# Impressed Current Cathodic Protection at EBMUD

March 12, 2019 Keith Packard, PE

#### Introduction



#### **Raw Water Supply**

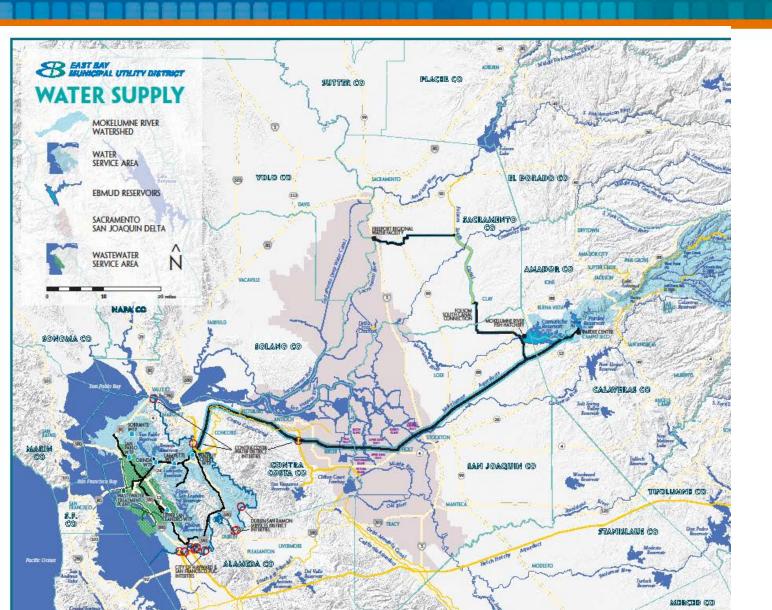
Mokelumne Aqueducts

#### Water in the Service Area

- Treatment
- Storage
- Transmission
- Distribution

# Raw Water Supply





#### Mokelumne Aqueduct – 300 MGD





# Aqueduct No. 1



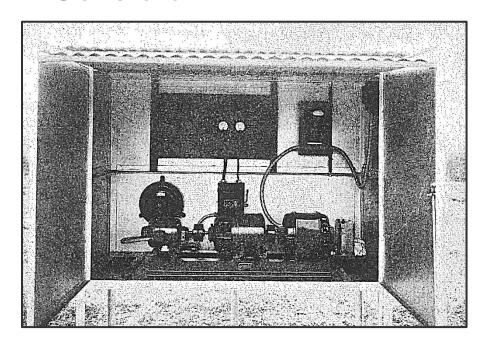
Coating Condition Assessment, 1932



#### Cathodic Protection "Booster"



20 Volt, 50 Amp Motor Generator



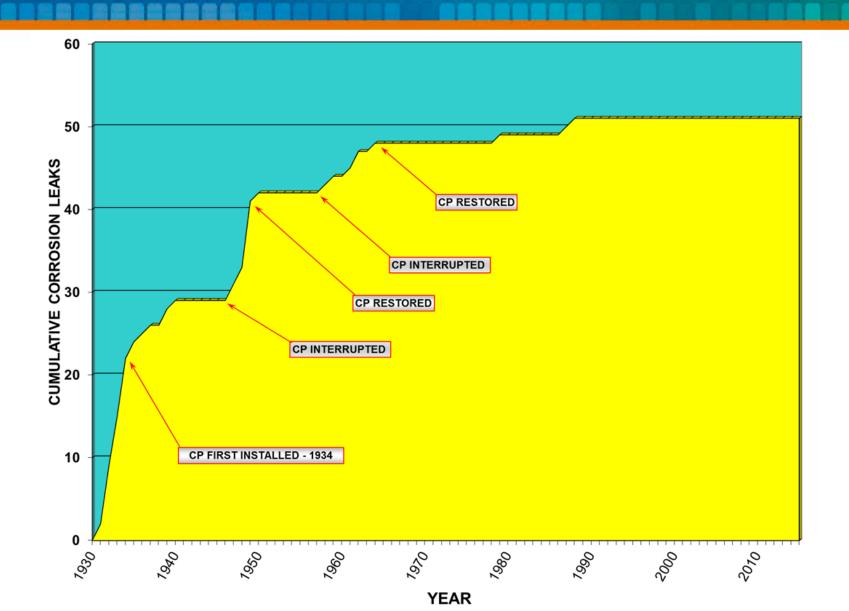
12 CPS in 1937 with 250 Amp Capacity

15 Volt, 12 Amp Vacuum Tube Rectifier



#### Leak History and CP History





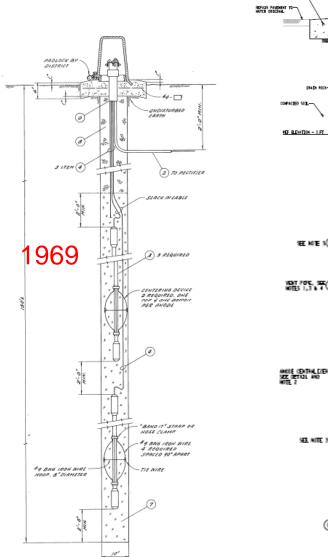
# Mokelumne Aqueduct - ICCP

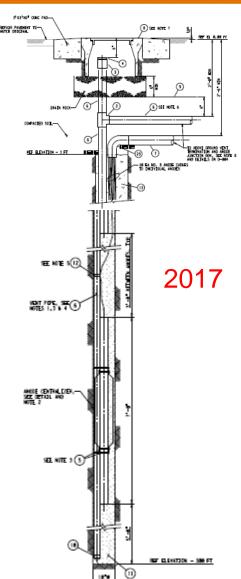


- Design Standardized during the 1990's
- 44 CPS Locations, 2 Mile Interval
- 50 Volt, 50 Amp Rectifier
- 2,100 Amp Capacity with 950 Amp Operating Output
- 300-Foot Deep Anode Well
- 10, 90-pound HSCI Anodes

#### Deep Anode Well









#### Impressed Current C P









50 Volt, 50 Amp Rectifier

90-Pound HSCI Tubular Anodes

Post Mounted AJB

# Rectifier and Negative JB





### **Combined JB into Rectifier**





#### **Rectifier Remote Monitoring**



2019, Installed 2 RMU's

Data Logger and Transmitter

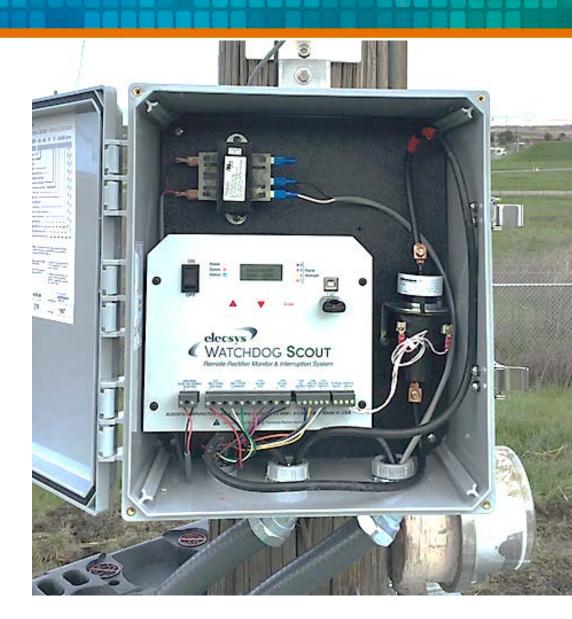
Interruption

Alarms

Smart phone app

Export to GIS

Expand to all 44



#### Service Area



Distribution – 4,000 Miles, 1,300 Miles of Steel (550 Miles Dielectric)

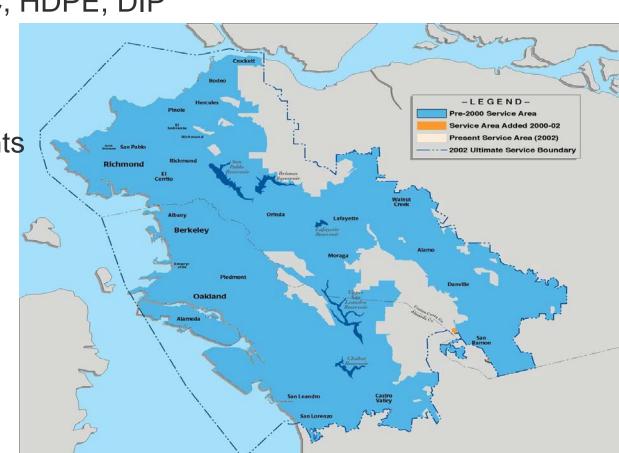
Cast Iron, AC, Steel, PVC, HDPE, DIP

Transmission – 400 Miles

Six Water Treatment Plants

175 Water Storage Reservoirs

69 Steel Tanks



# **Corrosion Control - 1926**



Stray Current from Trolleys

Resistance and Current Measurements

ICCP to "Drain"
Current to
Ground

Trolleys Removed after WW II



#### **Distribution System CPS**



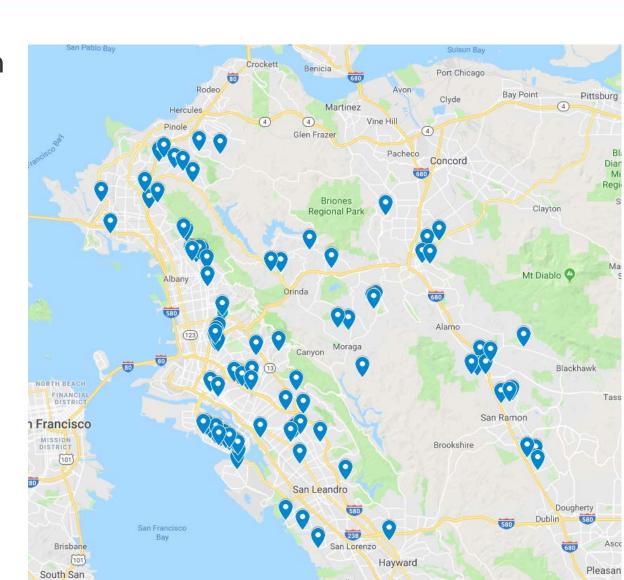
1980's, Many Installed as "Hot-Spot" Protection

110, 20 Volt, 5 Amp below grade rectifiers

Un-metered electrical service

130-foot deep anode wells

30 <u>+</u> of the wells have replaceable anodes



#### **Below Grade Rectifiers**



Transmission 20 Volt, 10 Amp

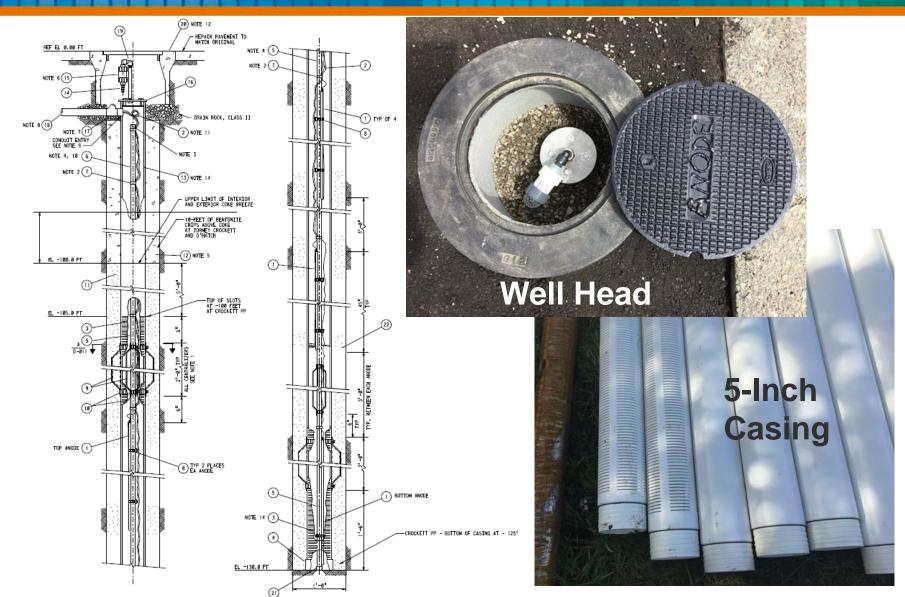






# Replaceable Anode Well District Design





#### Rehabilitate below ground CPS



Evaluate the Pipeline for each CPS
Risk and Consequence of Failure
Pipe Diameter and Pipe Coating
Move to Above Grade Enclosure
PG&E Electric Meter
Rehabilitate 54 of the 110 CPS.



#### **Welded Steel Reservoirs**



September 1996 – Galvanic Anode CP of 32 Reservoirs

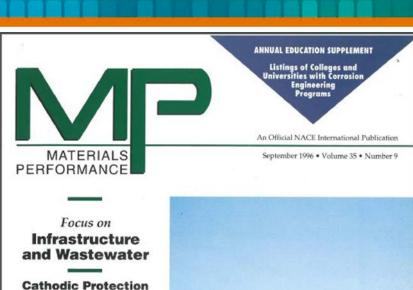
Average Current Density = 0.004 millamps per square foot

High Performance Coatings and Linings

#### Except

Water Resistivity – Up to 18,000 Ohmcm

Reinforced Concrete Floors



of Reservoir Tank Interiors

**MIC** in Wastewater **Plants** 

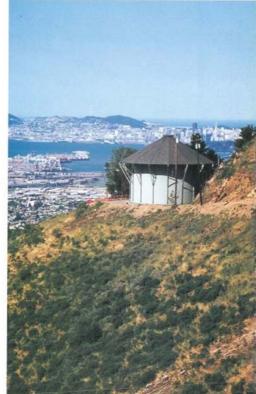
Corrosion in Copper **Tube Systems** 

Also:

Repairs to Marine Structures

Corrosion of Stainless Steels in High Manganese Fresh Water





### Impressed Current C P









#### **EBMUD Infrastructure**



Raw Water Watershed and Transmission

Water Treatment Plants (Filtration)

Surface Water Storage

**Treated Water Storage** 

Transmission Pipelines

**Pumping Plants** 

Distribution Pipelines

Copper Service Laterals

Wastewater Collection and Treatment

Reclaimed Water System

#### Thank you



Phase 13 – Mokelumne Aqueducts Recoating <u>+</u>60 Gully Crossings

