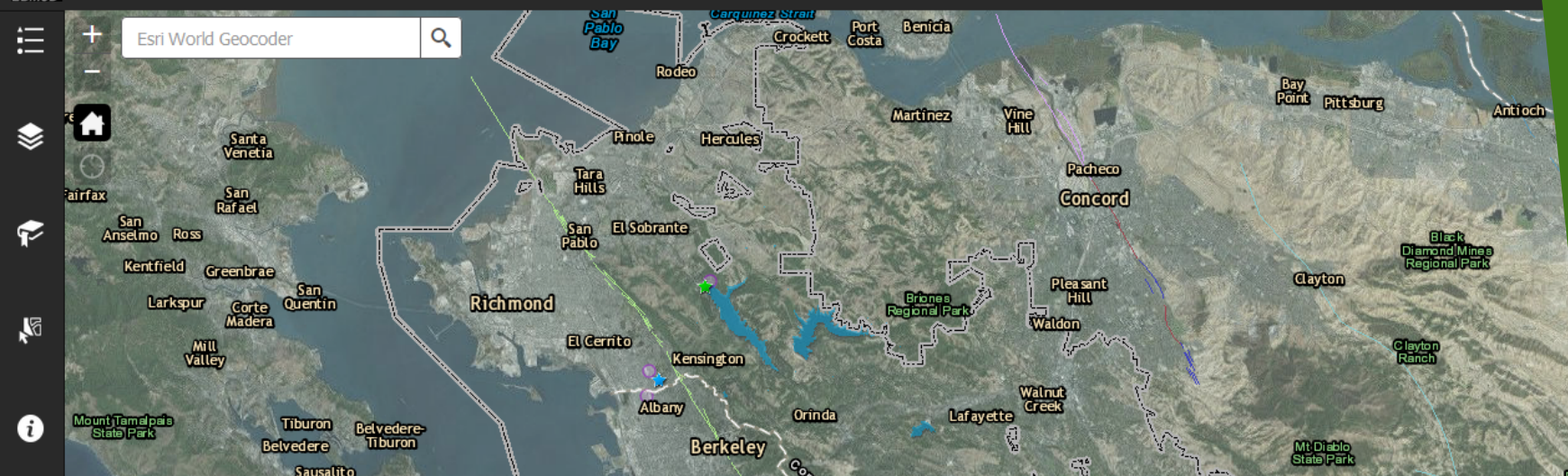




## Dam Safety Monitoring Program



# Dam Safety Monitoring Program Web Mapping Pilot Project

Presenter: Rachel Wong | EBMUD Mapping Services



# Presentation Outline

## **Background**

- EBMUD Water Supply
- District Dam Locations
- Monitoring Dam Safety Challenges

## **Project Goal**

- Objectives

## **Demonstration**

- Dam Safety Monitoring Program

## **Methodologies**

- ArcGIS Online
- d3.js
- Safe Software FME Desktop

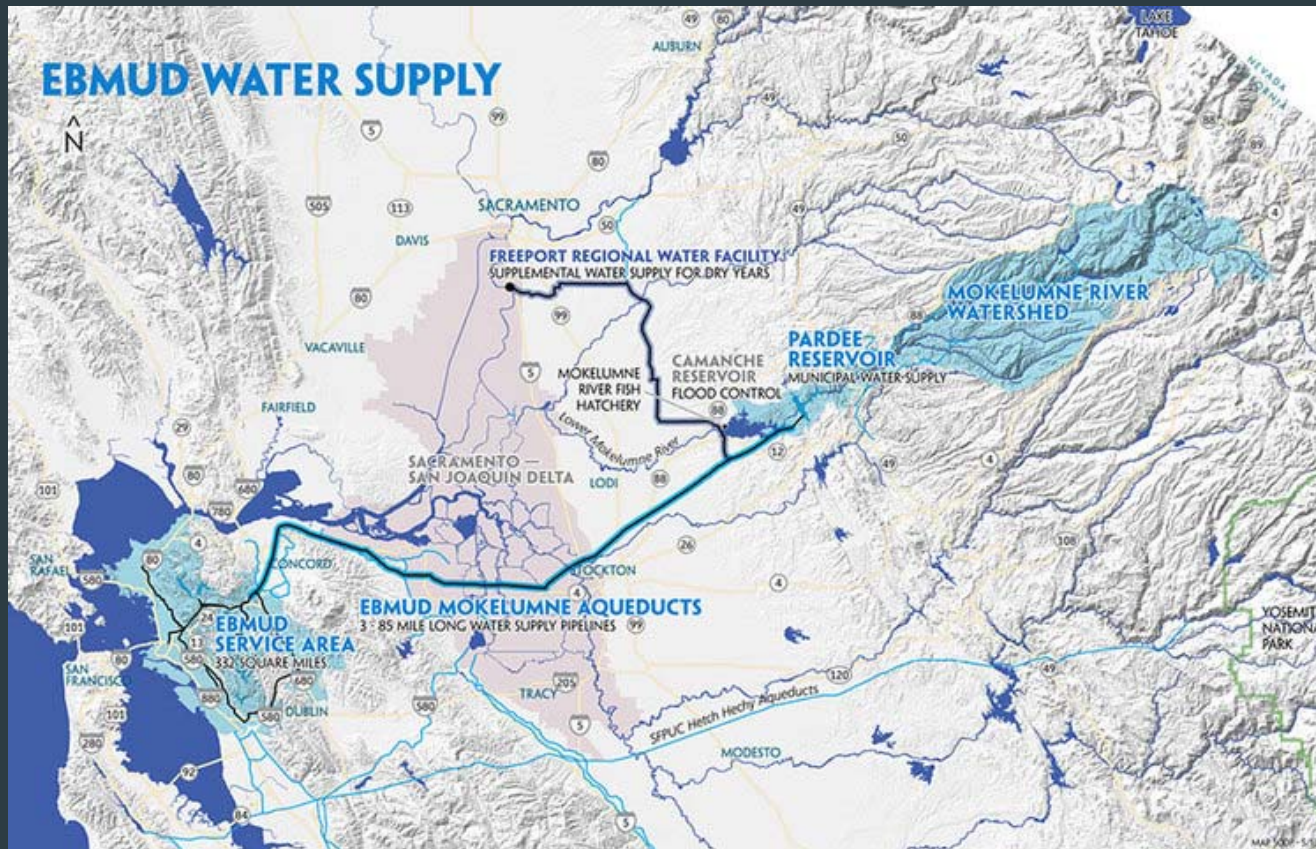
## **Conclusion**

- Next Step
- Acknowledgements

## **Questions and Answers**

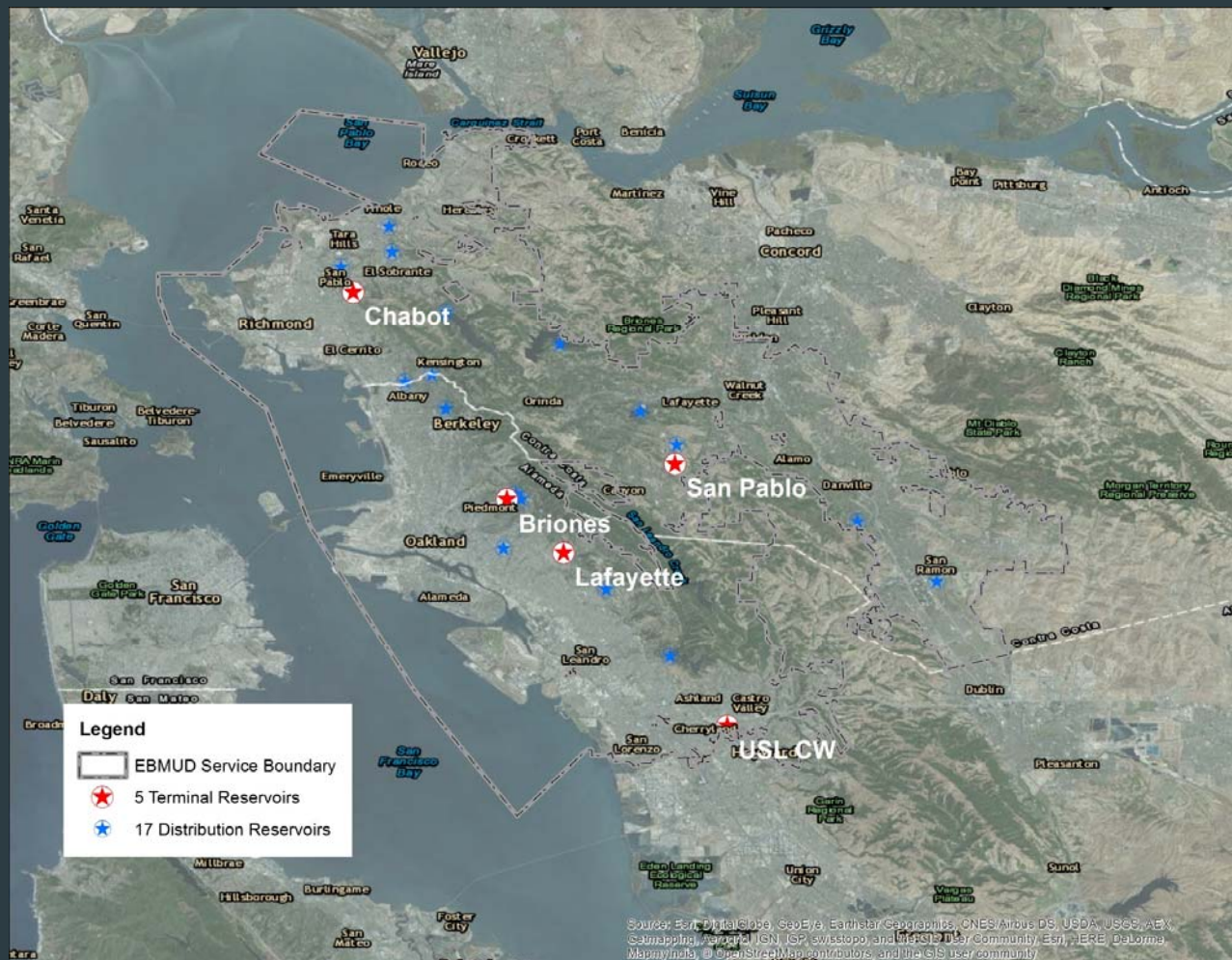


# EBMUD Water Supply





# EBMUD Dam Locations





# Monitoring Dam Safety Challenges

← → ↻ 🏠 w-lithium-p/DamTrackerPro/default.aspx

Apps Customize Links Sign out Google ad Google SeismoSoft - Compar BMW K1300S- Sierra

**Dam Tracker Pro** ▶home Home - Sign Out

Instrument Readings

Instrument Plots

Instrument Info

Monthly Leakage Report

Manual Readings Entry

Upload Readings

Field Sheets

Missing List

Exception List

Review Exceptions

Add Instrument

**Dam Tracker Pro** ▶search - instrument readings Home - Sign Out

From 02/28/2016 To 02/28/2017 Previous Month Current Month Find Readings

**Unselected Reservoirs**

39TH AVE (3114)  
ALMOND (3120)  
ARGYLE NO. 2 (3130)  
BERRYMAN (3108)  
BRIONES (3115)  
CAMANCHE (3116)  
CENTRAL (3100)  
CHABOT (3105)  
CLAREMONT (3101)  
DANVILLE (3128)  
DUNSMUIR (3118)  
ESTATES (FORMER) (3110)  
FAY HILL (3109)  
LAFAYETTE (3102)  
LELAND (3121)  
MALONEY (3124)  
MORAGA (3122)  
NORTH (3127)  
PARDEE (3104)  
PIEDMONT (3111)  
SAN PABLO (3106)  
SAN PABLO CLEARWELL (312)  
SCHAPIRO NO. 1 (FORMER) (3)  
SENECA (3126)  
SOBRANTE CLEARWELL (312)  
SOUTH (FORMER) (3125)  
SUMMIT (FORMER) (3112)  
USL (3131)  
USL CLEARWELL (3117)  
WALNUT CREEK CLEARWELL  
WATSON (3133)

**Unselected Instrument Tips**

▶

◀

**Instrument Types**  
0-Reservoir Staff Gauge  
1-Standpipe Piezometer  
3-Diaphragm Piezometer  
4-Earth Pressure Cell  
5-Survey Monument  
6-Survey Monument-temp  
7-Drain  
8-Crack Meter  
11-Inclinometer

**Selected Reservoirs**

CENTRAL (3100)  
DINGEE (3103)  
SAN PABLO (3106)  
SAN PABLO CLEARWELL (312)

**Selected Instrument Tips**  
3100010010A - TU-33A  
3100010010B - TU-33B  
3100010020A - TU-34A  
3100010020B - TU-34B  
3100010030A - TU-35A  
3100010030B - TU-35B  
3100010050A - TU-37A  
3100010050B - TU-37B  
3100010060A - TU-38A  
3100010070A - TU-39A  
3100010080A - TU-40A  
3100010090A - TU-41A  
3100010100A - TU-48A  
3100050010A - ND-1V  
3100050020A - ND-2V  
3100050030A - ND-3V  
3100050040A - ND-4V  
3100050050A - ND-5V  
3100050060A - ND-6V  
3100050070A - ND-7V  
3100050090A - SD-2V  
3100050100A - SD-3V  
3100050110A - SD-4V  
3100050120A - SD-5V  
3100050130A - SD-6V  
3100050200A - C-1V  
3100050200B - C-1H  
3100050210A - C-2V  
3100050210B - C-2H  
3100050220A - C-3V  
3100050220B - C-3H  
3100050230A - C-4V  
3100050230B - C-4H  
3100050240A - C-5V

☒ Sort Alphabetically  
☐ Sort by Reservoir Code

☐ Sort by Instrument ID  
☐ Sort by Instrument Name

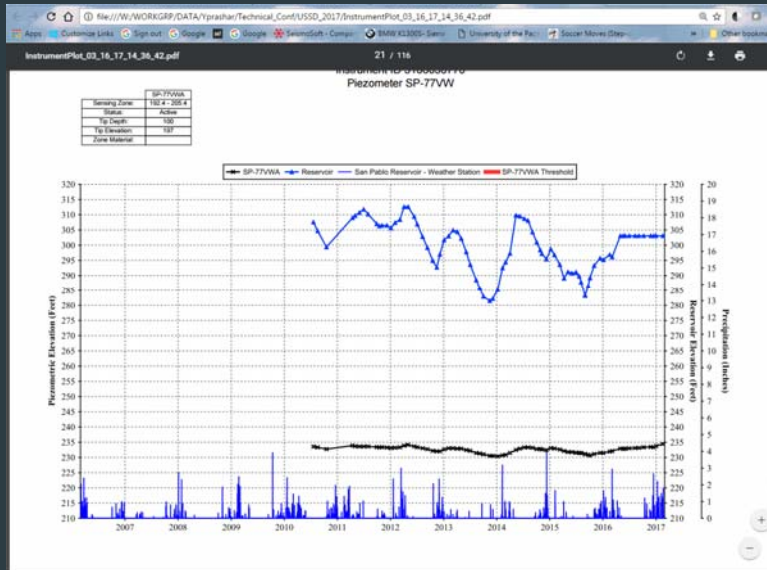
☒ Active Instrument Tips  
☐ Inactive Instrument Tips  
☐ All Instrument Tips

**Query Name To Add**

| Query ID                                                             | Owner           | Query Name                       |
|----------------------------------------------------------------------|-----------------|----------------------------------|
| 573571                                                               | mhlee           | Bi_Annual GW report              |
| <a href="#">Select</a> <a href="#">Update</a> <a href="#">Delete</a> | 483863/tcumming | Camanche North Dikes Instruments |
| <a href="#">Select</a> <a href="#">Update</a> <a href="#">Delete</a> | 482254/hchan    | Camanche South Dikes Instruments |



# Monitoring Dam Safety Challenges



## Dam Tracker Pro > readings

[Home](#) - [Sign Out](#)

[revise search](#) [export to excel](#)

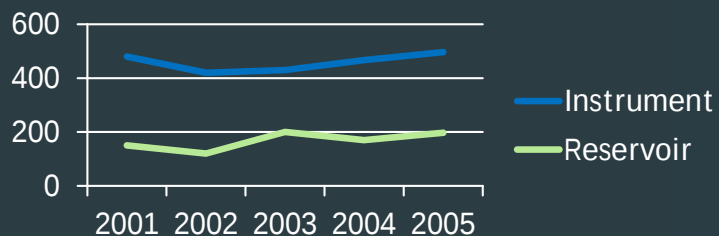
500 reads (500 max)

[notes help](#)

|                      | Instrument ID               | Name                   | Date       | Time  | Raw Reading | Raw Unit | Final Reading | Normal Min | Normal Max | Final Unit | Res. Level | Notes |
|----------------------|-----------------------------|------------------------|------------|-------|-------------|----------|---------------|------------|------------|------------|------------|-------|
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 02/14/2017 | 13:30 | 16.60       | feet     | 188.2         | 180        | 190        | feet       | 183.50     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 01/23/2017 | 14:30 | 16.10       | feet     | 188.7         | 180        | 190        | feet       | 183.30     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 12/21/2016 | 13:00 | 29.60       | feet     | 175.2         | 180        | 190        | feet       | 182.60     | No    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 11/28/2016 | 14:00 | 23.00       | feet     | 181.8         | 180        | 190        | feet       | 181        |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 10/07/2016 | 13:30 | 22.20       | feet     | 182.6         | 180        | 190        | feet       | 185.90     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 09/13/2016 | 14:00 | 22.00       | feet     | 182.8         | 180        | 190        | feet       | 181.80     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 08/16/2016 | 13:45 | 21.70       | feet     | 183.1         | 180        | 190        | feet       | 184.40     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 07/11/2016 | 13:00 | 20.90       | feet     | 183.9         | 180        | 190        | feet       | 185.60     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 06/08/2016 | 15:15 | 20.70       | feet     | 184.1         | 180        | 190        | feet       | 188.70     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 05/02/2016 | 15:00 | 19.00       | feet     | 185.8         | 180        | 190        | feet       | 184        |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 04/20/2016 | 10:00 | 18.50       | feet     | 186.3         | 180        | 190        | feet       | 190.60     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 03/17/2016 | 11:00 | 16.90       | feet     | 187.9         | 180        | 190        | feet       | 188.50     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 02/03/2016 | 11:00 | 24.00       | feet     | 180.8         | 180        | 190        | feet       | 189.80     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 01/04/2016 | 10:30 | 23.90       | feet     | 180.9         | 180        | 190        | feet       | 185.90     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 12/01/2015 | 11:15 | 24.00       | feet     | 180.8         | 180        | 190        | feet       | 183        | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 11/02/2015 | 14:00 | 24.00       | feet     | 180.8         | 180        | 190        | feet       | 183.60     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 10/01/2015 | 15:15 | 24.00       | feet     | 180.8         | 180        | 190        | feet       | 184.50     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 09/02/2015 | 10:15 | 23.90       | feet     | 180.9         | 180        | 190        | feet       | 190.80     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 08/17/2015 | 08:30 | 23.90       | feet     | 180.9         | 180        | 190        | feet       | 186.50     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 08/04/2015 | 10:55 | 23.90       | feet     | 180.9         | 180        | 190        | feet       | 191.10     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 07/13/2015 | 10:15 | 23.90       | feet     | 180.9         | 180        | 190        | feet       | 186.90     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 06/03/2015 | 10:30 | 24.00       | feet     | 180.8         | 180        | 190        | feet       | 190.60     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 05/04/2015 | 13:30 | 24.00       | feet     | 180.8         | 180        | 190        | feet       | 186        | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 04/16/2015 | 13:50 | 24.00       | feet     | 180.8         | 180        | 190        | feet       | 190.70     | 70    |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 03/05/2015 | 15:00 | 23.60       | feet     | 181.2         | 180        | 190        | feet       | 184.60     |       |
| <a href="#">Edit</a> | <a href="#">3100010010A</a> | <a href="#">TU-33A</a> | 02/18/2015 | 11:15 | 23.60       | feet     | 181.2         | 180        | 190        | feet       | 187.20     |       |



# Goal & Objectives



| Dam Tracker Pro Readings |        |            |       |             |              |            |            |             |              |        |      |
|--------------------------|--------|------------|-------|-------------|--------------|------------|------------|-------------|--------------|--------|------|
| Instrument ID            | Name   | Date       | Time  | Raw Reading | True Reading | Normal Min | Normal Max | Normal Unit | Normal Level | Notes  | Help |
| 1000100101               | TL-33A | 02/14/2017 | 13:30 | 18.00       | Feet         | 188.2      | 180        | 190         | Feet         | 181.50 |      |
| 1000100101               | TL-33A | 02/15/2017 | 14:30 | 18.10       | Feet         | 188.7      | 180        | 190         | Feet         | 181.20 |      |
| 1000100101               | TL-33A | 02/16/2017 | 13:00 | 20.00       | Feet         | 179.2      | 180        | 190         | Feet         | 182.40 |      |
| 1000100101               | TL-33A | 11/20/2016 | 14:00 | 23.00       | Feet         | 181.8      | 180        | 190         | Feet         | 181    |      |
| 1000100101               | TL-33A | 10/07/2016 | 13:30 | 22.00       | Feet         | 182.4      | 180        | 190         | Feet         | 181.90 |      |
| 1000100101               | TL-33A | 09/13/2016 | 14:00 | 22.00       | Feet         | 182.4      | 180        | 190         | Feet         | 181.00 |      |
| 1000100101               | TL-33A | 08/04/2016 | 13:45 | 21.70       | Feet         | 183.1      | 180        | 190         | Feet         | 184.40 |      |
| 1000100101               | TL-33A | 07/11/2016 | 13:00 | 20.00       | Feet         | 183.6      | 180        | 190         | Feet         | 185.60 |      |
| 1000100101               | TL-33A | 06/08/2016 | 15:15 | 20.70       | Feet         | 184.1      | 180        | 190         | Feet         | 186.70 |      |
| 1000100101               | TL-33A | 05/02/2016 | 15:00 | 19.00       | Feet         | 185.6      | 180        | 190         | Feet         | 184    |      |
| 1000100101               | TL-33A | 04/20/2016 | 10:00 | 18.50       | Feet         | 186.1      | 180        | 190         | Feet         | 180.60 |      |
| 1000100101               | TL-33A | 03/17/2016 | 11:00 | 18.50       | Feet         | 187.6      | 180        | 190         | Feet         | 181.50 |      |
| 1000100101               | TL-33A | 02/10/2016 | 11:00 | 24.00       | Feet         | 180.8      | 180        | 190         | Feet         | 189.00 | 70   |
| 1000100101               | TL-33A | 01/04/2016 | 10:30 | 23.00       | Feet         | 180.9      | 180        | 190         | Feet         | 188.90 | 70   |
| 1000100101               | TL-33A | 12/16/2015 | 13:15 | 24.00       | Feet         | 180.8      | 180        | 190         | Feet         | 188    | 70   |
| 1000100101               | TL-33A | 11/02/2015 | 14:00 | 24.00       | Feet         | 180.8      | 180        | 190         | Feet         | 188.60 | 70   |
| 1000100101               | TL-33A | 10/15/2015 | 15:15 | 24.00       | Feet         | 180.8      | 180        | 190         | Feet         | 184.50 | 70   |
| 1000100101               | TL-33A | 09/02/2015 | 15:15 | 23.00       | Feet         | 180.9      | 180        | 190         | Feet         | 180.60 | 70   |
| 1000100101               | TL-33A | 08/17/2015 | 00:30 | 23.00       | Feet         | 180.9      | 180        | 190         | Feet         | 186.50 | 70   |
| 1000100101               | TL-33A | 08/04/2015 | 03:35 | 23.00       | Feet         | 180.9      | 180        | 190         | Feet         | 181.10 | 70   |
| 1000100101               | TL-33A | 07/13/2015 | 10:15 | 23.00       | Feet         | 180.9      | 180        | 190         | Feet         | 186.90 | 70   |
| 1000100101               | TL-33A | 06/03/2015 | 10:30 | 24.00       | Feet         | 180.8      | 180        | 190         | Feet         | 180.60 | 70   |
| 1000100101               | TL-33A | 05/04/2015 | 13:30 | 24.00       | Feet         | 180.8      | 180        | 190         | Feet         | 186    | 70   |
| 1000100101               | TL-33A | 04/14/2015 | 15:30 | 24.00       | Feet         | 180.8      | 180        | 190         | Feet         | 180.70 | 70   |
| 1000100101               | TL-33A | 03/05/2015 | 15:00 | 23.40       | Feet         | 181.2      | 180        | 190         | Feet         | 184.60 |      |
| 1000100101               | TL-33A | 02/19/2015 | 11:15 | 23.60       | Feet         | 181.2      | 180        | 190         | Feet         | 187.10 |      |

## Non-spatial Data



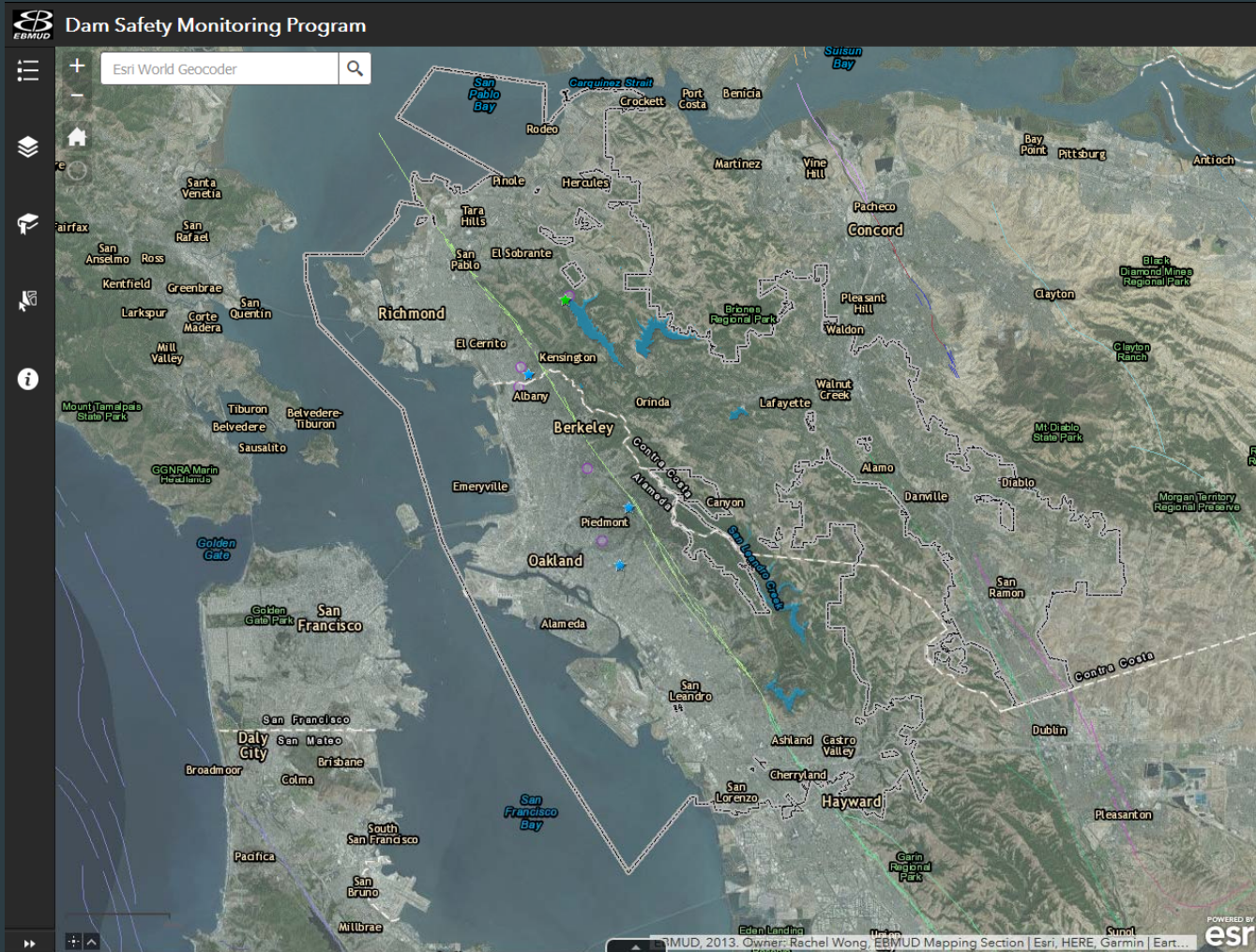
## Spatial Data

## Objectives

- Survey the dam/reservoir Instrument locations.
- Display the instruments on the map.
- Visualize the temporal data.
- Show real time updates from Oracle database.



# Demonstration



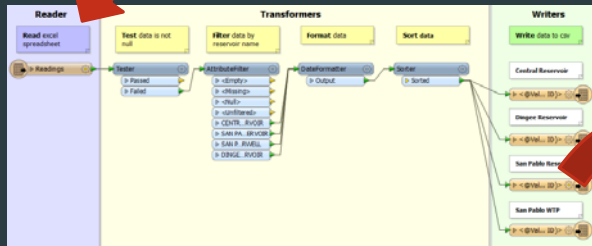


# Methodologies

Dam Tracker Pro

| Instrument ID | Name          | Date       | Time  | Raw Reading | Raw Unit | Normal Reading | Normal Unit | Raw Level | Normal Level |
|---------------|---------------|------------|-------|-------------|----------|----------------|-------------|-----------|--------------|
| 001           | San Pablo WTP | 12/14/2017 | 13:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 002           | San Pablo WTP | 12/14/2017 | 14:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 003           | San Pablo WTP | 12/14/2017 | 15:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 004           | San Pablo WTP | 12/14/2017 | 16:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 005           | San Pablo WTP | 12/14/2017 | 17:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 006           | San Pablo WTP | 12/14/2017 | 18:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 007           | San Pablo WTP | 12/14/2017 | 19:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 008           | San Pablo WTP | 12/14/2017 | 20:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 009           | San Pablo WTP | 12/14/2017 | 21:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 010           | San Pablo WTP | 12/14/2017 | 22:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 011           | San Pablo WTP | 12/14/2017 | 23:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 012           | San Pablo WTP | 12/15/2017 | 00:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 013           | San Pablo WTP | 12/15/2017 | 01:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 014           | San Pablo WTP | 12/15/2017 | 02:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 015           | San Pablo WTP | 12/15/2017 | 03:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 016           | San Pablo WTP | 12/15/2017 | 04:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 017           | San Pablo WTP | 12/15/2017 | 05:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 018           | San Pablo WTP | 12/15/2017 | 06:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 019           | San Pablo WTP | 12/15/2017 | 07:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 020           | San Pablo WTP | 12/15/2017 | 08:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 021           | San Pablo WTP | 12/15/2017 | 09:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 022           | San Pablo WTP | 12/15/2017 | 10:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 023           | San Pablo WTP | 12/15/2017 | 11:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 024           | San Pablo WTP | 12/15/2017 | 12:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 025           | San Pablo WTP | 12/15/2017 | 13:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 026           | San Pablo WTP | 12/15/2017 | 14:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 027           | San Pablo WTP | 12/15/2017 | 15:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 028           | San Pablo WTP | 12/15/2017 | 16:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 029           | San Pablo WTP | 12/15/2017 | 17:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 030           | San Pablo WTP | 12/15/2017 | 18:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 031           | San Pablo WTP | 12/15/2017 | 19:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 032           | San Pablo WTP | 12/15/2017 | 20:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 033           | San Pablo WTP | 12/15/2017 | 21:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 034           | San Pablo WTP | 12/15/2017 | 22:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 035           | San Pablo WTP | 12/15/2017 | 23:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 036           | San Pablo WTP | 12/16/2017 | 00:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 037           | San Pablo WTP | 12/16/2017 | 01:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 038           | San Pablo WTP | 12/16/2017 | 02:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 039           | San Pablo WTP | 12/16/2017 | 03:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 040           | San Pablo WTP | 12/16/2017 | 04:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 041           | San Pablo WTP | 12/16/2017 | 05:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 042           | San Pablo WTP | 12/16/2017 | 06:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 043           | San Pablo WTP | 12/16/2017 | 07:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 044           | San Pablo WTP | 12/16/2017 | 08:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 045           | San Pablo WTP | 12/16/2017 | 09:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 046           | San Pablo WTP | 12/16/2017 | 10:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 047           | San Pablo WTP | 12/16/2017 | 11:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 048           | San Pablo WTP | 12/16/2017 | 12:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 049           | San Pablo WTP | 12/16/2017 | 13:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 050           | San Pablo WTP | 12/16/2017 | 14:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 051           | San Pablo WTP | 12/16/2017 | 15:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 052           | San Pablo WTP | 12/16/2017 | 16:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 053           | San Pablo WTP | 12/16/2017 | 17:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 054           | San Pablo WTP | 12/16/2017 | 18:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 055           | San Pablo WTP | 12/16/2017 | 19:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 056           | San Pablo WTP | 12/16/2017 | 20:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 057           | San Pablo WTP | 12/16/2017 | 21:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 058           | San Pablo WTP | 12/16/2017 | 22:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 059           | San Pablo WTP | 12/16/2017 | 23:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 060           | San Pablo WTP | 12/17/2017 | 00:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 061           | San Pablo WTP | 12/17/2017 | 01:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 062           | San Pablo WTP | 12/17/2017 | 02:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 063           | San Pablo WTP | 12/17/2017 | 03:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 064           | San Pablo WTP | 12/17/2017 | 04:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 065           | San Pablo WTP | 12/17/2017 | 05:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 066           | San Pablo WTP | 12/17/2017 | 06:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 067           | San Pablo WTP | 12/17/2017 | 07:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 068           | San Pablo WTP | 12/17/2017 | 08:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 069           | San Pablo WTP | 12/17/2017 | 09:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 070           | San Pablo WTP | 12/17/2017 | 10:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 071           | San Pablo WTP | 12/17/2017 | 11:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 072           | San Pablo WTP | 12/17/2017 | 12:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 073           | San Pablo WTP | 12/17/2017 | 13:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 074           | San Pablo WTP | 12/17/2017 | 14:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 075           | San Pablo WTP | 12/17/2017 | 15:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 076           | San Pablo WTP | 12/17/2017 | 16:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 077           | San Pablo WTP | 12/17/2017 | 17:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 078           | San Pablo WTP | 12/17/2017 | 18:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 079           | San Pablo WTP | 12/17/2017 | 19:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 080           | San Pablo WTP | 12/17/2017 | 20:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 081           | San Pablo WTP | 12/17/2017 | 21:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 082           | San Pablo WTP | 12/17/2017 | 22:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 083           | San Pablo WTP | 12/17/2017 | 23:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 084           | San Pablo WTP | 12/18/2017 | 00:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 085           | San Pablo WTP | 12/18/2017 | 01:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 086           | San Pablo WTP | 12/18/2017 | 02:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 087           | San Pablo WTP | 12/18/2017 | 03:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 088           | San Pablo WTP | 12/18/2017 | 04:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 089           | San Pablo WTP | 12/18/2017 | 05:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 090           | San Pablo WTP | 12/18/2017 | 06:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 091           | San Pablo WTP | 12/18/2017 | 07:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 092           | San Pablo WTP | 12/18/2017 | 08:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 093           | San Pablo WTP | 12/18/2017 | 09:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 094           | San Pablo WTP | 12/18/2017 | 10:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 095           | San Pablo WTP | 12/18/2017 | 11:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 096           | San Pablo WTP | 12/18/2017 | 12:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 097           | San Pablo WTP | 12/18/2017 | 13:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 098           | San Pablo WTP | 12/18/2017 | 14:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 099           | San Pablo WTP | 12/18/2017 | 15:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |
| 100           | San Pablo WTP | 12/18/2017 | 16:10 | 18.50       | Feet     | 186.2          | 100         | Feet      | 105.50       |

Non-spatial temporal data exported from Oracle



Using FME to prepare the non-spatial temporal data



Using ArcGIS Online to visualize the dam instrument locations



Using d3.js line graphs to visualize the temporal data





# ArcGIS Online



## GIS Online Mapping Center

### EBMUD Featured Maps and Apps



B-Map Viewer



District Service Area



PRP Viewer



Project Tracker

# D3.js (Data-Driven Documents)



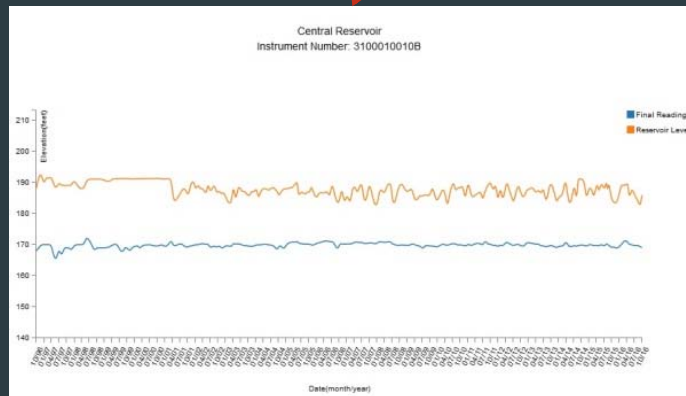
JavaScript library  
<https://d3js.org>



HTML document

```
1 date,Final Reading,Reservoir Level
2 19971001,185.0,189.0
3 19971101,185.0,189.0
4 19971201,187.0,189.0
5 19980101,187.0,191.0
6 19980301,187.0,188.0
7 19980401,187.0,188.0
8 19980501,186.0,188.0
9 19980601,187.0,191.0
10 19980801,186.0,191.0
11 19980901,186.0,191.0
12 19981001,186.0,191.0
13 19981101,186.0,191.0
14 19981201,186.0,191.0
15 19990301,187.0,190.0
16 19990414,187.8,191.2
17 19990506,186.9,191.2
18 19990604,187.0,191.1
19 19990702,186.8,191.2
20 19990813,185.8,191.2
21 19990909,186.5,191.2
```

CSV file



Example  
3100010010B.html



# D3.js (Data-Driven Documents)

```
4 <head>
5 <script src="http://d3js.org/d3.v3.min.js"></script>
6 <style>
7   body {
8     font: 10px Arial;
9   }
10
11   .axis path,
12   .axis line {
13     fill: none;
14     stroke: grey;
15     stroke-width: 1;
16     shape-rendering: crispEdges;
17   }
18
19   .line {
20     fill: none;
21     stroke: steelblue;
22     stroke-width: 1.5px;
23   }
24 </style>
25 </head>
```

Directly link to the library

```
27 <body>
28 <script>
29
30   var url = window.location.pathname;
31
32   var pagename = url.substring(url.lastIndexOf('/')+1);
33   var filename = pagename.substr(0, pagename.lastIndexOf('.'));
34
35   var margin = {top: 200, right: 100, bottom: 100, left: 100};
36   width = 1000 - margin.left - margin.right;
37   height = 600 - margin.top - margin.bottom;
38
39   var parseDate = d3.time.format("%Y%m%d").parse;
40
41   var x = d3.time.scale()
42     .range([0, width]);
43
44   var y = d3.scale.linear()
45     .range([height, 0]);
46
47   var color = d3.scale.category10();
48
49   var xAxis = d3.svg.axis()
50     .scale(x)
51     .orient("bottom").ticks(50)
52     .tickFormat(d3.time.format("%m/%y")); // tickFormat
```

Define the date format

Read the csv file

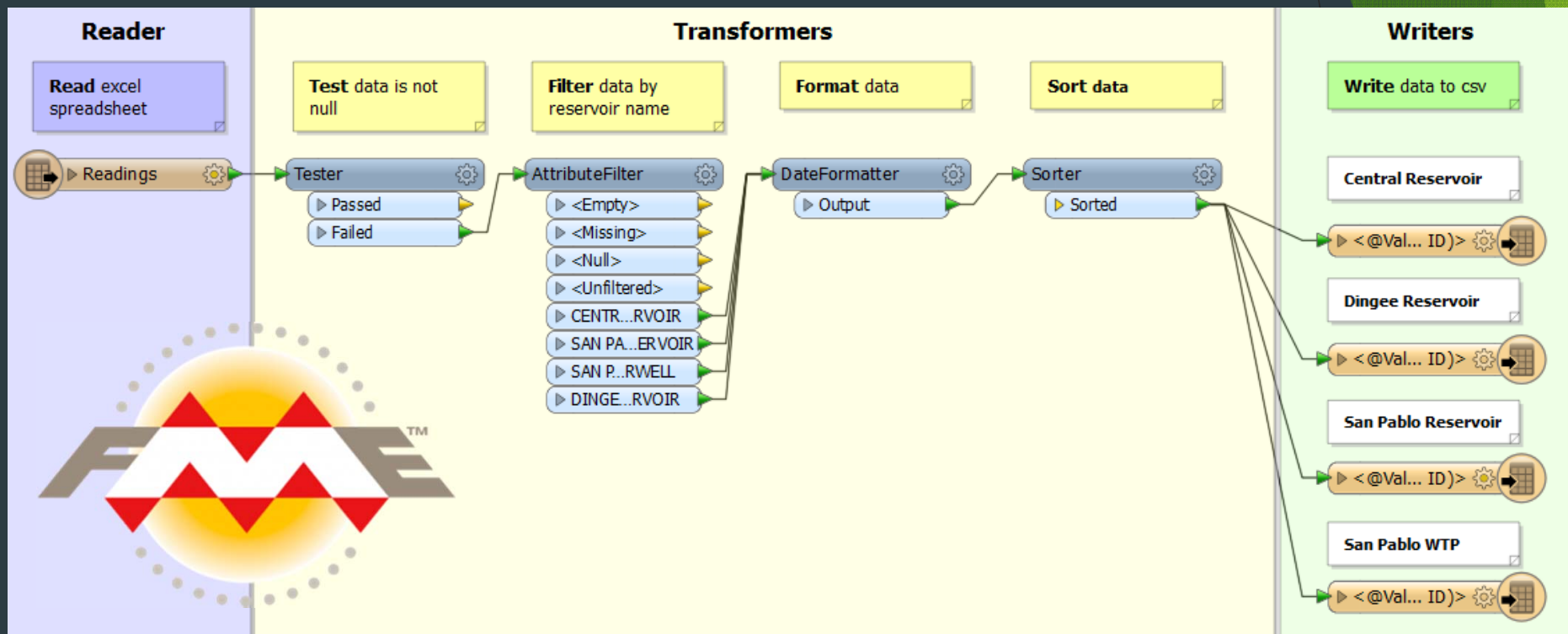
```
73 d3.csv("../Data/Example.csv", function(error, data) {
74   data.forEach(function(d) {
75     d.date = parseDate(d.date);
76   });
77
78   color.domain(d3.keys(data[0]).filter(function(key) {
79     return key !== "date";
80   }));
81
82   var instruments = color.domain().map(function(name) {
83     return {
84       name: name,
85       values: data.map(function(d) {
86         return {
87           date: d.date,
88           elevation: +d[name]
89         };
90       });
91     };
92   });
93
94   // Add titles to x axis
95   svg.append("text")
96     .attr("x", (width / 2))
97     .attr("y", height + (margin.bottom/2) + 20)
98     .attr("text-anchor", "middle")
99     .style("font-size", "10px")
100    .text("Date(month/year)");
```

CSS example

SVG example

<https://github.com/wingyw/Baywork>

# Safe Software FME Desktop



## Conclusion & Next Step

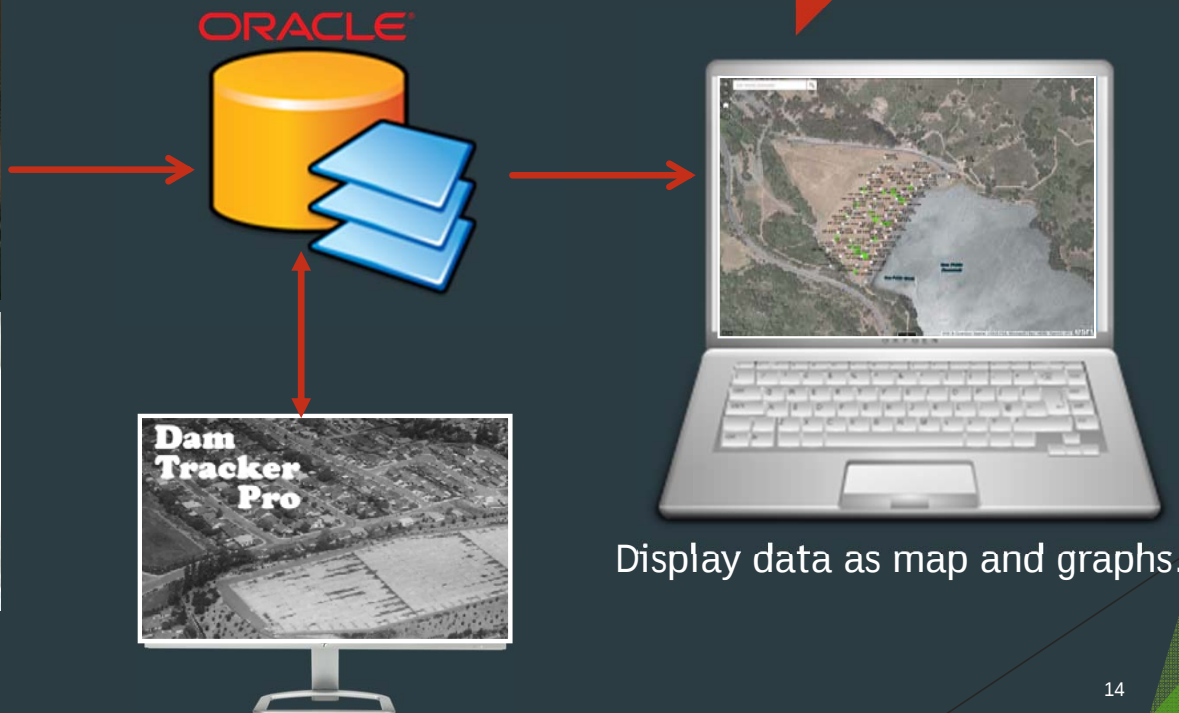
Data Collection

Data Storage

Data Display



Underdrains



Export data to Dam Tracker Pro



# Acknowledgements



## Geotechnical Engineering

Yogesh Prashar  
Zhihua Li  
Kin Lee

## IT Applications

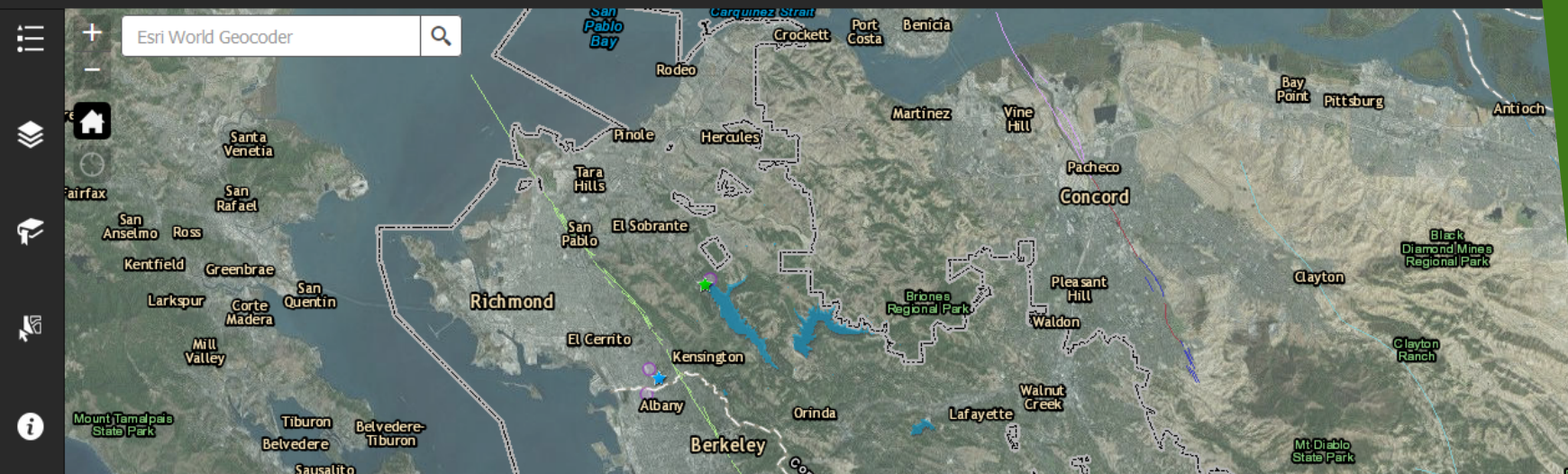
Brian T. Parodi

## Surveying

Steven J. Martin



## Dam Safety Monitoring Program



# Questions & Answers

Email: [Rachel.Wong@ebmud.com](mailto:Rachel.Wong@ebmud.com)

<https://github.com/wingyw/Baywork>

Thank you!