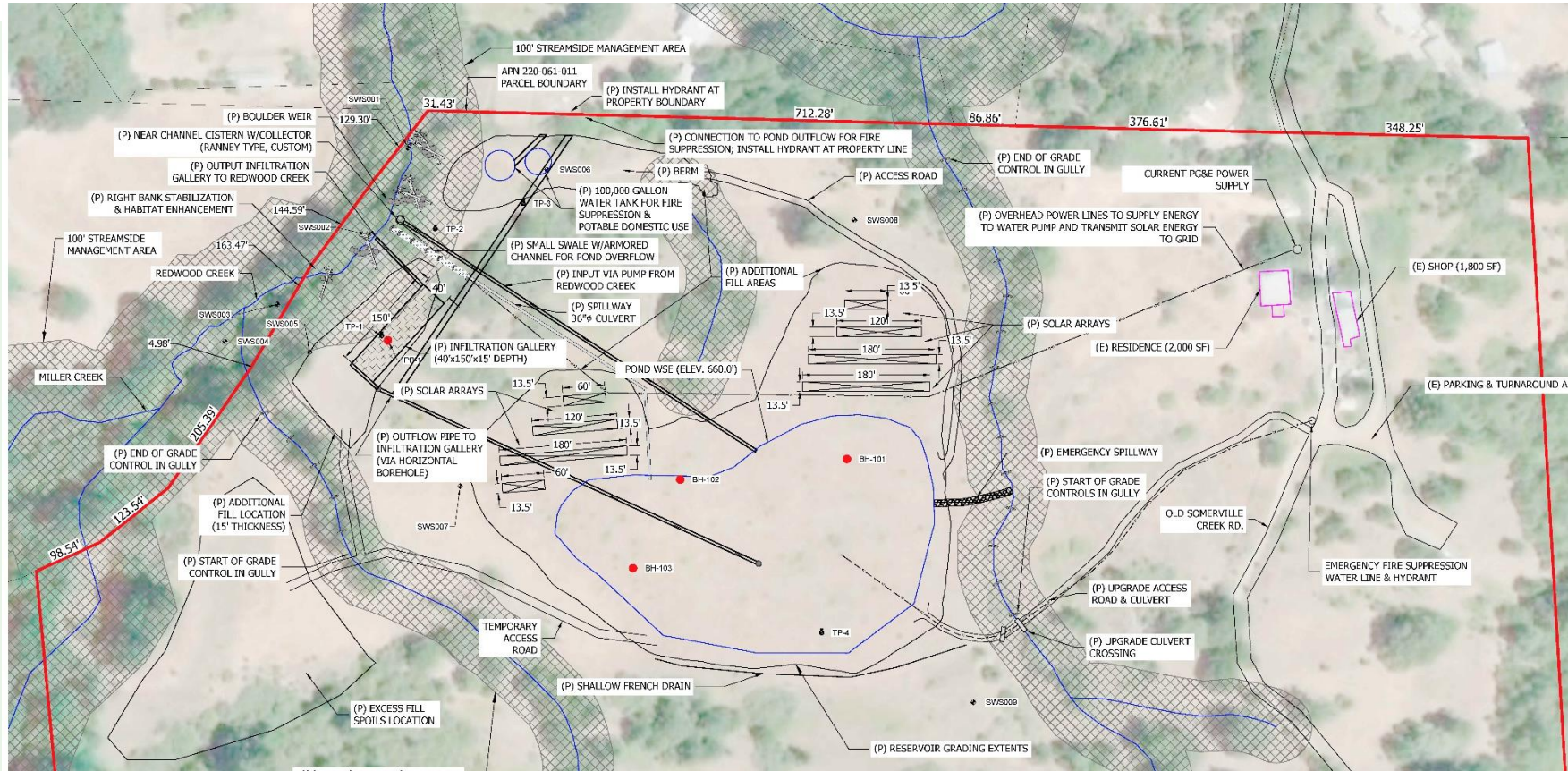


MARSHALL RANCH FLOW ENHANCEMENT PROJECT



Pond Planning and Groundwater Recharge Workshop and Field Tour
Saturday, August 17, 2019 • Beginnings Octagon, Briceland



PROJECT GOAL – DELIVER 50 GALLONS PER MINUTE OF FLOW TO REDWOOD CREEK JULY - NOVEMBER



~50 gal/minute flow in creek

Zero flow conditions occurring for ~3 summer months during typical dry season

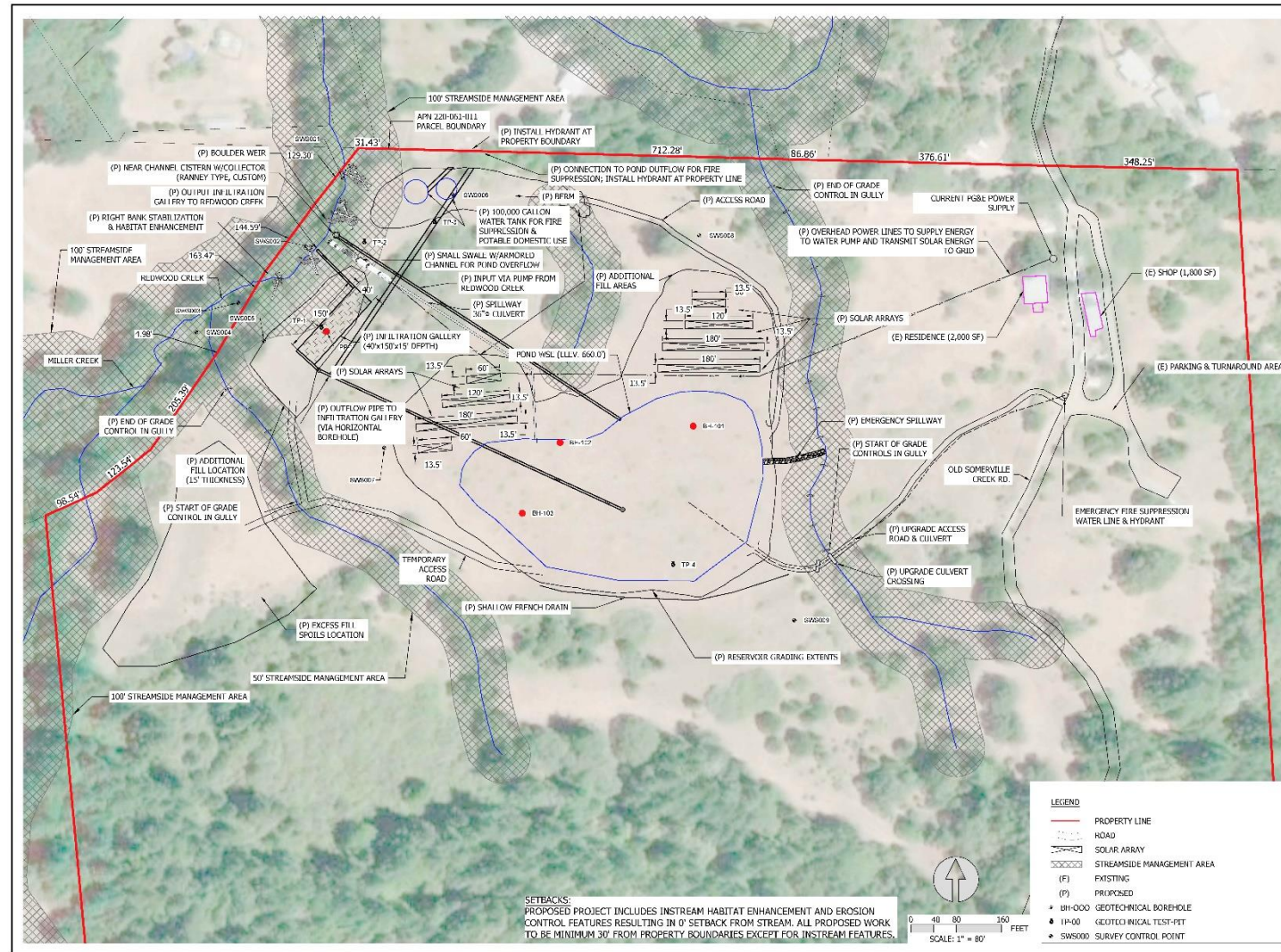


STORAGE POND LOCATION



PROJECT DESIGN OVERVIEW

- 16 million gallon pond
- Input from rainwater catchment and diversion during wet season
- Managed outflow to Redwood Creek
- Gully remediation in adjacent tributaries



MARSHALL RANCH FLOW ENHANCEMENT PROJECT
 APN 220-061-011
 HUMBOLDT COUNTY, CA
Stillwater Sciences
 2855 TELEGRAPH AVENUE, SUITE 400
 BERKELEY, CA 94712 P: (510) 843-8088

PROJECT NUMBER: 603.01
 SCALE: AS NOTED
 DATE: 6/17/2019

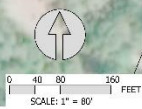
DESIGN: JM
 DRAWN: CL
 CHECKED: JM
 APPROVED: JM

SITE PLAN
 SHEET 3 OF 3

LEGEND

- PROPERTY LINE
- ROAD
- SOLAR ARRAY
- STREAMSIDE MANAGEMENT AREA
- (F) EXISTING
- (P) PROPOSED
- BH-000 GEOTECHNICAL BOREHOLE
- HP-000 GEOTECHNICAL TEST-PT
- SWS000 SURVEY CONTROL POINT

SETBACKS:
 PROPOSED PROJECT INCLUDES INSTREAM HABITAT ENHANCEMENT AND EROSION CONTROL FEATURES RESULTING IN 0' SETBACK FROM STREAM. ALL PROPOSED WORK TO BE MINIMUM 30' FROM PROPERTY BOUNDARIES EXCEPT FOR INSTREAM FEATURES.

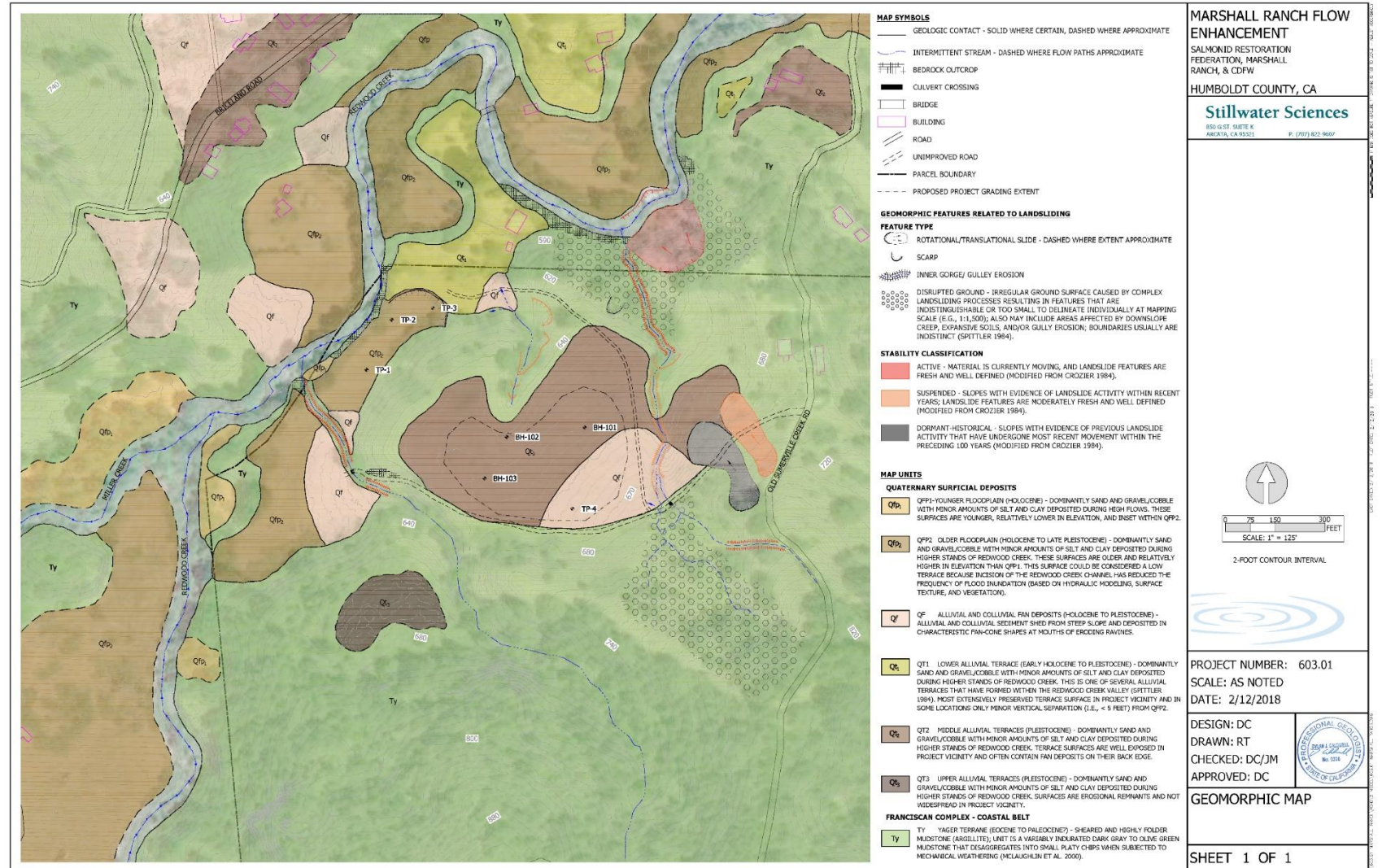


FLOW AUGMENTATION DELIVERY POINT INTO REDWOOD CREEK



GEOMORPHIC ASSESSMENT

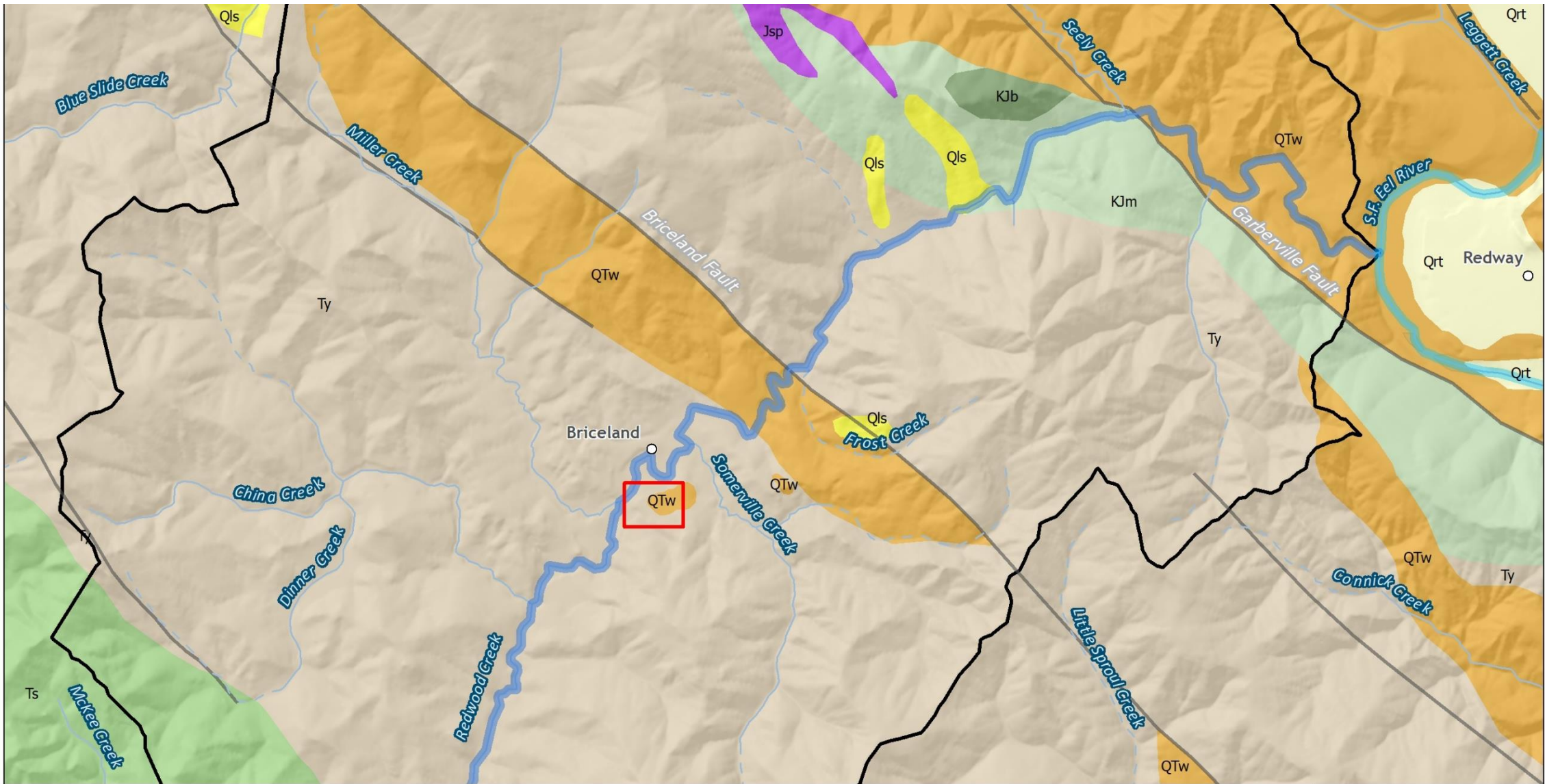
- Identify and characterize site geomorphology and potential hazards
- Assess risks associated with potential hazards
- Support opportunities and constraints assessment
- Inform project designs



GEOMORPHIC ASSESSMENT

Assessment Approach

- Topographic survey integrated with 2007 NCALM LiDAR
- Existing data review
 - Geologic mapping
(McLaughlin et al. 2000 - USGS Miscellaneous Field Studies MF-2336)
 - Geomorphic/landslide mapping
(Spittler 1984 - DMG Open-File Report 84-10)
 - Historical aerial photos
(1942, 1947, 1954, 1963, 1965, 1984, 1988, 1996, 2000, 2005, 2009, 2010, 2012, 2014)
- Geomorphic mapping and site assessment
- Geotechnical investigation



Geologic Map

Lithologic Units

- Quaternary and Tertiary Overlap Deposits
- Landslides (Qls)
- River terrace (Qrt)
- Wildcat Group (QTw)

Franciscan Complex

- Sandstone (Ts)
- Yager terrane (Ty)
- Melange (KJm)
- Broken formation (KJb)

Coast Range Ophiolite

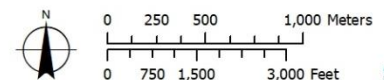
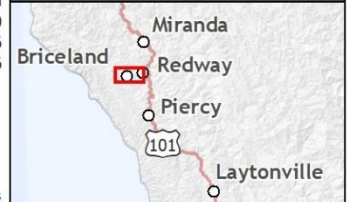
- Del Puerto terrane
- Serpentinized peridotite (Jsp)

- Project Site
- Redwood Creek Watershed
- Quaternary Faults

- ~ Redwood Creek
- ~ S.F. Eel River
- ~ Stream - Perennial
- ~ Stream - Intermittent

Map Sources:
 Geology: Modified from McLaughlin et al. 2000
 Rivers, Cities, Roads: ESRI 2016
 Quaternary Faults: USGS 2006

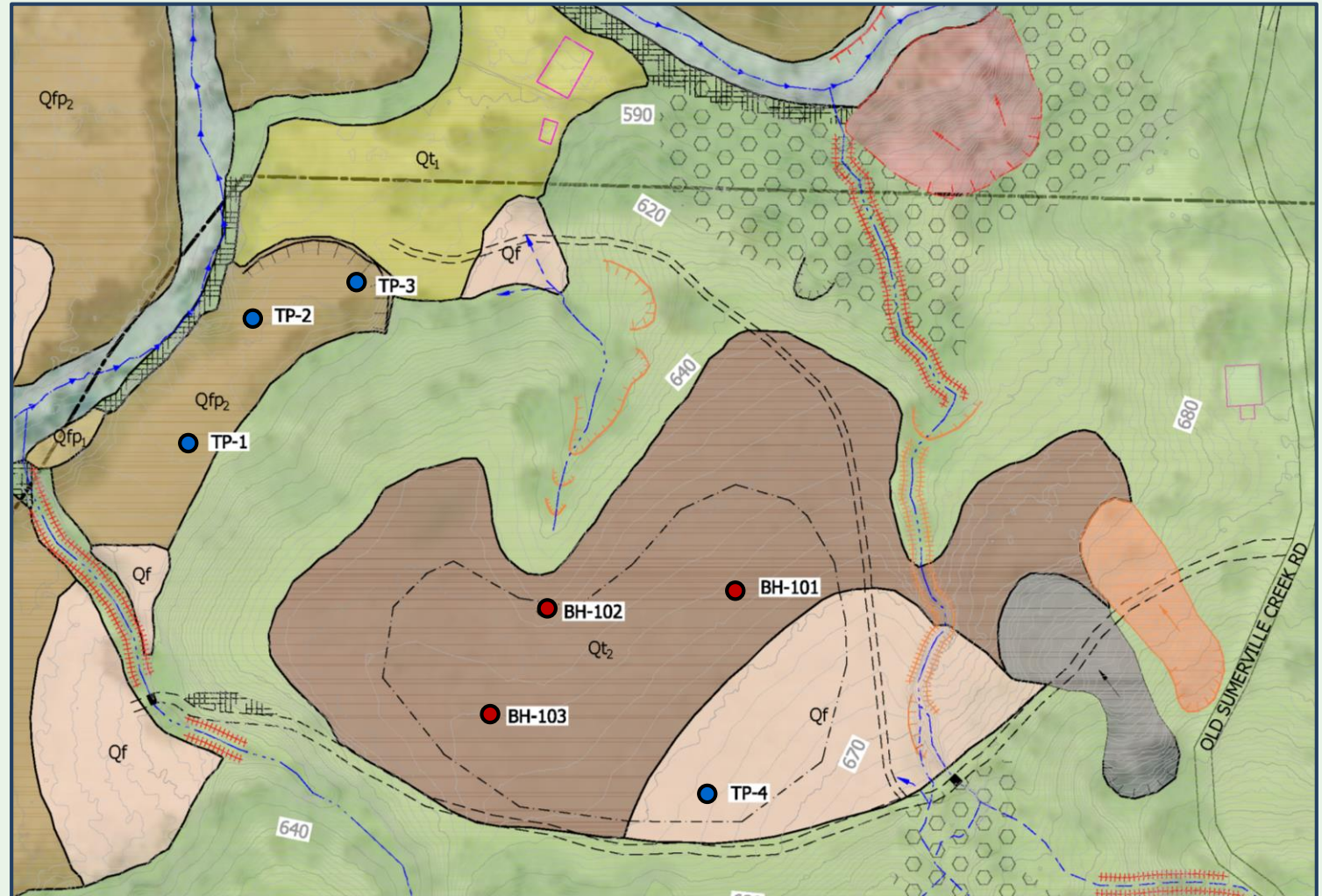
Map Location



Stillwater Sciences

GEOTECHNICAL INVESTIGATION

- Three deep (~50 ft) geotechnical borings on Qt_2
- Three ~10 ft deep test pits on Qfp_2
- One ~10 ft test pit on Qt_2
- Six groundwater wells with data loggers

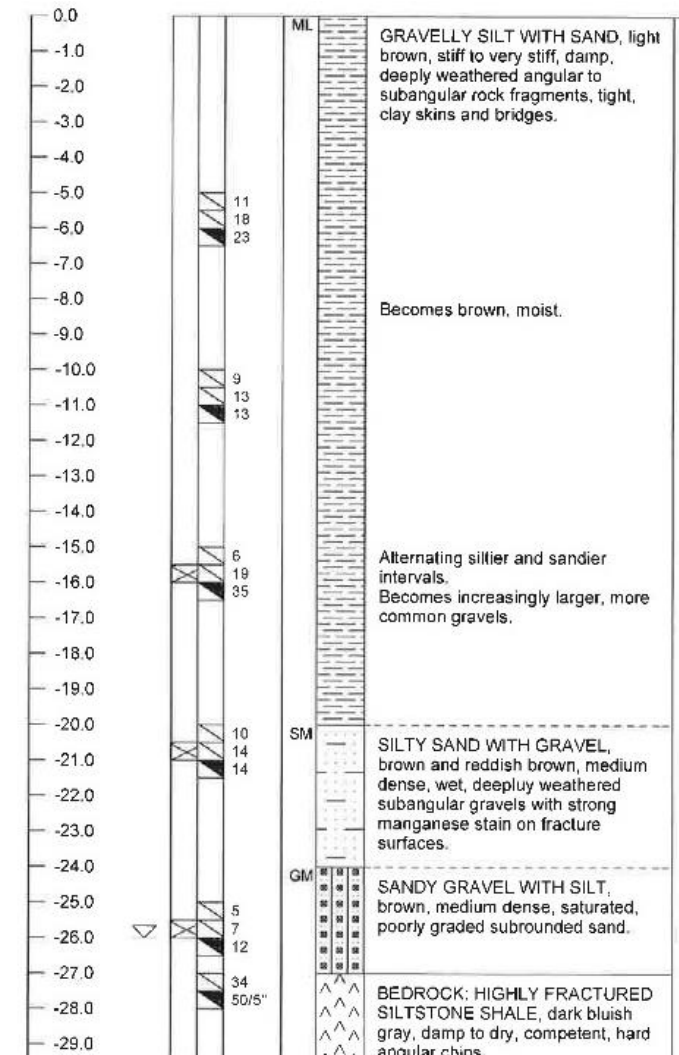


GEOTECHNICAL INVESTIGATION

Geotechnical borings on Qt_2

- 8-19 ft deposit of silt with sand (overbank deposit)
- Approximately 8 ft fining upward deposit of silty sand with gravel (channel lag fining upward into overbank deposit)
- Fractured siltstone shale bedrock 16-27 ft below ground surface (629-633 ft elevation)
- Hydraulic conductivity $\sim 3 \times 10^{-7}$ to 8×10^{-6} cm/sec (very slowly permeable)

BH-101

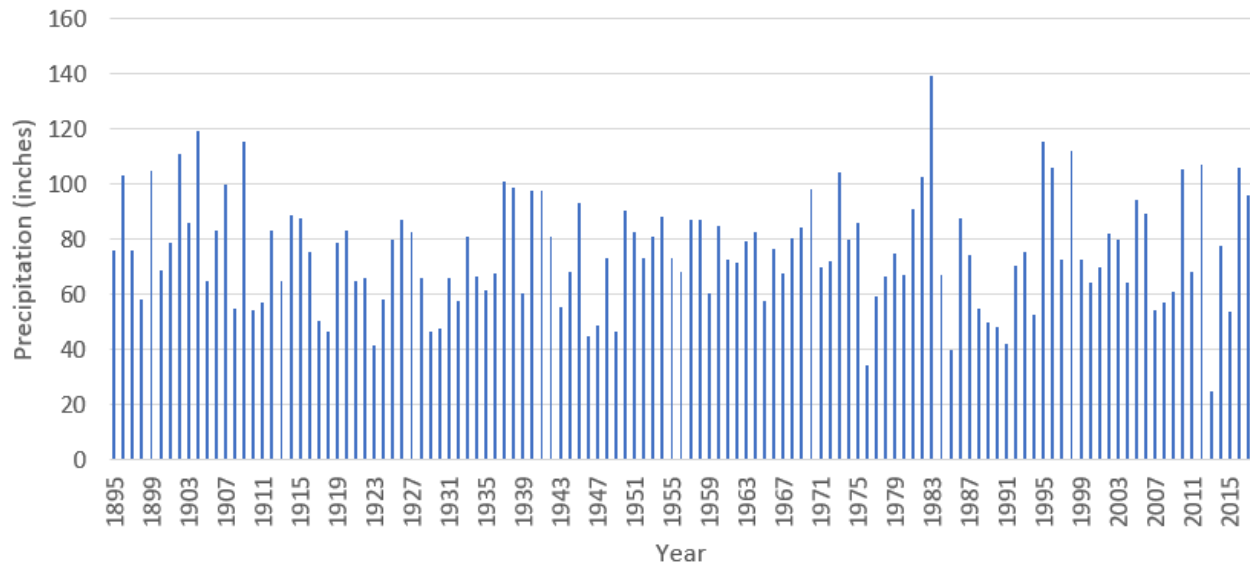


HYDROLOGIC EVALUATION

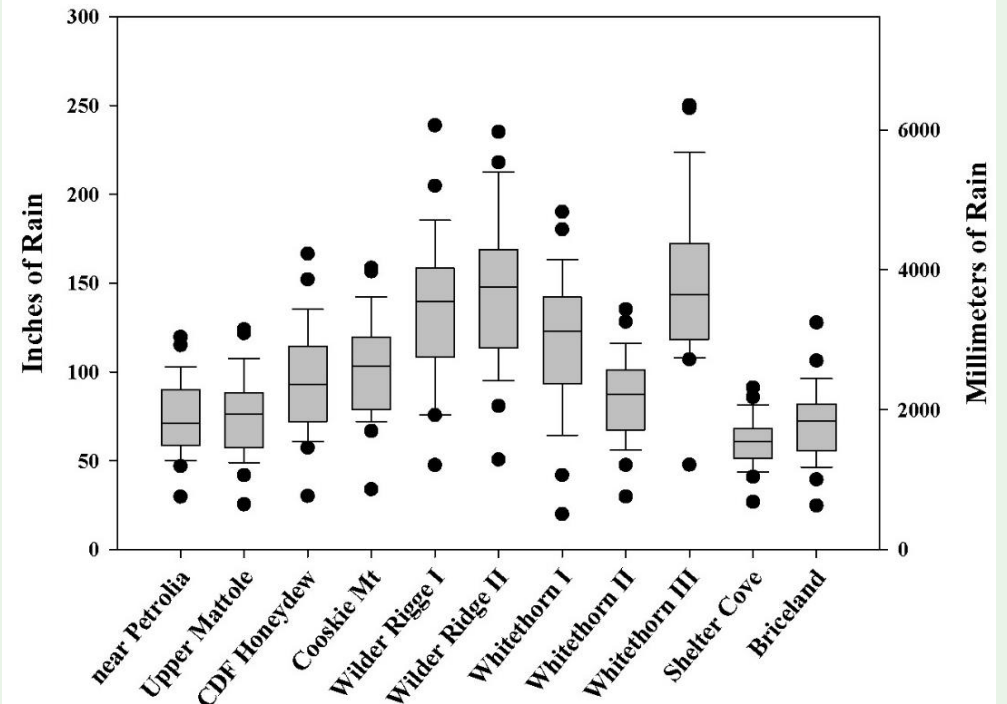
FILLING RESERVOIR:

- Determine minimum annual precipitation
- Data sources:
 - Mattole Restoration Council
 - PRISM
- 5th percentile = 45"; we are using 48"

Briceland Annual Precipitation (interpolated from PRISM)

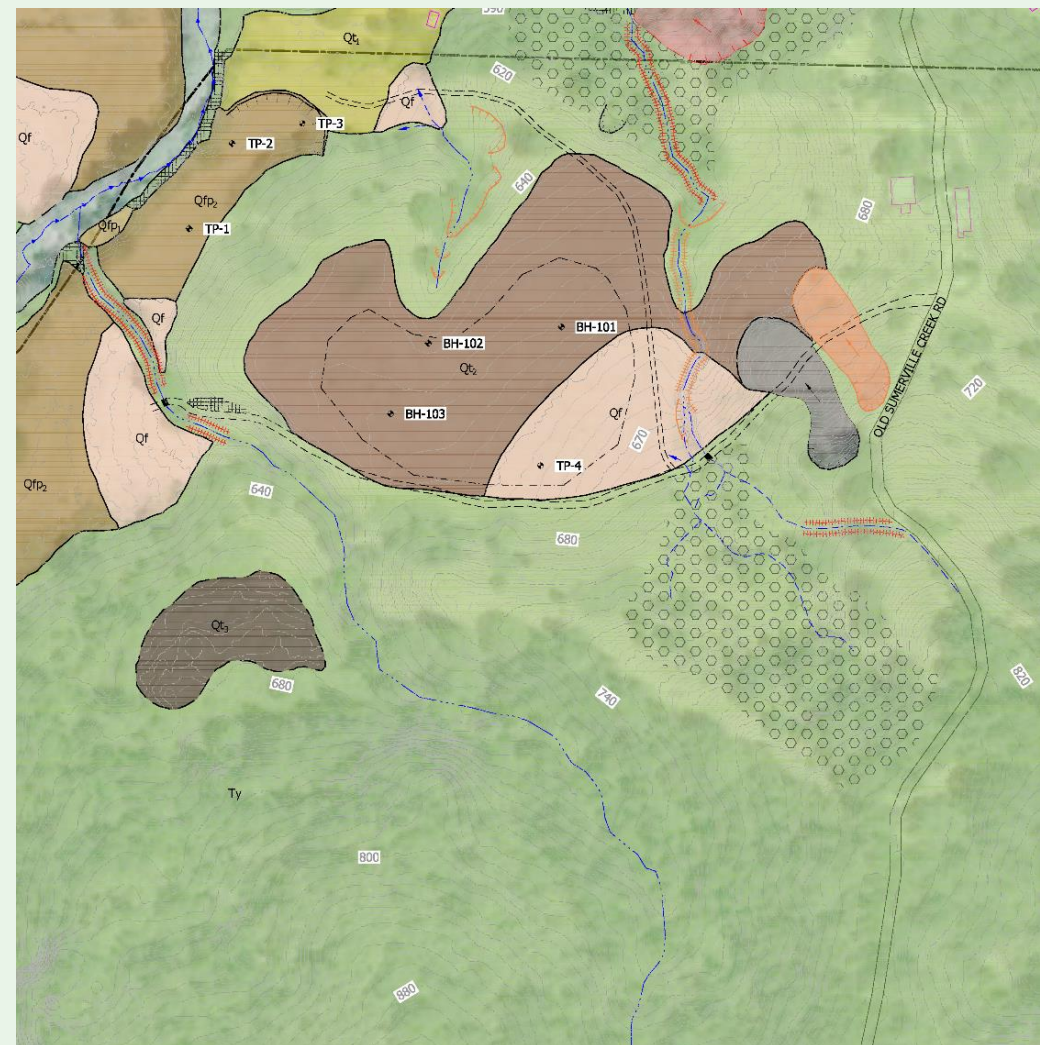


Rainfall, 1953-1990



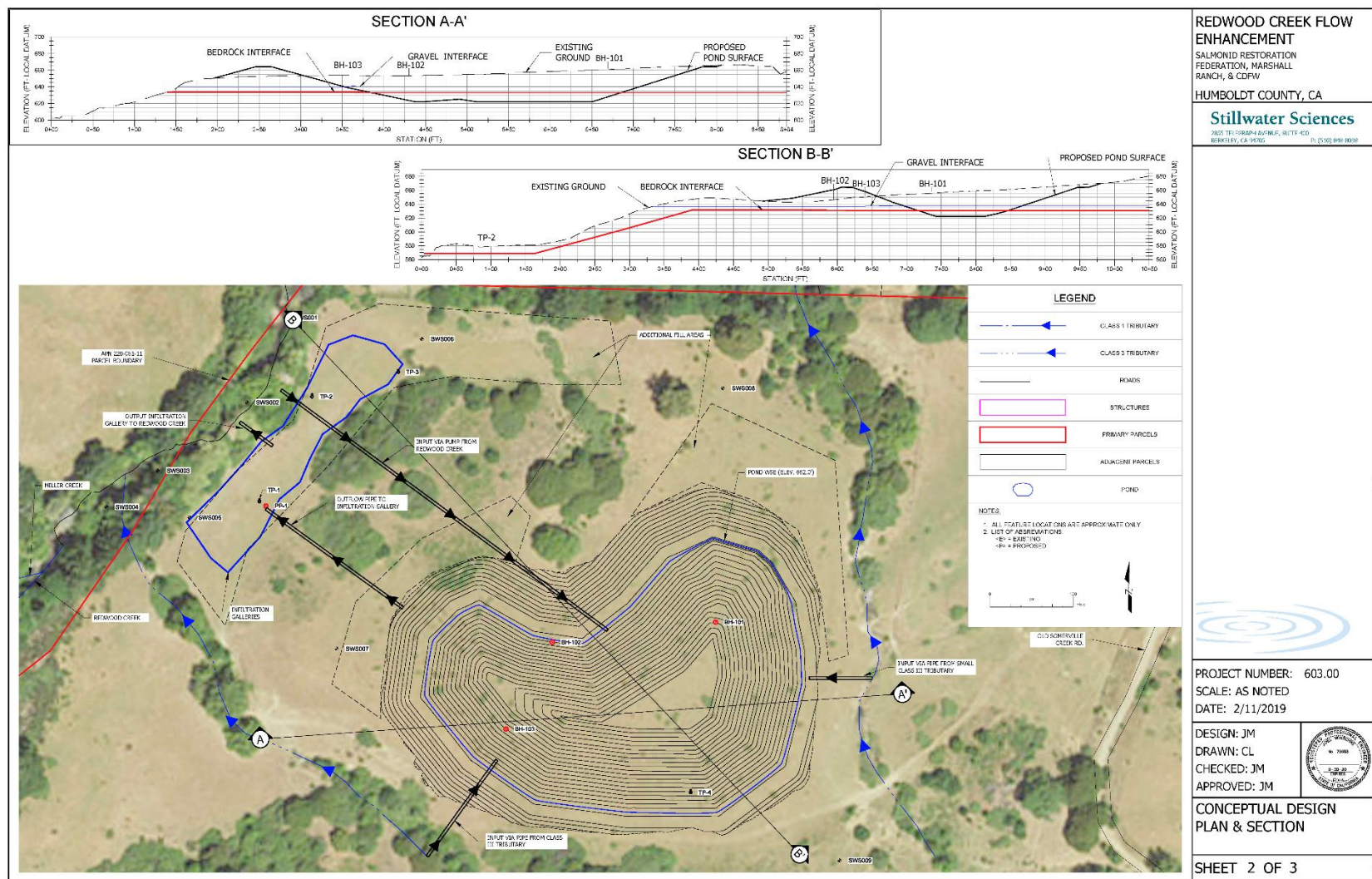
HYDROLOGIC EVALUATION

SOURCE TO FILL RESERVOIR	POTENTIAL PRODUCTION (MILLION OF GALLONS)
Direct Rainfall	6
Sheet Flow from Hillslope (2.5 acres, C=0.4)	1.3
Diversion from Eastern Tributary (20 acres, C=0.2)	1.1
Diversion from Western Tributary (20 acres, C=0.2)	5.2
Diversion from Redwood Creek (60 gpm for 90 days)	7.8
Total	21.4



DESIGN ALTERNATIVES

- Up to ~21.5 million gallon pond
- Input from multiple sources
- Outflow to filtration/cooling gallery, then to Redwood Creek
- Passive or managed outflow?
- Gully remediation in adjacent tributaries



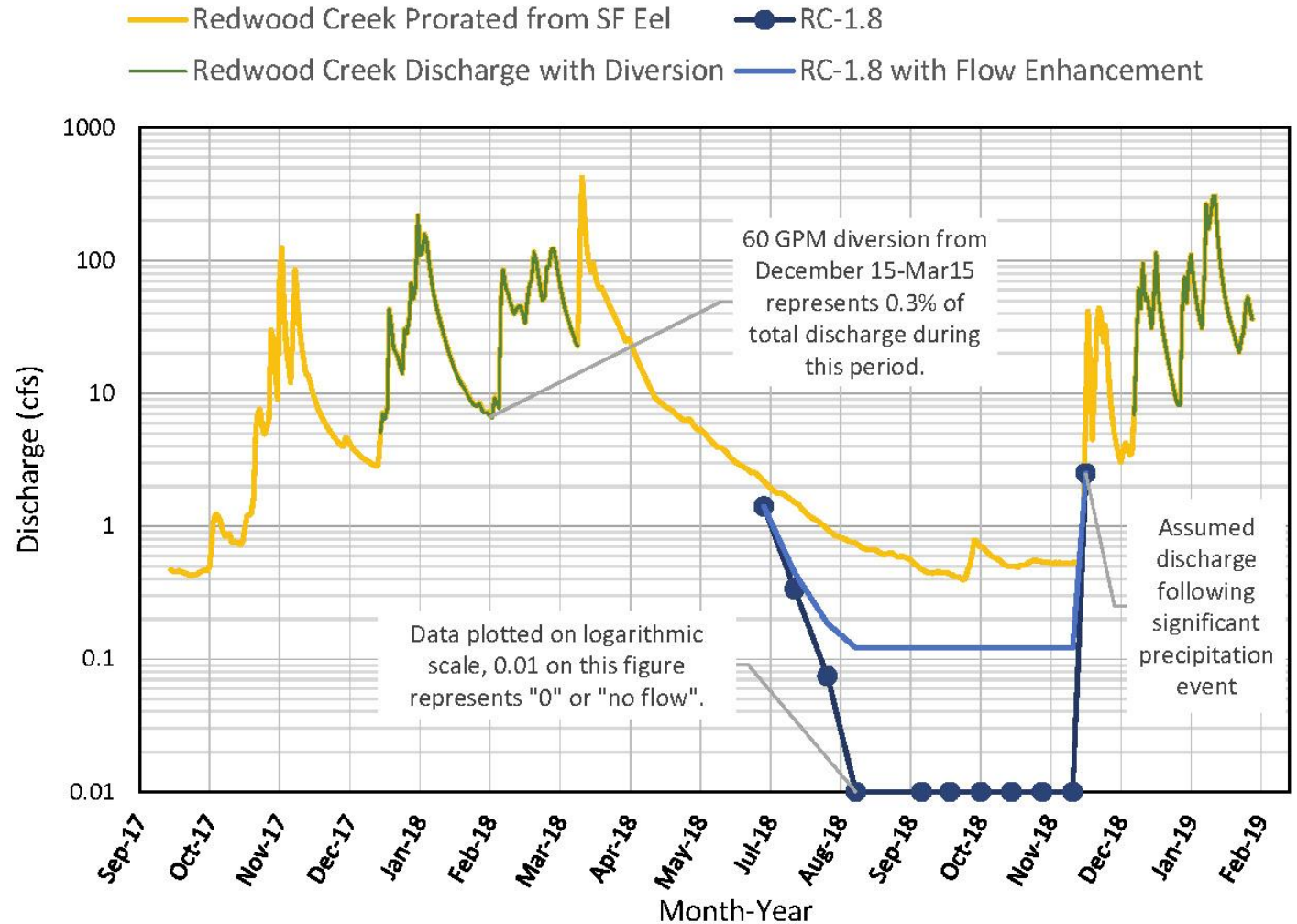
REDWOOD CREEK FLOW ENHANCEMENT
 SALMONID RESTORATION FEDERATION, MARSHALL RANCH, & CDFW
 HUMBOLDT COUNTY, CA
Stillwater Sciences
 2025 TELLER AVENUE, SUITE 400
 BERKELEY, CA 94704

DESIGN ALTERNATIVES

POND VOLUME (MILLIONS OF GALLONS)	POND VOLUME MINUS EVAPO-RATION LOSS (MILLIONS OF GALLONS)	FLOW BENEFIT WITH MECHANIZED OUTFLOW VALVE, ASSUMES 5 MONTH RELEASE TIME (GPM)	FLOW BENEFIT WITH PASSIVE OUTFLOW, ASSUMES 8 MONTH RELEASE TIME (GPM)	COMMENTS
6.0	4.0	19	12	Fills with rainfall only
8.5	5.7	26	16	Fills with rainfall, hillslope, and eastern tributary
13.5	9.0	42	26	Fills with rainfall, hillslope, eastern tributary, and western tributary
16.3	10.9	50	31	Fills with rainfall, hillslope, eastern tributary, and water pumped from Redwood Creek
21.5	14.3	66	41	Maximum capacity based on site and hydrologic constraints

EXPECTED STREAM FLOW RESULTS

Graphic representation of post-project hydrograph



ADDITIONAL PROJECT COMPONENTS

- **Water Rights - need appropriate water right to fill pond from diversion**
- **This project fits into broader conservation efforts on the Marshall Ranch with the entire ownership under protection with a Conservation Easement**
- **Operations and Maintenance - Solar array added to project to cover long term O&M**
- **Emergency Fire Suppression Integration - Working with BVFD to include fire suppression component - additional tanks and pump system included in overall plan; will seek funding from additional sources**

CURRENT PROJECT STATUS

- Currently developing 65% engineering design plans; CEQA permitting process also underway
- Apply for construction/implementation grant funding in September
- Start of construction target date: June 2021

GENERAL POND PLANNING AND DESIGN CONSIDERATIONS

- **Choosing pond location:**
 - Gentle/stable terrain
 - No drainages or wetlands
- **Sizing pond**
 - Estimate water use
 - Site constraints
 - How to fill pond
- **Lined or unlined?**
- **Permitting:**
 - typically only need Grading Permit from Humboldt County
- **Issues with cannabis**

