Geotechnical Site Characterization:
Overview of How Caltrans Performs and Determines Site Conditions

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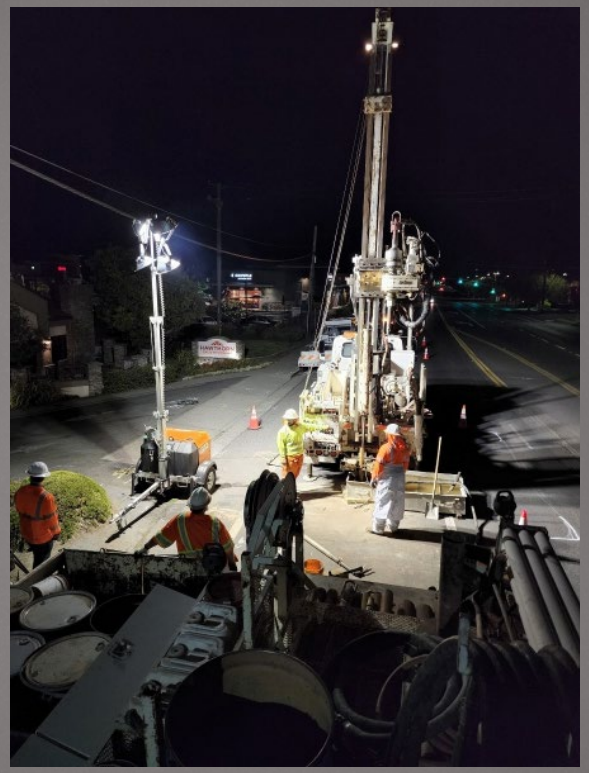
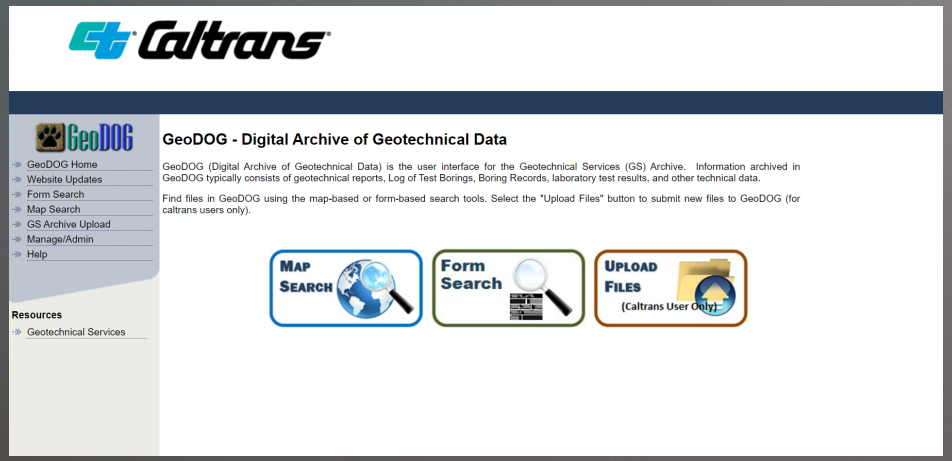
Objectives/ Agenda

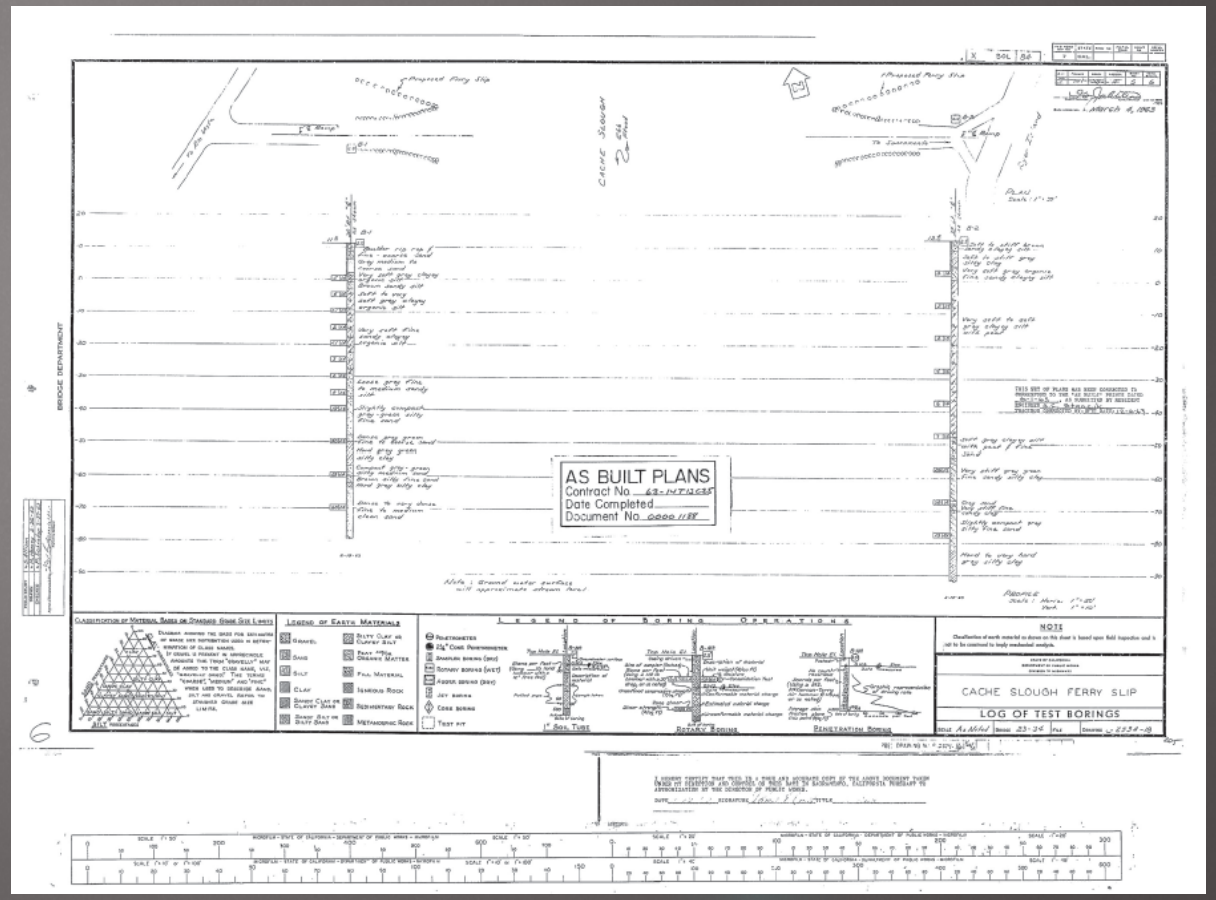
- Understanding of the Geotechnical Process
- Types of site condition challenges that can be encountered
- How Geotechnical Services Manages Risk
- Ongoing Continual Improvement



Developing a Site Investigation Plan

- Review of existing records
  - Maps
  - Literature
  - Log of Test Borings (LOTB's)
  - Reports





Planning Borings

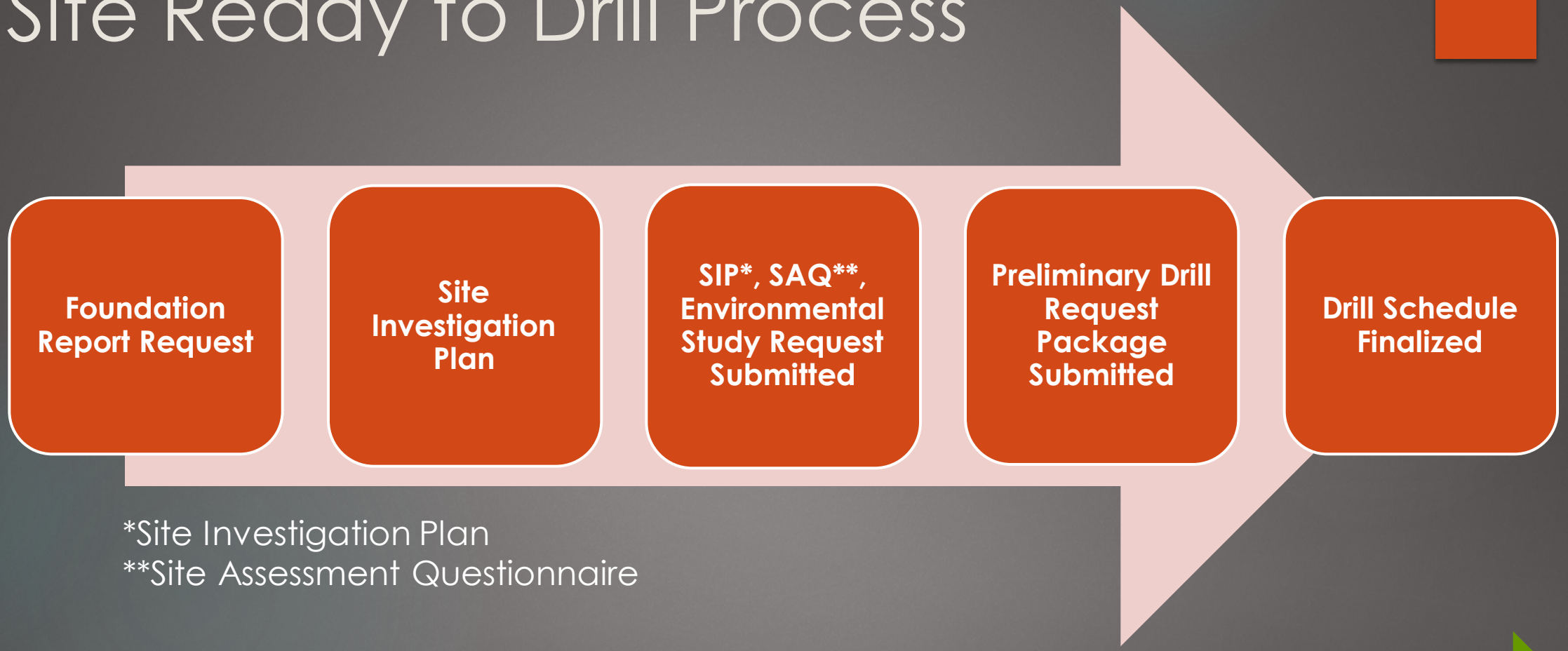
- Number, locations, and depths
- AASHTO LRFD BDS Section 10.4.2, Subsurface Exploration

- Internal Guidance
- Geotechnical Manual
  - Geotechnical Investigations Module

Table 10.4.2-1—Minimum Number of Exploration Points and Depth of Exploration (modified after Sabatini et al., 2002)

Application	Minimum Number of Exploration Points and Location of Exploration Points	Minimum Depth of Exploration
Retaining Walls	A minimum of one exploration point for each retaining wall. For retaining walls more than 100 ft in length, exploration points spaced every 100 to 200 ft with locations alternating from in front of the wall to behind the wall. For anchored walls, additional exploration points in the anchorage zone spaced at 100 to 200 ft. For soil-nailed walls, additional exploration points at a distance of 1.0 to 1.5 times the height of the wall behind the wall spaced at 100 to 200 ft.	Investigate to a depth below bottom of wall at least to a depth where stress increase due to estimated foundation load is less than ten percent of the existing effective overburden stress at that depth and between one and two times the wall height. Exploration depth should be great enough to fully penetrate soft highly compressible soils, e.g., peat, organic silt, or soft fine grained soils, into competent material of suitable bearing capacity, e.g., stiff to hard cohesive soil, compact dense cohesionless soil, or bedrock.
Shallow Foundations	For substructure, e.g., piers or abutments, widths less than or equal to 100 ft, a minimum of one exploration point per substructure. For substructure widths greater than 100 ft, a minimum of two exploration points per substructure. Additional exploration points should be provided if erratic subsurface conditions are encountered.	Depth of exploration should be: • great enough to fully penetrate unsuitable foundation soils, e.g., peat, organic silt, or soft fine grained soils, into competent material of suitable bearing resistance, e.g., stiff to hard cohesive soil, or compact to dense cohesionless soil or bedrock ; • at least to a depth where stress increase due to estimated foundation load is less than ten percent of the existing effective overburden stress at that depth; and • if bedrock is encountered before the depth required by the second criterion above is achieved, exploration depth should be great enough to penetrate a minimum of 10 ft into the bedrock, but rock exploration should be sufficient to characterize compressibility of infill material of near-horizontal to horizontal discontinuities. Note that for highly variable bedrock conditions, or in areas where very large boulders are likely, more than 10 ft or rock core may be required to verify that adequate quality bedrock is present.
Deep Foundations	For substructure, e.g., bridge piers or abutments, widths less than or equal to 100 ft, a minimum of one exploration point per substructure. For substructure widths greater than 100 ft, a minimum of two exploration points per substructure. Additional exploration points should be provided if erratic subsurface conditions are encountered, especially for the case of shafts socketed into bedrock. To reduce design and construction risk due to subsurface condition variability and the potential for construction claims, at least one exploration per shaft should be considered for large diameter shafts (e.g., greater than 5 ft in diameter), especially when shafts are socketed into bedrock.	In soil, depth of exploration should extend below the anticipated pile or shaft tip elevation a minimum of 20 ft, or a minimum of two times the minimum pile group dimension, whichever is deeper. All borings should extend through unsuitable strata such as unconsolidated fill, peat, highly organic materials, soft fine-grained soils, and loose coarse-grained soils to reach hard or dense materials. For piles bearing on rock, a minimum of 10 ft of rock core shall be obtained at each exploration point location to verify that the boring has not terminated on a boulder. For shafts supported on or extending into rock, a minimum of 10 ft of rock core, or a length of rock core equal to at least three times the shaft diameter for isolated shafts or two times the minimum shaft group dimension, whichever is greater, shall be extended below the anticipated shaft tip elevation to determine the physical characteristics of rock within the zone of foundation influence. Note that for highly variable bedrock conditions, or in areas where very large boulders are likely, more than 10 ft or rock core may be required to verify that adequate quality bedrock is present.

Site Ready to Drill Process



*Site Investigation Plan
**Site Assessment Questionnaire

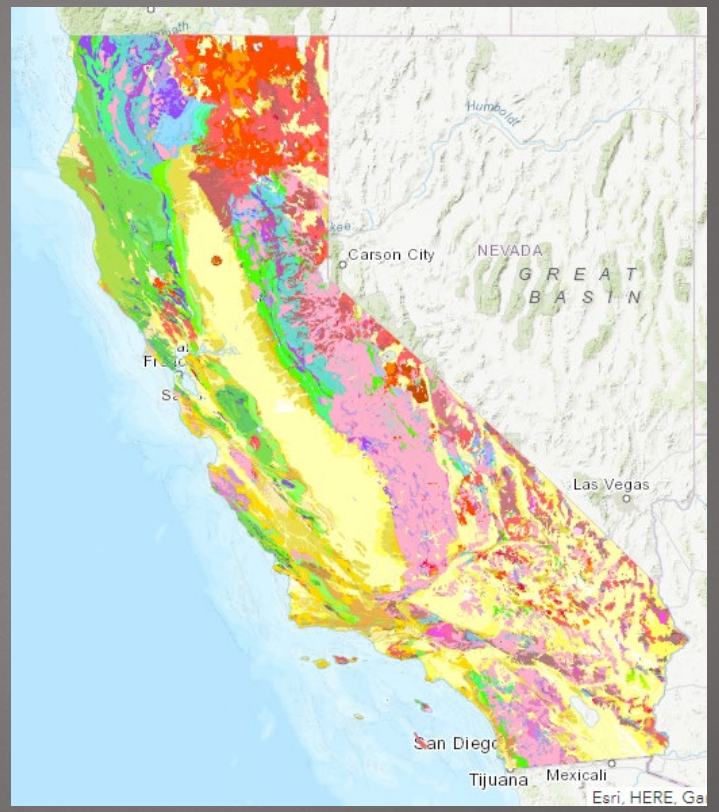
Best Case Scenario- 3-4 Months

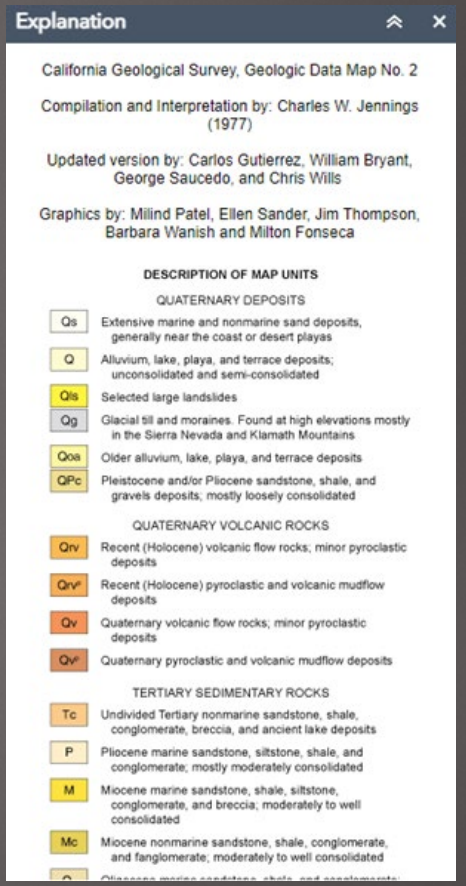
Average Scenario- 6-9 Months

Worst Case Scenario- 12-36 Months

Planning for Site Conditions

- Research of site (past/present)
  - As built data/Geology Map
  - Drilled Borings/Cone Penetrometer Testing (CPT)/Seismic Refraction/ Groundwater Elevations
- Physical Challenges to Borings
  - Steep and mountainous terrain
  - Highly variable geology in California
- Logistical/ Administrative Challenges to Borings
  - Obtaining Environmental Clearances/ Permits
    - Categorical Exemptions/ Categorical Exclusions (CE/CE)
  - Lane Closures
  - Well Drilling Permit/ Local Enforcement Agencies (LEA)





Types of Differing Site Conditions

- Man made buried objects
- Unanticipated boulders/ cobbles
- Caving soils
- Unanticipated groundwater
- Complex geology (shear zones, faults, bedding contacts)
- Rock too hard/ rock matrix too weak
- Inadequate bearing capacity
- Geology encountered at the site doesn't match boring logs
- Contaminated Ground water (District Environmental would take Lead)

Geotechnical Risk Management

- Cost/ Time
- Alternatives to Contract Change Order (CCO)- Value Engineering Change Proposal (VCEP)
- Project Risk Register
  - Environmental or Right of Way restrictions that require Geotechnical Services to extrapolate
  - Late project changes

- Examples of Situations where we take a Calculated Risk
  - Overhead Sign Structures
  - Soundwalls
  - Culverts

Process Improvements

- Geotechnical Services Quality Management System → Continual Improvement
- Guidance/Documented Processes/Procedures/Policy
  - Dewatering Module- In Progress, est June 2024
  - Collapsible Soils Module- Feb 2024
  - Below Grade Structure Module- November 2023
  - Groundwater Module- 2023
- Lessons Learned/ Root Cause Analysis
- Project Risk Management Training

Questions/ Discussion