

April 4, 2022

Municipal Utilities/Public Works Commission

Water Infrastructure Condition/Seismic/Structural
Assessment

Summary of Findings, Conclusions, and
Recommendations

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Richard Brady & Associates

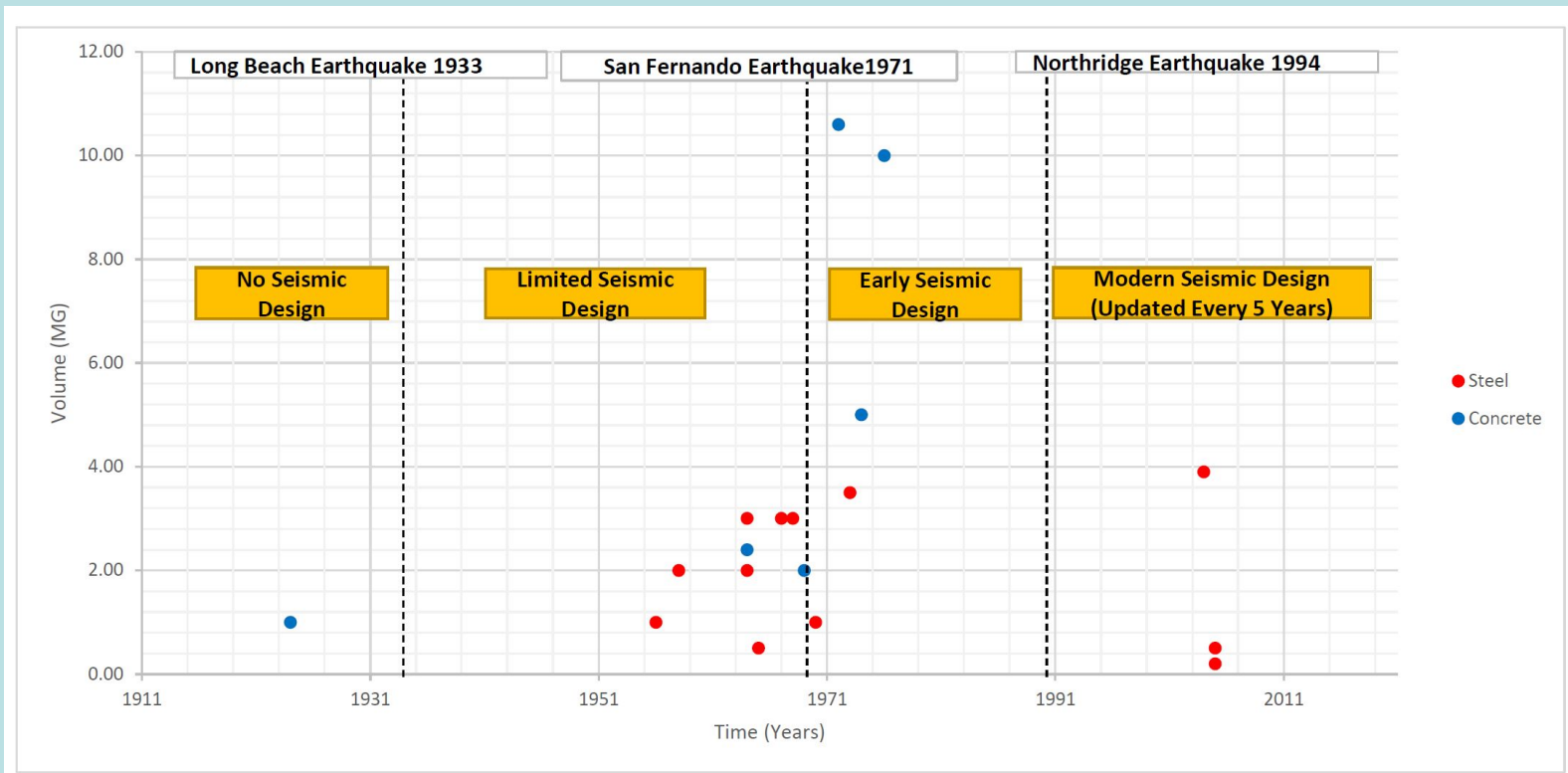
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Today's Agenda

- Review our Scope of Work – what were we tasked to do?
- Recap of our efforts to date
- The Good News
- The Not So Good News
- Brief review of the recommended capital projects
- Next steps
- The Big Idea



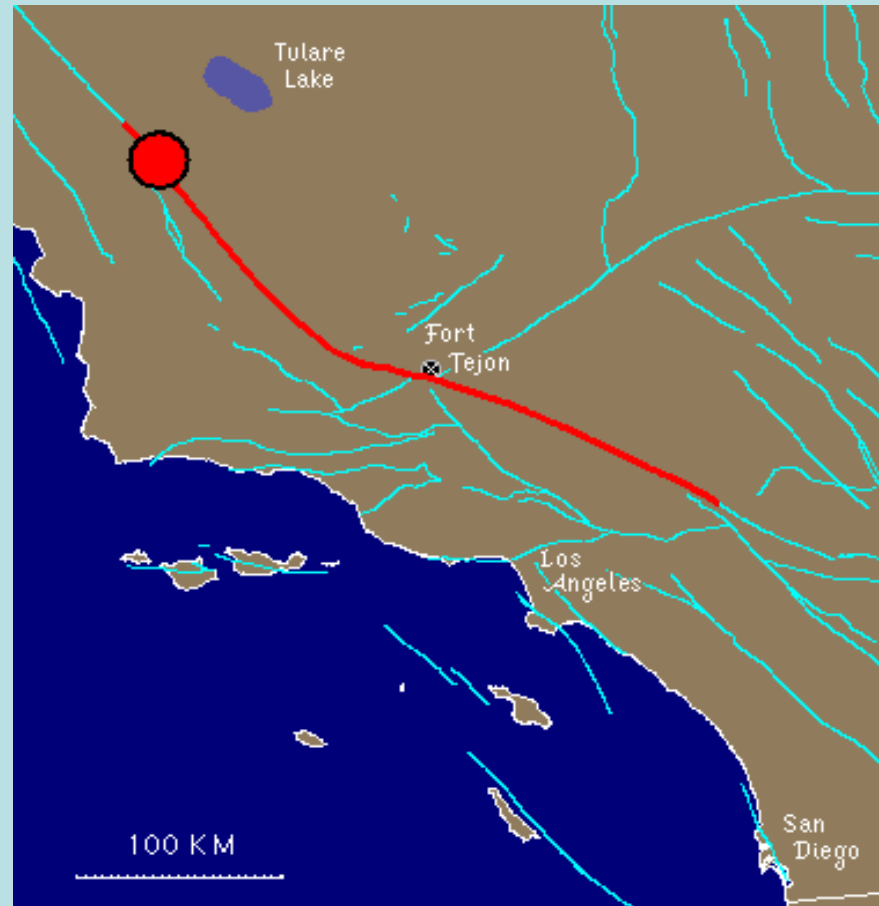
The Big Challenge at Hand – How do we improve earthquake resiliency of the City's Water Delivery System...comprised of 15 of 18 Reservoirs that don't comply with current Seismic Design Codes?



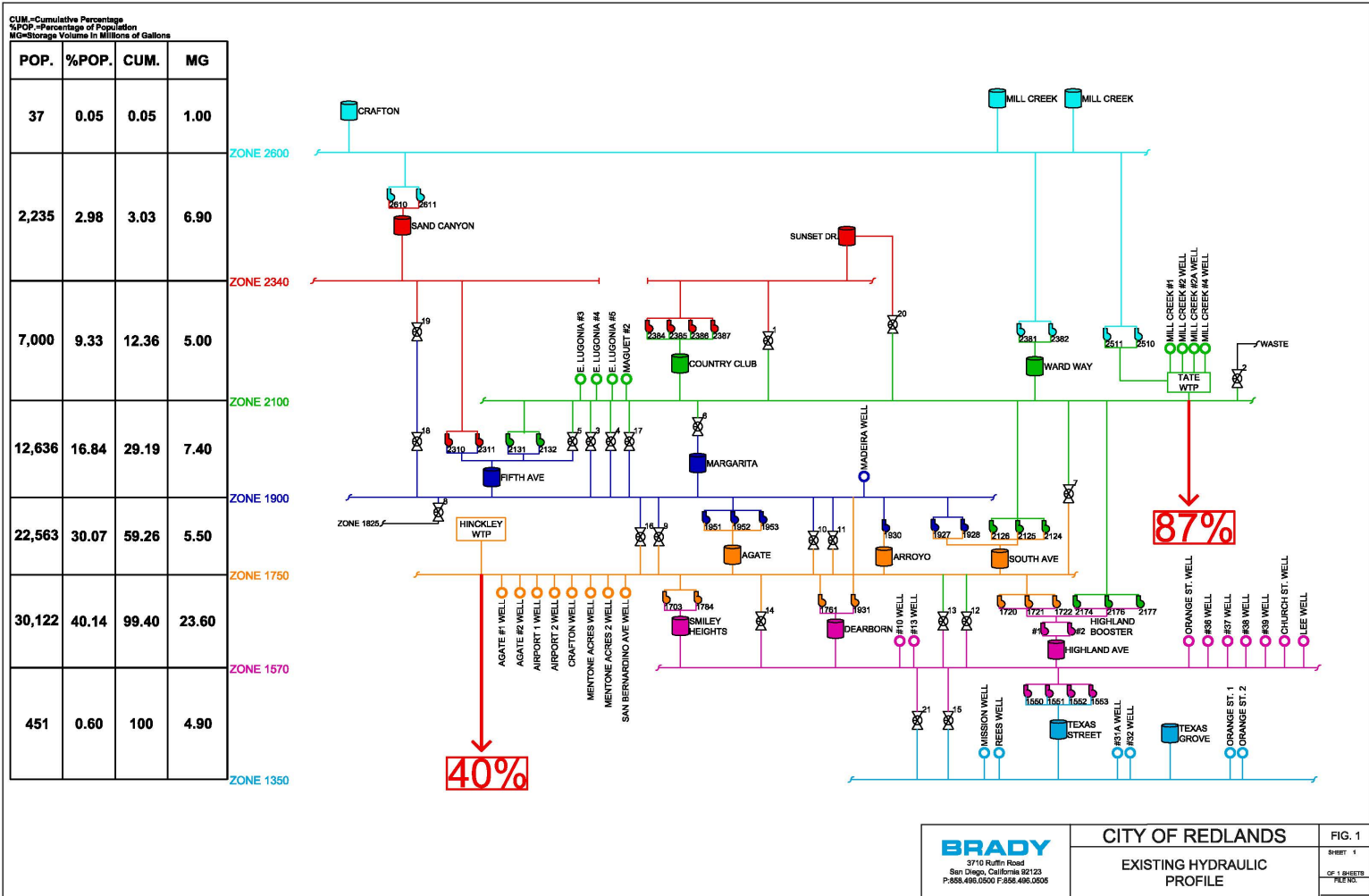
Last Major Earthquake along San Andreas occurred in 1857
– average number of years between major earthquakes
that would affect the City of Redlands is 175-200 years

2032

2057



Existing Hydraulic Profile



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Recap of our efforts and where we are today

- Kick-off meeting held April 1, 2021 and monthly after
- Records research, site visits, data gathering
- Reservoir inspections using an underwater drone
- Geotechnical investigations conducted
- Numbers were “crunched”
- Results shared with City staff
- Priority list of capital projects developed
- Draft Executive Summary submitted for City review

The Good News

- The majority of the City's concrete reservoirs, including the 1 MG Country Club 1 dating to 1924, are in reasonably good shape
- Only one pump station – Ward Way – is in need of attention

The Not So Good News

- All 12 of the City's steel tanks do not meet current seismic codes
- As a result, high water elevations need to be lowered
- Lower elevations = loss of storage = 6 MG
- Sunset needs immediate replacement

Current Condition



Agate Reservoir

Grade: C

-Excessive Shell Stress



Arroyo Reservoir

Grade: D

-Seismic Overturning
-Insufficient Freeboard



Crafton Hills Reservoir

Grade: C

-Excessive Shell Stress
-Insufficient Freeboard



Mill Creek East

Grade: B

-Seismic Overturning
-Insufficient Freeboard



Mill Creek West

Grade: B

-Seismic Overturning
-Insufficient Freeboard



Sand Canyon Reservoir

Grade: C

-Excessive Shell Stress
-Seismic Overturning
-Insufficient Freeboard



Smiley Reservoir

Grade: C

-Excessive Shell Stress
-Insufficient Freeboard



South Reservoir

Grade: C

-Insufficient Freeboard



Texas Grove Reservoir

Grade: B

-Excessive Shell Stress
-Seismic Overturning
-Insufficient Freeboard



Texas Street Reservoir

Grade: D

-Seismic Overturning
-Insufficient Freeboard



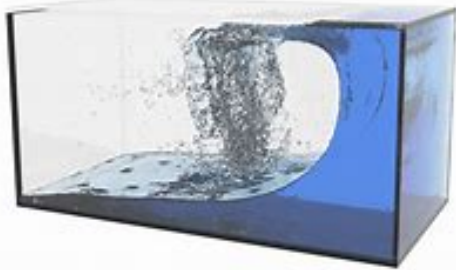
Ward Way Reservoir

Grade: D

-Insufficient Freeboard

Failure Mechanisms

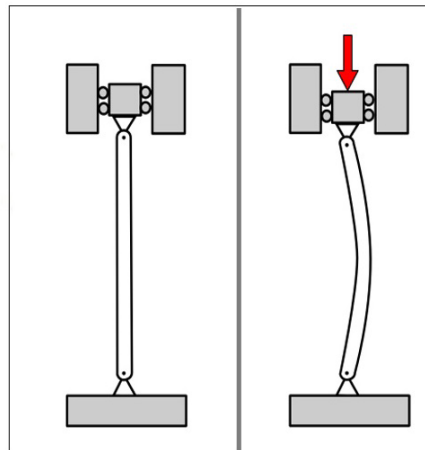
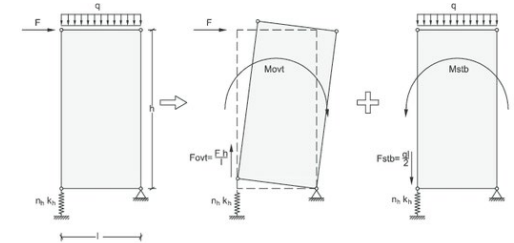
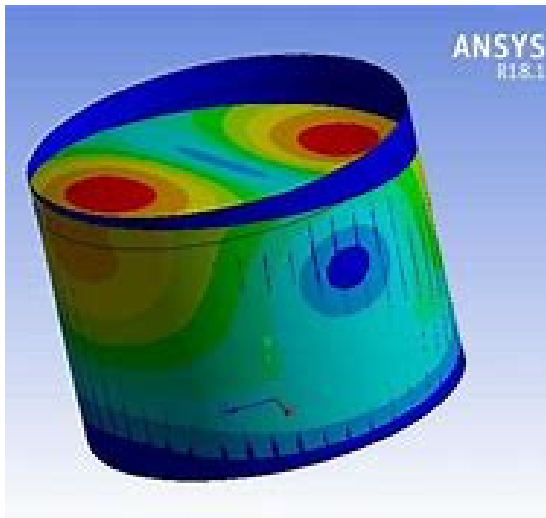
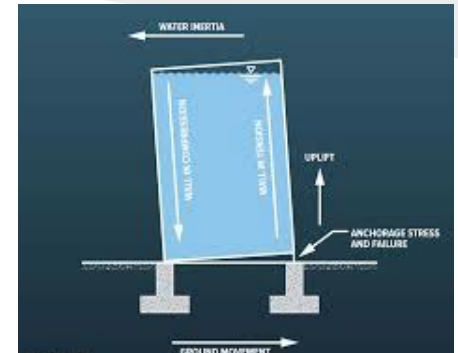
Insufficient Freeboard:



Extreme Stress:



Seismic Overturning:



Tank	Current Operating Volume	Operating Volume to Meet Code	Operational Capacity %	Reduction Justification
Agate Reservoir	3,000,000	2,163,000	72%	Extreme Stresses Developed in 1st and 2nd layer plates when subjected to seismic loading
Arroyo	500,000	194,400	39%	Seismic anchorage required to resist overturning and not enough freeboard
Crafton Hills	1,000,000	780,500	78%	Extreme stresses in multiple layers of tank shell under seismic loading and insufficient freeboard.
Mill Creek E	200,000	90,420	45%	Seismic anchorage required to resist overturning and not enough freeboard
Mill Creek W	200,000	90,420	45%	Seismic anchorage required to resist overturning and not enough freeboard
Sand Canyon	3,500,000	2,658,000	76%	Extreme stresses in multiple layers of tank shell in both seismic and static case, freeboard was also not sufficient
Smiley	3,000,000	2,037,000	68%	Extreme stress in first layer of tank shell in seismic case, freeboard was also not sufficient
South	2,000,000	1,412,000	71%	Freeboard not sufficient
Texas Grove	4,000,000	2,760,000	69%	Extreme stresses in multiple layers of tank shell in both seismic and static case, freeboard was also not sufficient
Texas Street	1,000,000	642,000	64%	Seismic anchorage required to resist overturning and not enough freeboard
Ward Way	2,000,000	1,322,000	66%	Freeboard not sufficient
Total:	20,400,000	14,149,740	69%	Entire system will be reduced 30% in order to meet seismic standards

Recommended Capital Projects

1. 750,000 gallon temporary Sunset tank
2. New Sunset Reservoir, size TBD
3. Second inlet pipeline to the Tate WTP
4. New 60-inch pipe leaving Hinckley to achieve CT, then remove Agate baffles
5. Seismic retrofit at 10 MG Highland Reservoir
6. New Fifth Avenue Reservoir and Pump Station
7. Improve 2.4 MG Margarita or replace storage elsewhere
8. Lower operating levels at all steel tanks
9. No work needed at Dearborn or Country Club Reservoirs
10. New building around Ward Way

The many problems with Sunset Reservoir...

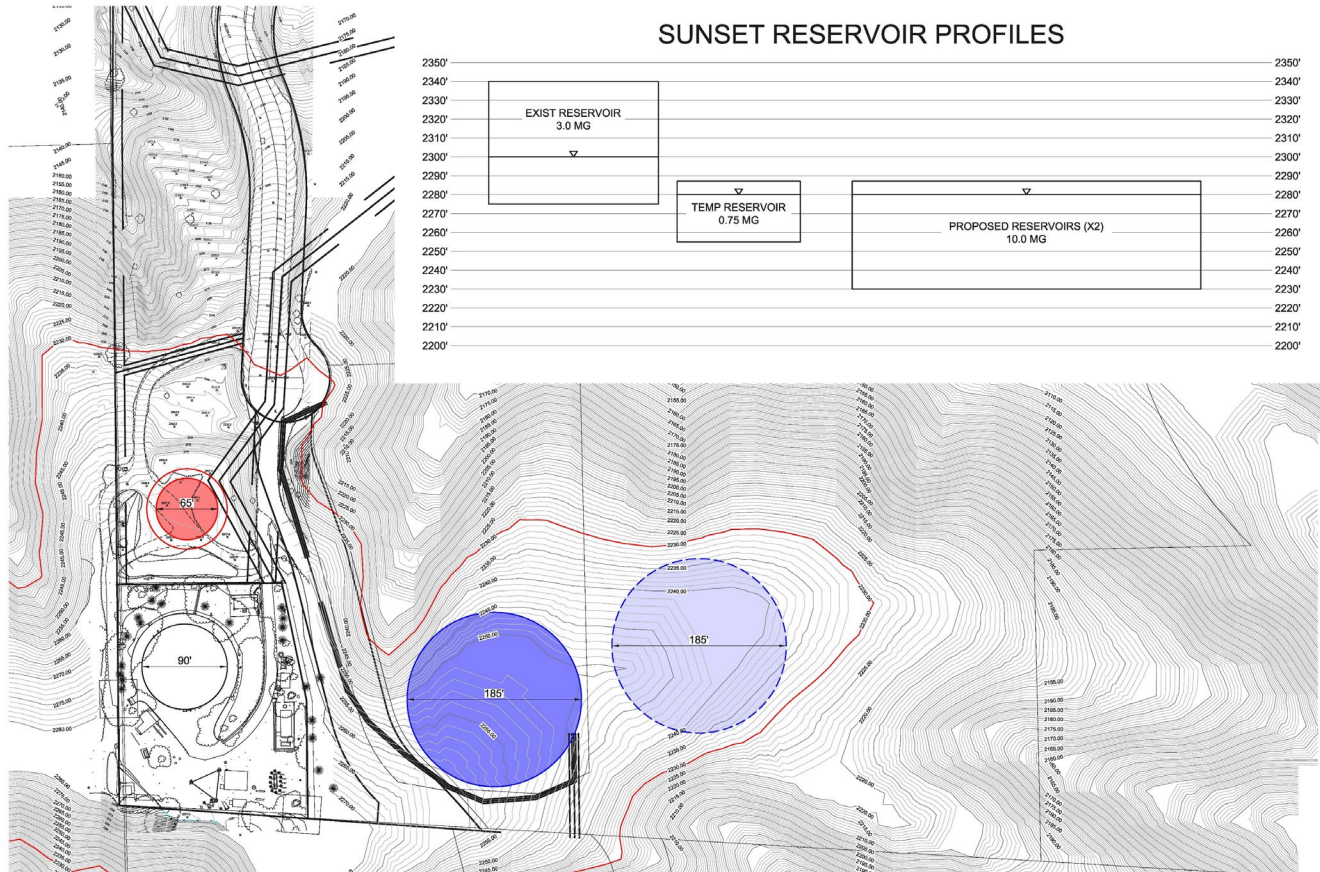


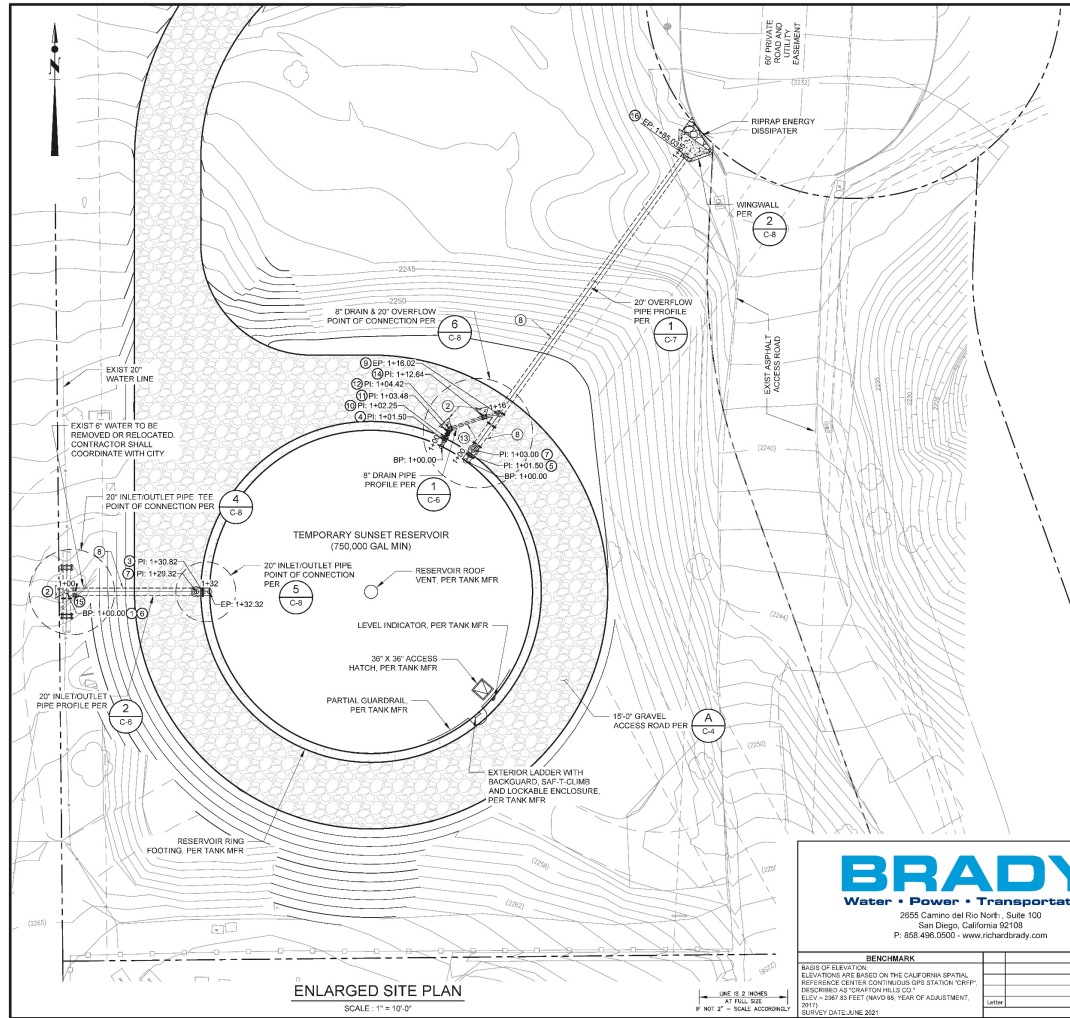
New Sunset Opportunity





Temporary Sunset New Sunset





KEY NOTES

- ① CONNECT NEW 20" DI PIPE TO EXIST 20" WATERLINE
- ② TYPICAL THRUST BLOCK PER DETAIL 3, DWG C-8
- ③ CONNECT NEW 20" DI PIPE TO TANK INLET/OUTLET PIPE NOZZLE FLANGE
- ④ CONNECT NEW 8" DI DRAIN PIPE TO TANK DRAIN PIPE NOZZLE FLANGE
- ⑤ CONNECT NEW 20" DI OVERFLOW PIPE TO TANK OVERFLOW PIPE NOZZLE FLANGE.
- ⑥ 20" DIP TEE
- ⑦ 2-20" 90° DIP VERT ELBOWS
- ⑧ 20" DIP SPOOL
- ⑨ 20" x 8" DIP WYE
- ⑩ 2-8" 90° DIP VERT ELBOWS
- ⑪ 8" BUTTERFLY VALVE
- ⑫ 8" 22.50° DIP ELBOW
- ⑬ 8" DIP SPOOL
- ⑭ 8" 11.25° DIP ELBOW
- ⑮ 20" BUTTERFLY VALVE
- ⑯ HEADWALL - WING TYPE

ENLARGED SITE PLAN

SCALE: 1" = 10'-0"

LINE IS 2 INCHES AT FULL SIZE
IF NOT 2" - SCALE ACCORDINGLY

BRADY
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CITY OF REDLANDS
Municipal Utilities and Engineering Department

SUNSET RESERVOIR - TEMPORARY REPLACEMENT

**ENLARGED SITE
IMPROVEMENTS PLAN**

Designed by:	Reviewed By:
Date:	Name, Title, E.C.E. #
Checked by:	Approved By:
Date:	Name, Title, E.C.E. #
Drawn by:	Name, Title, E.C.E. #
Date:	Sheet _____ of _____ Sheets
Checked by:	Scale: _____
Date:	North
	Vert: _____

BENCHMARK

BASIS OF ELEVATION:
 ELEVATIONS ARE BASED ON THE CALIFORNIA SPATIAL REFERENCE CENTER CONTIGUOUS GPS STATION "CRSP" DESIGNATED AS "ORANITEH HILLS CO" ELEV = 2287.83 FEET (NAVD 88, YEAR OF ADJUSTMENT: 2017) SURVEY DATE: JUNE 2021

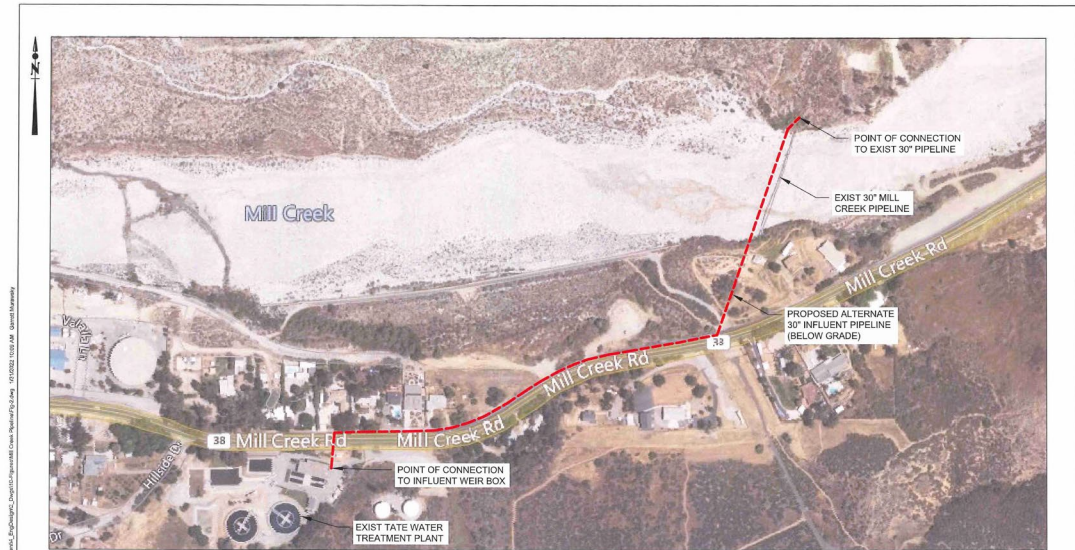
Letter	Description	Date	Issue	Initial

Revisions

DWG NO. C-3
P:\PROJECTS\REDLANDS_Sunset_Reservoir_V2\Design\CD\CD_C3_EnlargedSitePlan.dwg | Plot Date: 3/7/2023



Second Mill Creek Pipeline to the Tate WTP



PROPOSED PIPELINE PLAN

SCALE = 1" = 200'

EXHIBIT A

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CITY OF REDLANDS
 MILL CREEK PIPELINE
 PROPOSED PIPELINE PLAN

FIGURE 2
DATE JAN 2022

PROJECT: 20200201-00101 - 13 Redland Passover Rd, Engineering - Design - Mill Creek Pipeline to Tate WTP, 10/20/21 10:28 AM, Garrett Maroney

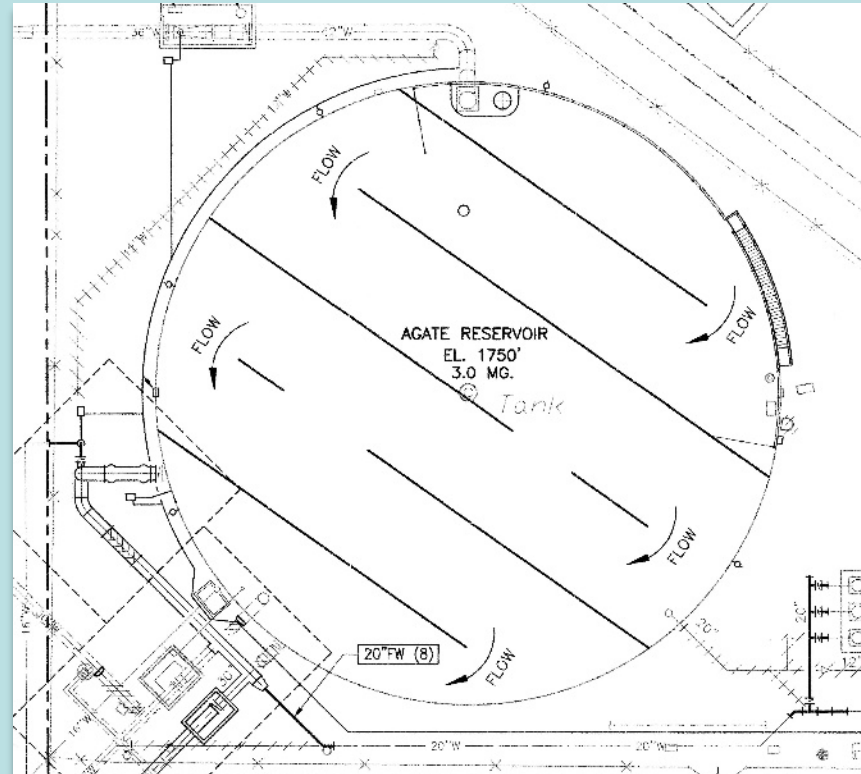


Agate Reservoir

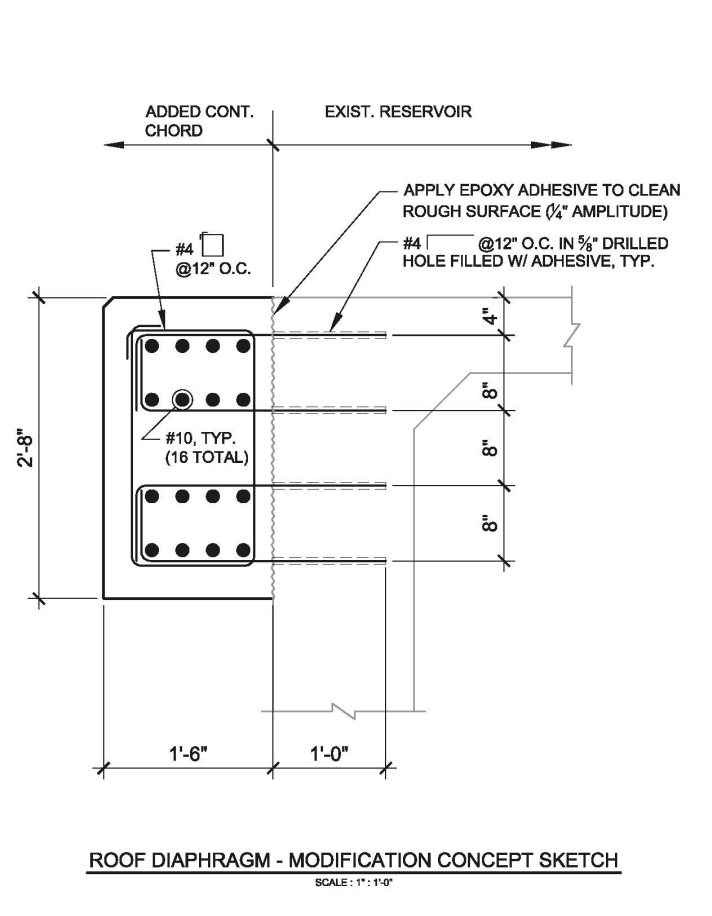
New 60-inch pipeline to achieve CT
Remove baffles to protect the tank
from failure



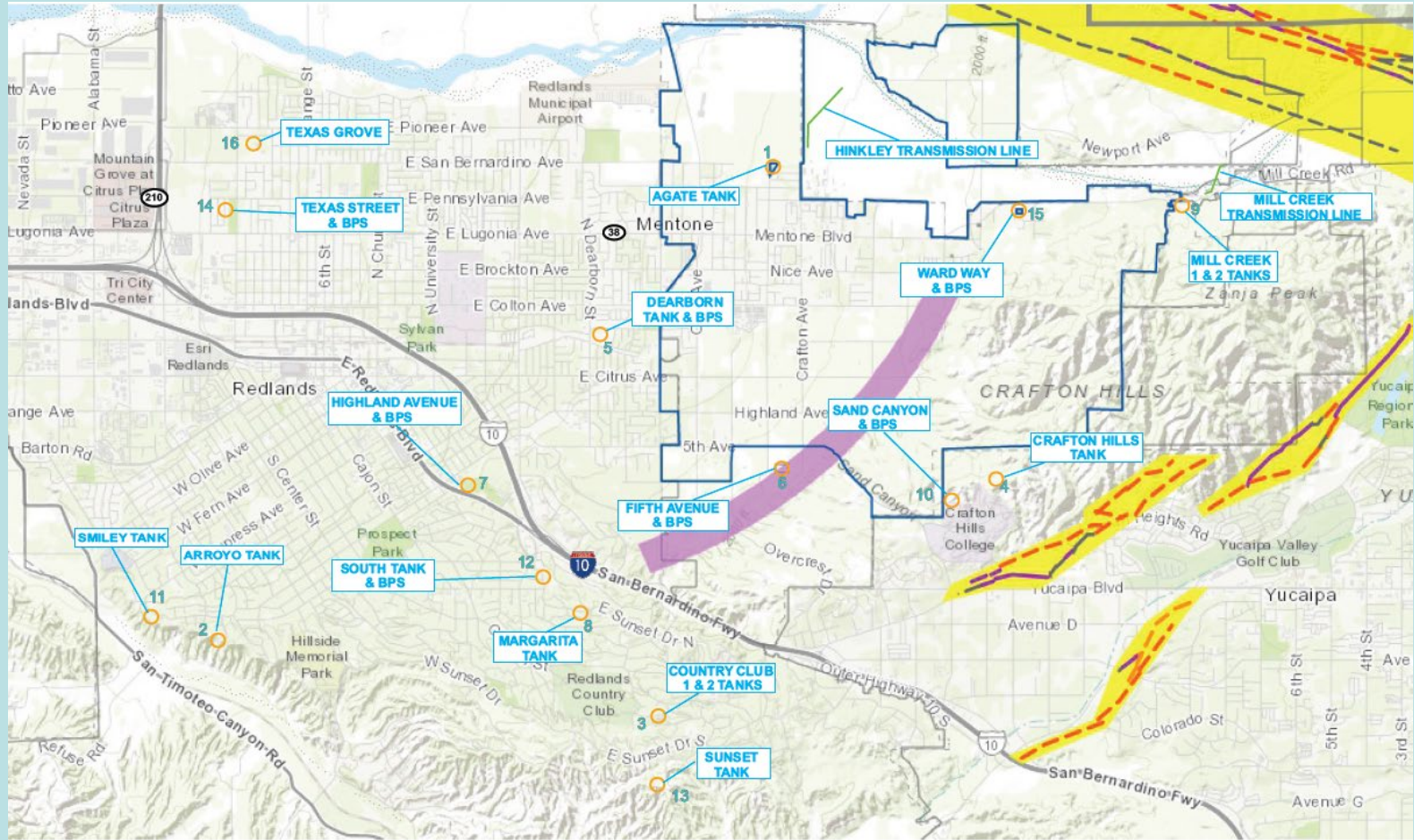
Hypalon curtains shown anchored to the floor



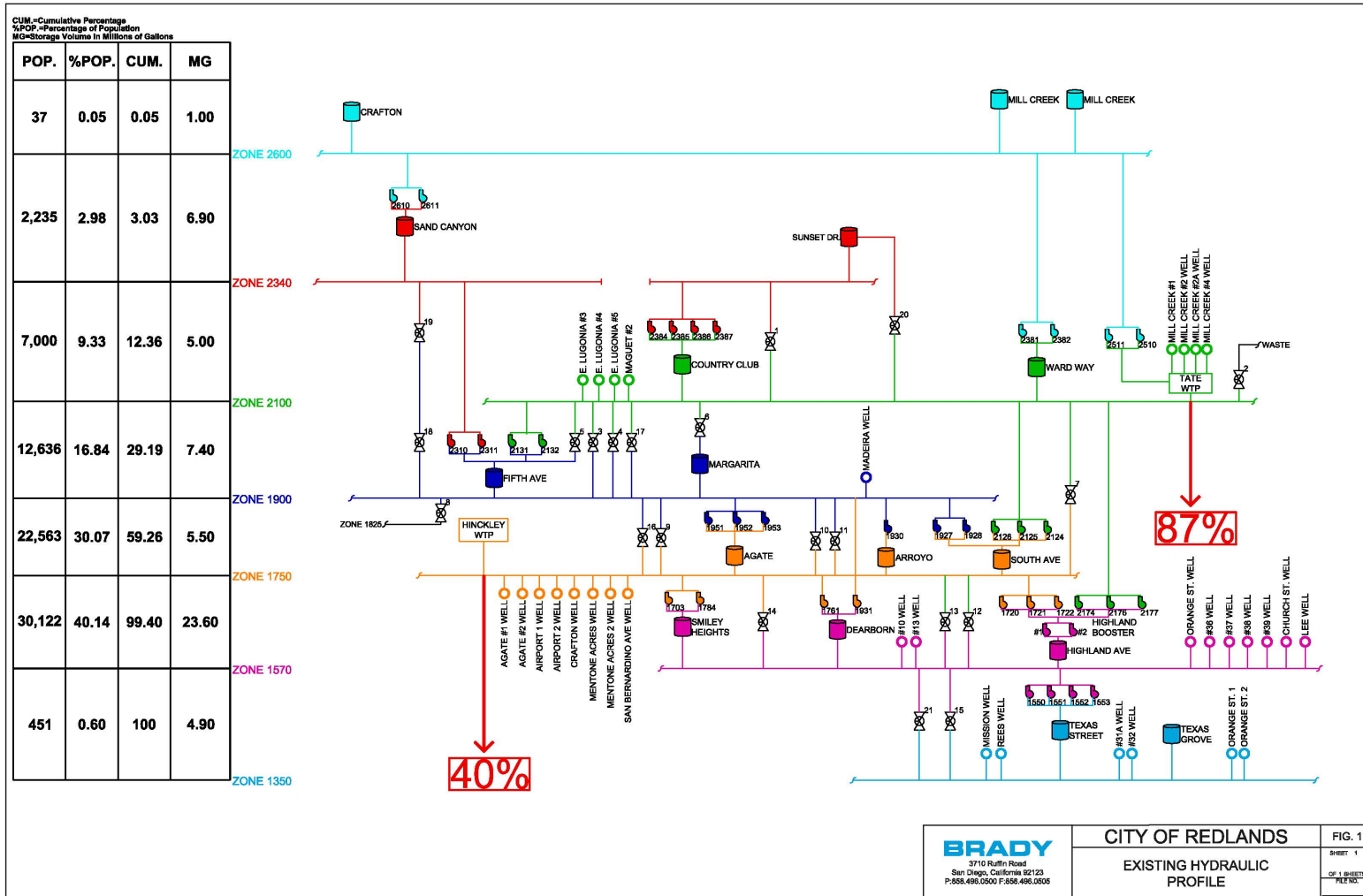
10 MG Highland Reservoir



Surface Fault Rupture Potential Impacts the 5 MG Fifth Avenue Reservoir



Existing Hydraulic Profile



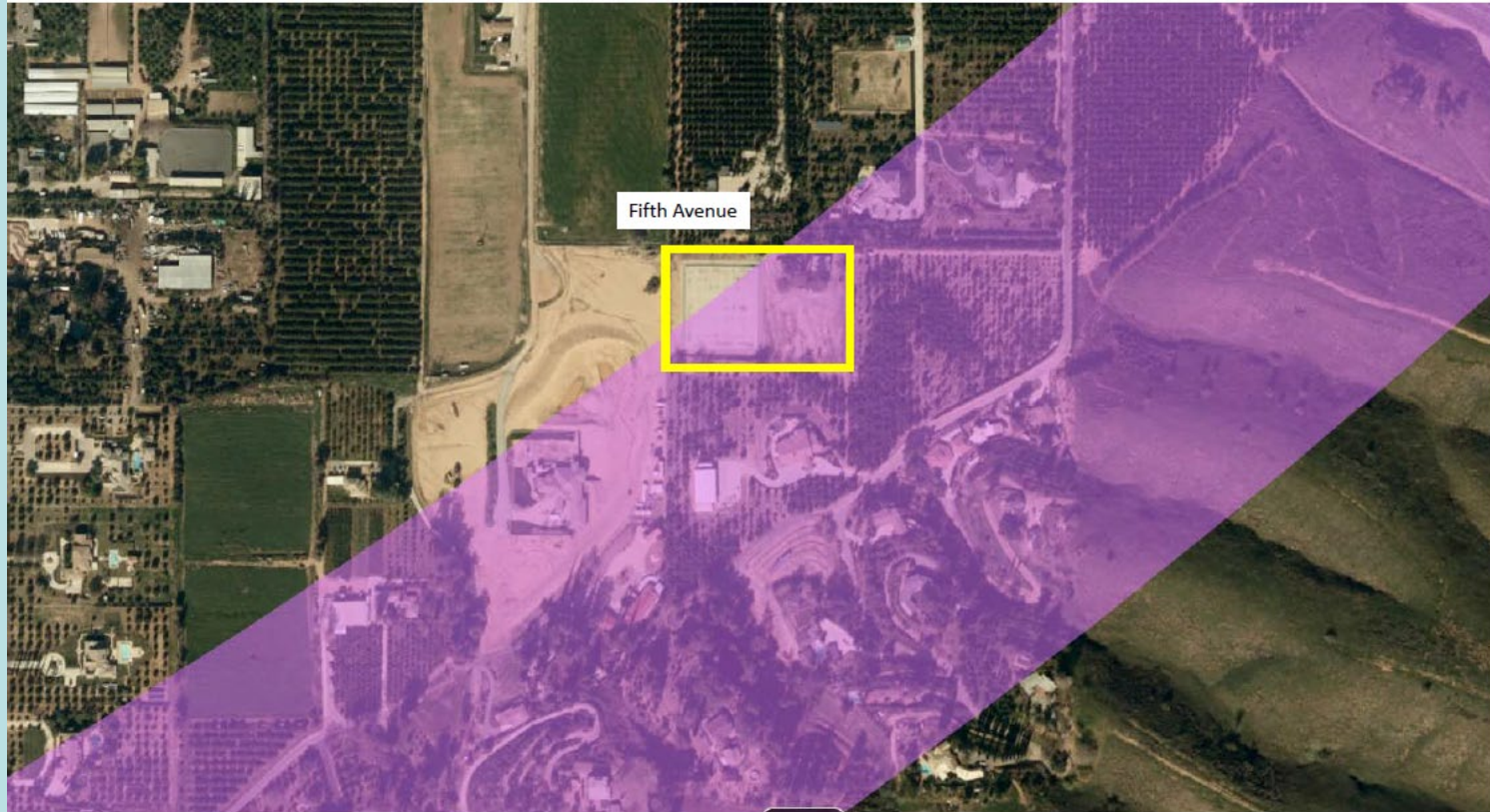
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Reservoir Canyon Fault



County Fault Zone



New Fifth Avenue Reservoir and Pump Station





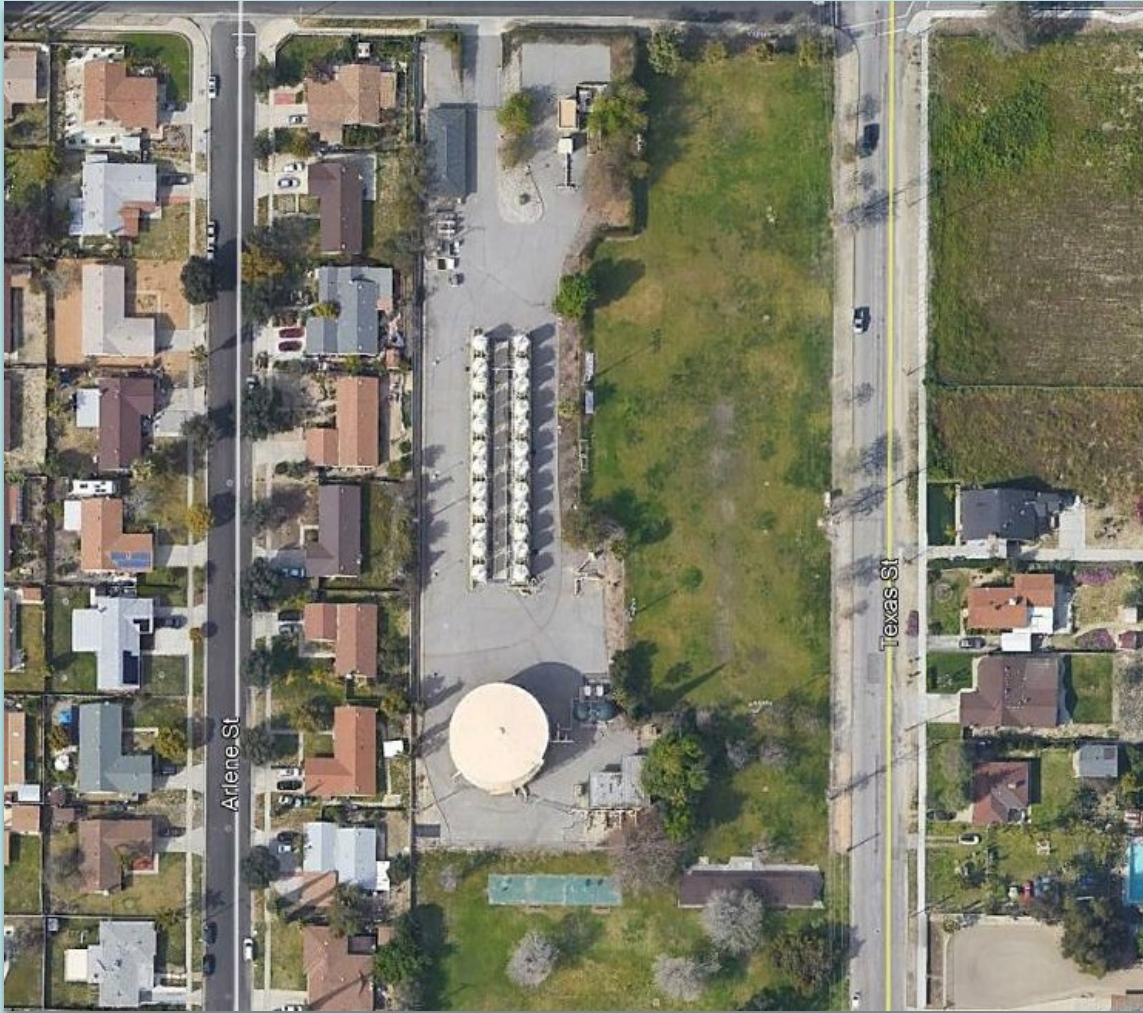
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2.4 MG Margarita Reservoir



1 MG Texas Street Reservoir



10 MG Dearborn and Country Club 1 and 2



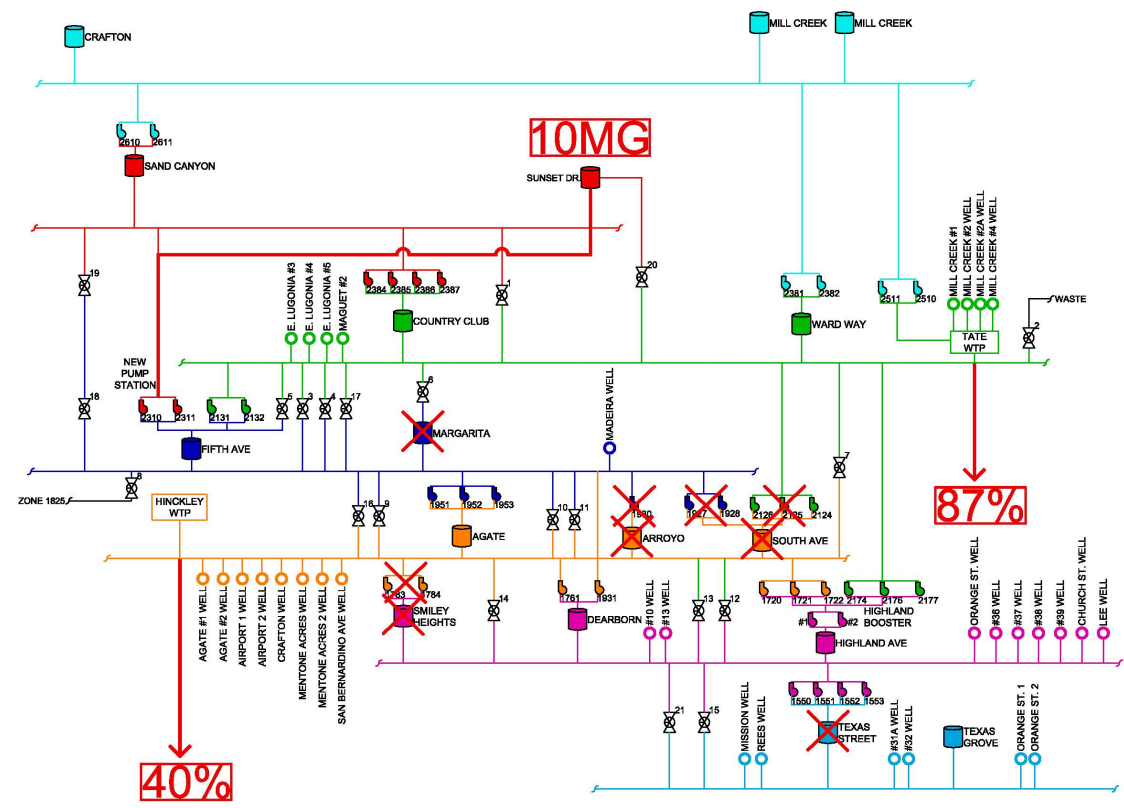
The Next Steps

1. We need a solution to the loss of 6 MG of storage in the City's steel tanks
2. In the interim, when the reservoirs high water elevations are lowered to meet seismic codes, we need to understand the impacts to fire readiness
3. Eventually we need to locate the Reservoir Canyon Fault at the Fifth Avenue Reservoir site
4. As soon as practical, we need to enter the Fifth Avenue Reservoir for a closer look, perform some testing to determine wall thicknesses and reinforcing steel placement
5. Advance the consolidation concept to avoid any further capital investments in the older steel tank infrastructure

CUM.=Cumulative Percentage
 %POP.=Percentage of Population
 MG=Storage Volume in Millions of Gallons

POP.	%POP.	CUM.	MG
37	0.05	0.05	1.00
2,235	2.98	3.03	14
7,000	9.33	12.36	5.00
12,636	16.84	29.19	7.40
22,563	30.07	59.26	5.50
30,122	40.14	99.40	24
451	0.60	100	4.90

ZONE 2600
 ZONE 2340
 ZONE 2100
 ZONE 1900
 ZONE 1750
 ZONE 1570
 ZONE 1350



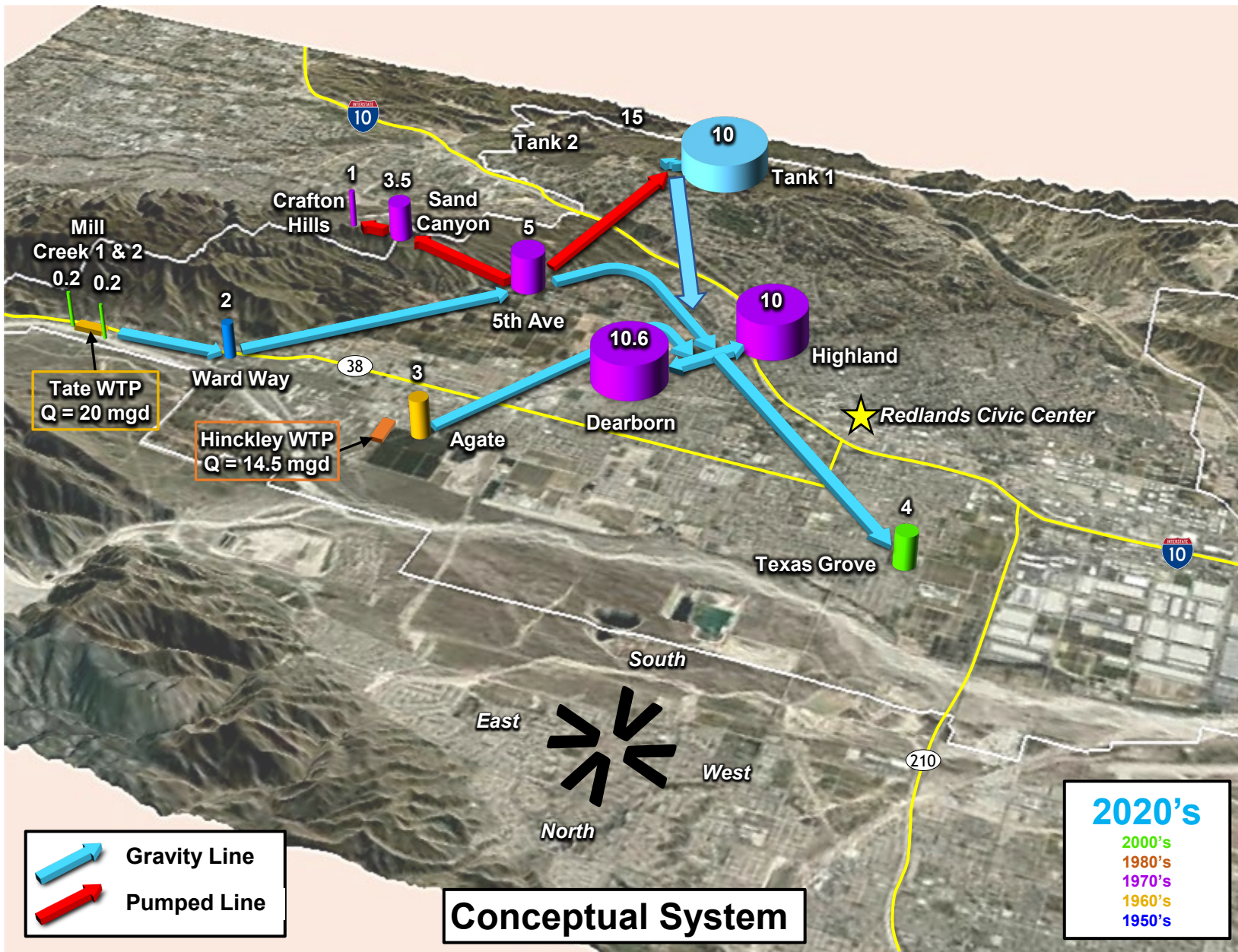
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CITY OF REDLANDS
 FUTURE HYDRAULIC
 PROFILE

FIG. 1
 SHEET 1
 OF 1 SHEETS
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The Big Idea



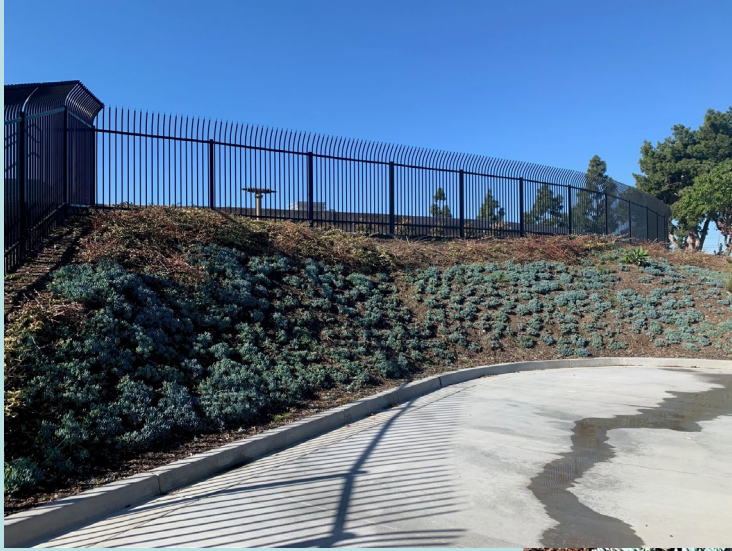


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The End