BRACKISH GROUNDWATER TREATMENT

WATER RESILIENCE PORTFOLIO OBJECTIVES

Coastal brackish pump and treat project proposal is consistent with the following water resiliency principles from California's January 2020 draft Water Resiliency Portfolio:

- ✓ **Embrace innovation and new technologies**
- ✓ **Prioritize multi-benefit approaches that meet several needs at once**
- ✓ **Strengthen partnerships with local, federal and tribal governments, water agencies and irrigation districts, and other stakeholders**

BACKGROUND

Traditional approach to managing seawater intrusion:

- ✓ Fill basin from the top with enhanced recharge activities
- ✓ Direct use of surface water to the extent practical
- ✓ Limit pumping to bring basin into balance
- ✓ Despite good efforts, saline intrusion remains a significant problem for basin sustainability

Basin Sustainability Plan

FCGMA recently published Groundwater Sustainability Plan for the Oxnard Plain

Primary objective is to prevent expansion of the basin area impacted by saline water

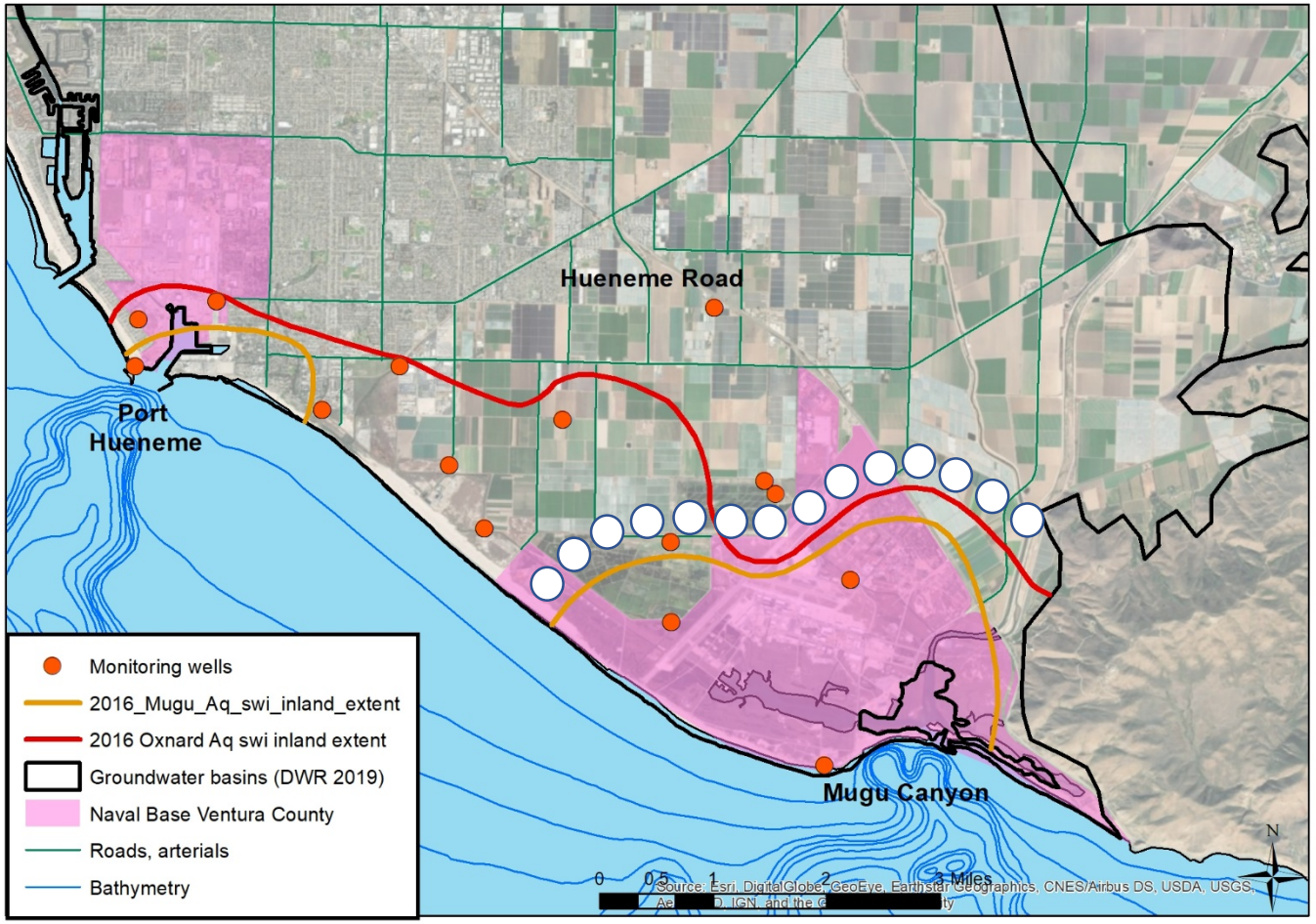
Main proposed mechanism to achieve this is a significant reduction in groundwater pumping

Water Resilience Portfolio Current Nexus

"Capturing precipitation when it comes in increasingly short and intense periods is crucial. This requires finding ways to redirect and store flood flows into aquifers."

"Many users of groundwater must reduce their demand, recharge aquifers, or both in order to bring groundwater basins into sustainable conditions…"

Injection Barrier Concept



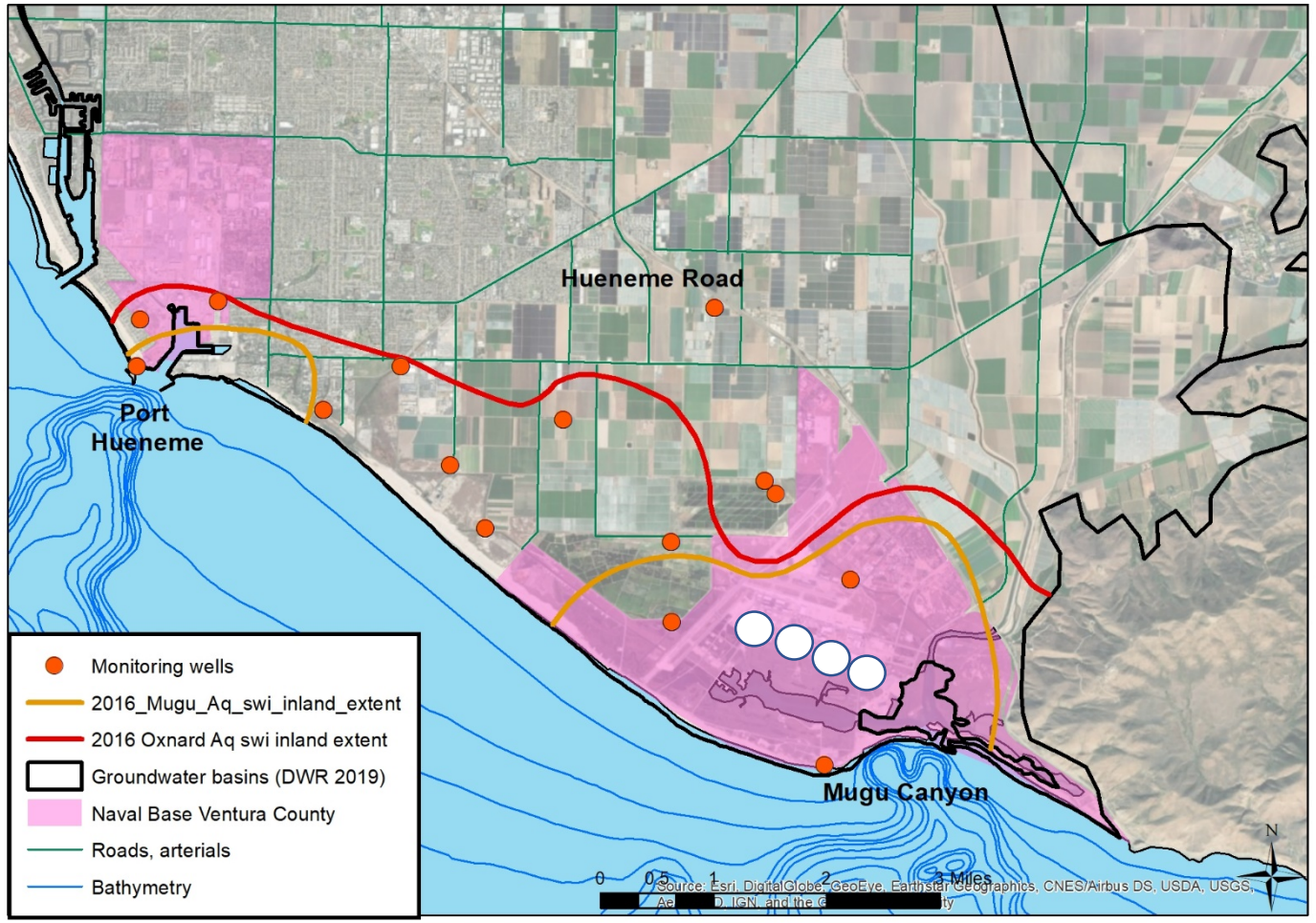
Surround areas of degraded water quality with a dense array of injection wells

Inject enough water to create a groundwater ridge/divide to prevent further intrusion

Difficult to site, hard to confirm that an effective barrier is being maintained

What water might be used?

Extraction Barrier Concept



Use coastal extraction wells to create groundwater depression, water flows towards wells from all directions

If extraction rates are sufficient, seawater should not advance inland past the wells

Brackish water is treated and put to beneficial use, brine is disposed of

Product water offsets groundwater pumping within the basin

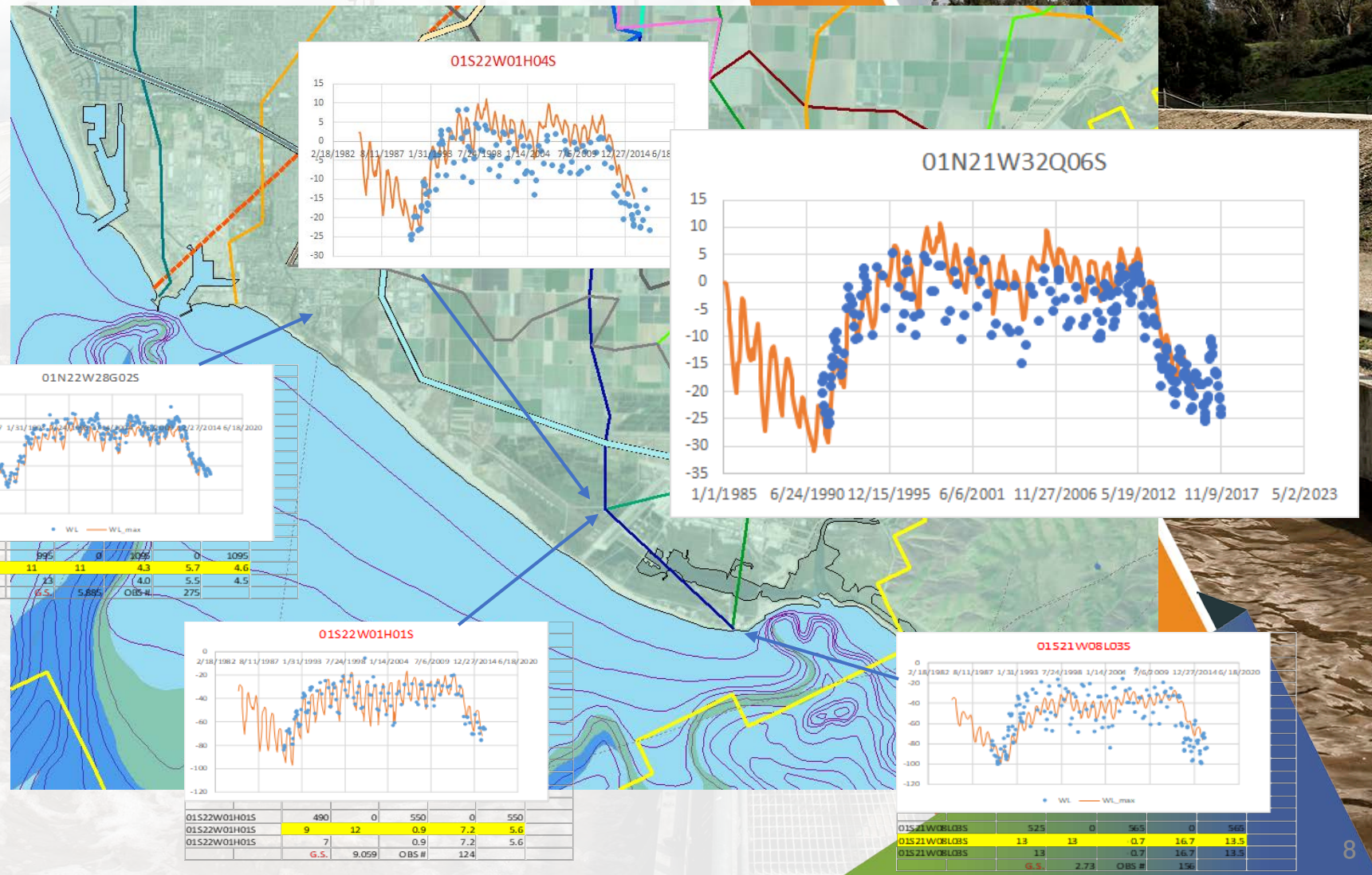
United's Groundwater Flow Model

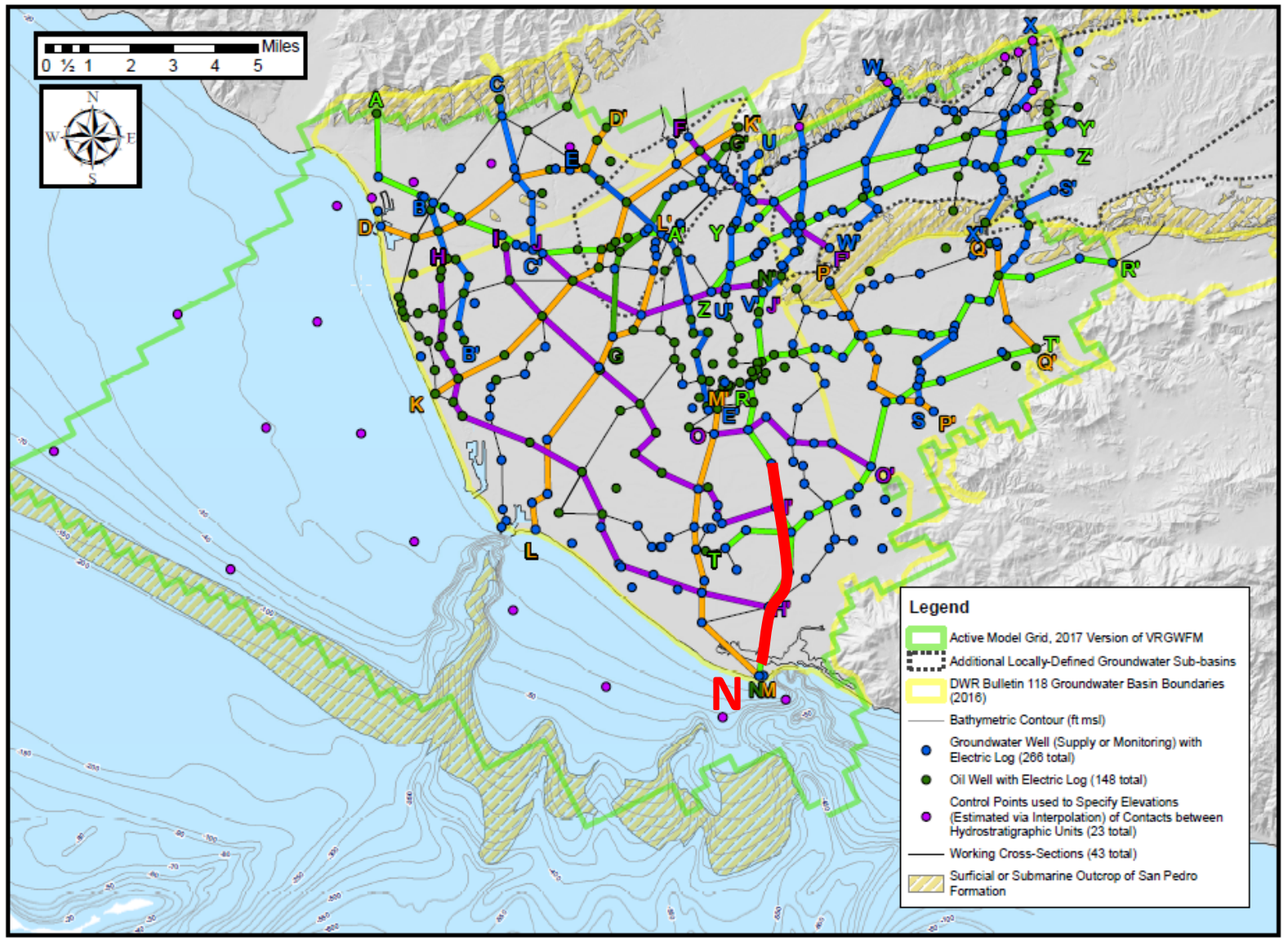
Existing version of the model is well calibrated

Prop 1 grant was offered to improve model in coastal area, simulate seawater density

Refine local geologic mapping, degree of confinement

Run various simulations for scale of project and uses of produce water





Aquifers were mapped as part of the development of United's regional groundwater flow model

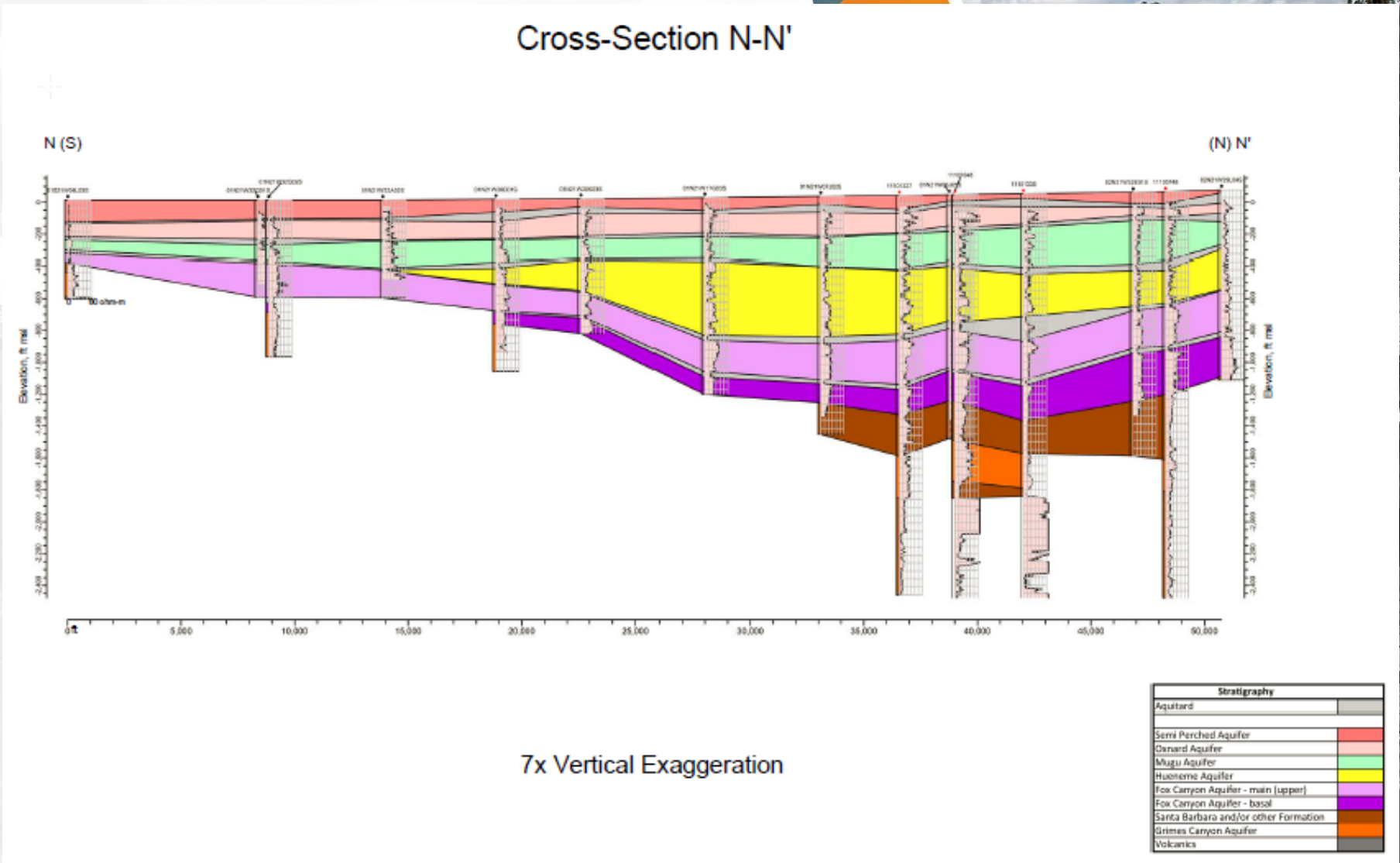
Geologic Cross Section N-N’

Section extends north from Laguna Point (coastal well at left)

Semi-perched aquifer is relatively thick

Oxnard and Mugu aquifers are highly permeable and lie flat

Hueneme aquifer eroded away in the Mugu area, UAS overlies Fox Canyon aquifer

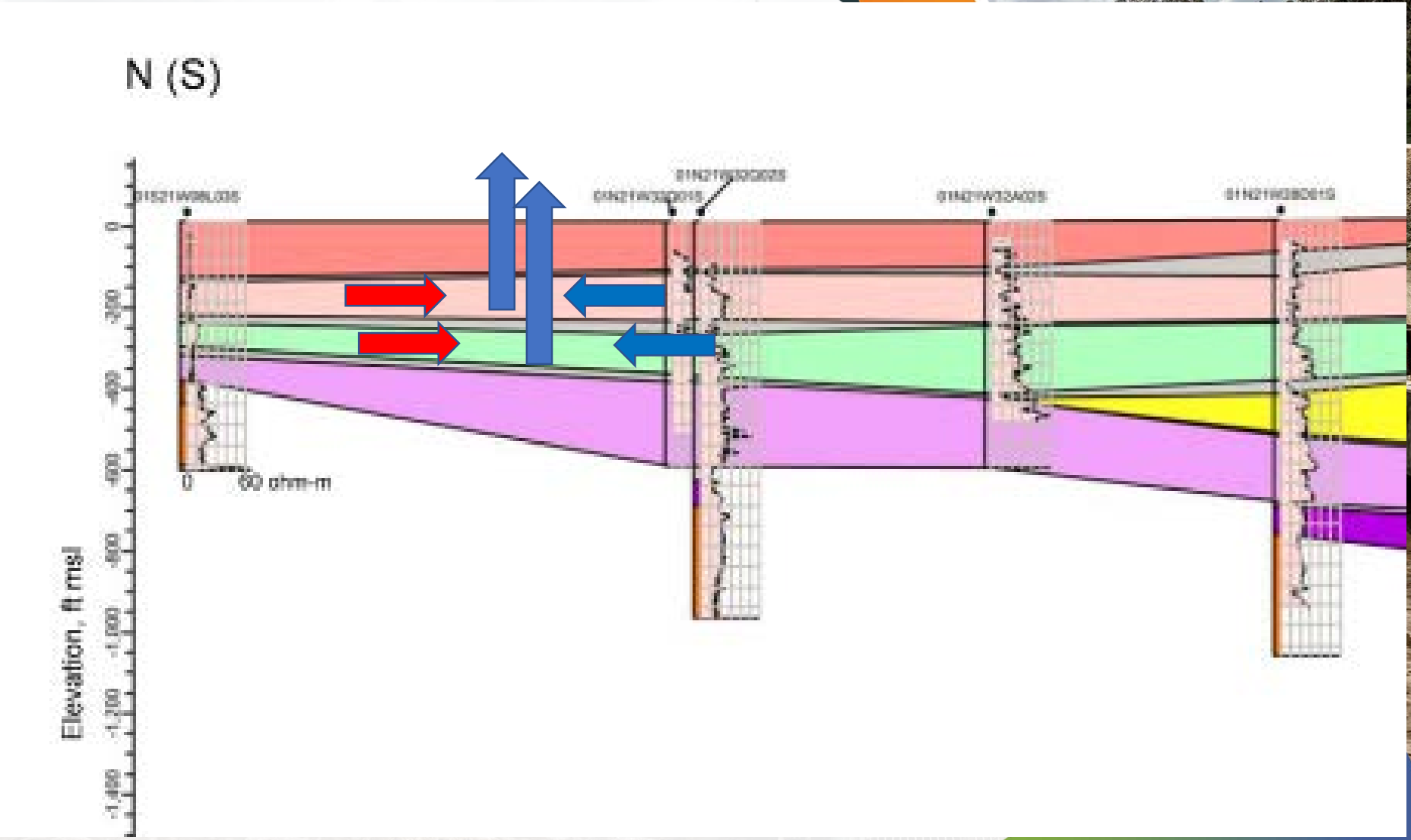


Section N-N’ Detail and Horizontal Flow with Project

Extraction wells induce flow towards coastal zone from inland areas

Also increases the onshore flow of seawater

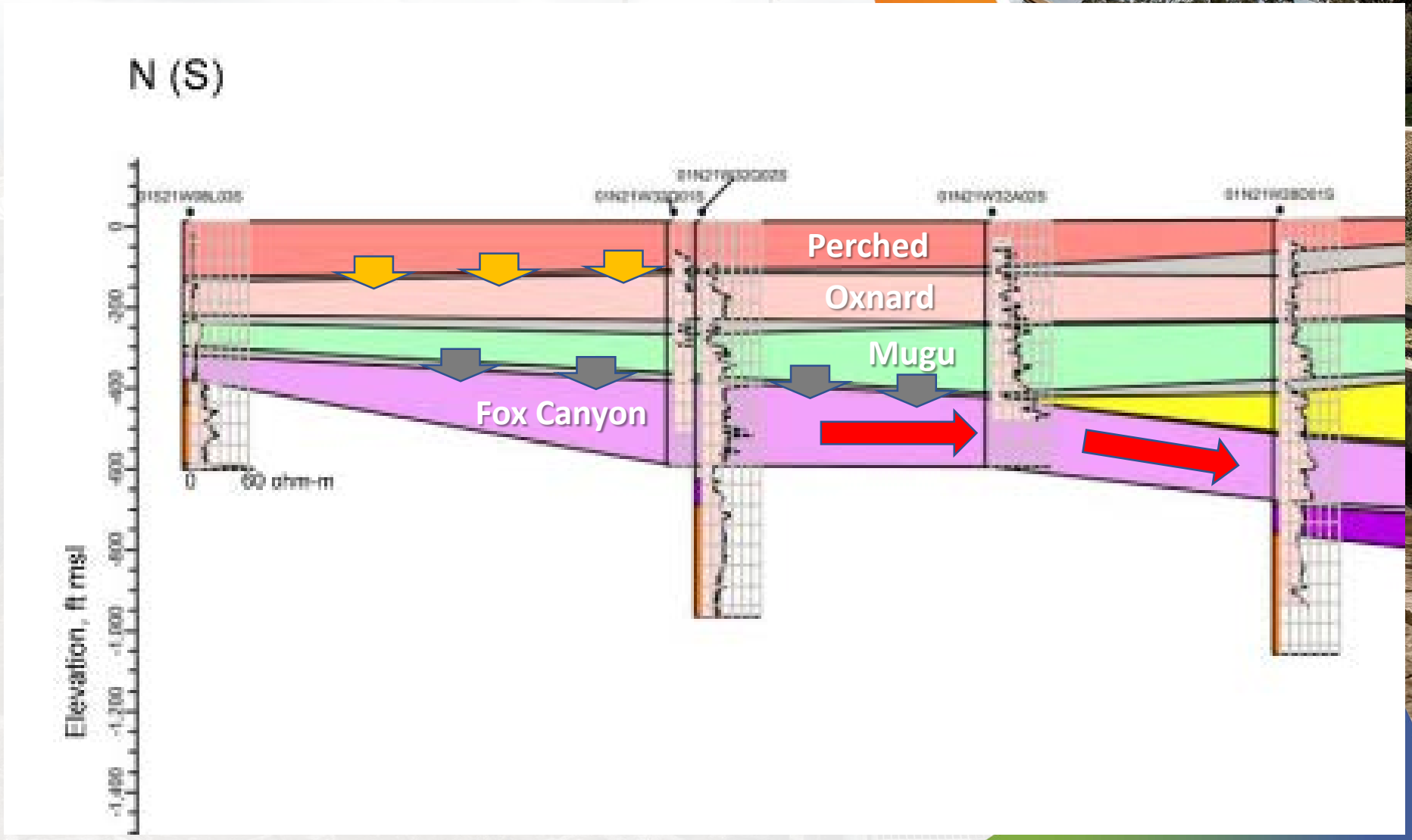
No need for an ocean intake



Section N-N’ Detail and Vertical Flow with Project

Must assess potential for inducing flow down from the Semi-perched aquifer

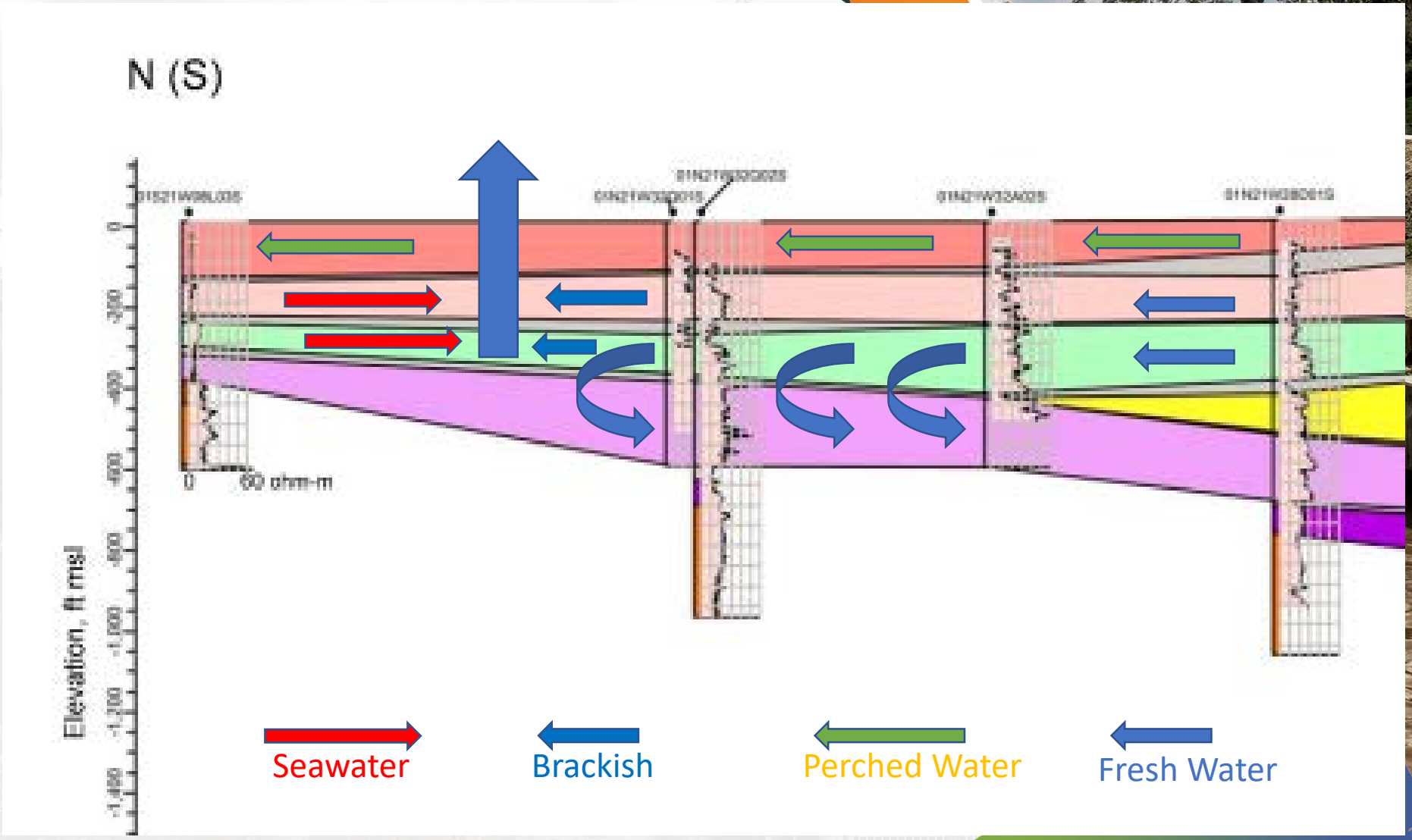
Model will also assess flow from Mugu aquifer to the underlying Fox Canyon aquifer, where downward gradient exists



Section N-N’ Detail and Conceptual Project Optimal Flow

Model pumping rates in Oxnard aquifer that avoid significant vertical flow down from perched aquifer

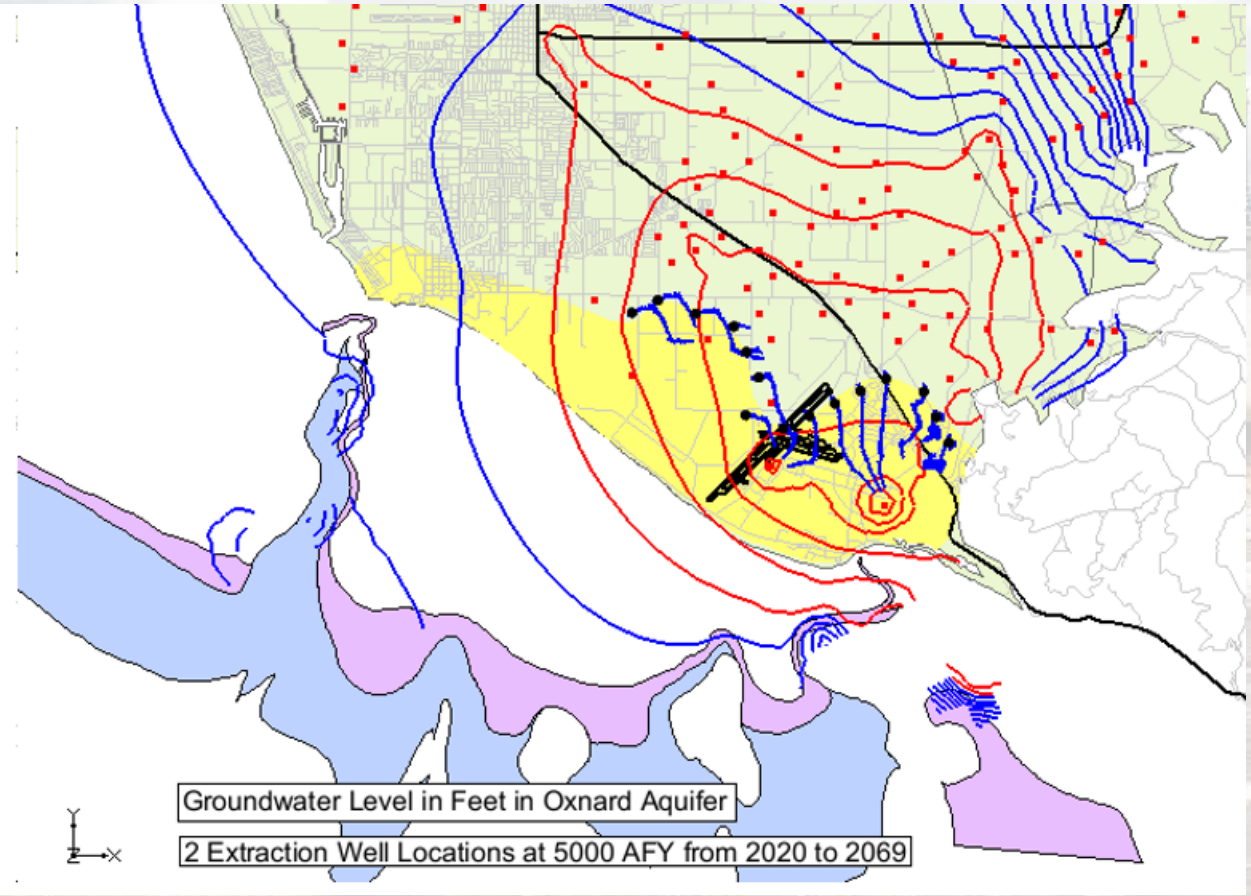
Model Mugu aquifer pumping rates to draw, over time, fresh water over area of mergence with lower aquifers

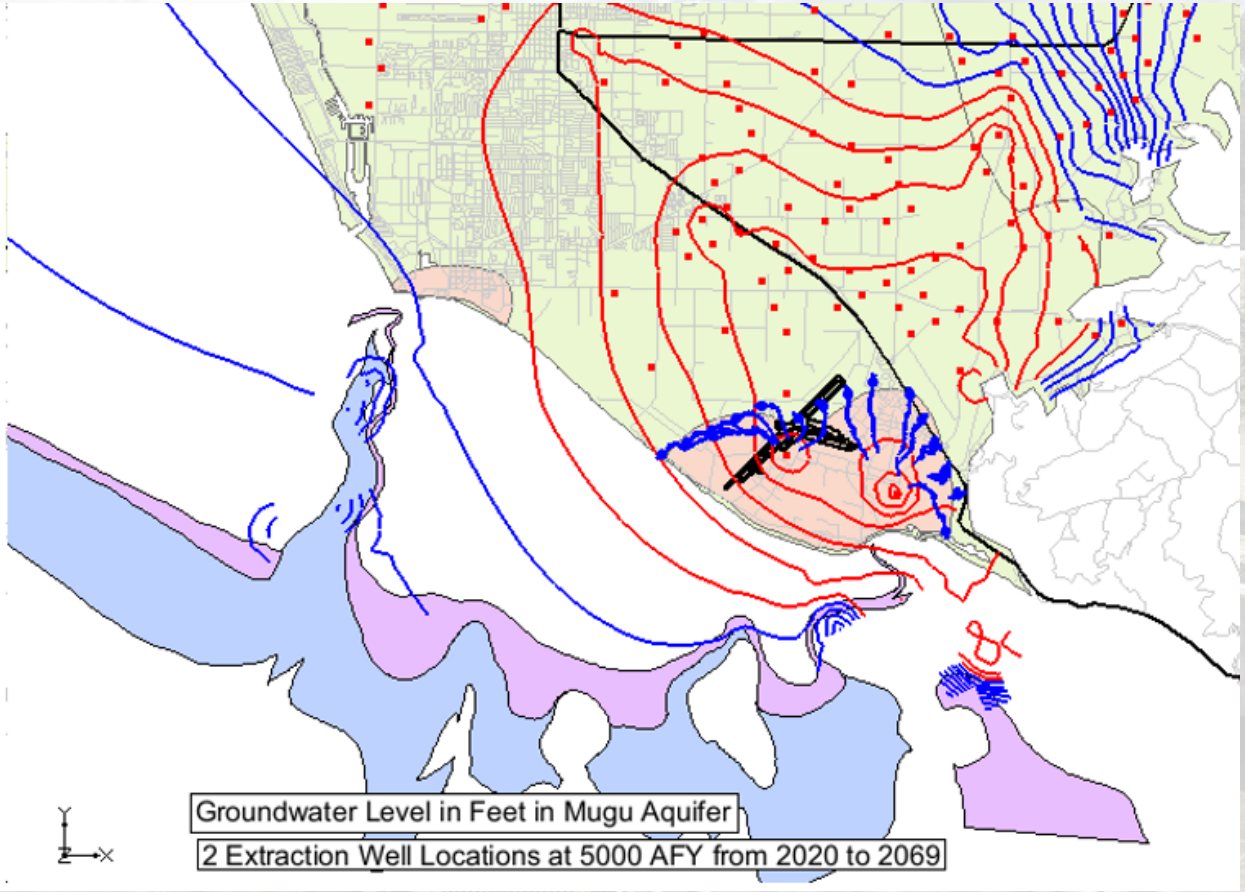


Preliminary Groundwater Modeling

- Extraction Rate: 5,000 acre-ft per year
  - 2,500 AF from Oxnard aquifer
  - 2,500 AF from Mugu aquifer
- This amount of coastal pumping cleans up existing brackish water and prevents new intrusion in Mugu area
- Used FCGMA's GSP baseline scenario:
  - No pumping reductions
  - No projects
  - Extracted water pumped to waste

Particle Tracks, Preliminary Modeling



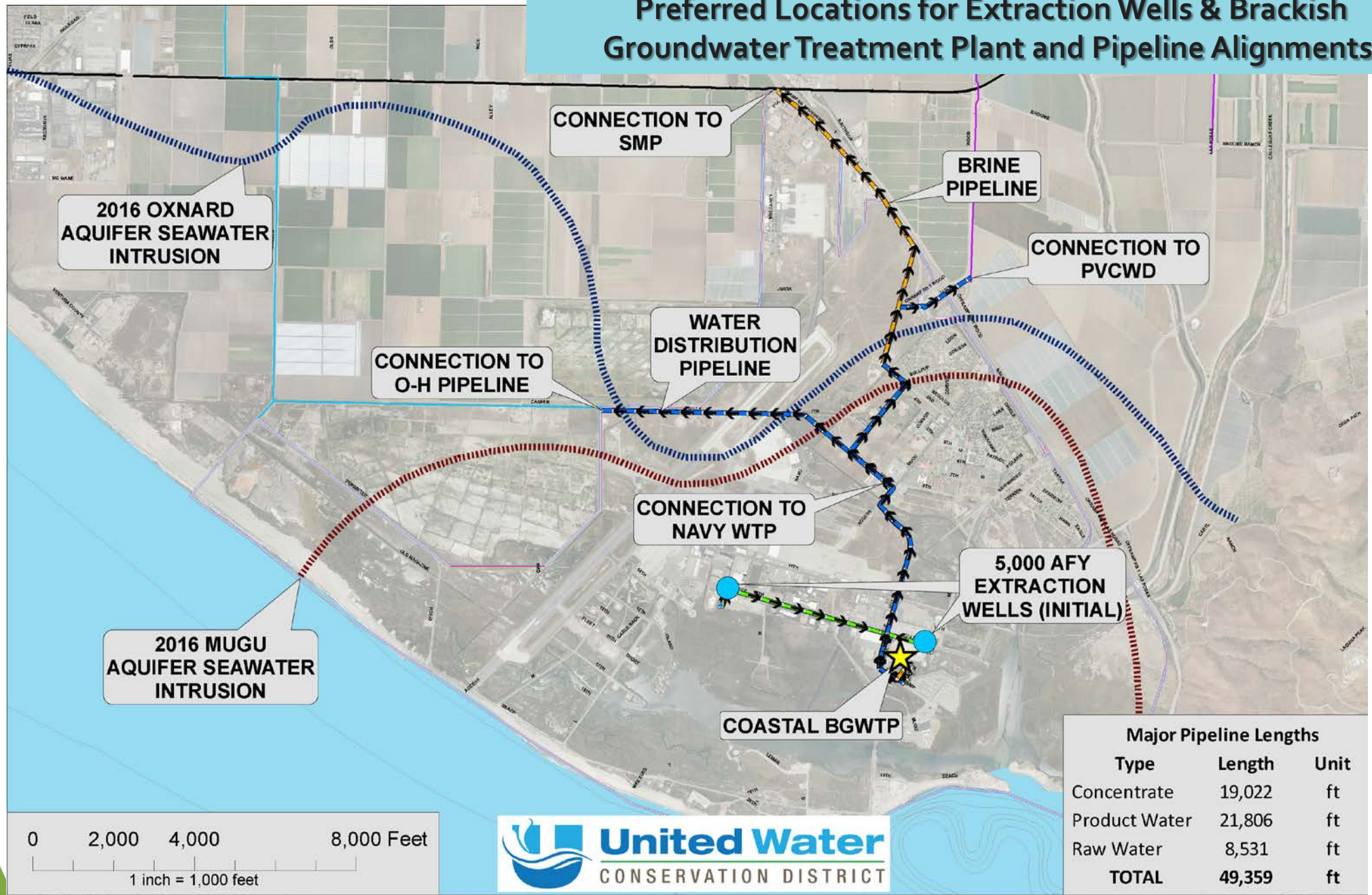


Contour lines: **RED** below sea level, **BLUE** above sea level
Blue lines: Particle tracking paths
Animations in yearly time step from 2020 to 2069

Two well locations with 5,000 AFY
2,500 AFY from Oxnard Aquifer
2,500 AFY from Mugu Aquifer

Engineering Concepts

Preferred Locations for Extraction Wells & Brackish Groundwater Treatment Plant and Pipeline Alignments

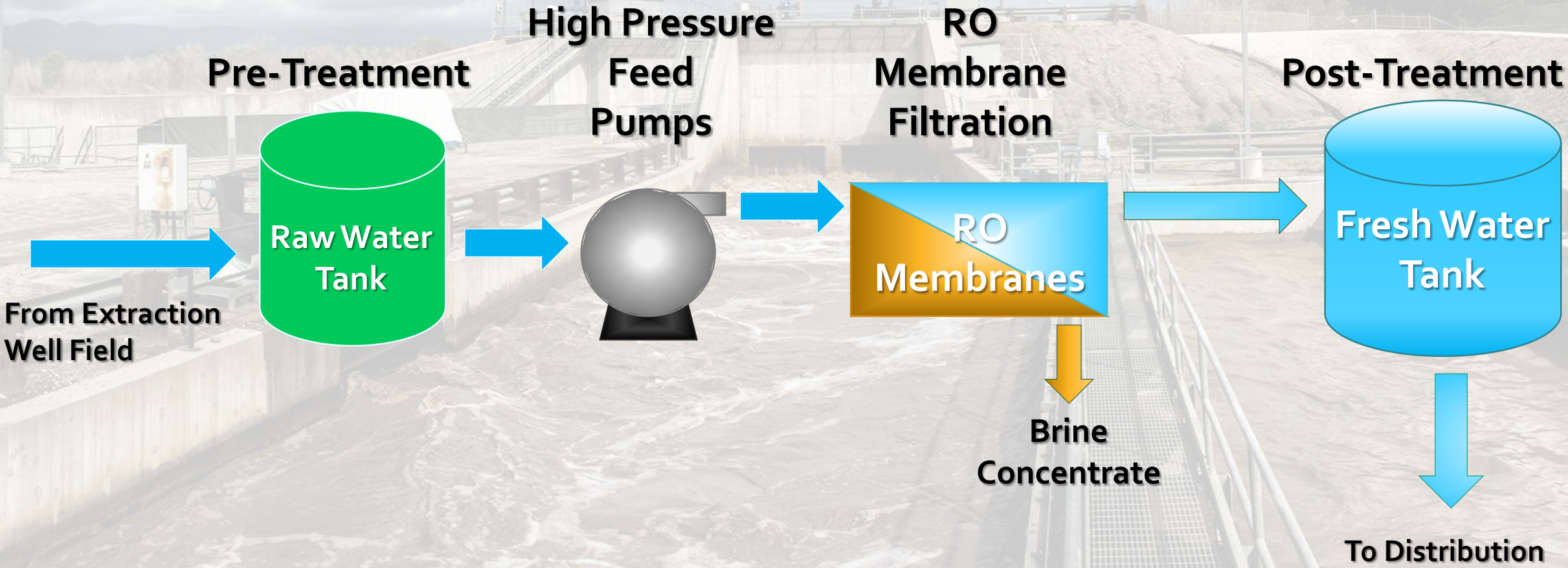


Major Pipeline Lengths

Type	Length	Unit
Concentrate	19,022	ft
Product Water	21,806	ft
Raw Water	8,531	ft
TOTAL	**49,359**	**ft**

Preferred Coastal Brackish Groundwater Treatment Plant Site Layout near Mugu Lagoon (~2.5 acres)

Typical RO Treatment Train



Engineering Design Elements

- Well Field Extraction
  - 5,000 AFY min. (max. to be determined)
- RO Efficiency
  - 70% recovery (initial estimate)
- Brine Disposal
  - Calleguas Salinity Management Pipeline
- Brine Concentrate Management
  - To be evaluated
- Energy Optimization
  - Energy recovery systems to be evaluated

Water Resources Design Elements

- Demonstrate to FCGMA an alternative approach to sustainability on the Oxnard Plain is viable
- Evaluate range of pumping quantities and desired timelines for brackish groundwater recovery and treatment
- Determine who customers will be so basin response to reduced pumping can be simulated
- Identify regulatory requirements, mitigate environmental concerns to the extent practical

YIELD

LIKELY A MINIMUM DIRECT YIELD OF **3,500 AF** PER YEAR

HELPS OPTIMIZE BASIN YIELD, LESS PUMPING CUTS REQUIRED IN INLAND AREAS

BENEFITS

MANAGE CURRENT BRACKISH WATER AND PREVENT FUTURE LANDWARD EXPANSION OF SEAWATER INTRUSION

IMPROVE GROUNDWATER QUALITY IN THE MUGU AREA

PROVIDE A NEW, RELIABLE, HIGH-QUALITY LOCAL WATER SUPPLY

OPERATE A COASTAL DESALINIZATION PLANT WITHOUT OPEN-WATER INTAKES

PROVIDE ALTERNATIVE OR BACKUP WATER SUPPLY FOR THE NAVAL BASE VENTURA COUNTY

PUMPING IN THIS STRATEGIC AREA PROVIDES AN ALTERNATIVE PATH TO BASIN SUSTAINABILITY

CHALLENGES

PRODUCT WATER COST
IDENTIFY CUSTOMERS, DESIGN DISTRIBUTION SYSTEM

COST SHARING AND DETERMINATION OF BENEFITS

PERMITTING AND REGULATORY COMPLIANCE

BRINE DISPOSAL

PARTNERS

United Water
CONSERVATION DISTRICT

SAN NICOLAS ISLAND
POINT MUGU
NAVAL BASE
VENTURA
COUNTY
PORT HUENEME

CITY OF PORT HUENEME
The Friendly City By The Sea

PHWA
PORT HUENEME
WATER AGENCY

AGRICULTURAL
WATER USERS

FOX CANYON GROUNDWATER MANAGEMENT AGENCY
EST. 1982

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

CALLEGUAS
MUNICIPAL WATER
DISTRICT

CALIFORNIA
WATER BOARDS
Los Angeles - R4

COLLABORATIVE OPPORTUNITIES

US NAVY
- *RELIABLE SUPPLY ON BASE*

PORT HUENEME WATER DISTRICT
- *ALTERNATIVE SUPPLY*

CALLEGUAS
- *DIVERSIFY SUPPLY WITHIN SERVICE AREA*

FOX CANYON GMA
- *HELPS ACHIEVE SUSTAINABILITY GOALS*
- *MITIGATE FUTURE SEAWATER INTRUSION RISK*

WATER USERS ON THE SOUTHERN OXNARD PLAIN
- *ALTERNATIVE HIGH-QUALITY WATER SUPPLY*

THE SOLUTION: COLLABORATION

Sustainability	Resilience	Water Quality	GHGs	DACs	Economy-Farms
✓	✓		✓		✓
✓	✓	✓			✓
✓	✓	✓			✓
✓	✓	✓	✓	✓	✓
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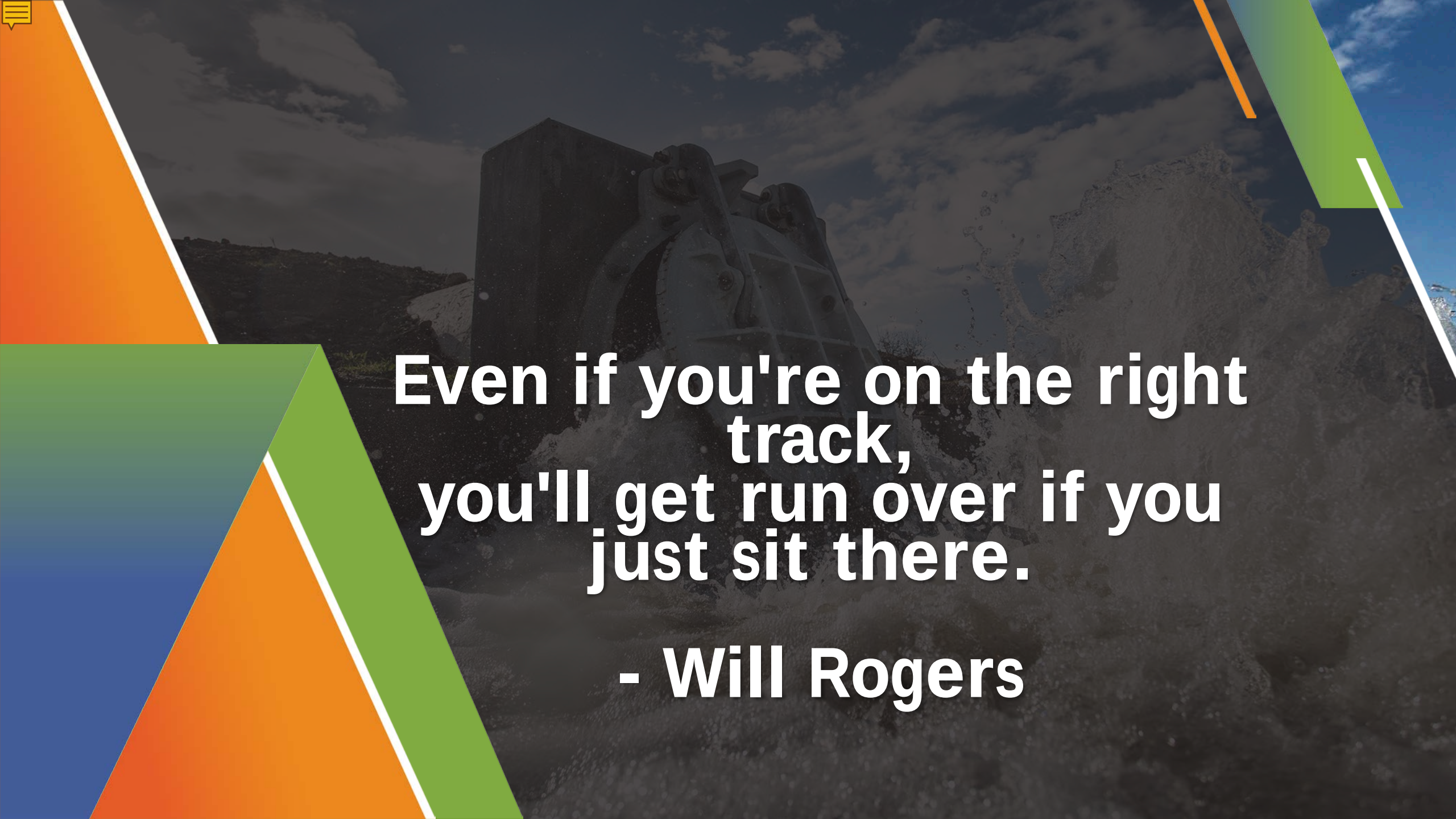
Even if you're on the right track,
you'll get run over if you just sit there.
- Will Rogers