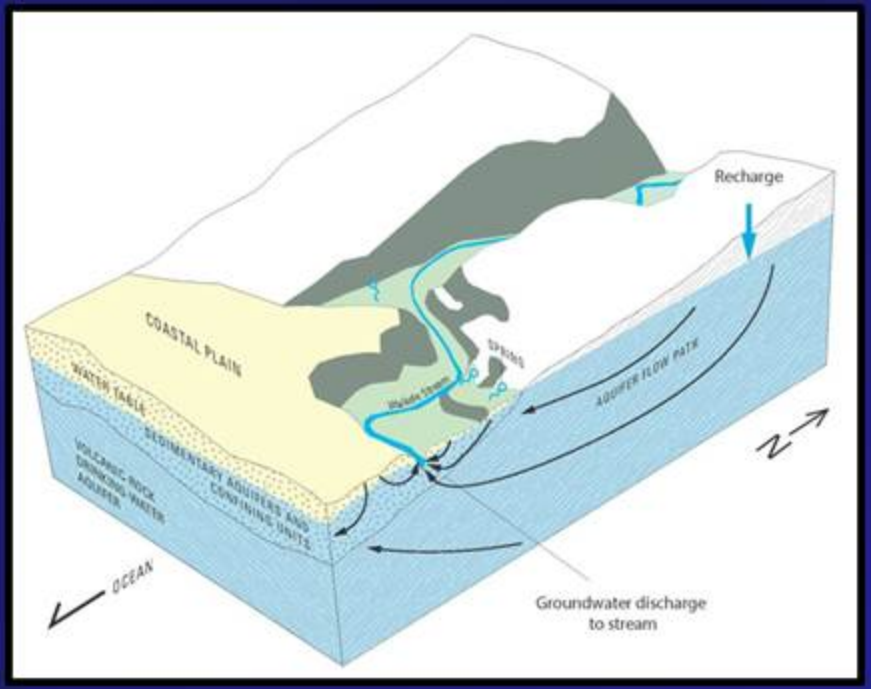
Hydrogeologic Framework and Conceptual Model

Hydrogeologic Framework – 3D distribution of rocks, structures, and hydraulic properties

Conceptual Model – groundwater occurrence and flow in aquifer

Require data on

- Geology
- Water levels
- Aquifer & well performance tests
- Well yields



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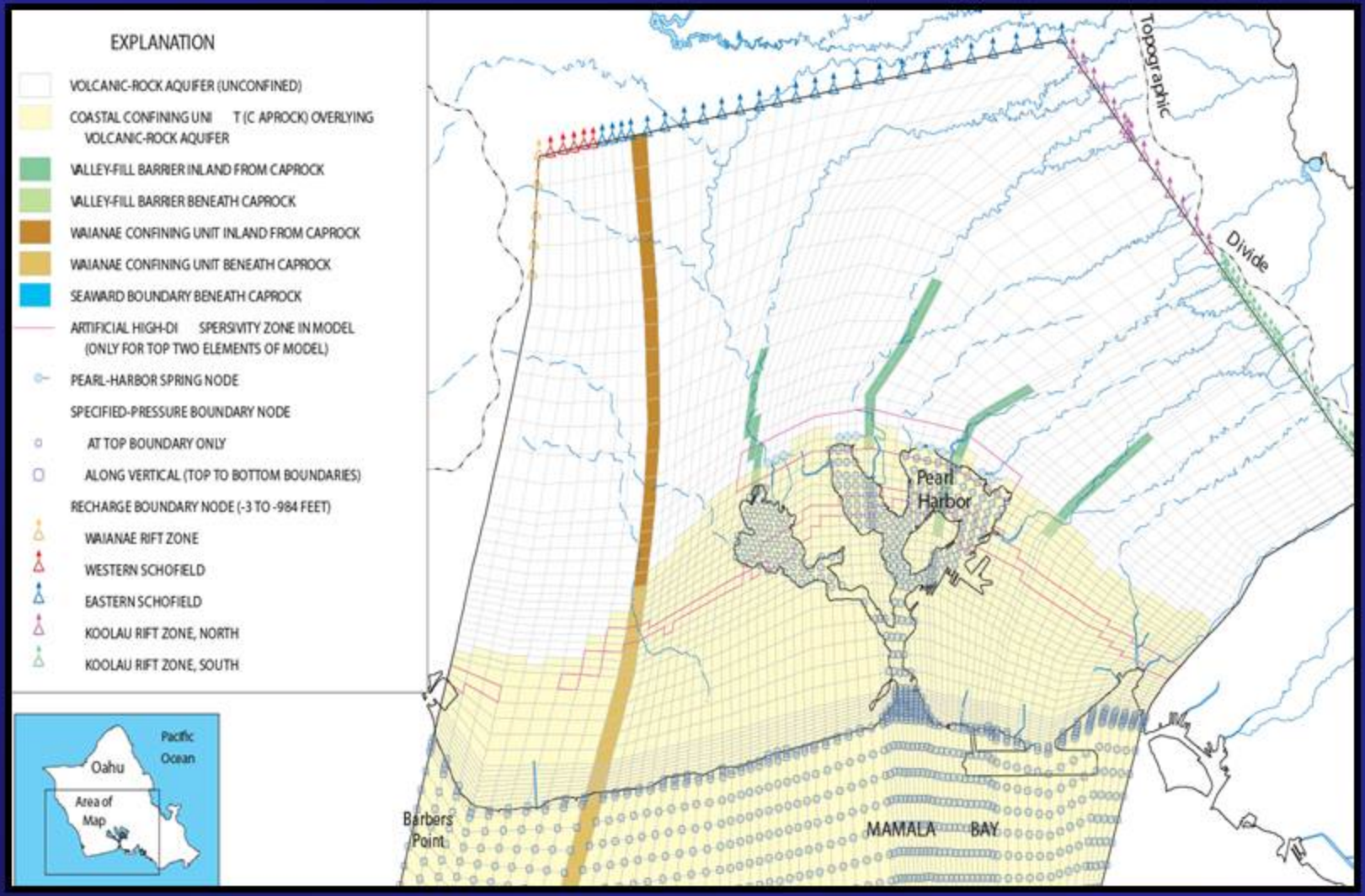
Numerical Groundwater Modeling

Computer Simulation of an Aquifer



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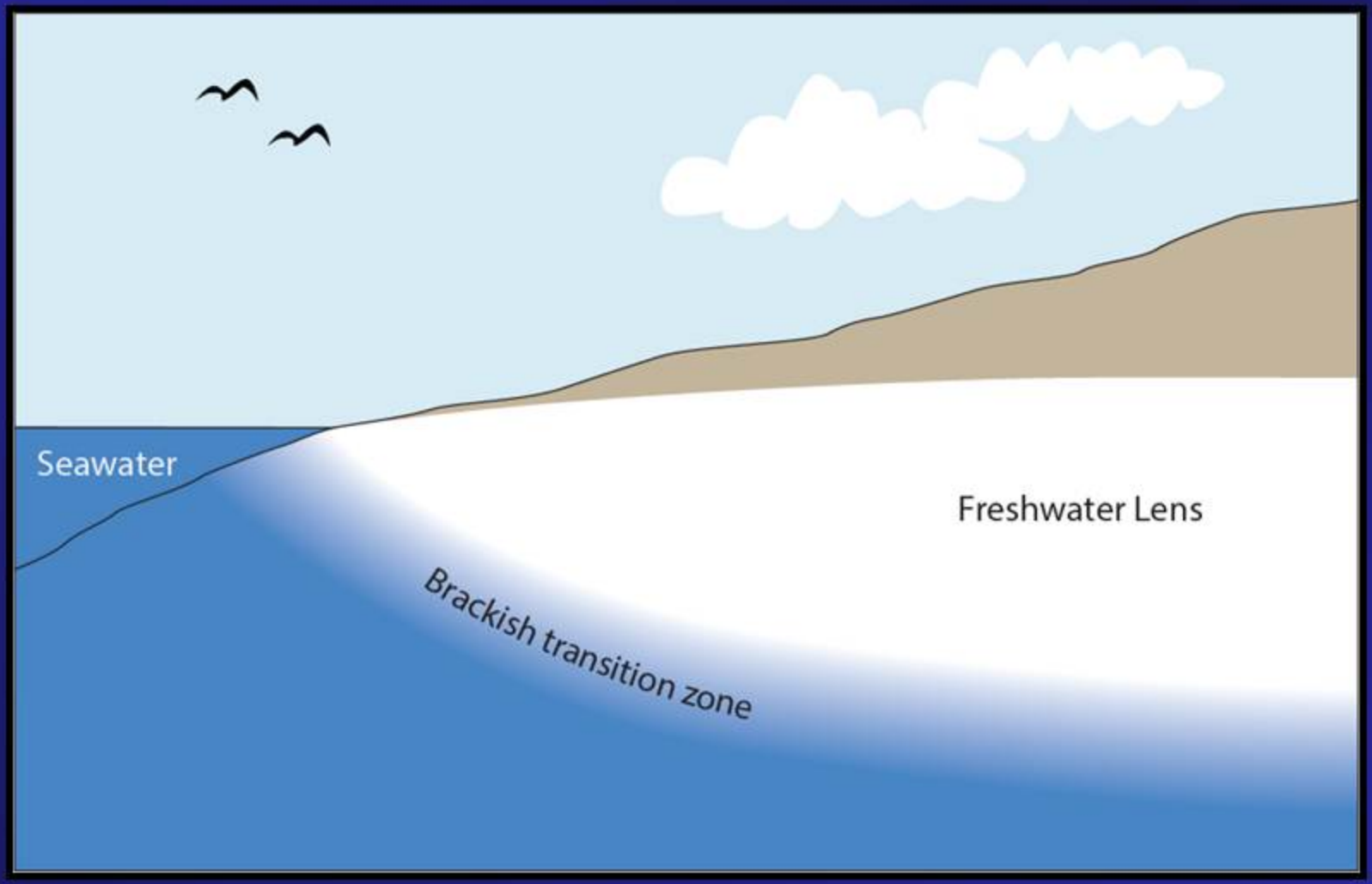
Models Must be Able to Simulate Saltwater-Freshwater Systems



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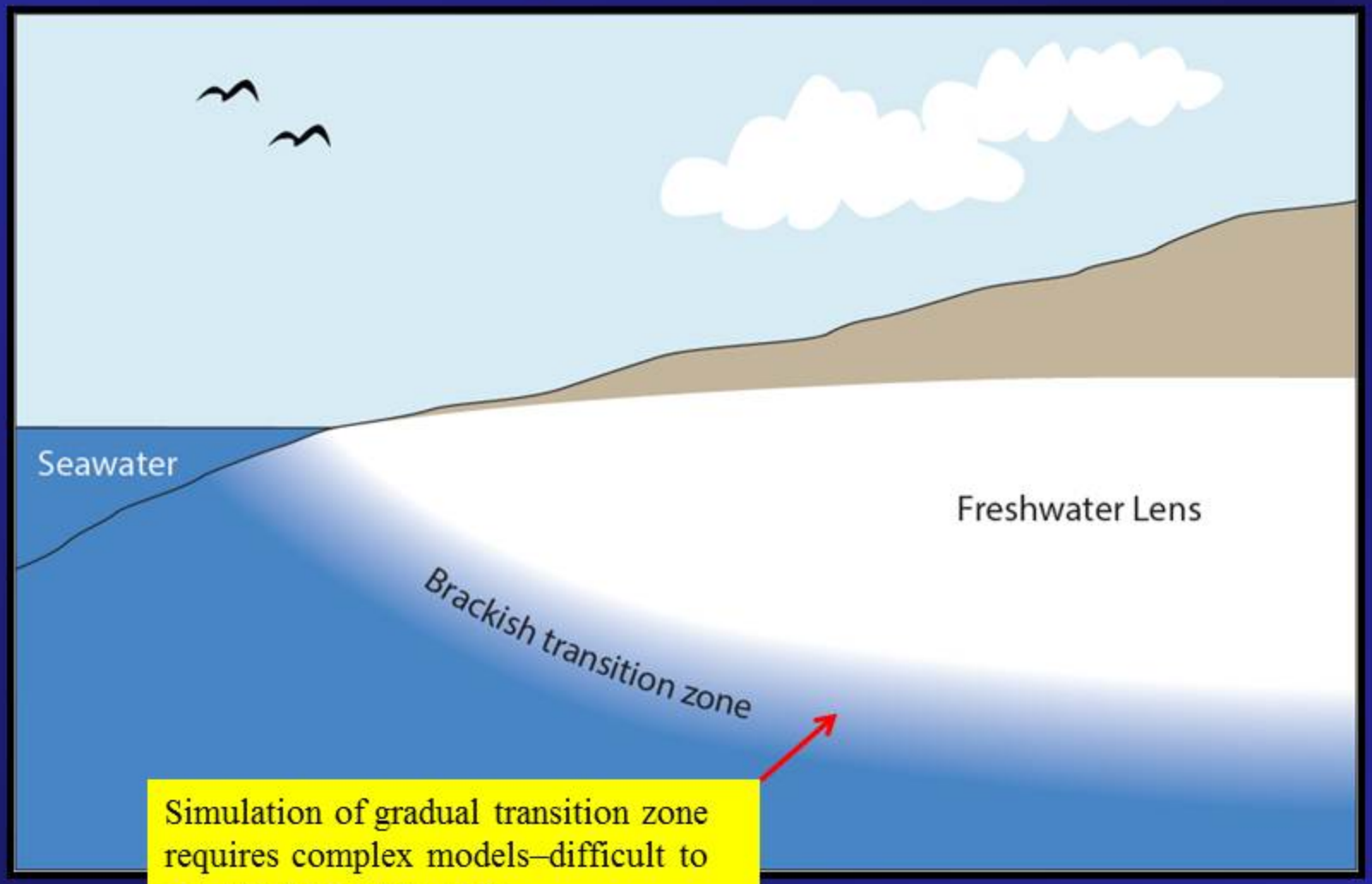
Modeling Transition Zone



Simulation of gradual transition zone requires complex models–difficult to use at island-wide scale

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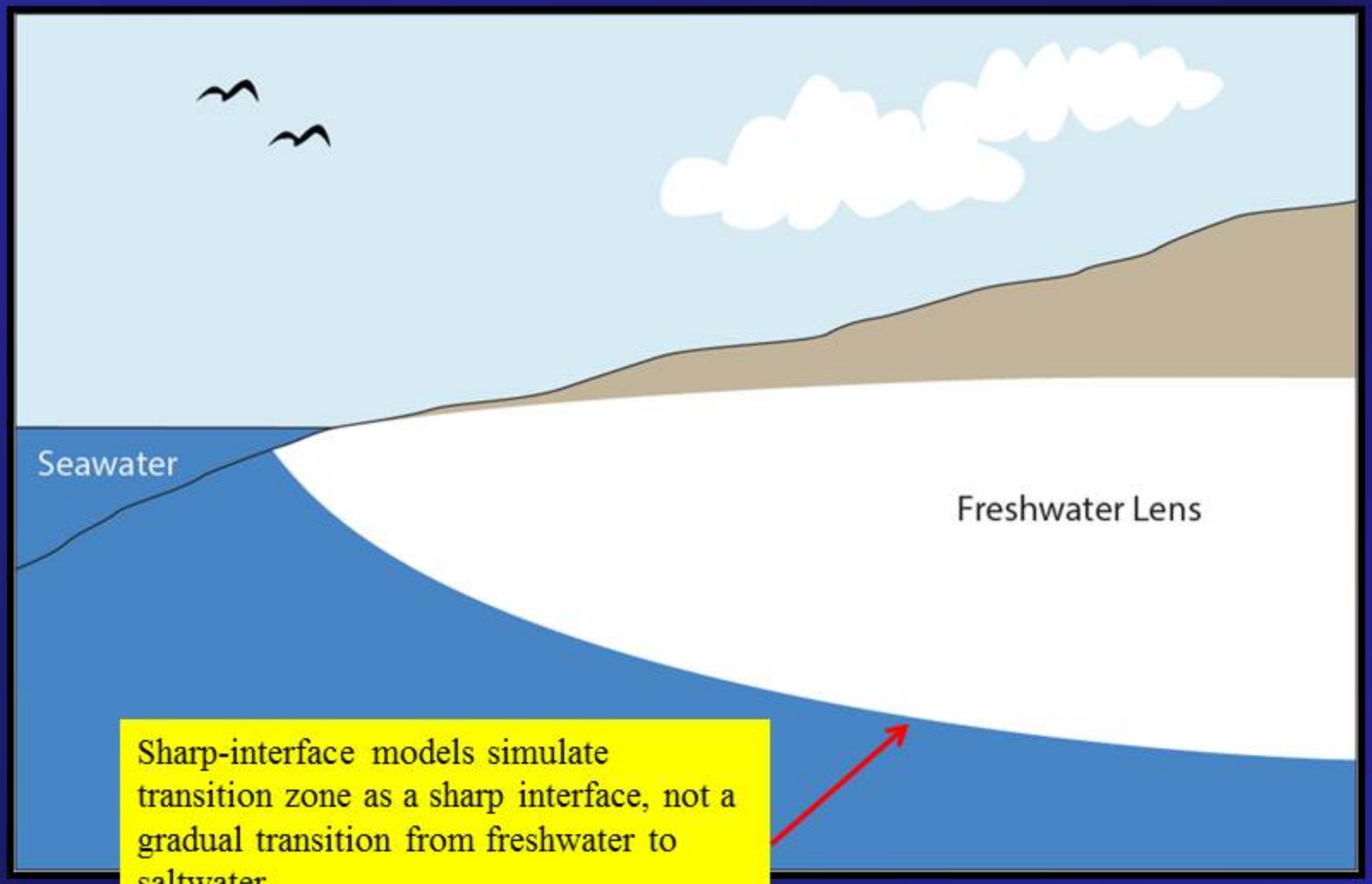
Sharp–Interface Simplification



Sharp-interface models simulate transition zone as a sharp interface, not a gradual transition from freshwater to saltwater.

Easier to create whole-island models.

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Resource Assessment

Sharp-interface models

- Allow whole–island models
- Meet resource assessment objectives

Use models to assess groundwater resources

- Study past, present, future human impacts
- Study effects of climate change

Models can be used to evaluate adequacy of current data network

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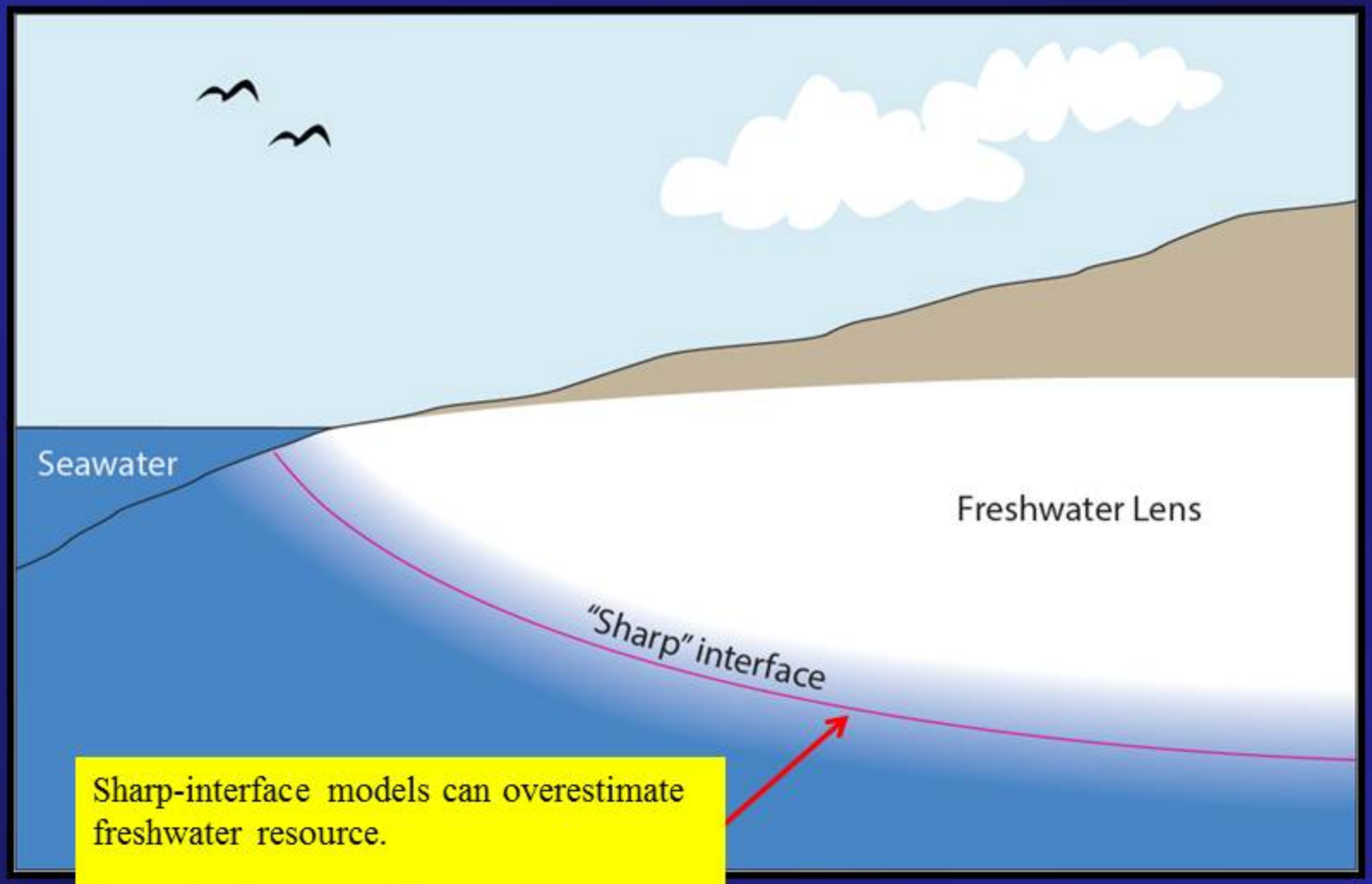
Limitation of Sharp–Interface Models



Sharp-interface models can overestimate freshwater resource.

In critical areas, gradual transition zone must be simulated

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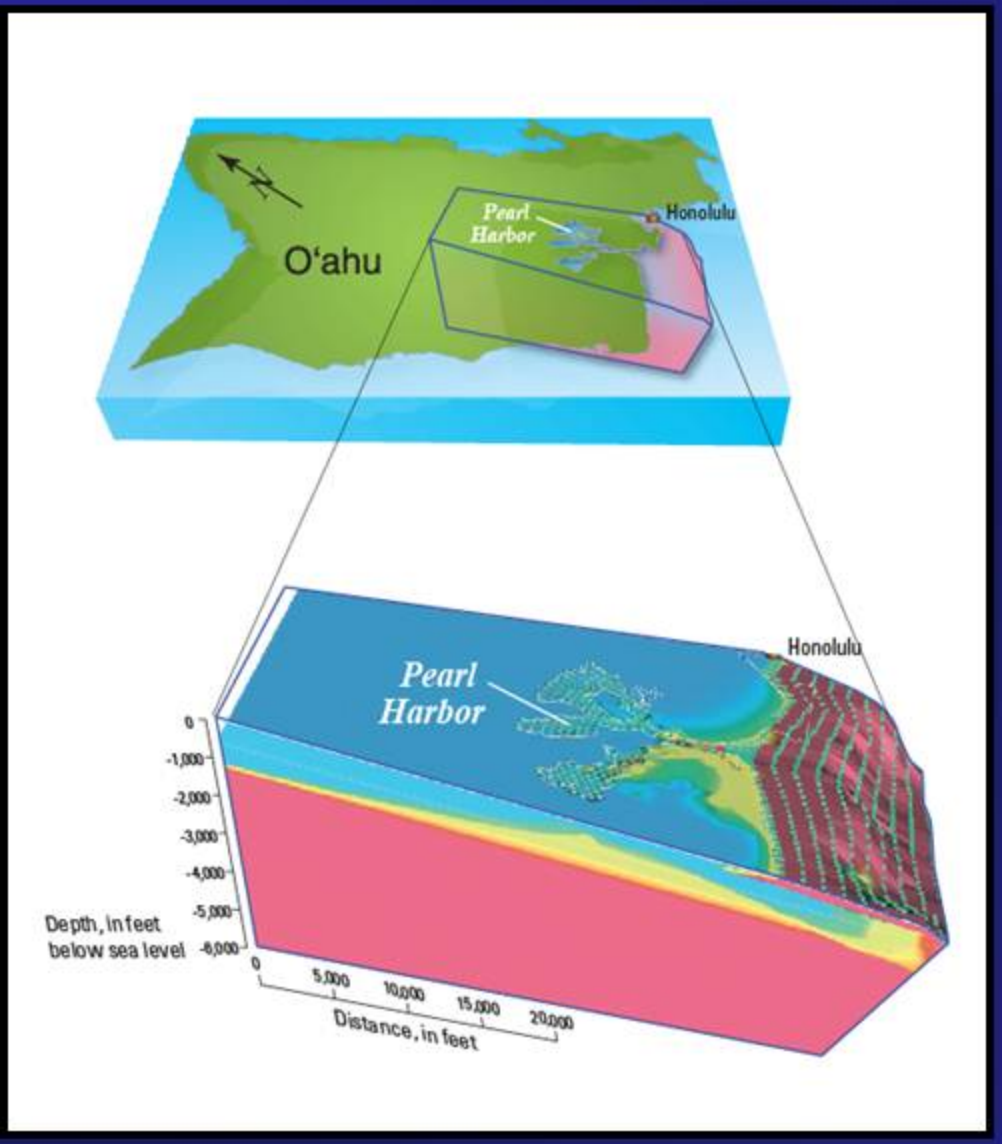
Future use of Models from this Study



Continue to be used as a tool for assessing future conditions at island-wide scales

Provide a hydrogeologic framework in which more complex models can be embedded

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Study Scope

West Maui Volcano, from off Lahaina coast

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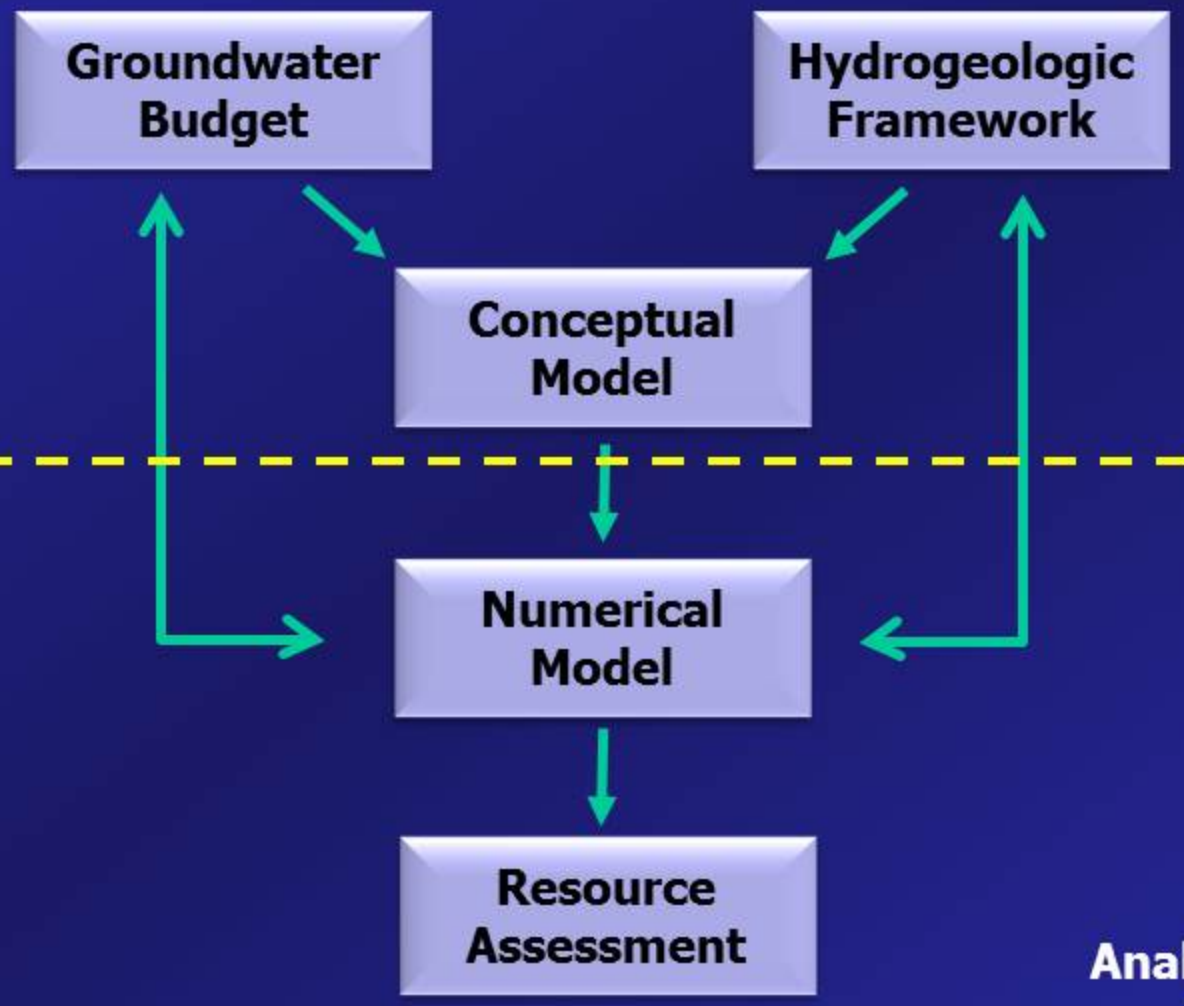
Study Elements



Kauai
Oahu
Maui
Big Island

Kauai
Oahu
Maui

Analysis of future conditions
Oahu only

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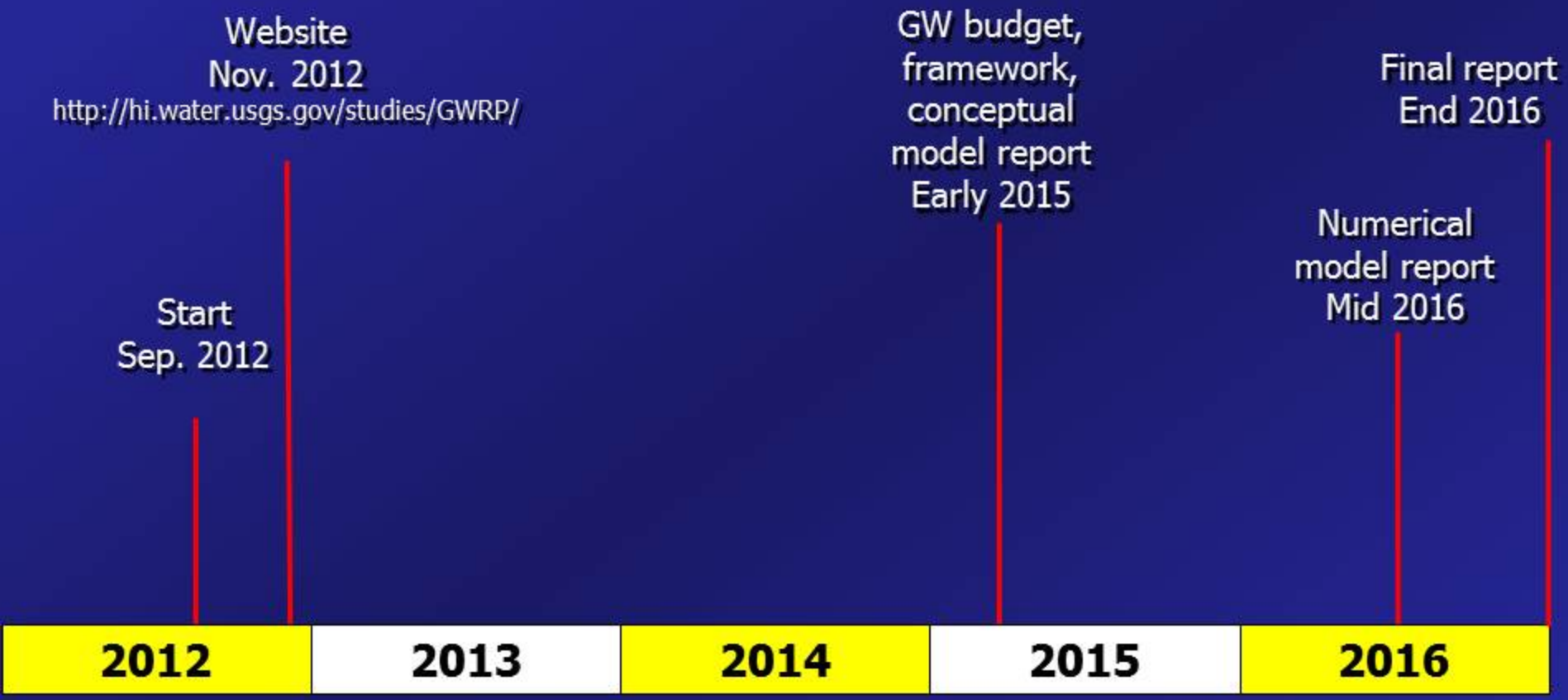
Study Period



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Recap: Hawaii Volcanic Rock Aquifer Study

- Updated assessment of groundwater availability in the Hawaii Volcanic Rock Aquifers
- Objectives: assess current condition, reconstruct the past, provide tools and information for the future
- Fully federally funded by the USGS Groundwater Resources Program
- Uses and complements studies already funded by the USGS Cooperative Water Program

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Fumes from active lava flow, Kilauea, Hawaii