San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

CONCEPTUAL ENGINEERING REPORT (CER)

Prepared for:

San Francisco Public Utilities Commission
525 Golden Gate Avenue, 9th Floor
San Francisco, California 94102

Prepared by:

SFPW – Infrastructure Design and Construction
Design and Engineering/Hydraulic Engineering Section
Project ID – CWWSIPFCDB14

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Department/Bureau	Name	Signature	Date
SFPW Project Engineer (Planning)	Chung Linh	[signature]	4/9/18
SFPW Hydraulic Section Manager	Lesley Wong	[signature]	4/9/18
SFPW Regional Project Engineer	Iqbal Dhapa	[signature]	4/9/18
SFPUC Project Manager	Saed Toloui	[signature]	4/24/18
Wastewater Enterprises OEM Representative	Ed Ho	[signature]	5-31-18
Health and Safety	Carolyn Jones	[signature]	5-31-18
Homeland Security	N/A		
Corrosion	N/A		
SFPUC Floodplain Coordinator	N/A		
Manager of Wastewater Enterprises Engineering	Joseph Wong	[signature]	5/10/18
Parsons (Tunnel Engineering)	Jon Kaneshiro	[signature]	4/9/18
SSIP Program Management Consultant	Bryce Wilson	[signature]	4/9/18

Note: If produced by others (Design Consultants or other City Departments), identify areas of responsibility between SFPUC and others.

Revisions

Rev	Date	Reason	Originator	Initials	Project Engineer	Initials
A						
B						

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ACRONYMS / ABBREVIATIONS

Acronym / Abbreviation	Definition
AAR	Alternative Analysis Report
BEM	Bureau of Environmental Management
Cal/OSHA	California Division of Occupational Safety and Health
CCSF	City and County of San Francisco
CEQA	California Environmental Quality Act
CER	Conceptual Engineering Report
City	City of San Francisco
EPBM	earth pressure balanced tunnel boring machine
FRP	fiberglass-reinforced plastic
HDPE	high-density polyethylene
in/sec	inch(es) per second
LOS	level of service
Muni	San Francisco Municipal Railway
NAR	Needs Assessment Report
NOA	naturally occurring asbestos
PEP	high-density polyethylene pipe
Project	Folsom Area Stormwater Improvement Project
psi	pounds per square inch
PPV	peak particle velocity
RCP	reinforced concrete pipe
ROW	right-of-way
SFMTA	San Francisco Municipal Transportation Agency
SFPUC	San Francisco Public Utilities Commission
SFPW	San Francisco Public Works
SSIP	Sewer System Improvement Project
TBM	tunnel boring machine
VCP	vitrified clay pipe

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EXECUTIVE SUMMARY

ES.1 Project Background

The primary objective of this project is to address the SFPUC Wastewater Enterprise level of service. Properties have been subject to stormwater inundation during moderate to heavy storms. Lower-lying areas in the vicinity can experience up to several feet of flooding during rain events. This project will manage stormwater to meet the level of service (i.e., to control and manage flows from a storm of a 3-hour duration that delivers 1.3 inches of rain) within the project study area.

Following the Needs Assessment and Alternatives Analysis, a tunneling alternative was advanced to the Conceptual Engineering phase. This report documents the development of the project concept. The conceptual design – including design criteria, opinion of probable construction cost, and construction/project schedule – contained in this report can be used as a basis for the detailed design phase.

ES.2 Project Summary

The project will construct a 4,000-linear-foot, 12-foot internal diameter tunnel from the vicinity of Alameda/Treat Streets to the vicinity of 7th/Berry Streets. The project will also construct nearly 12,500 linear feet of upstream components, including deepening an existing reinforced concrete box sewer, new reinforced concrete box sewers, upsizing existing pipe sewers, new auxiliary pipe sewers, and junction structures to divert flow toward the new tunnel infrastructure.

The total probable construction cost in 2021 dollars is $215.6 million, which includes markups, a 30% design/estimating contingency, and a 10% construction contingency. The total capital project cost in 2021 dollars is $273.6 million. The project cost estimate does not include any results from the easements acquisition analysis, which is underway.

The preliminary construction schedule for the entire project is approximately 2 years. It currently assumes that both the tunnel component and upstream components can be constructed simultaneously. The current estimated timeframe for construction is from summer 2020 to the end of 2022.

The project will proceed to design after this Conceptual Engineering Report is approved and finalized. Design is expected to be completed by the end of 2019. Environmental review, geotechnical investigation, and real-estate acquisition efforts will be performed in parallel with design.

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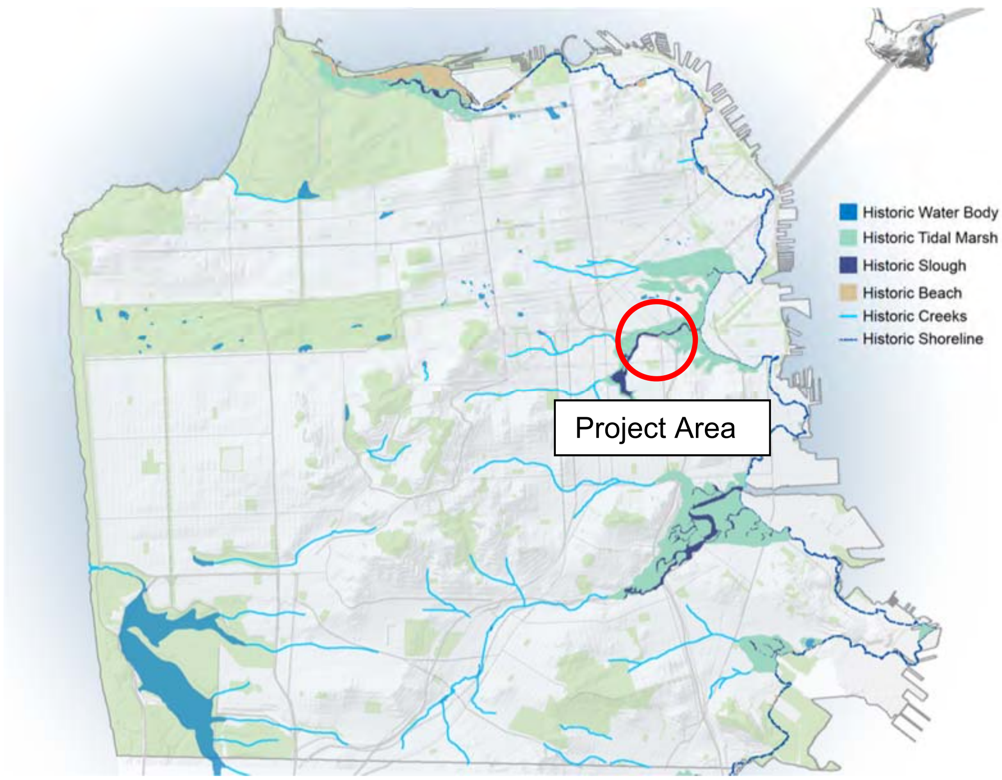
1.0 INTRODUCTION

1.1 Purpose

This Conceptual Engineering Report (CER) describes conceptual design of new conveyance infrastructure to meet the San Francisco Public Utilities Commission (SFPUC) Wastewater Enterprise level of service (LOS) to control and manage flows from a storm of a 3-hour duration that delivers 1.3 inches of rain. The project area shown in Figure 1 spans the Inner Mission neighborhood from 18th to 10th Streets.

Properties have been subject to stormwater inundation during moderate to heavy storms, including the statistically derived LOS storm. Lower-lying areas in the vicinity can experience up to several feet of flooding during rain events.

Figure 1
Project Location



Following the Needs Assessment and Alternatives Analysis, a tunneling alternative was advanced to the Conceptual Engineering phase. This report documents the development of the project concept. The conceptual design – including design criteria, opinion of probable construction cost, and construction/project schedule – contained in this report can be used as a basis for the detailed design phase.

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2.0 BACKGROUND

2.1 Project Need

The primary objective of the Folsom Area Stormwater Improvement Project (Project) is to address the current Wastewater Enterprise LOS. The complete suite of LOS Goals and Strategies is provided in Appendix A. The LOS for Stormwater Management includes the integration of green and grey infrastructure to manage stormwater and minimize flooding in a statistically derived storm lasting 3 hours, with a total of 1.3 inches of rainfall and a defined peak rainfall intensity (5-year 3-hour storm, or LOS storm).

Properties have been subject to stormwater inundation during moderate to heavy storms. Lower-lying areas in the vicinity can experience up to several feet of flooding during rain events. This project will manage stormwater to meet the Stormwater Management LOS within the Project study area.

2.2 Summary of Selected Alternative

The selected alternative from the Needs Assessment Report (NAR) and Alternative Analysis Report (AAR) consists of the following components:

Tunnel Component[1]**:**

- 4,200 linear feet of 12-foot inside diameter tunnel (or 3,500 linear feet of 12-foot inside diameter tunnel and 500 linear feet open-cut box sewer) from approximately the intersection of Alameda Street and Treat Street connecting to the Channel Consolidated Transport/Storage Box near the intersection of 7th Street and Berry Street.
- Launch and receiving shafts

Upstream Components[2]**:**

- Treat Street
    - Deepen existing box sewer on Treat Street from 16th Street to Alameda Street from 9 feet deep to 15 feet deep. This upstream component improves conveyance from the 17th and Folsom area to the Division Street sewers.
- 15th Street
    - Upsize approximately 1,000 linear feet of existing sewer on 15th Street from Shotwell Street to Mission Street from 66 inches and 72 inches to 72 inches and 78 inches. This upstream component improves conveyance to Harrison Street along 15th Street.
- Harrison Street
    - Upsize approximately 1,200 linear feet of existing 3-foot 0-inch by 5-foot 0-inch sewer on Harrison Street from 16th Street to 19th Street to a box sewer having a width of 108 inches and a height that varies from 6 feet to 8 feet. This upstream component provides relief to the Treat Street sewer

[1] Previously known as “Major Component” in the NAR/AAR
[2] Previously known as “Minor Components” in the NAR/AAR

  and improves conveyance from the 17th and Folsom area to the Division Street sewers.

- 18th Street
  - Upsize, to various sizes, approximately 900 linear feet to 1,200 linear feet of the 90-inch sewer and 60-inch auxiliary sewer on 18th Street from Harrison Street to Shotwell Street. This upstream component improves conveyance on 18th Street to the Harrison Street sewer.
- 17th Street and Harrison Streets and 17th Street and Treat Street
  - This upstream component improves conveyance and provides relief to the Treat Street sewer.
- 14th Street
  - Upsize approximately 1,200 linear feet of existing sewers on 14th Street from Harrison to Folsom Streets and approximately 600 linear feet of existing sewers on 14th Street from South Van Ness Avenue to Mission Street. Upsize the existing 75-inch sewer to an 84-inch sewer and the existing 3-foot 6-inch by 5-foot 3-inch brick sewer to a 66-inch sewer. Construct an additional weir at Harrison and 14th Streets. This upstream component improves conveyance to the Division Street dual-compartment sewer.
- 12th Street Reroute
  - Construct 1,050 linear feet of new 48-inch sewer to convey flow from the intersection of 12th and Folsom Streets to the intersection of 11th and Harrison Streets. This upstream component diverts flow from the intersection of 12th and Folsom Streets to the North Point Main at Harrison and 11th Streets, where the 11th Street Reroute can provide additional conveyance onto the Division Street sewer.
- 11th Street Reroute
  - Construct 850 linear feet of new 75-inch sewer to convey flow from the intersection of Harrison and 11th Streets to the Division Street sewer east of the intersection of Bryant and Division Streets. This upstream component improves conveyance by diverting flow from the North Point Main at Harrison and 11th Streets into the Division Street sewers.
- 17th and 18th Street Flow Distribution, Secondary
  - These upstream components distribute flow between 17th Street and 18th Street and improve conveyance to the tunnel component.
    - Construct 1,100 linear feet of 102-inch auxiliary sewer on 17th Street from Treat Street to South Van Ness Avenue.
    - Upsize the 15-inch headend sewer on South Van Ness Avenue from 17th Street to 18th Street to 42 inches.
    - Construct new 36-inch sewer to divert flows from 18th Street at the South Van Ness intersection.
- General Upsizing
  - Upsizes various sewers smaller than 30 inches throughout the analysis area to address localized areas not meeting LOS, including:
    - Erie Street – South Van Ness to Folsom
    - Trainor Street – 14th to 13th

- South Van Ness – 15th to 14th
- Folsom – 16th to 18th
- Shotwell – 18th to 19th
- 19th – Folsom to Treat
- Mistral – Treat to Harrison
- Alabama – 17th to Mariposa
- Harrison – 15th to Alameda

2.3 Modifications since Alternative Analysis Report

2.3.1 Tunnel Component Modifications

Based on discussions within the project team, the tunnel alignment in the AAR (referenced as the “AAR alignment”) shown in Figure 2 has been modified. The revised alignment (referenced as the “CER alignment”) is shown in Figure 3. The change in alignment results in:

- **Reduced tunnel length.** The AAR alignment requires 4,200 linear feet of tunnel drive. The CER alignment requires 4,000 linear feet of tunnel drive.
- **Reduced easement needs.** The AAR alignment required an easement through the Recology site that travelled beneath existing buildings. The CER alignment requires a smaller easement through Recology that does not lie beneath existing buildings, or no easement at all, depending on the method of construction. Refer to Section 9.2 on page 87 for further discussion on easement requirements.
- **Less congested downstream connection point.** The AAR alignment connected to the downstream portion of the Division Street Box sewer near proposed Central Bayside System Improvement Project connections. By connecting to an existing pre-constructed stub of the Channel Consolidated Transport/Storage Box, the CER alignment avoids the congestion near the proposed Central Bayside connection points.
- **Elimination of receiving shaft.** With the downstream connection point of the tunnel relocated to the pre-constructed stub of the Channel Consolidated Transport/Storage Box, a receiving shaft is no longer needed. Instead, the stub will act as a receiving structure, with only minor modifications to the stub required.
- **Operational flexibility.** The change in alignment presented an opportunity to interconnect the Division Street box sewer with the new tunnel infrastructure. This tie-in structure allows two paths for the flow to reach the downstream outfall structure, providing both flexibility and redundancy for operations and routine inspection needs.

The full tunnel length of the CER alignment would require acquisition of an easement through the Recology property. An alternative option is to terminate the 12-foot inside diameter tunnel at the intersection of Alameda and De Haro Streets, construct a cut-and-cover box sewer along De Haro and Berry Streets, and finally construct another trenchless sewer across 7th Street, beneath Caltrain. This alternative option has a total of 3,000 linear feet of 12-foot inside diameter tunnel, 550 linear feet of cut-and-cover box structure, and 450 linear feet of trenchless sewer installation. This alternative option will be discussed in the following chapters.

The updated list of upstream components is as shown in Table 1.

Table 1
Upstream Components

Location	Existing Size	Proposed Size(1)	Linear Footage
Treat Street – 16th to Alameda	10.5'wx9'h	10.5'wx15'h	985’
Treat Street @ 16th	N/A	4'2"x9'0"	24’
15th Street – Mission to Minna	66"	72"	253'
15th Street – Minna to Capp	66"	78"	120'
15th Street – Capp to South Van Ness	66"	78"	295'
15th Street – South Van Ness to Shotwell	66"–72"	78"	296'
Harrison Street – 19th to 18th(2)	3'0"x4'6"–3'0"x5'0"	9'0"x6'0"	585’
Harrison Street – 18th to 17th	3'0"x5'0"	9'0"x6'0"–9'0"x7'0"	708’
Harrison Street – 17th to 16th	3'0"x5'0"	9'0"x8'0"	340'
18th Street – Shotwell to Folsom	60"	108"	288'
18th Street – Folsom to Treat	60"	90"–108"	320’
18th Street – Treat to Harrison	N/A	60"	377'
17th Street – Treat to Harrison	N/A	90"	217'
14th Street – Folsom to Harrison	75"	84"	620'
14th Street – Mission to South Van Ness	3'6"x5'9"	66"	581’
Folsom Street – 12th to 11th	N/A	48"	425'
11th Street – Folsom to Harrison	N/A	48"	630'
11th Street – Harrison to Division	N/A	75"	841'
17th Street – South Van Ness to Shotwell	N/A	102"	306'
17th Street – Shotwell to Folsom	N/A	102"	312'
17th Street – Folsom to Treat	N/A	102"	453'
South Van Ness – 18th to 17th	12"–15"	42"	508'
South Van Ness @ 18th	N/A	36"	75'
Erie Street – South Van Ness to Folsom	12"–15"	12"–18"	395’
Trainor Street – 13th to 14th	12”	12"	303’
Folsom Street – 17th to 18th	15"	15"	294'
Folsom Street – 17th to 16th	12"	18"	154'
Folsom Street – 15th to 16th	12”	15”	90’
Shotwell Street – 19th to 18th	18"	18"	280'
19th Street – Folsom to Treat	12"	24"	298'
Mistral Street – Treat to Harrison	12"	12"	72'
Alabama Street – Mariposa to 17th	8"	12"–15"	430’
Harrison Street – 15th to Alameda	8"	12"	334'

(1) Where proposed size is the same as existing size, sewer will be reconstructed with reverse slope.
(2) Harrison Street – 16th to 19th Streets may be replaced with a similarly sized box sewer on Treat Street. This is pending condition assessment of the existing Treat Street box sewer, to be performed by another project team.

Figure 2
Alternative Analysis Report Alignment

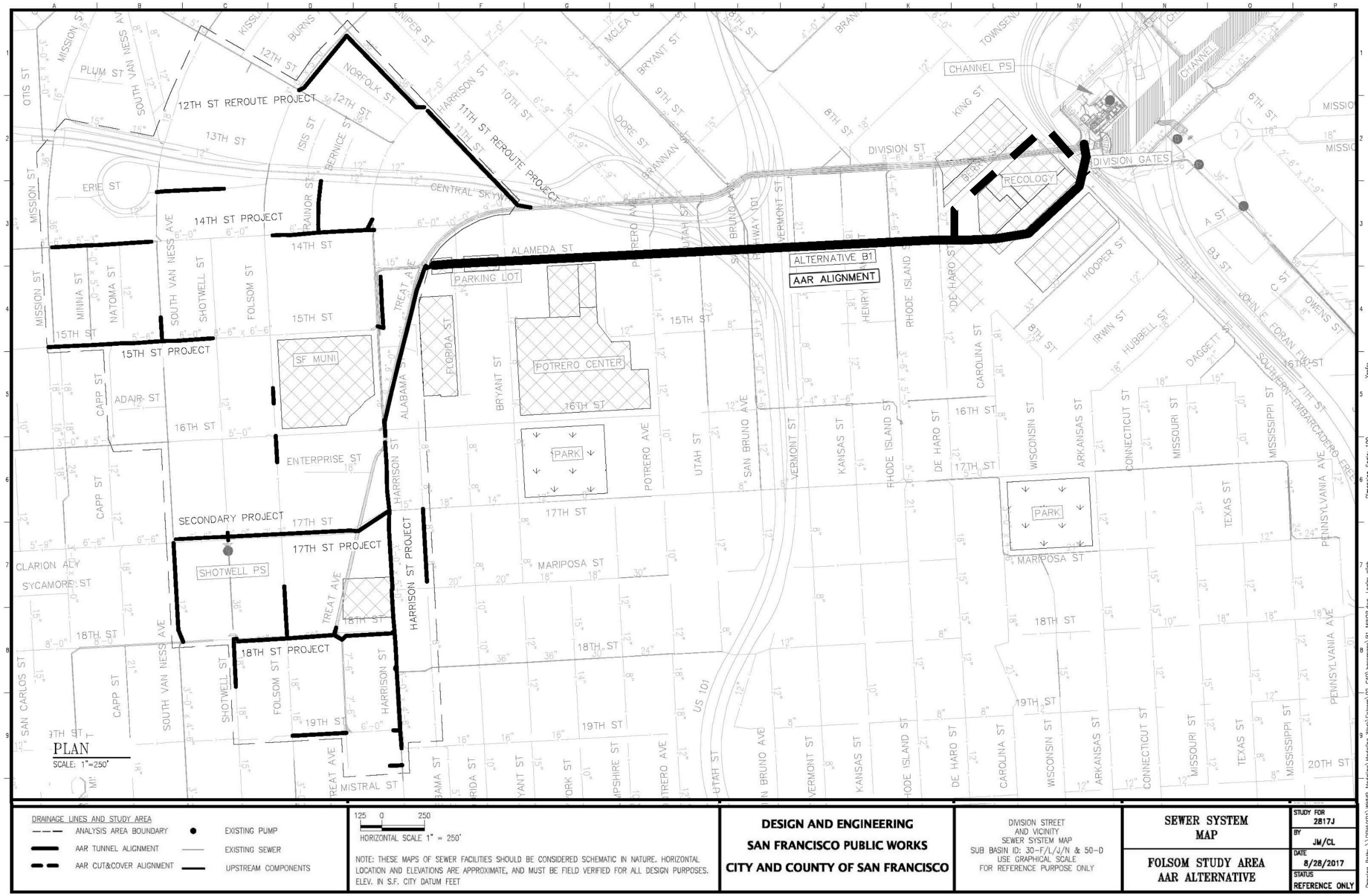

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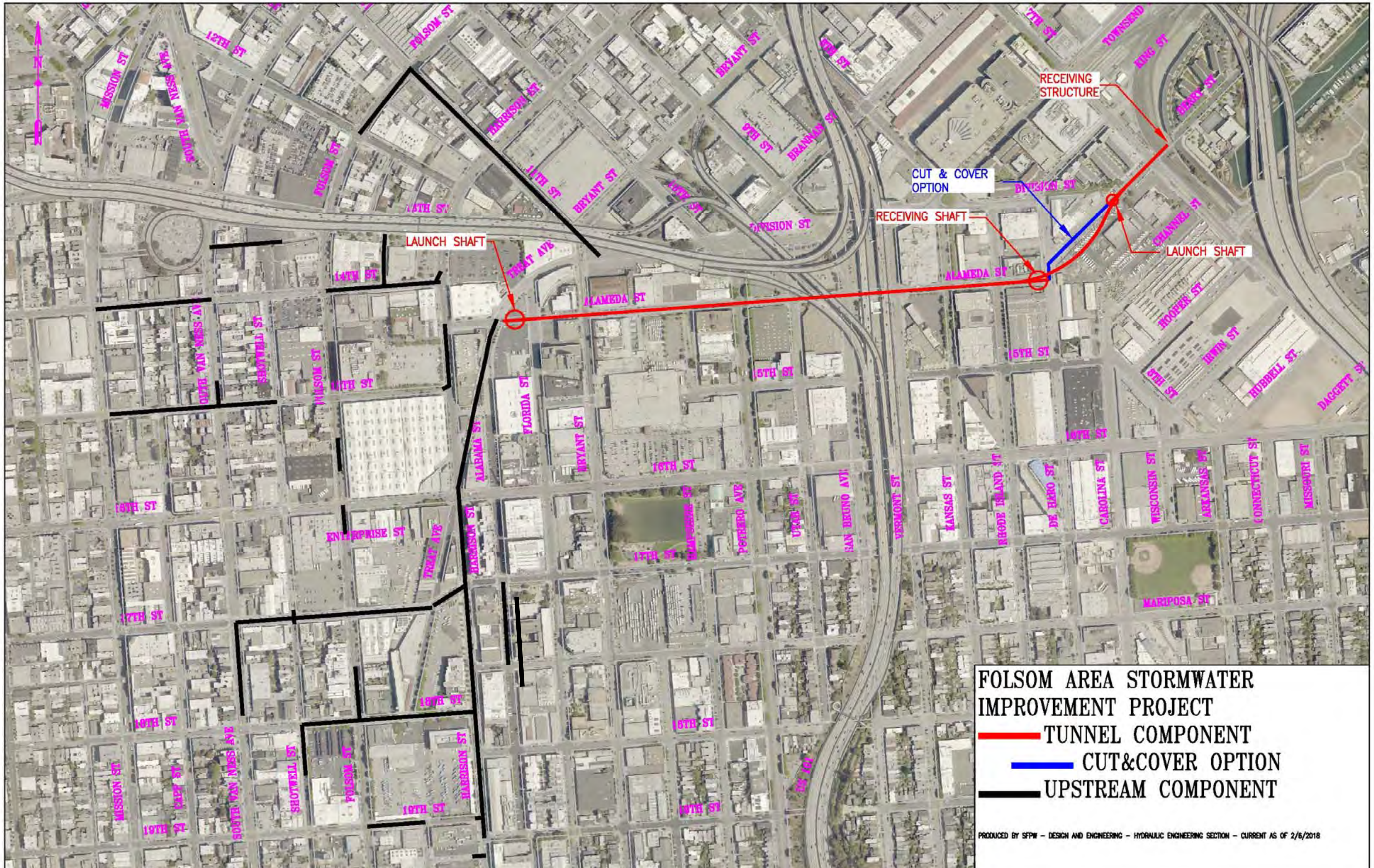
Figure 3
Conceptual Engineering Report Alignment



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2.4 Approach

The following major activities are documented in the CER, advancing the selected alternative from the NAR/AAR in preparation for design phase:

- Finalize the detailed hydrologic and hydraulic modeling analysis.
- Identify detailed design issues, including but not limited to hydraulic considerations, geotechnical considerations, staging and site access, utility information, and others.
- Develop a conceptual design for the intertie between the tunnel and Division Box structure.
- Identify and summarize environmental and real estate needs.
- Refine the construction cost and schedule.

The CER presents design criteria for the project and is a precursor to the future design efforts required to develop construction contract documents. The key focus of this preliminary design phase is to establish the design concepts and criteria for the conveyance infrastructure through site investigation and engineering evaluation. To more effectively present the information, the project components will be divided into general construction methods for the purposes of this report. They are:

- Tunnel and shaft construction
- Reinforced concrete structure construction
- Pipe installation (>36 inches)
- Pipe installation (≤ 36 inches)
- Modifications to existing structures

Key project deliverables will be provided with this report, including, but not limited to:

- Preliminary Utility Occupancy Plans
- 10% Plans
- List of Likely Project Specifications
- Environmental Checklist for CER
- Planning Level Opinion of Probable Construction Cost

Each deliverable will be used to further develop design criteria and evaluate their respective impacts on project schedule, cost, and feasibility in addition to other key information discussed in this report.

2.5 Standards and Guidelines

This project will comply with standards specified by the City and County of San Francisco (CCSF), Caltrans, and other nationwide codes as listed below:

- American Concrete Institute
- American Society of Civil Engineers
- Occupational Safety and Health Act
- Excavation Code of the CCSF
- American National Standards Institute

- Other recognized standards where required as guidelines for design, fabrication, and construction when not in conflict with the above-listed standards
- The codes and industry standards used for design, fabrication, and construction, including all addenda, in effect as stated in equipment and construction purchase or contract documents

Drawings, specifications, and calculations will be prepared following the applicable standards, codes, and guidelines:

- American Society for Testing and Materials for pipe material and installation and other sewer structures
- Excavation Code
- California Division of Occupational Safety and Health (Cal/OSHA) requirements

Should there be a conflict in the engineering design requirements, the more stringent requirement in the following compliance standards, codes, and guidelines shall be adopted:

- Federal and state requirements
- CCSF requirements
- Specific industry group or professional guidelines
- Accepted manufacturers' guidelines
- Project specific guidelines (e.g., equipment clearance, spare equipment arrangement)

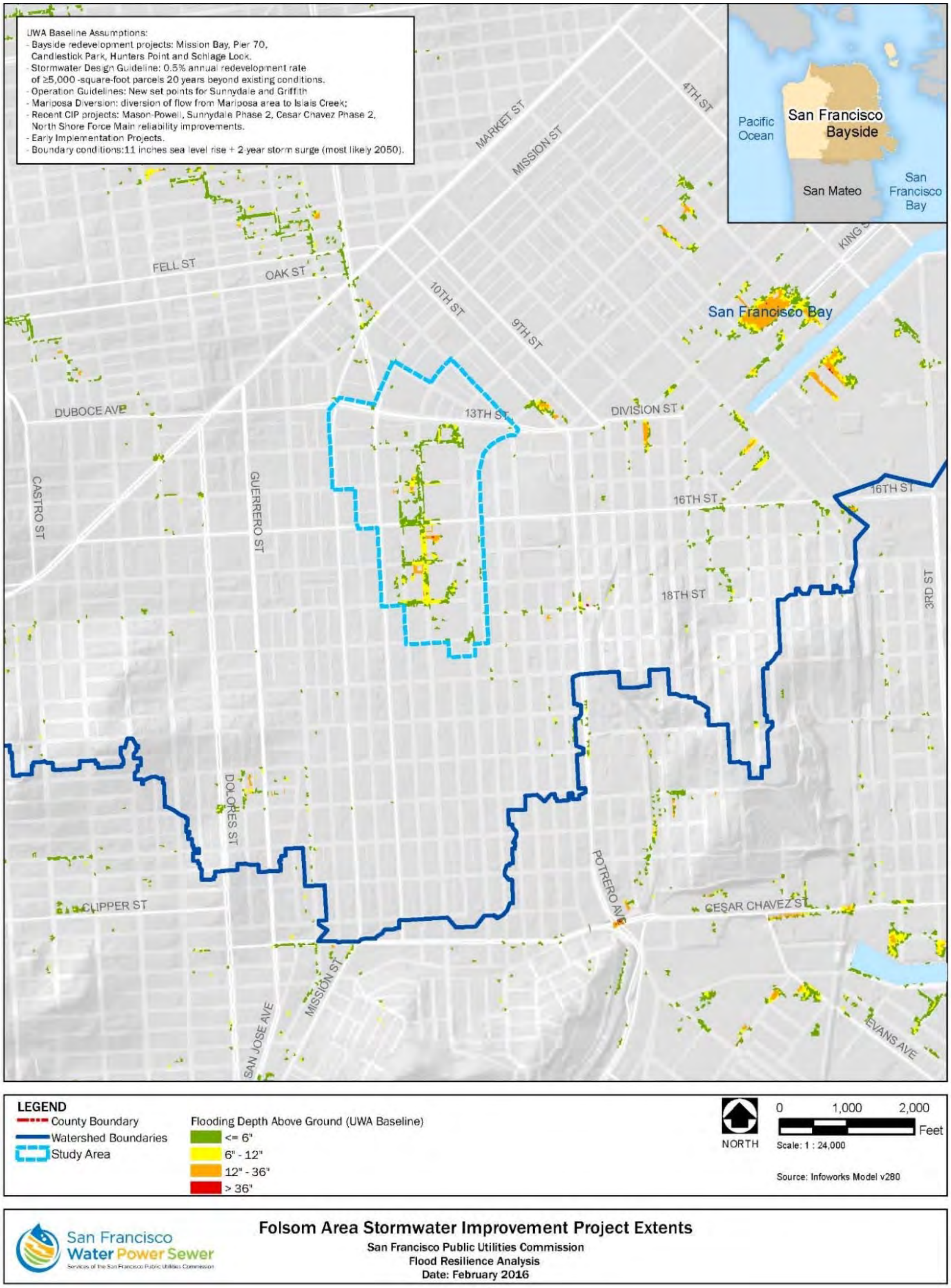
2.6 Performance Requirements/Goals

2.6.1 Project Study Area

The project study area is the boundary within which the performance metrics are considered. The project study area was intentionally developed to include all surface flooding in the 17th and Folsom neighborhood during the LOS storm. Previous study boundaries were considered from the *Flood Resilience Study* (SFPUC 2016b) and the *17th and Folsom Stormwater Management Technical Paper* (SFPUC 2015). Of these boundaries, the 15-foot elevation contour, based on the Old City Datum, most accurately encompassed all flooded areas in the LOS storm. Adjustments were made to the 15-foot contour to produce a hybrid boundary aligned with the public right-of-way (ROW) for City of San Francisco (City) streets. This final boundary is shown in Figure 4.

The area within the boundary is designated as the project study area. All alternatives analyzed must meet performance requirements and objectives within the project study area.

Figure 4
Project Study Area



Modeling results are based on previous version of model. Graphic is only to show study area and not necessarily the flooding depth.

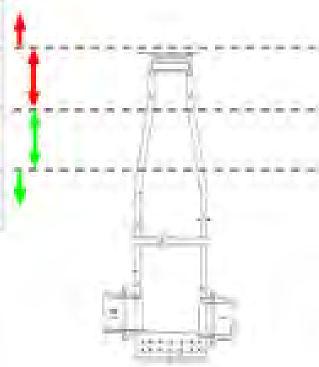
2.6.2 Freeboard Performance

In developing conveyance alternatives, the Project team strived to achieve a freeboard of at least 2 feet at every node or manhole within the project study area for the LOS storm, but certain outliers were exempted from this criterion due to unusual topographic configurations, limited impacts, or other factors. The performance for each alternative was defined by totaling the number of nodes within the Project study area under each of the following categories: Negative freeboard (excursion), 0–2 feet of freeboard, 2–4 feet of freeboard, and >4 feet of freeboard (Figure 5). The sum was compared to the baseline results.

Additionally, the freeboard at key locations, including 17th and Folsom, 18th and Shotwell, Enterprise Alley, and 14th and Harrison, were compared across all different options.

Figure 5
Categories for Freeboard Count

	Freeboard	# of Nodes
Freeboard Not Met	Negative	
	0-2 feet	
Freeboard Met	2-4 feet	
	+4 feet	



For areas outside of the Project study area, the project team ensured that project modeling did not worsen conditions (e.g., raise hydraulic grade line) in the LOS storm event. This metric was defined as maintaining (or improving) the baseline freeboard at Henry Adams.

3.0 CONCEPTUAL DESIGN: PROJECT-WIDE

The scope of work for the project includes the construction of 4,000 linear feet of 12-foot inside diameter (minimum) tunnel from approximately the intersection of Alameda Street and Treat Street connecting to a pre-constructed stub of the Channel Consolidated Transport/Storage Box near the intersection of 7th Street and Berry Street. In addition to the tunnel component, upstream components are also in the scope to divert flows toward the new tunnel infrastructure. This chapter discusses design issues that apply to the entire project. The following chapters discuss the conceptual design related to the different construction methods.

3.1 Hydraulic Sizing

The City's Hydrologic and Hydraulic Model, version EHY16_v2 was used as a baseline model for all planning sub-phases (NAR/AAR and CER). The City's level of service storm is used for sizing all project components to meet the performance goals stated in Section 2.6. Updated hydraulic analyses are summarized in Appendix B.

3.2 Topographic Survey

Topographic survey for all project components will be performed during the design phase.

The horizontal coordinate system used for topographic surveying will be the CCSF 2013 High Precision Network. The coordinate system is a low-distortion Mercator projection designed such that the combined grid factor is generally less than 1/100,000. The projection origin (Projection North = Geodetic North) is near the center of the City, which minimizes the convergence of meridians to ±3 minutes at the east and west edges of the City.

The vertical datum used for topographic surveying will be the CCSF 2013 NAVD88 Vertical Datum. The vertical datum is based on NAVD88 as recovered by the 2013 City high-precision leveling surveys. However, per Sewer System Improvement Project directive, all elevations used in this project will be converted from the NAVD88 datum to the converted Old City Datum.

3.3 Utility Survey

The project team transmitted a Notice of Intent and Request for Information through the Envista utility coordination program in April 2016 and November 2017 to the following companies to obtain utility information on their facilities located within the limits of this project:

- SFPUC – City Distribution Division
- AT&T Network Services
- AT&T California
- AT&T Legacy
- Comcast Cable
- Level 3 Communications
- San Francisco Municipal Transportation Agency (SFMTA)
- San Francisco Port Commission

- SFPUC Wastewater Enterprise
- Pacific Gas & Electric
- Qwest Communications
- Sprint Communications
- Time Warner Telecom
- Verizon
- Crown Castle
- Other utility companies

The utility responses were collected to prepare utility composite drawings that will serve as a reference for the design of the project components. See Appendix C for utility composite drawings.

The project team will coordinate as necessary during the design phase with utility companies, should there be a need for utility relocation.

3.4 Planning Level Drawings

See Appendix D for 10% design drawings.

3.5 Project Specifications

See Appendix E for list of likely project specifications.

3.6 Permitting

Table 2 lists permits that may be required for this Project. The contractor will be required to obtain all necessary permits prior to starting construction.

Table 2
Permits Required Prior to Construction

Jurisdiction	Permit Name
City and County of San Francisco	Excavation Permit
	Night Noise Permit, if applicable
	Special Traffic Permit, if applicable
State of California	Cal OSHA Permit for Tunneling
	Caltrans Permit

Additional permits that will be obtained by the project team include, but are not limited to:

- California Environmental Quality Act (CEQA) Approval
- Permit to Enter Property
- Stormwater Pollution Prevention Permit

3.7 Traffic Management

The project team will work with SFMTA in the design phase to schedule lane closures and implement other measures to minimize traffic and transit effects. Coordination with

SFMTA will also include provisions for temporary or alternative access and parking. Traffic control plans will be required for all parts of the work. Temporary signage and flaggers will be used. Temporary roadway barriers may be used to protect the workers and vehicles.

More in-depth discussion of traffic management will be discussed in the following chapters, where appropriate.

3.8 Flow Bypass during Construction

In general, flow can be bypassed through either upstream diversion, pump around, or internal bypass.

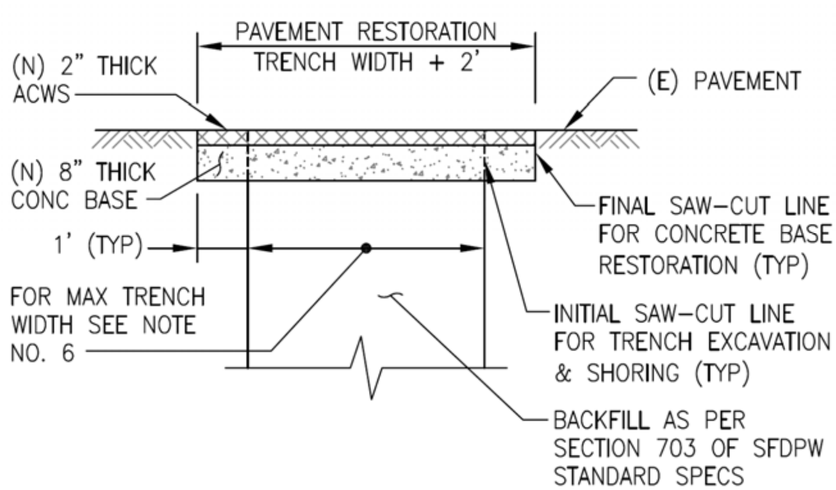
- **Upstream diversion.** Flow is routed to other sewers by installation of a weir, dam, or plug upstream of the area to be constructed.
- **Pump around.** Flow is pumped to other sewers via an aboveground portable pump. Intake and discharge hoses need to be routed on the surface or buried in the pavement.
- **Internal bypass.** Flow is allowed through a separate conduit in the work site, either internal to the sewer or within the trench.

3.9 Site Restoration

In general, the roadway in San Francisco consists of 8-inch-thick concrete street base and 2-inch-thick asphalt concrete wearing surface. Where the project requires cut-and-cover excavation work, the roadway will be restored per the Regulations for Excavating and Restoring Streets in San Francisco.

The contractor will be required to restore all areas disturbed by construction to original condition or better. The contractor will be required to restore the pavement per contract drawings and specifications. Figure 6 shows a typical trench restoration detail.

Figure 6
Typical Trench Restoration Detail



3.10 Americans with Disabilities Act–Compliant Curb Ramps

Article 2.4 of the San Francisco Public Works (SFPW) Code, as well as SFPW policy, requires that upon performing any excavation within a marked or unmarked crosswalk within the public right of way, all affected curb ramps shall be evaluated and/or reconstructed/upgraded per current standards. The project team will evaluate each curb ramp during design and engage the design services of the SFPW, Streets and Highways Section, where needed.

3.11 Materials Storage

The project team will work with SFMTA to determine acceptable street ROW locations for storage of construction materials and equipment. Additionally, there may be a location near the project site suitable for storing new and excavated material suitable for backfill; this will be determined during the design phase. Reuse of soil will be at the City's discretion, and environmental testing of existing materials will be completed prior to reuse.

The contractor will be required to adhere to project specifications for best management practices for management of construction materials, which can include:

1. Cover and berm loose stockpiled construction materials that are not actively being used.
2. Store chemicals in watertight containers (with appropriate secondary containment to prevent any spillage or leakage) or in a storage shed (completely enclosed).
3. Minimize exposure of construction materials to precipitation. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (e.g., poles, equipment pads, cabinets, conductors, insulators, bricks)
4. Implement best management practices such as rumble plates installation or wheel wash stations to prevent the off-site tracking of loose construction and landscape materials.
5. Provide for the continuous misting of water using hoses on the project, and on roads and other areas immediately adjacent to the project limits, wherever traffic or buildings that are occupied or in use are affected by such dust caused by hauling or other operations. The materials and methods used for water laying shall be subject to the approval of the City Representative.
6. Provide for prompt and daily proper removal from existing roadways of all dirt and other materials that have been spilled, washed, tracked, or otherwise deposited thereon by contractor's hauling and other operations.

3.12 Erosion and Sediment Control

The contractor will be required to adhere to the Construction Site Runoff Ordinance during construction. General guidelines will be provided in the project specifications, which require, at a minimum:

- **Stabilization practices.** Seeding, mulching, installation of geotextile fabric, etc., on areas where construction activities have temporarily or permanently ceased.
- **Structural practices.** Construction of silt fences, berms, dikes, sediment basins, sediment barriers, covered material, waste storage areas, and other such

devices to limit runoff and minimize the discharge of pollutants. Appropriate practices shall be incorporated for surface drainage.

- **Operational practices.** Dust control, housekeeping, nonhazardous regular waste collection and disposal, control of equipment fluids and lubricants, and similar practices to minimize pollutant generation.
- **Vehicle washing.** All vehicle washing shall occur at a designated equipment decontamination wash pad.
- **Wheel washing.** Wheel washing will occur at a designated wheel washing area.
- **Concrete washout.** Concrete washout will neither be allowed on site nor into the sewerage.
- **Saw cutting operations.** Provide a means to vacuum slurry generated from saw cutting operations, thereby preventing it from going into the storm drain.
- **Inspection.** The contractor shall conduct routine inspections of all structural and nonstructural pollution control measures. At the minimum, it should be conducted once every 2 weeks for the dry season, once a week during the rainy season, and 24 hours prior to forecast of precipitation events of 0.5 inch or greater, and immediately after precipitation events of 0.5 inch or greater with daily inspections on prolonged rainfalls.

3.13 Trench Restoration

Trench considerations include excavation requirements, pipeline bedding, backfill requirements, and suitability of on-site soil for use as backfill.

- **Excavation:** Excavation of a vertical trench will be performed with typical construction equipment. Construction contractors are required to keep trench width to a maximum of 3 feet larger than the pipe's outside diameter (1.5 feet on each side). Sides of the excavation shall be safely supported with typical shoring equipment such as sheetpiles or soldier pile and lagging. Trench boxes are generally not allowed. The contractor shall control its means and methods for excavation shoring at utility crossings.
- **Bedding and Backfill:** Figure 7 illustrates typical bedding and backfill requirements for a rigid pipe (i.e., reinforced concrete pipe [RCP] and vitrified clay pipe [VCP]). Figure 8 illustrates typical bedding and backfill requirements for a flexible pipe (i.e., fiberglass reinforced pipe [FRP] and high-density polyethylene pipe [PEP]).

Figure 7
Trench Bedding and Backfill Recommendations, Rigid Pipe

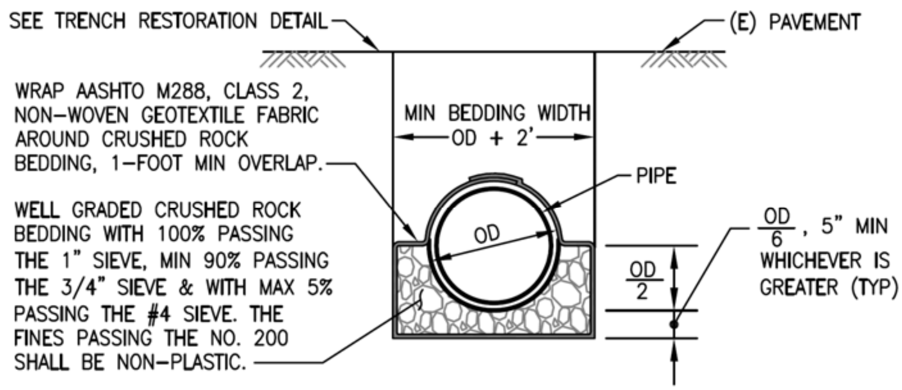
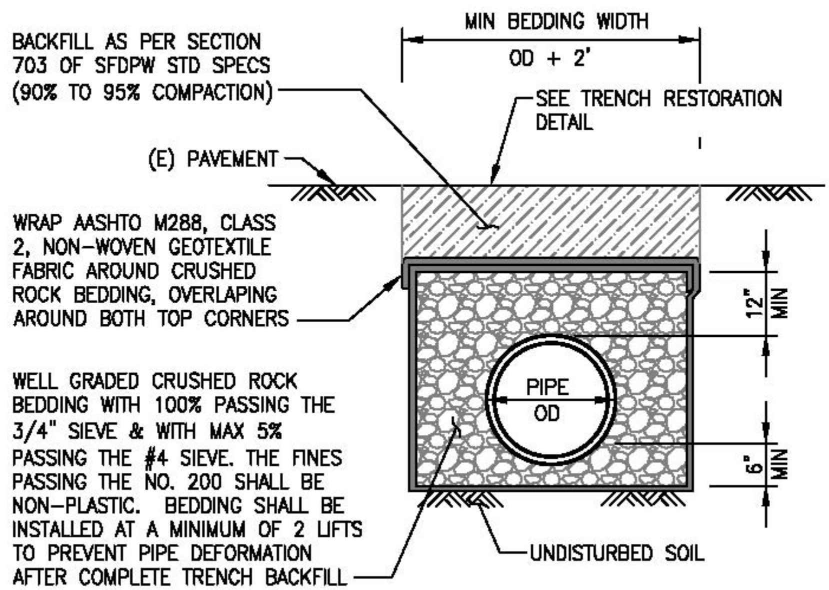


Figure 8
Trench Bedding and Backfill Recommendations, Flexible Pipe



3.14 Preliminary Geotechnical Considerations

A detailed geotechnical investigation program will be initiated in the design phase. Geotechnical considerations that affect the project include the type of temporary shoring support, protection of existing adjacent property, groundwater depth, and long-term performance of the structures through a significant seismic event. Results from the geotechnical investigation program will be made available to both the designers and the contractor to develop designs.

3.15 Design Quality Assurance and Quality Control

Upon completion of each phase and sub-phase, reviewers, consisting of project team members and stakeholders at SFPUC, will examine the design documents to verify the following have been properly implemented:

- Adherence to standards and procedures
- Design criteria
- Performance, appearance, and functional requirements as defined in this CER
- Constructability review
- Industry standards
- Code compliance

The Project Engineer will review and compile comments into a comment log and will forward the comments to the project design team. The design team will provide and document responses to all comments. If the designer disagrees with the comments, the designer will consult with the Project Engineer and the reviewer for further discussion. If there is no resolution, the designer of record will make the final decision. The Project Engineer will then coordinate and direct the design team to revise the design package based on the final resolution of the comments. This process will be repeated for the review of 35%, 65%, and 95% design until the final design package is completed and ready for bid.

3.16 Risk Assessment

As per SFPUC standard practices, risk workshops will be held throughout design to identify and mitigate risks associated with the project. The workshop will generally follow the process outlined below:

1. Project plans are developed to a stage suitable to discuss risk (typically 35% and 95%).
2. Key stakeholders are sent a blank risk register to populate with
    a. Risk description,
    b. Cause of risk,
    c. Effect of risk.
3. Key stakeholders meet to discuss and assign severity of impacts in terms of
    a. Probability of occurrence,
    b. Impact to cost,
    c. Impact to schedule.
4. Key stakeholders also assign ownership of the risk (i.e., designer or owner) and brainstorm possible mitigation measures.

The ultimate objective of the risk assessment process is to generate a suitable contingency amount to include in the project for any risks that are deemed non-mitigatable.

3.17 Construction Phasing

Because the tunnel and upstream components combine to be a fairly large project (greater than 16,500 linear feet of improvements), constructing all components simultaneously is nearly impossible. Issues that could arise in attempting to construct and activate all components at once include, but are not limited to, non-mitigatable traffic congestion, lack of staging area, and major environmental impacts.

The construction and activation of project components should be phased to address construction issues while still providing relief to the affected areas. To provide immediate relief to the three key locations outlined in the NAR/AAR, namely at 17th/Folsom, 18th/Shotwell and 14th/Harrison, the tunnel component, along with a select few upstream components, should be constructed first. These components are reflected in Figure 9 and consist of the components shown in Table 3. These components will be referred to as Tier 1 Components.

Figure 9
Construction Phasing

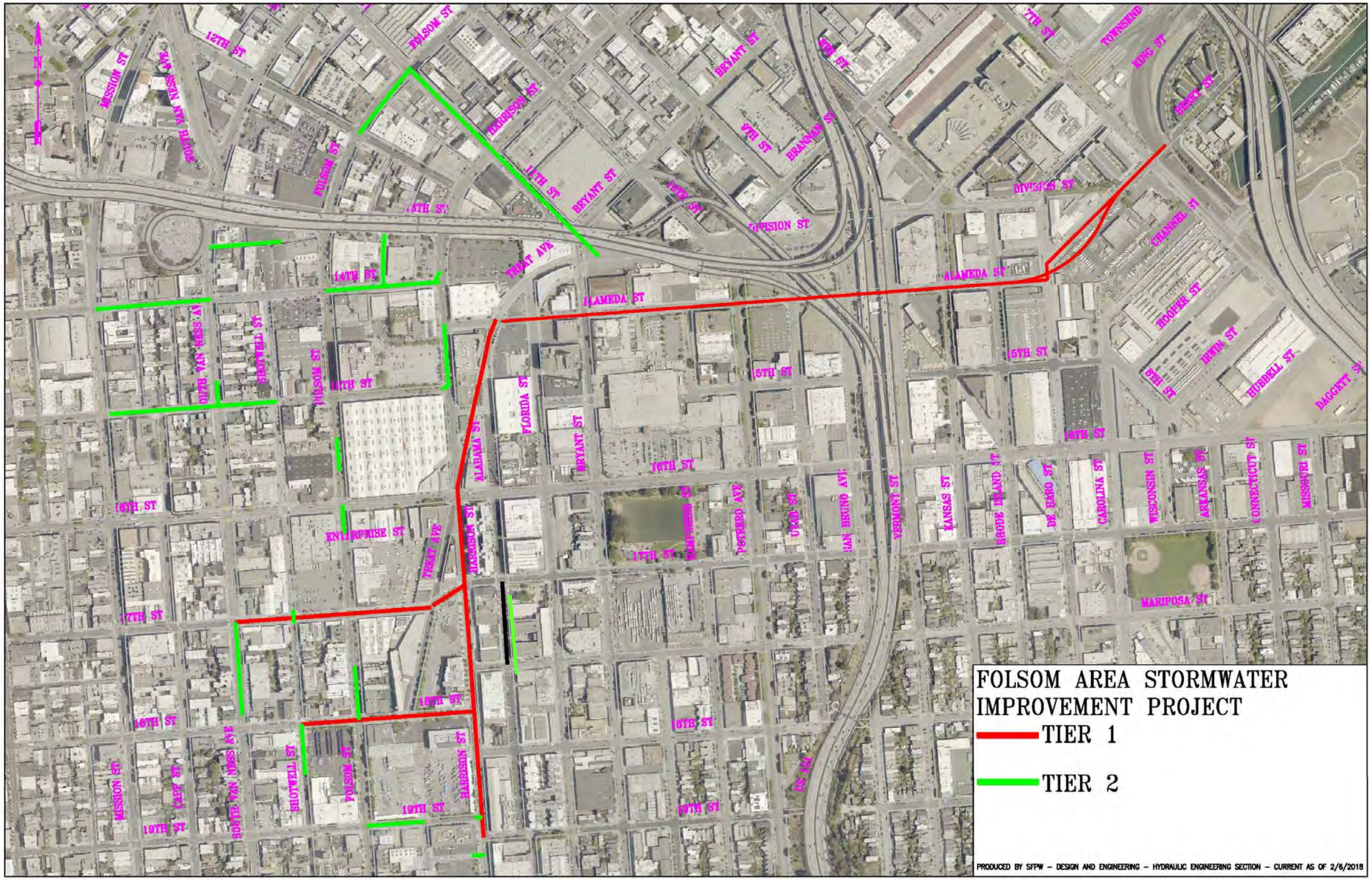


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Table 3
Tier 1 Components

Location	Existing Size	Proposed Size	Linear Footage
Tunnel Component	**N/A**	**12' ID**	**4,000'**
Optional Cut-and-Cover RC Box	**N/A**	**11'x11'**	**550'**
Upstream Components			
Treat Street – 16th to Alameda	10.5'wx9'h	10.5'wx15'h	985'
Treat Street at 16th	N/A	4'2"x9'0"	24'
Harrison Street – 19th to 18th	N/A	9'0"x6'0"	25'
Harrison Street – 19th to 18th	3'0'x4'6"–3'0"x5'0"	9'0"x6'0"	560'
Harrison Street – 18th to 17th	3'0"x5'0"	9'0"x6'0"	237'
Harrison Street – 18th to 17th	3'0"x5'0"	9'0"x7'0"	471'
Harrison Street – 17th to 16th	3'0"x5'0"	9'0"x8'0"	340'
18th Street – Shotwell to Folsom	60"	108"	288'
18th Street – Folsom to Treat	60"	90"–108"	320'
18th Street – Treat to Harrison	N/A	60"	377'
17th Street – Treat to Harrison	N/A	90"	217'
17th Street – South Van Ness to Shotwell	N/A	102"	306'
17th Street – Shotwell to Folsom	N/A	102"	312'
17th Street – Folsom to Treat	N/A	102"	453'
11th Street – Folsom to Harrison	N/A	48"	630
11th Street – Harrison to Division	N/A	75"	841

These Tier 1 components ensure that the flow from the LOS storm has a way to reach the downstream outfall. The hydraulic analyses showing the performance of just these Tier 1 components are provided in Appendix B.

The remaining upstream components, referred to as the Tier 2 components, consist of the upstream components shown in Figure 9 and Table 4.

Table 4
Tier 2 Components

Location	Existing Size	Proposed Size	Linear Footage
15th Street – Mission to Minna	66"	72"	253
15th Street – Minna to Capp	66"	78"	119
15th Street – Capp to South Van Ness	66"	78"	295
15th Street – South Van Ness to Shotwell	66"–72"	78"	296
14th Street – Folsom to Harrison	75"	84"	620
14th Street – Mission to South Van Ness	3'6"x5'3"	66"	581
Folsom Street – 12th to 11th	N/A	48"	425
South Van Ness – 18th to 17th	12"–15"	42"	508
South Van Ness @ 18th	N/A	36"	75
Erie Street – South Van Ness to Folsom	12"–15"	12"–18"	395
Trainor Street – 13th to 14th	12"	12"	303
Folsom Street – 17th to 18th	15"	15"	294
Folsom Street – 17th to 16th	12"	18"	154
Folsom Street – 16th to 15th	12”	15”	90
Shotwell Street – 19th to 18th	18"	18"	280
19th Street – Folsom to Treat	12"	24"	298
Mistral Street – Treat to Harrison	12"	12"	71
Alabama Street – Mariposa to 17th	8"	12"–15"	430
Harrison Street – 15th to Alameda	8"	12"	334

Should there be an unexpected issue in contract procurement for the tunnel, these Tier 2 components may still be constructed to provide *some* relief to the project area, albeit not to the key locations. The hydraulic performance for these Tier 2 components is also provided in Appendix B.

These Tier 2 components may be further divided into a Tier 3 components category by isolating those components that provide relief only to a limited area, such as within one block or one intersection. The performance or categorization of these Tier 3 components has not been analyzed.

The conceptual engineering considerations for these components are described in the following chapters based on construction methods or pipe size.

3.18 Operation and Maintenance

Various issues related to the operation and maintenance of the new facilities will need to be addressed during design. They include:

- **Venting.** Stagnant gasses such as hydrogen sulfide are highly correlated with significantly reduced service life. Gases can also displace conveyance capacity. The need for venting will be analyzed during design. Findings from the analysis will determine location and size of venting required.
- **Solids Handling.** Solids can also contribute to hydrogen sulfide gases, correlated with significantly reduced service life. Solids can also reduce conveyance capacity. Detailed design will take solids handling into consideration by ensuring proper pipe velocities to transport solids downstream.
- **Odors.** Odors are a nuisance and are also correlated with hydrogen sulfide gases. Proper venting can mitigate certain odor issues; this will be analyzed further during the design phase. Carbon scrubbers or chemical dosing stations may be needed to handle odors.

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4.0 CONCEPTUAL DESIGN: TUNNELS AND SHAFTS

This chapter applies to the tunnel and shafts for the alignment.

4.1 Civil

4.1.1 Alignment

The alignment, shown in Figure 3, starts from the drive or launch shaft in the SPCA parking lot (between Treat and Florida Streets). The alignment then traverses under Alameda Street, negotiating the reverse curve (S-curve) under De Haro Street and under Berry Street with a radius on the order of 500 to 700 feet.[3] The tunnel continues under Berry Street and then under the Division Street four-compartment box sewer, which is supported on timber and reinforced concrete piles. As described in Section 4.4.1, the Division Street box will be underpinned to facilitate the removal of the piles (as necessary) in advance of the tunnel boring machine (TBM) and for the subsequent construction of drop structures to a larger junction structure. The alignment continues to the existing Channel Consolidated Transport/Storage Box end wall, which is about 17 feet wide by 35 feet high. There, the TBM bores through the end wall into the box, which will be prepared for the reception, eventual TBM disassembly, and removal from existing access hatches. The alignment is approximately 4,000 linear feet long.

4.1.2 Alternative Alignment

The alternative alignment, if any ROW is unobtainable, starts from the drive or launch shaft in the SPCA parking lot (between Treat and Florida Streets). The launch shaft may be located alternatively on Treat Street or Florida Street if the ROW in the SPCA parking lot cannot be obtained. The tunnel alignment then goes under Alameda Street and ends at a receiving shaft at De Haro Street and Alameda Street. The alignment from De Haro Street along Berry Street to the Division Street four-compartment box sewer would be constructed via cut-and-cover (or cover-and-cut to minimize surface disturbance by decking the street and construction underneath the temporary decking). The Division Street box sewer underpinning, construction of drop structures, and preparation for a larger junction structure would be similar to the preferred alignment discussed above. However, the area adjacent to and/or under the Division Street box sewer serves as a launch shaft for the same TBM (used for the longer drive) or a smaller TBM providing a minimum internal diameter of 7-foot bores through the Channel Consolidated Transport/Storage Box end wall. The TBM would be disassembled and removed from the existing access hatches and/or from the launch shaft on Berry Street as per the preferred alignment.

4.1.3 Tunnel Size

The minimum tunnel inside diameter is 12 feet to meet the LOS objective. The outside diameter of the liner is expected to be about 13 feet 6 inches to 13 feet 10 inches, while

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[3] Negotiating a tunnel on a reverse curve (S-curve) to stay in City Street ROW under Alameda St., under De Haro St. and under Berry St. would require a radius on the order of 100 to 200 feet. Such a tight radius is state-of-the-art though not unprecedented. Examples include the Marivel Interceptor in Paris, which was 15 feet inside diameter by 2.62 feet wide by 13.75 inches thick with 2.5-inch taper concrete segmented liner at a curve of 262 feet, circa 2000; and a cable tunnel in Bangkok, which was 10.5 feet inside diameter by 1 foot wide by 5 inches thick steel segmented liner at a curve of 105-foot radius, circa 2017. Very special considerations need to be made for such tight radii, including steering, segment length, and taper. The tightest standard-of-practice radius is on the order of 500 to 700 feet but for this project would require ROW under the Recology property at De Haro and Berry Streets.

the excavated diameter is expected to be on the order of 14 feet 6 inches to 15 feet. These dimensions consider durability considerations of the liner, structural/strength requirements of the liner, tunnel boring machine shield, and steering configuration and overcut of the cutterhead to negotiate turns.

The minimum diameter from under the Division Street box to Channel Consolidated Transport/Storage box is 7 feet inside diameter. If this scenario is designed, it is anticipated that the tunnel would be excavated by pipe jacking techniques such as microtunneling.

4.1.4 Accesses and Shaft Sizes

Main construction access would be at the launch shaft in the SPCA parking lot. Operations and maintenance access would be at the launch shaft and through the existing access hatches at the Channel Consolidated Transport/Storage box. The roof of the finished access shaft would have removable concrete slab panels, such that compact maintenance vehicles can be lowered with a crane into the tunnel for periodic maintenance as needed. These accesses will also serve as personnel entry points for inspection and installation of monitoring equipment. The finished diameter of the shaft is expected to be on the order of 30-foot inside diameter based on construction considerations discussed in Section 4.4.6.

4.1.5 Plan and Profile Drawings

The plan and profile of the tunnel and shaft is shown in Appendix D, Drawings C-1 to C-8.

4.2 Geologic Conditions

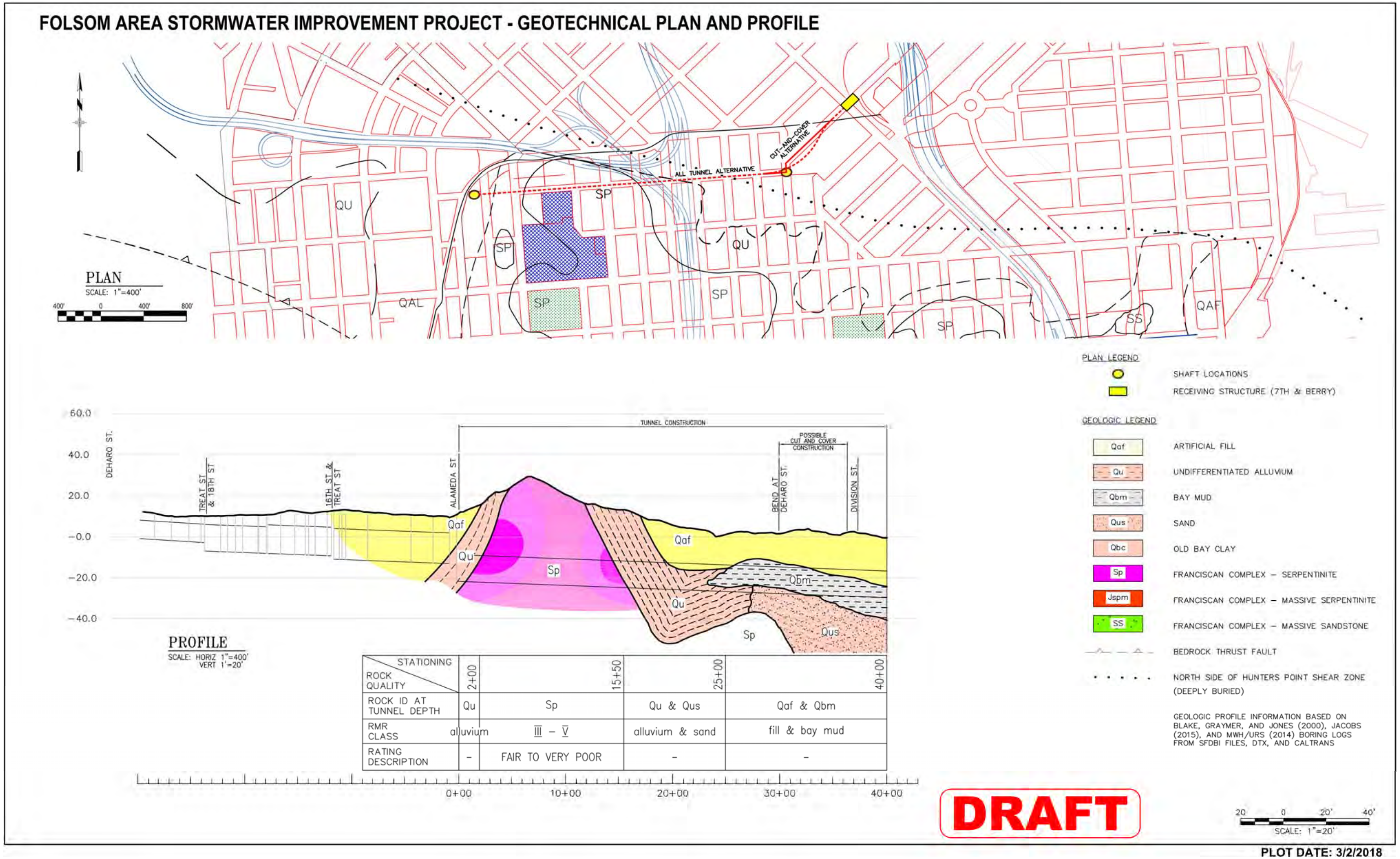
4.2.1 Soil and Underlying Geologic Conditions

The subsurface ground profile along the tunnel alignment is presented in Figure 10. The tunnel profile is divided into the following four different reaches based on the type of earth through which the tunnel will be excavated:

- Reach 1: Station 0+00 to Station 2+00 – Passing through alluvium
- Reach 2: Station 2+00 to Station 15+50 – Passing through serpentinite
- Reach 3: Station 15+50 to Station 25+00 – Passing through alluvium and sand
- Reach 4: Station 25+00 to the End – Passing through fill and bay mud

Geotechnical reports for site investigations that have been previously performed for nearby structures in the vicinity of the tunnel alignment are compiled in Appendix F.

Figure 10
Subsurface Ground Profile along the Tunnel Alignment



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4.2.2 Ground Characteristics for Design Parameters

Table 5 summaries estimated values for shear strength and deformability of the rock and soil layers.

Table 5
Estimated Strength Properties

Layer	Unit Weight [pcf]	Undrained Shear Strength [ksf]	Friction Angle [degrees]	Young's Modulus [ksf]
Sp – Serpentinite	152	3	-	6,000
Qu – Alluvium	120	2	-	800
Qbm – Bay Mud	95	1.7	-	200
Qaf – Fill	120	-	31	300

Note: Serpentinite's shear strength and deformability was estimated considering, intact rock uniaxial compressive strength of 1,828 pounds per square inch (psi), tensile strength of 462 psi; and rock mass Geological Strength Index (GSI) of 20.
ksf = kip(s) per square foot; pcf = pound(s) per cubic foot

4.2.3 Groundwater

Groundwater at the launch shaft in the SPCA parking lot area is expected to be 8 to 17 feet below ground surface (elevation 0). As the alignment follows Alameda Street in the rock section, groundwater is expected to be about 10 to 20 feet below ground surface and perched in fractures (elevation 10 to 20 feet). In the alluvium toward Recology and the waterfront, groundwater is expected to be relatively shallow (near elevation 0) in the fill, bay mud, and alluvium.

Groundwater seepage/inflow is not expected to be a problem in the rock section. Seeps and inflows could be expected at the launch shaft at the SPCA requiring water control. East of De Haro Street, shallow groundwater is expected in the fill, bay mud, and alluvium; dewatering and/or other mitigation measures will be required. Geotechnical investigations during final design will determine minimum support requirements for mitigating groundwater inflows. Final contract documents could include mitigation measures and could encourage the contractor to find alternative permitted discharge locations, such as the bay.

Observations of groundwater levels based on review of available geotechnical data in the area are summarized in Appendix F.

4.2.4 Gas Classification

The fill, bay mud, and alluvial materials as well as the proximity of nearby sewers would make the Cal/OSHA gas classification "potentially gassy," which will require regular monitoring for potential hazardous gases. Serpentinite is expected to be "non-gassy"; however, if one part of the tunnel is classified as "potentially gassy," the entire tunnel receives the same classification. Cal/OSHA will determine the tunnel gas classification based on the final design geotechnical investigations findings.

4.2.5 Serpentinite Environmental Considerations

Serpentinite is a low-grade metamorphic rock, typically altered with soft minerals such as chlorite, talc, and asbestos. Naturally occurring asbestos (NOA) minerals are commonly present in serpentinite at low concentrations. If concentrations exceed 1%, which is the CalEPA DTSC hazardous level, rock waste would need to be disposed of as Class II waste or specially permitted to be used in confined backfill (isolated from contact with the environment). Presence of NOA may also affect permitting requirements for tunnel air quality and ventilation. Metals such as chromium, lead, nickel, and vanadium can also be present in serpentinite and serpentinite-derived soils at concentrations that restrict waste disposal. It is planned to assess the occurrence of NOA minerals and metals in bedrock will be assessed as a component of the Phase 2 environmental investigation.

4.3 Structural

4.3.1 Material and Coatings

The tunnel(s), drop structure/shaft(s), hydraulic transition structures, and cut-and-cover boxes are designed to receive only wet weather flows. Consequently, it is anticipated that interior corrosion-proof plastic linings (e.g., high-density polyethylene [HDPE] or polyvinyl chloride) or special materials (e.g., polymer concrete, FRP) are likely not needed; however, an engineering evaluation of how best to prolong service life of the infrastructure will be undertaken during design. For all structures during final design, a durability report may be required to show that the specifications of the design mix are resistant to both external corrosion from the ground and groundwater as well as internal corrosion and erosion from the expected effluent and flow conditions.

Tunnel(s). A 12-foot inside diameter precast concrete segmented liner, such as shown on drawings in Appendix D Drawing T-1, will be used for the tunnel(s). The structural loadings require high-strength concrete with minimum compressive strengths on the order of 6,000 to 8,000 pounds per square inch (psi). Such mixes form dense concrete resistant to corrosion. Typical precast concrete segments for this diameter will be on the order of 9 to 11 inches thick and reinforced with steel fibers, and the mix includes pozzolan fly ash and sometimes microsilica and/or ground granulated blast-furnace slag to fill the micropores in the Portland cement concrete matrix. Typically, the geometry of the ring consists of four segments and key about 4 feet long, with the possibility of shorter segments on the order of 2 feet to negotiate curves if the all-tunnel alignment under Recology is selected. For the relatively shallow depth in terms of groundwater pressure, it is possible to construct the entire segment ring without steel fastening bolts (thus avoiding the negative effects of rust and possible expansion against concrete, spalling). The segmented rings can be constructed entirely with plastic guide rods and dowels. The precast segments are surrounded by annular grout with strength on the order of 300 psi between the excavated ground and the extrados of the liner.

Shaft(s). The launch shaft at the SPCA will also be the location of the permanent access shaft. The initial support will likely consist of concrete slurry wall or concrete secant pile wall socketed into bedrock, as shown on Appendix D Drawing S-1. The materials for the final liner will be cast-in-place concrete meeting the durability requirements established in final design. Drops may cause turbulence and release of corrosive gasses, which should be addressed in final design if special protective coatings, mixes, or other alternative materials are required. Thickness of the final concrete liner will be on the order of 2 feet.

For the cut-and-cover option, a shaft at De Haro and Alameda Streets is a receiving shaft. Similar initial support as for the drop shaft is required, as shown on Appendix D

Drawing S-2 and final liner will be like the SPCA launch shaft criteria, requirements, and constructability. However, there are no expected effluent drops at this location.

Hydraulic Transition Structures. For the cut-and-cover option, the shaft at De Haro and Alameda Streets will act as a transition structure to the cut-and-cover box (under De Haro and then Berry Streets), as shown on Appendix D Drawing S-3 (top). The base of the shaft will have a flow channel consisting of mass concrete reinforced with polypropylene fibers.

For the cut-and-cover option, the cut-and-cover box will transition from an approximately 11-foot by 11-foot box to a 12-foot inside diameter tunnel before or near the existing Division Street box tie-in, as shown in Appendix D Drawing S-3 (bottom). This box location will serve as a launch shaft location to tie-in to the existing Channel Consolidated Transport/Storage box end wall. Accommodations for future tie-in to the Division Street box sewer will have to be made after tunneling is complete. Such scenarios might include removing segments in the section under the Division Street box and then constructing a box structure and the tie-ins afterwards, or provisions for future stub outs to the existing Division Street box from the new concrete box must be made.

Cut-and-cover box. The box is 11 feet by 11 feet constructed of reinforced concrete or precast reinforced concrete box sections and is about 20 feet deep. The anticipated thickness of the roof and walls is on the order of 15 to 18 inches, and the base slab on the order of 20 to 24 inches thick.

A concrete box structure will be required under the existing Division Street Box. The structure under the Division Street Box may have block-outs to accommodate future connections to the Division Street box, as shown on Appendix D Drawing S-4. Similar considerations for durability as with other structures are required.

4.4 Construction

Construction methods for underground structures of the project depend on the geologic conditions. The underground construction activities consist of tunneling, shaft sinking, cut-and-cover construction, underpinning, and tie-ins to the Division Street Box and the Channel Consolidated Transport/Storage Box, as discussed in the following sections.

4.4.1 Construction Methods

Tunneling Methods. Excavation of tunnels through rock/soil mixed face conditions requires controlled-face and/or pressurized-face tunneling techniques. Typical methods which meet these criteria for this project include slurry TBM, earth pressure balanced TBM (EPBM), or hybrid methods, which may combine slurry and EPBM methods. Slurry TBM methods pump a bentonite slurry to the excavation face and excavation chamber as the cutter wheel advances, then remove the excavated material by pumping the mixture of slurry and soils back to the shaft. Typically, slurry TBM methods are used for coarse-grained materials with high permeability. EPBM methods use a screw conveyor to control the excavation face and remove material from the excavation chamber and typically are used for finer-grained materials such as clays and silts with lower permeability. Merging these two technologies is creating hybrid technologies; one example involves connecting slurry pumps to the screw conveyor. Appendix G provides more details of these technologies.

Many projects that involve rock and soil and under high external pressure have used slurry or hybrid methods with various consequences and lessons learned (although EPBM methods have been successful in special cases from 6 to 10 bars of pressure).

Optimizing the cutterhead configuration to be as universal as possible for excavating/cutting hard rock and soft soils requires different cutter tooling. Finding locations to change tooling of the cutterhead underground is another issue. Also, the open/non-pressurized or closed/pressurized mode of tunneling for slurry, EPBM, or hybrid methods can drastically affect the efficiency of excavation, advance rate, machine wear, and amount of settlement. Once in the serpentinite reach, it is expected that open mode (non-pressurized face) tunneling can be employed, and low groundwater infiltration is expected. Appendix G provides a survey of case histories with similar challenges for consideration when implementing the final design.

One of the driving factors in choosing pressurized face tunneling is the ability to deal with mixed face conditions by increasing the face pressure instantaneously to control the mixed face. For example, choosing a slurry machine introduces an additional potential complication to the tunneling process – that of the slurry composition and the plant required to produce and deliver the slurry to the tunnel face. The most significant risks include inadequate thrust and torque to bore through mixed-face ground. Steering problems may also occur in soil/rock mixed-face conditions. In addition, there is risk of excessive loss of ground when tunneling through a mixed face both during normal excavation and during the (often frequent) interventions. Also, the contact between the bedrock and the alluvium is an “unconformity” (i.e., it is an ancient erosional surface). At these locations, there may be a tendency to develop a colluvial layer, which often has a basal stony-pebbly layer of more permeable sands, gravels, and possibly cobbles.

Possible mitigations include but are not limited to:

- Detailed site investigation, to identify the location and nature of interfaces
- Alignment design to minimize the length of the tunnel in mixed face conditions
- Determining the locations for planned interventions and confirming suitability with borehole
- Allowing for frequent cutterhead interventions, planned and unplanned
- Countering the tendency of TBM to rise by slowing the advance rate and pointing the machine downward before reaching the mixed-face segment

Shaft construction. The launch shaft in the SPCA parking lot is mostly infill and undifferentiated alluvium, with a shallow groundwater table. For the CER, it is assumed that the initial support will be slurry wall or secant pile wall socketed into bedrock, as shown in Appendix D Drawing S-1. During final design geotechnical investigations, other conventional methods such as liner plate/ribs and lagging may be considered. The breakout of the tunnel will require a seal to prevent ground loss and a reinforcing collar around the tunnel opening. Tie-ins and drops will occur at this shaft for upstream flows, and similar precautions will be required. Internal hydraulic structures versus free fall and consequences of effluent air/gas releases will be investigated in final design. The SPCA shaft is oversized for the hydraulics needs because it is the launch shaft for the TBM. This shaft will also serve as an access shaft, and the lid will be provided with either precast elements or a hatch for inspection and maintenance equipment.

For the cut-and-cover option, the receiving shaft at Alameda and De Haro Streets is problematic because it is at an intersection and in front of the Recology Center. The shaft is expected to be constructed in fill and bay mud, with the base in undifferentiated alluvium or undifferentiated sands. For the CER, it is assumed that the initial support will be slurry wall or secant pile wall with a cut-off or tremie slab, as shown in Appendix D Drawing S-2. There are no tie-ins expected at this location, but it will serve as a transition structure to the cut-and-cover box. The shaft will have collar beams and break-out/break-in seals at the tunnel eye and box eye locations.

Cut-and-cover box. For the cut-and-cover option, the cut-and-cover box will extend from the Alameda and De Haro Streets intersection along Berry Street to the underpinning location at the Division Street box. The trenched sections will require shoring with sheetpiles or similar, and dewatering will be required. It is anticipated that De Haro Street will be decked/plated, while Berry Street will be open cut. Consequently, traffic management will play a large part in the constructability, as discussed in more detail in Section 4.5. The cut-and-cover section will also require construction of a transition structure back to a 12-foot-diameter tunnel, as described in 4.3.1.

Tie-in to the existing Channel Consolidated Transport/Storage Box. The 12-foot-diameter tunnel will tunnel into the end wall of the existing 17-foot-wide by 35-foot-high Channel Consolidated Transport/Storage Box. The existing wall is reinforced and will require demolition (saw cutting or hydro demolition, and provision for a seal) and preparation of the TBM and the tunnel liner, as shown in Appendix D Drawing S-3. The soil outside the box will likely require ground improvement such as jet grouting. Also, because the tunnel will dead end without a conventional retrieval shaft, the TBM must be dismantled from inside the existing box and removed from the shafts at De Haro, at the SPCA, or from hatches in the existing box.

Underpinning. The existing Division Street Box will require underpinning where it crosses under Berry Street to remove timber and concrete piles, discussed in Section 5.5.4. Once the underpinning is complete, to construct the tunnel to the Channel Consolidated Transport/Storage Box, the TBM and tunnel “false” supports must be under and through this area. The tunnel “false” supports must be removed and then a tie-in structure must be constructed under the Division Street box. This tie-in structure must connect to the tunnel to the northeast, to the cut-and-cover box to the southwest, and to the existing Division Street Box overhead.

Tie-in to the Existing Division Street Box. There will be a drop structure from the existing four-compartment Division Street box to the tunnel. Provisions must be made to construct a box with connections or stub-outs under the Division Street box. Scenarios of this structure are shown on Appendix D Drawing S-4**.**

4.4.2 Trench Considerations

Excavation. Trench excavation will be by conventional hydraulic excavators through fill, bay mud, and undifferentiated alluvium. It is anticipated that a dewatering well point system will be required. Final design geotechnical investigations will help determine the criteria for the specifications and the contractor’s dewatering requirements. Final contract documents could include mitigation measures and could encourage the contractor to find alternative permitted discharge locations, such as the bay.

Bedding and backfill. The cut-and-cover box foundation materials may require stabilization with lime or removal of soft material and replacement with lean concrete. It is anticipated that a concrete “mud” working slab will be required. Backfill may require import, depending on the findings of the final design geotechnical investigations. It is anticipated that the fill and undifferentiated alluvium may be suitable backfill, whereas the bay mud will not be suitable. It is possible that controlled low strength material and/or controlled density fill will facilitate backfill and eliminate compaction.

4.4.3 Access and Limits of Construction

The staging areas for tunnel construction are shown on Figure 11 and Figure 12. The launch shaft is expected to be in the SPCA parking lot (between Treat and Florida Streets). The launch shaft may be located alternatively on Treat Street or Florida Street if an easement in the SPCA parking lot cannot be obtained.

4.4.4 Materials Storage

An additional staging area is the Highway 101 viaduct, as shown in Figure 11 and Figure 12. This area would likely be used for standby/idle construction equipment e.g., front-end loaders, miscellaneous trucks) and materials storage (e.g., precast concrete segmented liner, temporary contractor utilities including fan line, rail, ties).

4.4.5 Flow Bypass during Construction

Flow bypass is not needed during construction of the tunnel.

4.4.6 Construction Issues

Shaft Size. The launch shaft will have a minimum diameter on the order of 30 to 35 feet for construction launch of the TBM, as selected by the contractor. The initial support will consist of slurry wall panels or secant piles with thickness on the order of 2.5 to 3 feet. During final design, the most practical support may be secant piles penetrated 10 feet into bedrock. In the Franciscan bedrock, the rock mass may be supported by ribs and lagging or rock bolts and shotcrete. The final liner will be on the order of 18 inches thick. Thus, the finished diameter will be on the order 27 to 32 feet inside diameter.

Hitting a Buried Object. Based on the geologic conditions, buried archaeological objects are not expected in the tunnel drive in the Franciscan Formation and serpentinite or in the undifferentiated alluvium. However, in the fill and younger bay mud, it is possible that timber and concrete piles and buried archaeological objects may be present. Also, coarser sediments consisting of gravels, cobbles, or boulders may be present in the undifferentiated alluvium.

Dealing with Buried Objects. In the launch shaft excavation, if buried objects are encountered in overlying sediments, they will be noticeable because conventional excavation with hydraulic excavators will likely be used. An archeologist/paleontologist would be present or on call during excavation.

During construction of the tunnel, however, because mechanized pressurized face tunneling methods are envisioned in the downstream portion of the alignment, encountered buried objects would not be as readily apparent as they would be for an open cut excavation (like the launch shaft). The TBM might experience chatter if encountering gravels, cobbles, boulders, or a pile. And, depending on the consistency of any archeological/paleontological artifacts, either the TBM may experience chatter or the object may not be detectable and would be pulverized by the machine’s cutting action. Gravels, cobbles, boulders, or a pile would be evident in the spoils. TBM cutterheads properly designed have been known to cut through gravels, cobbles, boulders, timber piles, and even steel piles. It is uncertain whether reinforced concrete piles are excavatable by a cutterhead or will require removal ahead of the TBM.

Potential for Surface Settlement. There is potential for surface settlement, particularly in soil reaches along the tunnel alignment and adjacent to the shaft associated with elastic movement and inelastic ground loss during excavation. The typical shape of surface settlement, sometimes referred to as the “mole track,” has a normal distribution, as shown exaggerated in Figure 13.

Figure 11
Overall Tunnel Shaft Site and Local Construction Traffic Plan

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Figure 12
Construction Traffic Route – Tunnel Drive Shaft Site to US-101

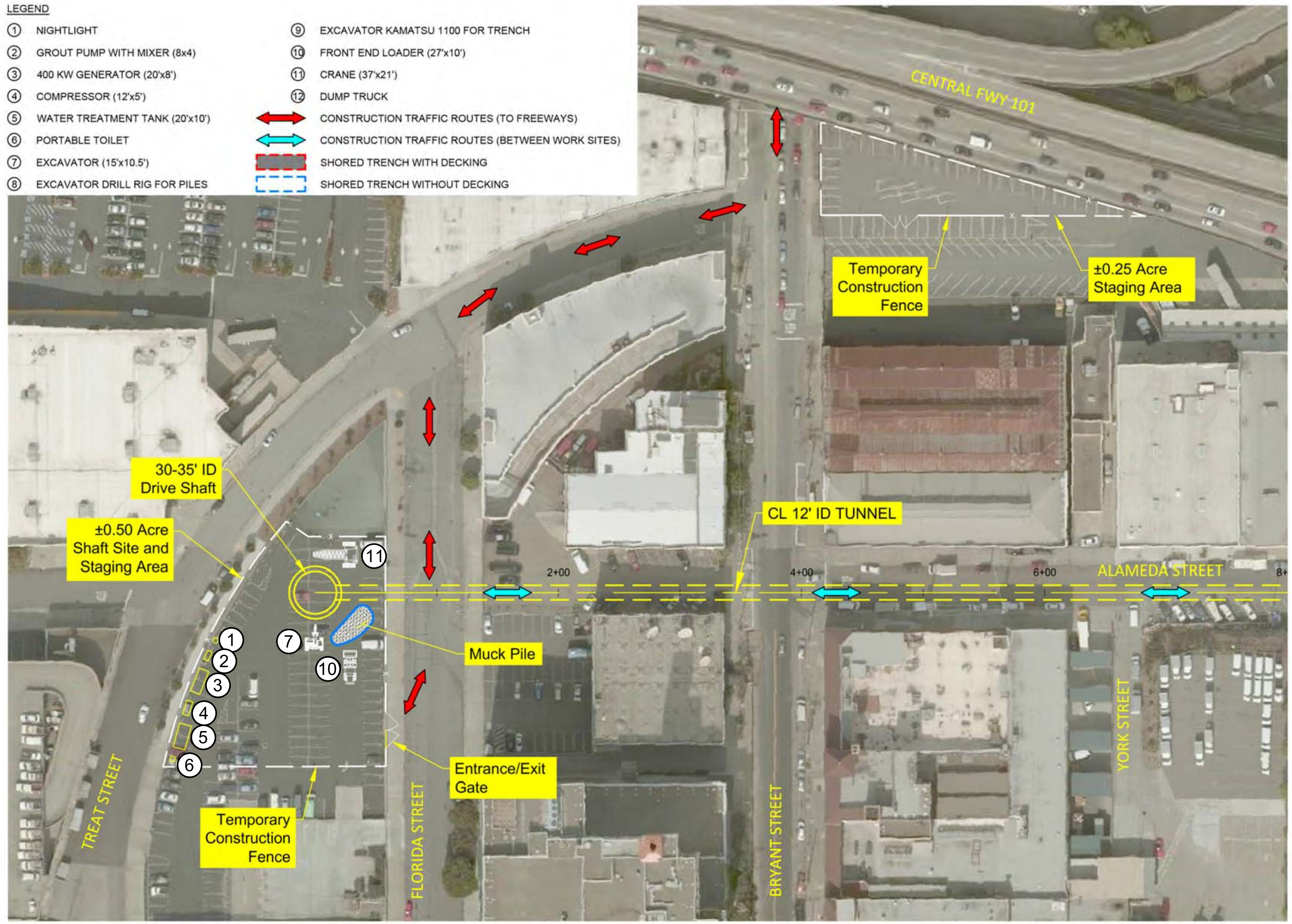

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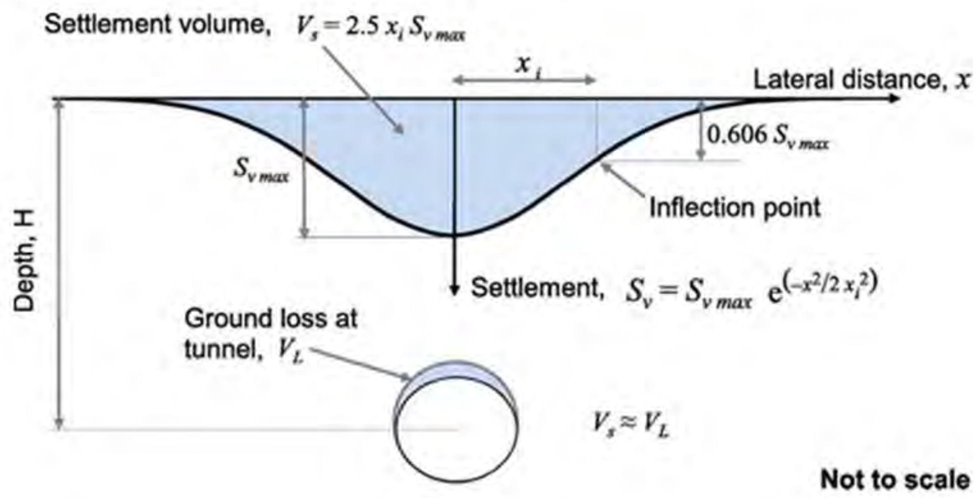
Figure 13
Typical Surface Settlement Profiled Due to Tunnel Excavation



A Greenfield analysis provides the expected settlement in an open field unencumbered by adjacent structures or terrain. A Greenfield settlement analyses for typical cross-sections adjacent to structures along the alignment was performed following the approach briefly described in Figure 13. The analyses are discussed in detail in Appendix H. The alignment was divided into the following categories:

- Station 0+00 to Station 2+00 and Station 15+50 to Station 25+00 – Passing through alluvium and sand (volume loss = 1%)
- Station 2+00 to Station 15+50 – Passing through serpentinite (volume loss = 0.5%)
- Station 25+00 to the End – Passing through fill and bay mud (volume loss = 1.7%)

For the shafts, a common conservative empirically based method was used which assumes the distance from the shaft at the ground surface to where the settlement is zero is 1.5 times the depth (H) of the slurry wall panel or secant pile; the maximum settlement can occur at the edge of the shaft or out to 0.2H away from the shaft; the maximum vertical settlement is 0.05%H; and the maximum horizontal ground movement is twice the maximum vertical movement.

For the cut-and-cover portion, the analysis method was an empirically based settlement profile that is scalable based on the excavation depth and the maximum horizontal movement occurring during construction: the distance from the wall at the ground surface to where the settlement is zero is 2 times the depth (H) of the excavation; the maximum settlement can occur at the edge of the excavation or out to 0.75H away from the excavation; and the maximum horizontal settlement is 0.17%H and 0.5 times the maximum horizontal movement.

Typically, a maximum settlement of less than 0.5 inch and a maximum angular distortion of less than 1/500 are considered acceptable. However, the sensitivity of structures and utilities shall be considered as well as the amount of earlier settlement they experienced due to other construction activities. Thus, for this CER stage, we defined the following risk categories:

- Negligible ($S_{max} \leq$ 0.1 inch, or distortion < 1/750): No further analysis or mitigation is required.
- Slight (0.1 < $S_{max} \leq$ 0.2 inch, or 1/750 < distortion < 1/500): At the least, more detailed analysis is needed.
- Moderate (0.2 < $S_{max} \leq$ 0.4 inch, or 1/500 < distortion < 1/300): In addition to further analysis, monitoring is needed with proper mitigation measures to be employed if action limit passes.
- High (S_{max} > 0.4 inch, or distortion > 1/300): In addition to further analysis and monitoring, mitigation measures are most probably needed, which shall be verified and specified during final design.

The preliminary analyses were performed only to identify any fatal flaws, of which there were none. In final design, detailed analyses based on geotechnical investigations and a more thorough review of adjacent structures and utilities is warranted for the areas with moderate to high risk.

Settlement due to construction. Based on the analyses, the expected settlements and impacts on adjacent structures and utilities are summarized in Tables H.8, H.9, and H.10 of Appendix H. Table 6 summarizes the structures and utilities with impact risk categories of slight, moderate, or high due to construction activities. Project design documents will provide provisions to monitor and mitigate settlement.

Potential for noise and vibration impacts. This section assesses potential noise and vibration impacts from ground vibrations due to TBM operation, ground vibrations due to sinking a shaft by conventional excavation methods, and noise due to surface construction equipment. Appendix I provides a more detailed discussion of noise and vibration impacts.

TBM Operation. Tunnel construction for the sewer tunnel will create vibrations. However, it is anticipated that the vibrations due to TBM activity will have no adverse effect on the nearest residents or daily visitors and workers at commercial and industrial enterprises along the alignment. The vibration/noise caused by TBM operation will be generally less than the expected ambient background vibration/noise levels above the ground surface and will have no potential to cause structural damage.

At some locations along the alignment, vibration and noise may be perceptible. These effects are expected to be within the normal ambient noise levels experienced by commercial visitors and workers in light industrial enterprises in day-to-day operations. Existing ambient noise and vibration is also higher in areas adjacent to the busier street crossings and overhead freeway viaducts.

For the eastern half of the tunnel in soil and alluvium, given that the distance between the tunnel and nearest residential receptors is relatively close (30 to 50 feet), the estimated maximum peak particle velocity (PPV) from soil TBM operation is estimated to be in the range of 0.04 inch per second (in/sec) to 0.007 in/sec. The maximum TBM vibrations for the nearest sensitive receptors are anticipated to be in the range of “just perceptible.”

For the western portion of the tunnel, which is in rock, the distance between the tunnel and nearest residential receptors is large (700 to 1,100 feet) and the estimated maximum PPV is less than 0.002 in/sec, which is in the “not felt” range. For commercial/industrial workers in the western portion of the alignment, maximum PPV due to TBM tunneling in rock will be less than 0.07 in/sec, in the “noticeable” to “just perceptible” range.

Table 6
Impacts on Different Buildings/Structures within Zone of Interest

Const. Option	Structures' Description and Location; or Street Name (Utilities)	S_{max} [inch]	Distortion	Risk Category
Tunnel or C&C	2-Story Building SW of Alameda St & Bryant St	0.38	1/1100	Moderate
	2-Story Building SE of Alameda St & Bryant St	0.16	1/1500	Slight
	3-Story Building SW of Alameda St & Potrero Ave	0.2	1/1360	Slight
	1-Story Building SE of Alameda St & Potrero Ave	0.2	1/1360	Slight
Tunnel	3-Story Building NW of Alameda St & De Haro St	0.6	1/300	High
	1-Story Building SW of Berry St and 7th St	0.6	1/300	High
C&C	3-Story Building NW of Alameda St & De Haro St	0.55	Var.	High
	3-Story Building SW of Alameda St & De Haro St	0.28	Var.	Slight
	1-Story Building SW of Berry St and 7th St	< 0.1	Negligible	Slight
	1-Story Building SE of Alameda St & De Haro St	0.3	Var.	Moderate
	2-Story Building NW of Berry's St and 7th St	0.3	Var.	Moderate
Tunnel or C&C	Treat Ave. (9' ϕ Conc. Box Sewers; PG & E Electric; and 21" ϕ VCP Sewer) Florida St. (24" ϕ VCP Sewer; and UNK ϕ UNK Sewer) Bryant St. (12" ϕ VCP Sewer; PG & E Electric; Auxiliary Water Supply; and Muni Overhead Wires) Potrero Ave. (14" ϕ VCP Sewer; 15" ϕ VCP Sewer; 6" ϕ 110 kV PG & E Electric; and Auxiliary Water Supply) Utah St. (27" ϕ VCP Sewer) San Bruno Ave. (2'x3' ϕ Conc. Sewer; 24" ϕ ISP Sewer; and 6" ϕ 115 kV Transmission) Vermont St. (18" ϕ VCP Sewer; and 8" ϕ VCP Sewer)	< 0.65	< 1/500	Slight
	Kansas St. (18" ϕ VCP Sewer; 20" ϕ HDPE Sewer; 8" ϕ ISP Sewer; 14" ϕ ISP Sewer; and Auxiliary Water Supply)	0.7	1/500	Moderate
	Rhode Island St. (4.5' ϕ Conc. Sewer; 3.5'x5.25' ϕ Conc. Sewer; and 14" ϕ ISP Sewer) De Haro St. (15", 21", & 27" ϕ VCP Sewers) Berry St. (15" ϕ VCP Sewer; 12" ϕ VCP Sewer; PG&E Deactivated Gas; 4" ϕ PG&E Gas; and ATT) 7th St. (6' ϕ Conc. Sewer; and ATT)	1.2	1/300	High
	Diversion St. @ Berry St. (9.5'x8.25' ϕ Conc. Box Sewers)	[1]		High

[1] Considering the intersection of the tunnel and existing sewer box, the impact is in the High category. Special construction staging will be utilized; see construction methods in the main body of CER.

C&C = cut and cover; ISP = iron stone pipe; VCP = vitrified clay pipe

Conventional Tunnel Excavation. If construction methods require the use of blasting for a portion of the work (e.g., deepening the launch shaft), the contractor will be responsible for developing a blasting plan to demonstrate how blasting effects will be kept within well-known safe limits (e.g., U.S. Bureau of Mines criteria, or equivalent). Vibration monitoring may need to be performed at off-site residences to ensure that PPV limits are not exceeded.

Surface Construction. Acceptable project noise levels for surface construction equipment will be maintained by the contractor. Maximum permissible noise limits for various pieces of construction equipment will need to be established along with project noise reduction practices. Various portable sound barriers are available for this purpose. Equipment types will be selected and operational practices will be developed that keep noise below maximum permissible limits. Monitoring with microphones and recording devices may need to be conducted periodically to demonstrate that acceptable noise level limits are being achieved. Such monitoring may be performed at surface construction locations such as the launch shaft. If the cut-and-cover option is selected, noise monitoring may also be performed at various locations near the shored excavations at the intersection of Alameda and De Haro Streets and along Berry Street to Sta. 34+00.

Work hours. Tunnel work hours are typically 5 days per week, 24 hours per day, either two-10-hours shifts with a 4-hour maintenance/pump watch shift or three-8-hour shifts. Weekends are typically reserved for maintenance/pump watch.

4.5 Traffic Management

The following is a preliminary overview of potential traffic impacts of the tunneling portion of the project. SFMTA and the Environmental Project Manager will be consulted to fully define and potentially mitigate traffic issues during design.

4.5.1 Tunnel Launch Shaft

The proposed tunnel will start at a tunnel launch shaft in the SPCA parking lot, near the intersection of Treat and Florida Streets. Construction traffic to the shaft site will enter through a parking entrance along Florida Street, and Bryant Street will be used to route construction traffic to the US-101 freeway. There will also be local construction traffic between the shaft site and the staging area at the southeast corner of US-101 and Bryant Street. Local construction traffic is also expected along Alameda Street, which leads to the cut-and-cover section of the project. Figure 11 and Figure 12 present the construction routes described above.

4.5.2 Tunnel Boring Machine Receiving Pit and Cut-and-Cover Box Sewer

The proposed tunnel will end at a receiving pit at the intersection of Alameda and De Haro Streets. Receiving pit construction/restoration and TBM removal will require night and/or weekend closures of De Haro Street between Alameda and Berry Streets. The typical traffic configuration for reinforced concrete box sewer cut-and-cover construction along both De Haro and Berry Streets will allow one traffic lane in each direction, but no street parking. To limit traffic and parking impacts at the intersections along De Haro Street, temporary traffic decking could be used to maintain the current traffic configuration during normal business hours. To access the I-280 freeway, construction traffic will take 7th Street either to Brannan or Mission Bay Drive. Local construction traffic is also expected along Alameda Street, which leads back to the tunnel shaft site. Figure 14 through Figure 17 present the general construction layout, traffic configurations, and traffic routes described above.

Figure 14
Construction on De Haro and Berry Reception Shaft

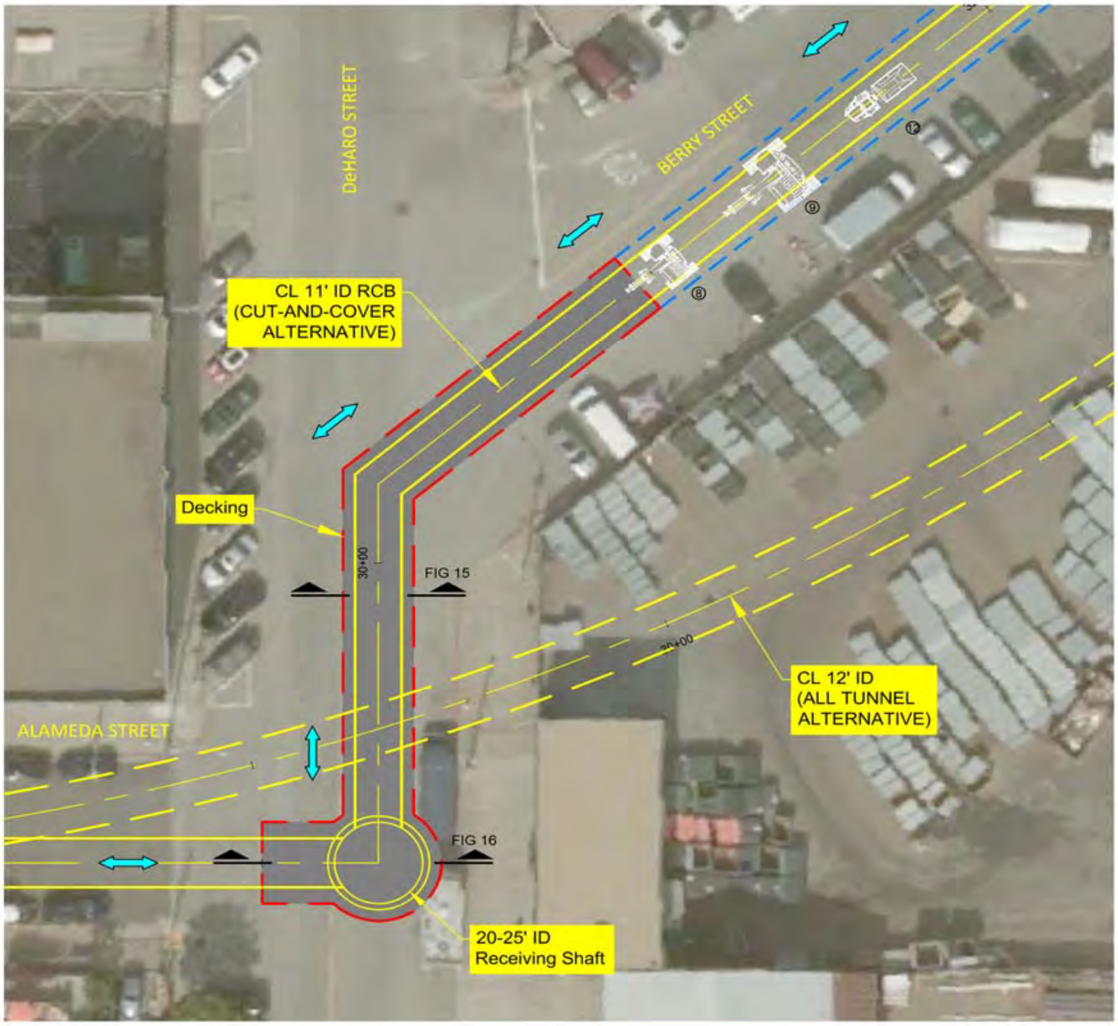


Figure 15
Traffic Configuration – Reinforced Concrete Box (De Haro and Berry)

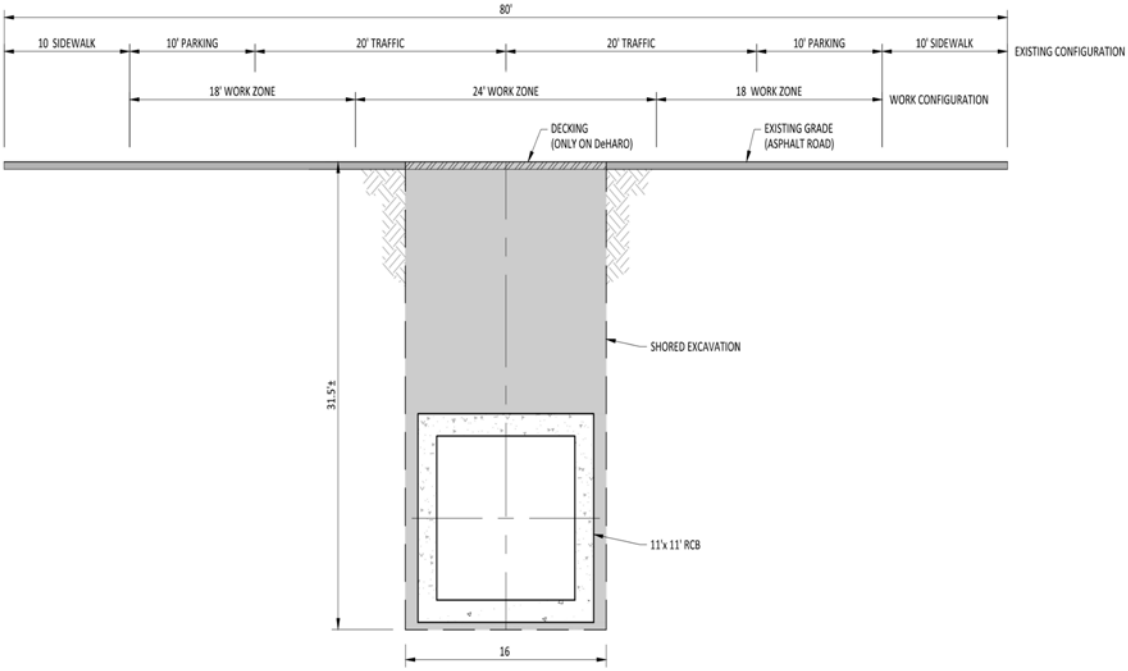


Figure 16
Traffic Configuration – Tunnel/Junction Structure (De Haro and Alameda)

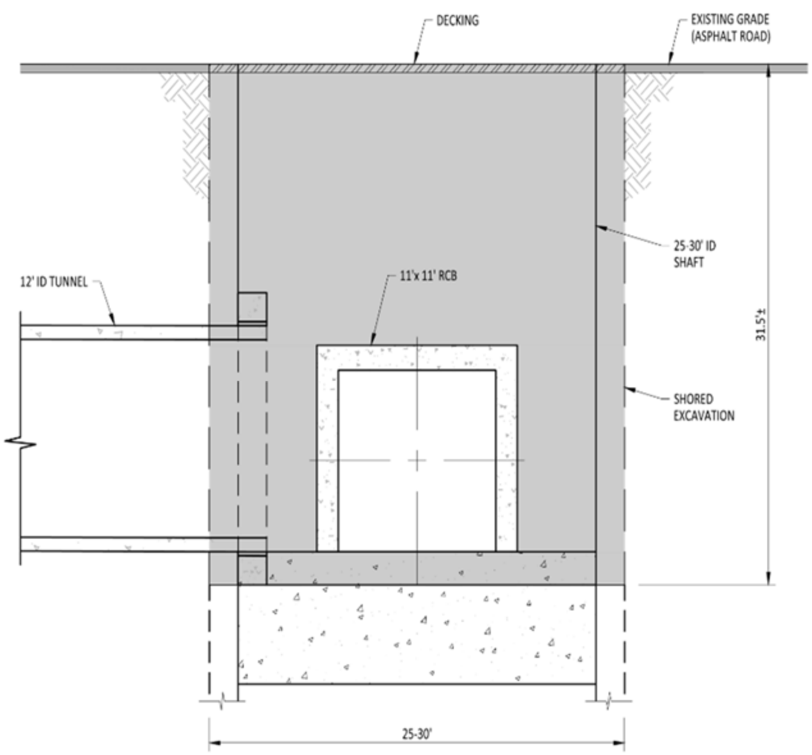


Figure 17
Construction Traffic Route – Cut-and-Cover to I-280

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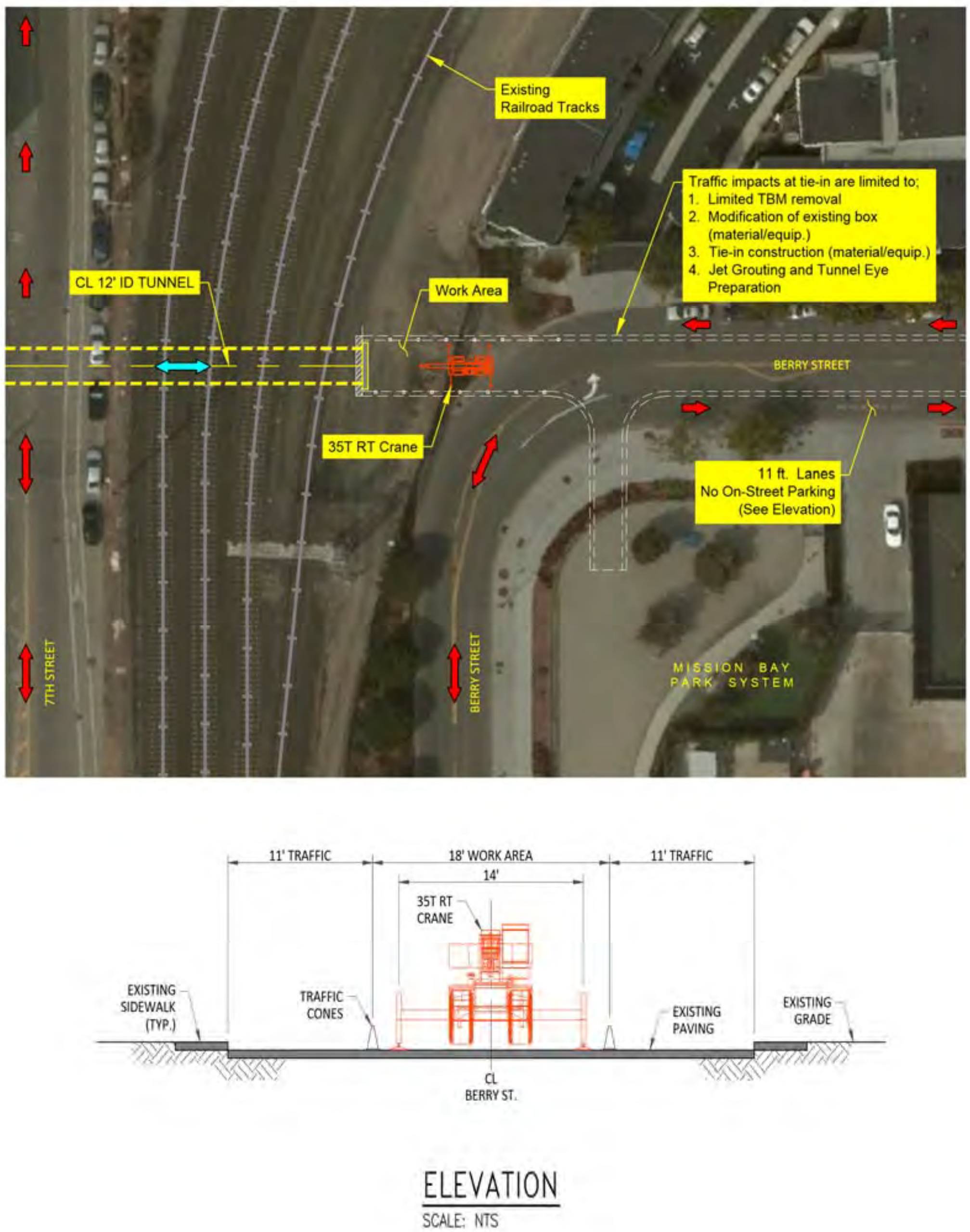
4.5.3 Tunnel Boring Machine Receiving and Tie-in

The final tie-in for the project is on Berry Street. Work will be limited to the removal of the TBM and construction of the final connection to the existing facility. Work will be performed through a maintenance access hatch for the existing facility. A boom truck or 30-40T hydraulic crane will be needed occasionally for material handling and will be staged within a typical traffic closure during normal work hours. Construction traffic will drive East on Berry to access I-280 and South to Mission Bay Drive to head back to the tunnel shaft site. A typical traffic configuration at the final tie-in is shown in Figure 18.

Figure 18
Traffic Configuration – Berry Tie-In



4.5.4 Traffic Impacts

Expected construction traffic volumes are described in Table 7. The added construction traffic volume is approximately 1% relative to the existing traffic count data provided in the SFMTA 1993–2015 Traffic Study. Consequently, the construction impact on existing traffic volumes will be negligible.

Nevertheless, the project team will work with SFMTA in the design phase to schedule lane closures and implement other measures to minimize traffic and transit effects. Coordination with SFMTA will also include provisions for temporary or alternative access and parking. In addition, the project specifications should include provisions to mitigate business impacts (e.g., signage, parking) and to protect/maintain existing pavement (e.g., sweeping, repair). Traffic safety measures to ensure public and worker safety shall also be required along the construction traffic routes. Safety measures include proper traffic control devices, temporary barriers, signage, and flagman at key points of entry to the work zones.

Table 7
Projected Construction Traffic Volume

Item	Work Zone	Location	Construction Activity	Estimated Duration. See Note 2. (Working Days) NEED TO CONFIRM	Duration (Mo)	Max. Construction Traffic Count (Vehicles/hour)	Peak Hour Traffic Count, See Note 1 (Vehicles/hour)	Traffic Considerations
1	Tunnel Shaft Site	Treat and Florida (To Bryant)	Shaft and Tunnel Construction	150	7.5	6	1097	Local construction traffic to Bryant staging area
2	TBM Receiving Pit	De Haro (Alameda to Berry)	Shoring, TBM Removal, RCB and Transition Structure	60	3	4	384	Intersection Work: Weekend and/or Night Closures
3	RCB Cut and Cover	Berry (DeHaro to 7th)	Shoring / RCB / MTBM Launch	150	7.5	2	1008	Limit to 1-lane each direction; No street parking
4	MTBM Receiving and Tie-in to Existing Facility	Berry St.(at 7th and East of RR Tracks)	MTBM Removal and Tie-in to Existing Facility	30	1.5	3	358	Weekend and/or Night Closures

1) Durations are based on alignment with cut and cover RCB on Berry Street.
2) Peak Hour Traffic Count per SFMTA 1993-2015 Data Report; Based on maximum traffic count along proposed route from that work zone.
   a. Tunnel Shaft - Bryant and 9th
   b. TBM Receiving Pit - De Haro and 16th
   c. RCB Cut and Cover - 7th and Brannan
   d. MTBM receiving pit - Berry and 4th

5.0 CONCEPTUAL DESIGN: REINFORCED CONCRETE SEWERS AND STRUCTURES

This chapter applies to the upstream components shown in Table 8 and includes the deepening of existing box sewer on Treat Street, the replacement of a 3-foot by 5-foot sewer on Harrison Street with a box sewer, and the construction of an intertie structure between the Division Street box sewer and the new tunnel along Berry Street.

Table 8
Reinforced Concrete Sewers and Structures

Sewer Location	Existing Size	Proposed Size	Linear Footage
Treat Street – 16th to Alameda	10.5'wx9'h	10.5'wx15'h	985'
Treat Street @ 16th	N/A	4'2"x9'0"	24'
Harrison Street – 19th to 18th	3'0'x4'6"–3'0"x5'0"	9'0"x6'0"	585'
Harrison Street – 18th to 17th	3'0"x5'0"	9'0"x6'0"–9'0"x7'0"	708'
Harrison Street – 17th to 16th	3'0"x5'0"	9'0"x8'0"	340'
Optional Cut and Cover			
Berry Street – De Haro toward 7th	N/A	11'x11'	550'
Structures			
Berry Street – De Haro to 7th Street (intertie structure)	N/A	N/A	N/A

5.1 Design Criteria

The design of reinforced concrete box sewers and junction structures will meet the requirements set forth in this report and those listed in Table 9.

Table 9
Design Criteria for Reinforced Concrete Sewers and Structures

Description	Criterion
Reinforced Concrete Sewer and Tie-In Structure Design	
Material	Reinforced concrete
Installation method	Cut-and-cover cast-in-place
Box sizes	Varies as per Table 8
Junction structure size	To be determined in Design
Cover	2-foot minimum
Minimum velocity	2 ft/sec for average sanitary flow, where achievable
Geotechnical Engineering Design	
Depth of excavation (maximum)	Up to 35 feet for intertie Up to 20 feet for reinforced concrete box sewer

Description	Criterion
Depth to groundwater	Approximately 10 feet with seasonal fluctuations.
Excavation shoring: max. allowable movement	1 inch
Excavation shoring: tiebacks/bracing	One row up to 10 feet excavation and two rows for excavation up to 20 feet
Excavation: bottom seal	Required to stop bottom heave
Excavation: dewatering	Required to maintain groundwater at 3 feet below bottom of excavation
Allowable bearing pressures (mat foundation)	600 psf in soil 4,000 psf in rock
Passive resistance (allowable) on face storage structure	250 pcf above groundwater (equivalent pressure) in soil 175 pcf below groundwater (equivalent pressure) in soil
Seismic design criteria	Per SFPUC General Seismic Requirements Seismic Performance Class: I
Structural Engineering Design	
Design live loads	Concrete slab: 250 psf or HS20 Walls: Surcharge from traffic and construction
Dead loads	Vertical loads due to the weight of all permanent structural and nonstructural components. The numerical value of various commonly used materials can be found in the following publications: ▪ ASCE/SEI 7-10, Minimum Design Loads for Buildings and Other Structures ▪ AISC Steel Construction Manual ▪ CRSI Design Handbook ▪ Manufacturers' catalogs of equipment Actual or estimated equipment weights shall be verified with the appropriate discipline engineer prior to submitting final calculations.
Seismic, soil, hydrostatic loads	New and modifications to existing structures must resist effects of seismic ground motions in accordance with Section 1613 of CBC
Temporary design live loads adjacent to shafts	600 psf

Description	Criterion
Concrete design	▪ 28-day compressive strength (f'c): • Lean Concrete: 2,000 psi • Slabs: 4,500 psi • Walls: 4,500 psi ▪ Concrete shall be rated Moderate for sulfate exposure, per ACI 350-06. ▪ ACI 318 ▪ ACI 350
Cement	Portland, ASTM Type II
Reinforcing steel	▪ Yield strength (fy): 60,000 psi ▪ Deformed bars: ASTM A615, Grade 60 ▪ Min cover
Deflection limits	▪ Limitation Values in CBC
Minimum cover for reinforcing bars	▪ Concrete not in contact with earth or weather – 1½ Inches ▪ Concrete exposed to water or sewage – 2 inches ▪ Concrete exposed to earth or weather – 2 inches ▪ Concrete cast against earth – 3 inches

ACI = American Concrete Institute; CBC = California Building Code; pcf = pound(s) per cubic foot; psf = pound(s) per square foot; psi = pound(s) per square inch

Drawings, specifications and calculations will be prepared following the relevant standards, codes, and guidelines, including, but not limited to, complying with the standards specified by Caltrans, the City, and other nationwide codes that are listed below, as applicable:

- American Concrete Institute
  - ACI 201.2-08 (Guide to Durable Concrete)
  - ACI 210R-93 (Erosion of Concrete in Hydraulic Structures)
  - ACI 222.3R-11 (Guide to Design and Construction Practices to Mitigate Corrosion of Reinforcement in Concrete Structures)
  - ACI 224R-01 (Control of Cracking in Concrete Structures)
  - ACI 308R-01 (Guide to Curing Concrete)
  - ACI 318 (Building Code Requirements for Structural Concrete)
  - ACI 350 (Code Requirements for Environmental Engineering Concrete Structures and Commentary)
  - ACI 350.5-12 (Specifications for Environmental Concrete Structures)
  - ACI 365.1R-00 (Service Life Prediction)
- American Society of Civil Engineers
  - ASCE/SEI 7 (Minimum Design Loads for Buildings and Other Structures)

- American Association of State Highway and Transportation Officials, 12th Edition
- American Society for Testing and Materials, Table 2.1
  - RCP
  - FRP
  - Polymer concrete
- Caltrans
- 2016 California Building Code
- City and County of San Francisco Mechanical Code
- California Occupational Safety and Health Act
- Construction Specification Institute format
- Excavation Code of the San Francisco City and County
- American National Standards Institute
- National Fire Protection Association
- Uniform Building Code
- SFPUC Design Standards, Codes, and References
  - General Seismic Requirements for Design for New Facilities and Upgrade of Existing Facilities, June 2014
  - Safe Design Guidelines, Version 2.0, March 2012
- Title 24 California Code of Regulations Sections 2-5301 et seq., Energy Conservation
- Other recognized standards where required to serve as guidelines for design, fabrication, and construction when not in conflict with the above-listed standards
- The codes and industry standards used for design, fabrication, and construction, including all addenda, in effect as stated in contract documents
- City and County of San Francisco Subdivision Regulations
- City and County of San Francisco Standard Plans and Specifications

Drawings, specifications, and calculations will be prepared following the applicable standards, codes, and guidelines, including:

- ASTM-C76 and others for RCP and fiberglass pipe
- Excavation Code
- Cal/OSHA requirements

Should there be a conflict in the engineering design requirements, the more stringent requirement in the following compliance standards, codes, and guidelines will be adopted:

- Federal and state requirements
- City requirements
- Specific industry group or professional guidelines
- Accepted manufacturers' guidelines
- Project-specific guidelines (e.g., equipment clearance, spare equipment arrangement)

5.2 Civil

5.2.1 Alignment

The alignment of the new box sewers will generally utilize the alignment of the existing infrastructure within the public right-of-way. Treat Street construction activities will be a deepening of one of the existing box sewer compartments, keeping within the same general footprint of the existing infrastructure. Harrison Street box sewer will be constructed along the same alignment of an existing 3-foot by 5-foot sewer, albeit at an increased width.

Gravity sewers are designed with a minimum velocity of 2 ft/sec at average sanitary flows to promote self-cleaning velocities.

Gravity sewers are designed with a minimum of 2 feet of ground cover.

5.2.2 Manholes/Accesses

Manholes will be located at intervals of no more than 350 feet; at every change in size, grade, or alignment; at all junctions of sewers; at ends of sewers; and where catch basin culverts join pipe sewers.

For reinforced concrete box sewers, pre-cast risers are typically installed atop the box sewer. SFPW Standard Plan No. 87,190 – Standard 26" Manhole Frame & Cover and No. 87,191 – 30" Manhole Frame and Cover will be referenced for design and construction.

Where requested by SFPUC, access hatches may be designed and constructed to provide additional access for larger equipment.

5.2.3 Utility Support and Relocation

Utility facilities are generally within 5 feet of the ground surface; sewer facilities, on the other hand, are usually at depths closer to 10 to 15 feet below the ground surface. At locations of large box sewer infrastructure, there may be less than 5 feet of cover to allow utilities to pass through.

For deepening the existing box sewer on Treat Street, there is no change to the depth of cover to the box sewer, and it is also within the same footprint. Utility conflicts are not expected to be a major issue for the final location of the expanded infrastructure; however, the contractor may have to address utility crossings during construction. Utility crossings are usually supported in place during construction.

For the box sewer on Harrison Street, the design team will utilize the same alignment as the existing 3-foot by 5-foot brick sewer, but the footprint will be significantly wider. Reference information gathered from the utility agencies will be used to identify potential conflicts. Potholing during design will be used to confirm conflicts.

Where conflicts are unavoidable, the design team will coordinate with utility agencies to support and/or relocate their facilities as per standard utility notification procedures. Utilities that cross the sewer excavation can usually be supported in place; utilities that are parallel and within the shoring limits will likely need to be relocated before excavation.

5.3 Geotechnical

The general geotechnical design criteria are based on past projects and practices. Geotechnical design criteria may be revised based on results from the detailed geotechnical investigation program that will be initiated in the design phase.

As per the SFPUC General Seismic Requirements, reinforced concrete box sewers should fall under Seismic Performance Class I, described as "normal and ordinary pipeline use, common pipelines in most water and wastewater systems."

5.4 Structural

The general sewer structural design criteria are based on the following load considerations:

- Dead load from the soil and pavement above the sewer, and surrounding soils
- Live load from traffic above the sewer, groundwater surrounding the sewer if applicable, and flow inside the sewer
- Seismic load as determined by the SFPUC General Seismic Requirements and Section 1613 of 2016 California Building Code

5.4.1 Material and Coatings

For large sewer box infrastructure, cast-in-place reinforced concrete is the only material under consideration due to its proven track record. The City has many large reinforced concrete box sewers that were constructed 100+ years ago still in use. In addition to its durability, the capability to adjust cross-sections to fit site needs allow for ease of construction.

Reinforced concrete's main drawback, being susceptible to corrosion, may be addressed during design. The project team will determine whether there is a need for corrosion resistance during design and, if necessary, include one or more of the following options for corrosion resistance:

- Epoxy coating
- Sacrificial concrete
- Corrosion-resistant admixture

5.5 Construction

5.5.1 Construction Methods

General cut-and-cover construction methods will be used to construct the reinforced concrete box sewers. Five types of potential excavation support systems are considered for the project: speed shoring, interlocking sheet piles, conventional soldier pile and lagging (with dewatering), soil mixing, and soil mixing and jet grouting. For reinforced concrete sewers, due to their moderate depths, interlocking sheet piles or conventional soldier pile and lagging will likely be the contractor's chosen methods. Shoring design is typically provided by the contractor's licensed engineer to meet the needs at each project site.

For the tie-in structure at Berry Street, the existing infrastructure will be underpinned to allow work beneath the box sewer. Due to the depth of the tie-in structure at Berry Street, roughly 35 feet deep, the contractor will likely opt for a more robust shoring system that can include a combination of sheet piles, soldier pile and lagging, and soil mixing with or without jet grouting. Again, shoring design is typically provided by the contractor's licensed engineer to meet the needs at each project site.

A conceptual sequence of construction is described in more detail in Sections 5.5.3 and 5.5.4.

5.5.2 Flow Bypass for Reinforced Concrete Box Construction

For upsizing the reinforced concrete box on Treat Street, because only one of two compartments will be impacted, the remaining compartment may be utilized to carry dry-weather flow that would normally travel through the compartment to be deepened. Because the box sewer is the largest infrastructure in the vicinity, other sewers will not be able to handle the additional flow during a wet-weather event. Special consideration must be made for the sewers that are meant to transport and store stormwater flows. In such instances, the contractor may be required to perform all work within one dry-weather season (typically defined as May 15 through October 15) or to provide a bypass pumping system with enough capacity to handle wet-weather flow. Another option is to construct a watertight shoring system to anticipate an influx of stormwater and allow the excavation to flood. Following a storm event, the contractor would clean the work area prior to resuming construction activities.

For construction of new reinforced concrete box sewer on Harrison Street, the capacity of the existing 3-foot by 5-foot sewer is not as large as the Treat Street sewer and should be easily bypassed either with an upstream diversion or with a pump-around option.

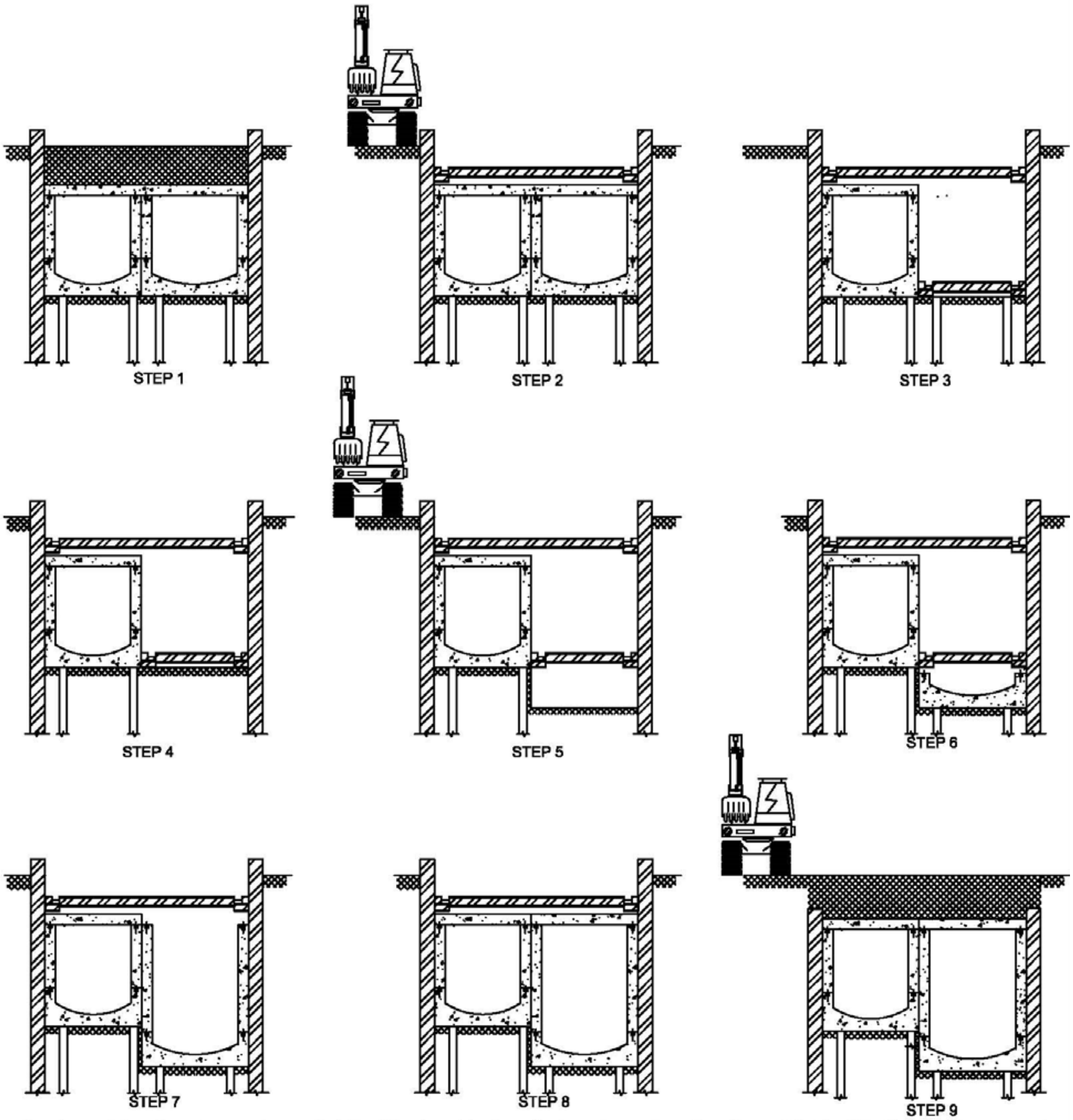
5.5.3 Construction Sequence for Reinforced Concrete Box Sewers

Although construction methods will vary, the following is a broad overview of the sequence of activities that a contractor could undertake for the construction of the box sewers on Treat Street and Harrison Street. Refer to Figure 19 for a schematic overview of the following sequence.

1. Install shoring system on both sides of existing sewer box or pipe.
2. Excavate to first layer of struts, and install struts, if required.
3. Excavate and demolish existing infrastructure to second layer of struts, and install struts, if required.
4. Demolish remaining infrastructure and remove piles.
5. Excavate to depth of new box sewer.
6. Construct piles and base slab of new sewer box.
7. Remove second layer of struts, if used, and construct walls of new sewer box.
8. Construct roof slab of new sewer box.
9. Remove first layer of struts, if used; backfill, cut or remove shoring; and restore trench.

The figure shows the existing box sewers on Treat Street but can be easily adapted for the replacement of the 3-foot by 5-foot sewer on Harrison Street. For brevity, the 3-foot by 5-foot case is not shown.

Figure 19
Reinforced Concrete Box Sewer Construction Sequence



5.5.4 Construction Sequence for Tie-In Structure

Although construction methods will vary, the following is one option for constructing the tie-in structure at Berry Street. Refer to Figure 20, Figure 21, and Figure 22 for a schematic overview of the sequence described below.

1. Install shoring system on both sides of existing four-compartment sewer.
2. Excavate to below the bottom slab of the four-compartment sewer and install first layer of struts.
3. Underpin existing four-compartment sewer utilizing second layer of struts.
4. Excavate to third layer of struts and install struts.
5. Excavate to depth of tunnel crossing.
6. Remove pile supports for four-compartment sewer.
7. Construct new piles and base slab of junction structure.

7a. Tunnel passes through structure.

8. Construct walls of junction structure, remove third layer of struts.
9. Construct roof of junction structure.
10. Construct internal modifications to activate tie-in structure.
11. Backfill, cut or remove shoring, and restore trench.

5.5.5 Construction Duration

The estimated duration of construction activities is as shown below in Table 10. Each 500-foot segment of box expansion is expected to take 4.5 months, with a total duration of approximately 23 calendar months for all box construction work. Construction activities may be shortened if multiple segments are constructed at the same time.

Table 10
Construction Duration, Reinforced Concrete Box Sewer, 500-Foot Segment

Task	Duration (Calendar Months)
Pavement demolition	0.5
Shoring	1.0
Box/pile demolition	1.0
Doweling/reinforcement	0.5
Pour/cure concrete	1.0
Pavement restoration	0.5
Total duration (per 500-foot segment)	**4.5**

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Figure 20
Intertie Construction Sequence

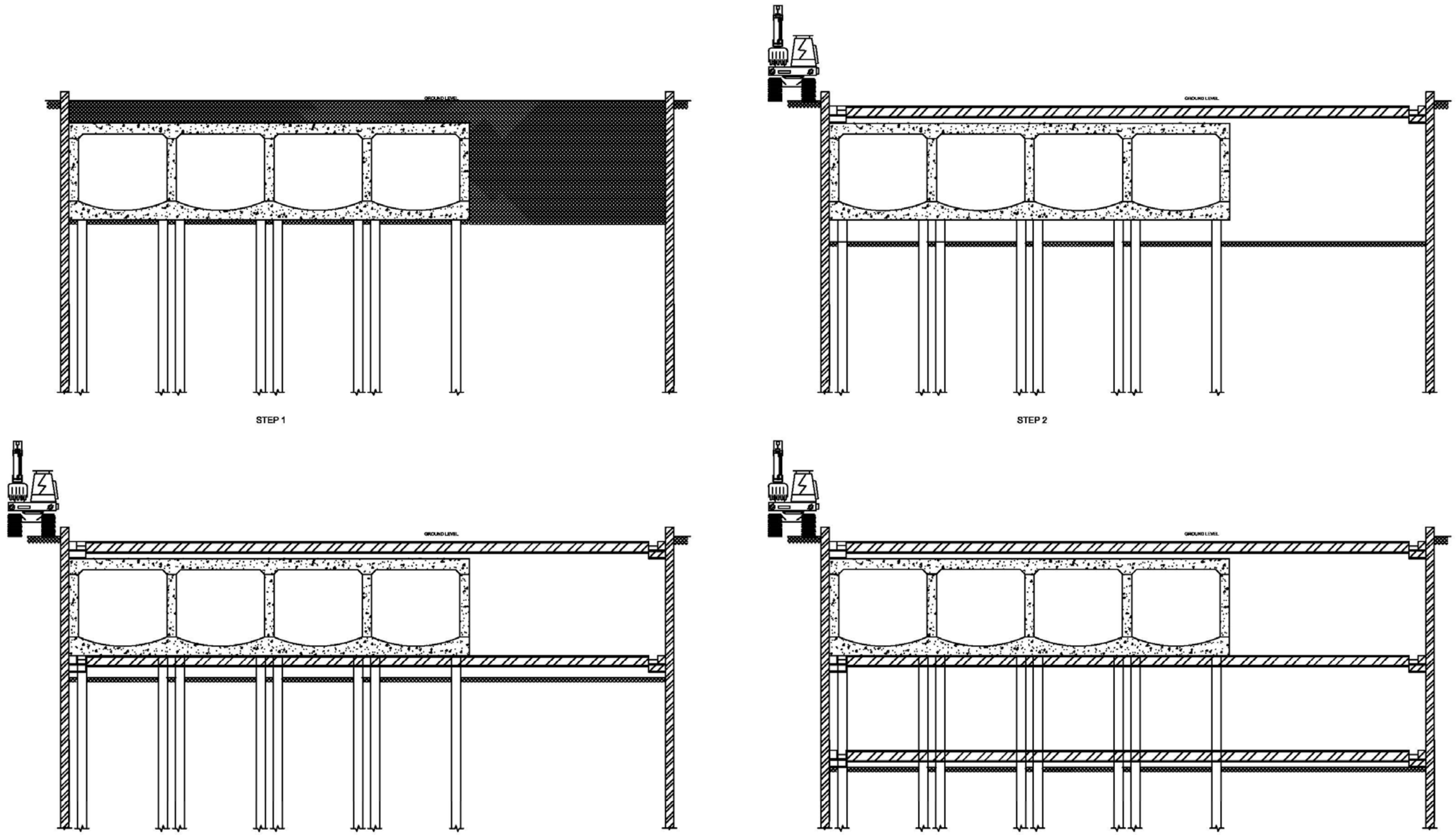

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Figure 21
Intertie Construction Sequence

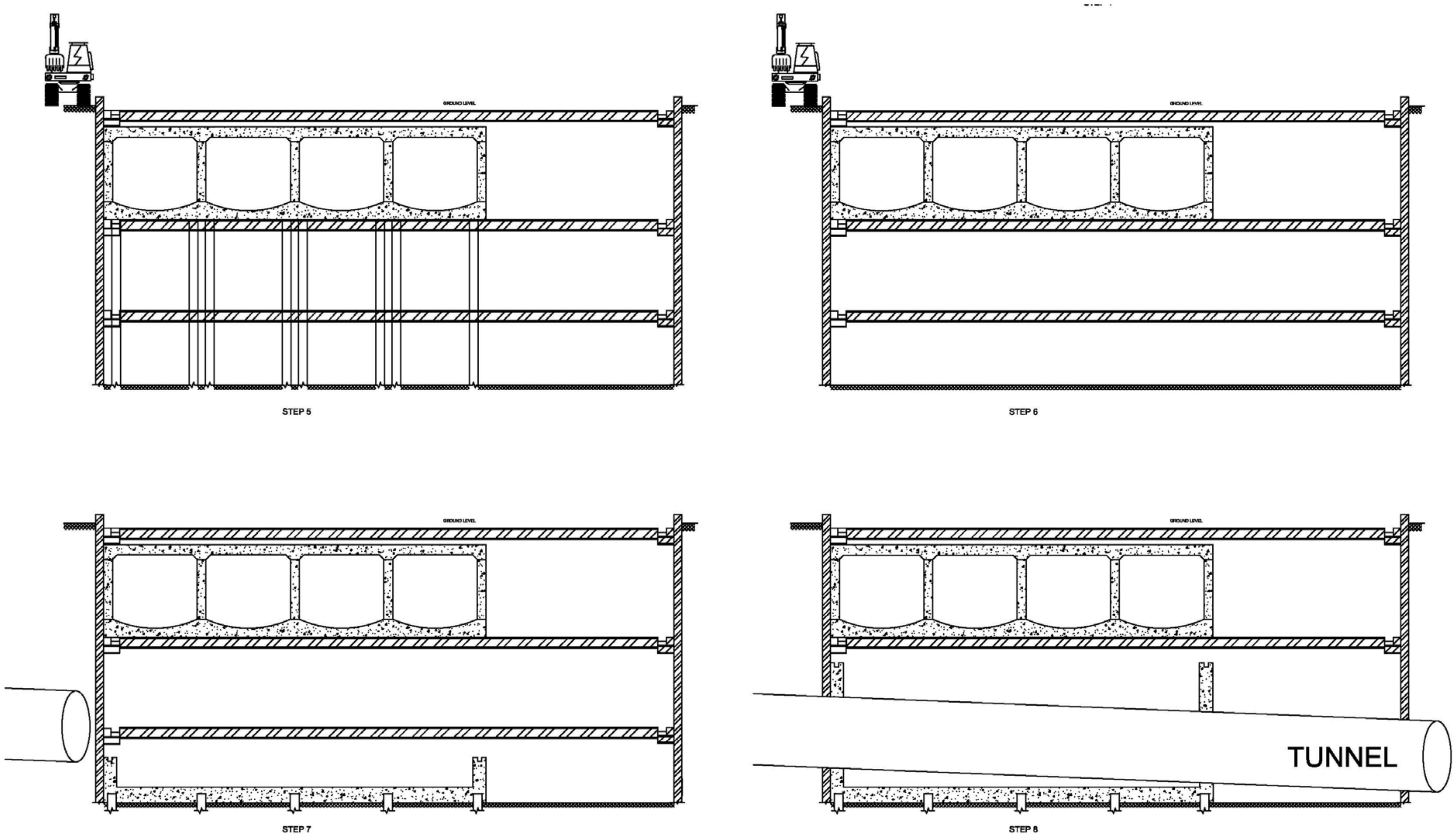

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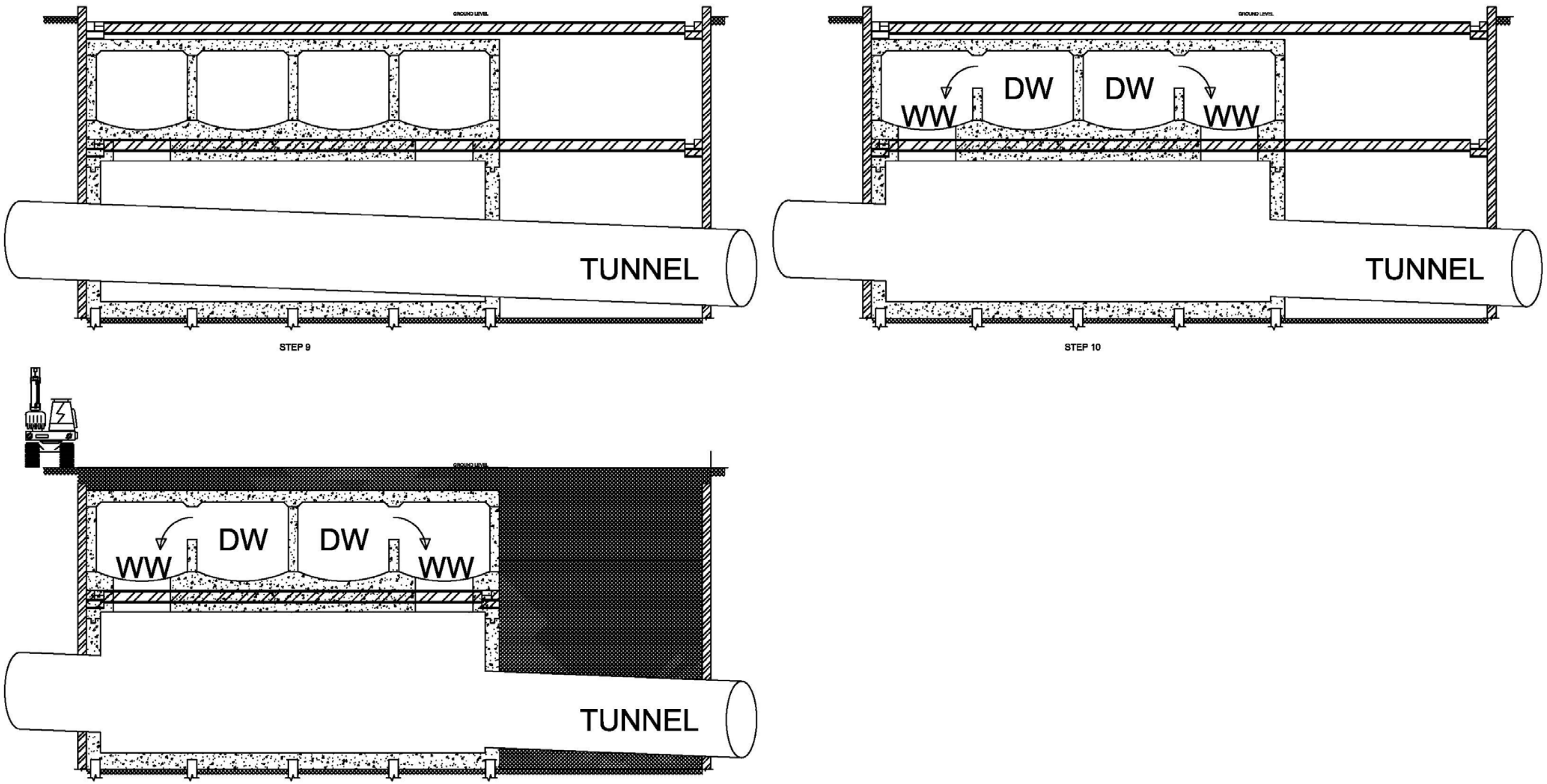
Figure 22
Intertie Construction Sequence



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6.0 CONCEPTUAL DESIGN: PIPES > 36 INCHES

This chapter applies to the upstream components shown in Table 11, and includes pipe upsizing and construction of new auxiliary pipes.

Table 11
Pipes > 36 Inches

Location	Existing Size	Proposed Size	Linear Footage
15th Street – Mission to Minna	66"	72"	253'
15th Street – Minna to Capp	66"	78"	119'
15th Street – Capp to South Van Ness	66"	78"	295'
15th Street – South Van Ness to Shotwell	66"–72"	78"	296'
18th Street – Shotwell to Folsom	60"	108"	288'
18th Street – Folsom to Treat	60"	90"–108"	320'
18th Street – Treat to Harrison	N/A	60"	377'
17th Street – Treat to Harrison	N/A	90"	217'
14th Street – Folsom to Harrison	75"	84"	620'
14th Street – Mission to South Van Ness	3'6"x5'3"	66"	581'
Folsom Street – 12th to 11th	N/A	48"	425'
11th Street – Folsom to Harrison	N/A	48"	630'
11th Street – Harrison to Division	N/A	75"	841'
17th Street – South Van Ness to Shotwell	N/A	102"	306'
17th Street – Shotwell to Folsom	N/A	102"	312'
17th Street – Folsom to Treat	N/A	102"	453'
South Van Ness – 18th to 17th	12"–15"	42"	508'

6.1 Design Criteria

The design of pipes greater than 36-inch diameter will meet the requirements set forth in this report and those listed in Table 12.

Table 12
Design Criteria for Pipes > 36 Inches

Description	Criterion
Pipeline Design	
Pipe material	▪ Filament-wound fiberglass reinforced polyester (FW-FRP) (ASTM D-3262, D-3754) ▪ Centrifugally cast fiberglass reinforced polymer mortar (CC-FRP) (ASTM D-3262, D-3754) ▪ RCP – Wall “C” and Class IV minimum (ASTM C76)
Installation methods	Cut-and-cover
Pipeline size	Varies as per Table 11
Pipeline cover	4-foot minimum
Minimum velocity	2 ft/sec for average sanitary flow, where achievable
Geotechnical Engineering Design	
Depth of excavation (maximum)	5 feet – 15 feet
Depth to groundwater	Approximately 10 feet with seasonal fluctuations
Excavation shoring: max. allowable movement	1 inch
Seismic design criteria	Per SFPUC General Seismic Requirements Seismic Performance Class: I

Drawings, specifications, and calculations will be prepared following the standards, codes, and guidelines, including, but not limited to, complying with the standards specified by Caltrans, the City, and other nationwide codes that are listed below, as applicable:

- American Concrete Institute
  - ACI 201.2-08 (Guide to Durable Concrete)
  - ACI 210R-93 (Erosion of Concrete in Hydraulic Structures)
  - ACI 222.3R-11 (Guide to Design and Construction Practices to Mitigate Corrosion of Reinforcement in Concrete Structures)
  - ACI 224R-01 (Control of Cracking in Concrete Structures)
  - ACI 308R-01 (Guide to Curing Concrete)

  - ACI 318 (Building Code Requirements for Structural Concrete)
  - ACI 350 (Code Requirements for Environmental Engineering Concrete Structures and Commentary)
  - ACI 350.5-12 (Specifications for Environmental Concrete Structures)
  - ACI 365.1R-00 (Service Life Prediction)
- American Society of Civil Engineers
  - ASCE/SEI 7 (Minimum Design Loads for Buildings and Other Structures)
- American Association of State Highway and Transportation Officials, 12th Edition
- American Society for Testing and Materials, Table 2.1
  - RCP
  - FRP
  - Polymer concrete
- Caltrans
- 2016 California Building Code
- City and County of San Francisco Mechanical Code
- California Occupational Safety and Health Act
- Construction Specification Institute format
- Excavation Code of the San Francisco City and County
- American National Standards Institute
- National Fire Protection Association
- Uniform Building Code
- SFPUC Design Standards, Codes, and References
  - General Seismic Requirements for Design for New Facilities and Upgrade of Existing Facilities, June 2014
  - Safe Design Guidelines, Version 2.0, March 2012
- Title 24 California Code of Regulations Sections 2-5301 et seq., Energy Conservation
- Other recognized standards where required to serve as guidelines for design, fabrication, and construction when not in conflict with the above-listed standards
- The codes and industry standards used for design, fabrication, and construction including all addenda, in effect as stated in contract documents
- City and County of San Francisco Subdivision Regulations
- City and County of San Francisco Standard Plans and Specifications

Drawings, specifications, and calculations will be prepared following the applicable standards, codes, and guidelines, including:

- ASTM-C76 and others for RCP and fiberglass pipe
- Excavation Code
- Cal/OSHA requirements

Should there be a conflict in the engineering design requirements, the more stringent requirement in the following compliance standards, codes, and guidelines will be adopted:

- Federal and state requirements
- City requirements
- Specific industry group or professional guidelines
- Accepted manufacturers' guidelines
- Project-specific guidelines (e.g., equipment clearance, spare equipment arrangement)

6.2 Civil

6.2.1 Alignment

The alignment of the new pipe will generally utilize the alignment of the existing infrastructure. Where an existing pipe alignment does not exist, the pipe alignment will be chosen to minimize subsurface utility conflicts.

Gravity sewers are designed with a minimum velocity of 2 ft/sec at average sanitary flows to promote self-cleaning velocities.

Gravity sewers are designed with a minimum of 4 feet of ground cover.

6.2.2 Manholes

Manholes will be located at intervals of no more than 350 feet; at every change in size, grade, or alignment; at all junctions of sewers; at ends of sewers; and where catch basin culverts join pipe sewers.

For pipelines greater than 36 inches, SFPW Standard Plan No. 87,182 – Standard Concrete Manhole for Pipe Sewers 27" to 48" Diameter and No. 87,183 – Standard Concrete Manhole for Pipe Sewers 4'3" to 10'0" Diameter will be utilized as reference for design and construction. SFPW Standard Plan No. 87,190 – Standard 26" Manhole Frame & Cover will also be referenced for design and construction.

6.2.3 Utility Support and Relocation

Utility facilities are generally within 5 feet of the ground surface; sewer facilities, on the other hand, are usually at depths closer to 10 to 15 feet below the ground surface. At locations of large box sewer infrastructure, there may be less than 5 feet of cover to allow utilities to pass through.

Where conflicts are unavoidable, the design team will coordinate with utility agencies to support and/or relocate their facilities as per standard utility notification procedures. Utilities that cross the sewer excavation can usually be supported in place; utilities that are parallel and within the shoring limits will likely need to be relocated prior to the excavation.

6.3 Geotechnical

The general geotechnical design criteria are based on past projects and practices. Information from the detailed geotechnical investigation program is not expected to significantly impact the design of pipes greater than 36 inches.

Per the SFPUC General Seismic Requirements, pipelines should generally fall under Seismic Performance Class I, described as "normal and ordinary pipeline use, common pipelines in most water and wastewater systems."

6.4 Structural

The general sewer structural design criteria are based on the following load considerations:

- Dead load from the soil and pavement above the sewer, and surrounding soils
- Live load from traffic above the sewer, groundwater surrounding the sewer if applicable, and flow inside the pipe

6.4.1 Pipe Material and Coatings

For pipes > 36 inches, FRP, PEP, and RCP are considered for installation. VCP is ruled out due to lower cost effectiveness and lack of availability in these larger pipe sizes.

- **Fiberglass-reinforced polymer pipe.** FRP is composed of epoxy/polyester resin and sand and is reinforced with fiberglass that is spirally wound around the pipe. It is a corrosion-resistant, high-strength material that comes in standard 20-foot lengths with bell-spigot connections. It has a service life of 50 years. Due to the material's innate corrosion-resistance, no coatings are necessary.
- **High-density polyethylene pipe.** HDPE goes through an extrusion process to make pipes as large as 50 feet long with a service life of approximately 50 years. Typically, contractors join HDPE pipe using electrofusion, then lower the long lengths that span from manhole to manhole into the sewer trench. HDPE is highly resistant to hydrogen sulfide gas and the low-concentration acid found in a sanitary sewer. The material's flexibility is beneficial in areas where soil movement is a concern. The material is heat-fused together to form a leak-free joint, which is preferable where groundwater infiltration is a concern. HDPE is lighter than typical sewer pipes like VCP, and floatation can be a concern when high groundwater is present. Mitigation measures can be taken to prevent floatation, if necessary. Bedding and backfill of HDPE pipes also requires special attention to ensure the pipe performs well and maintains its structural integrity and circularity. Due to the material's innate corrosion-resistance, no coatings are necessary.
- **Reinforced concrete pipe.** RCP is a widely available, rigid, high-strength pipe with bell-spigot connections. It must be laid in several 6- to 10-foot segments to span the distance between manholes. Proper pipe placement is important to ensure the pipes are properly supported to avoid misaligned and leaking joints. The material is susceptible to hydrogen sulfide attack and may require a corrosion-resistance coating to prolong its useful life. RCP has a service life of 70 to 100 years.

6.5 Construction

6.5.1 Construction Methods

General cut-and-cover construction methods will be used to construct the pipes greater than 36 inches. Five types of potential excavation support systems are considered for the project: speed shoring, interlocking sheet piles, conventional soldier pile and lagging (with dewatering), soil mixing, and soil mixing and jet grouting. For pipes greater than 36 inches, due to their moderate depths, interlocking sheet piles or conventional soldier pile and lagging will likely be the contractor's chosen methods. Shoring design is typically provided by the contractor to meet the needs at each project site.

A conceptual sequence of construction is described in more detail in Section 6.5.2.

6.5.2 Construction Sequence for Pipes > 36 Inches

Although construction methods will vary, the following is a broad overview of the sequence of activities that a contractor could undertake for the construction of sewer pipes. Refer to Figure 23 for a schematic overview of the sequence described below.

1. Install shoring system on both sides of the pipe alignment.
2. Excavate to struts, and install struts, if required.
3. Excavate to depth of new sewer pipe.
4. Install bedding and pipe.
5. Remove struts, if used, and backfill.
6. Backfill, cut or remove shoring, and restore trench.

The figure shows a new pipe alignment with bedding for a rigid pipe. It can be easily adapted for the replacement of an existing pipe or for a flexible pipe. For brevity, these other cases are not shown.

6.5.3 Construction Duration

Construction duration for pipe installation is based on production rates of previous contracts, as shown in Table 13, and calculated for pipes greater than 36 inches in Table 14. The total duration is approximately 475 working days, or approximately 20 calendar months. Construction activities may be shortened if multiple headings are constructed at the same time.

Table 13
Pipe Installation Production Rate

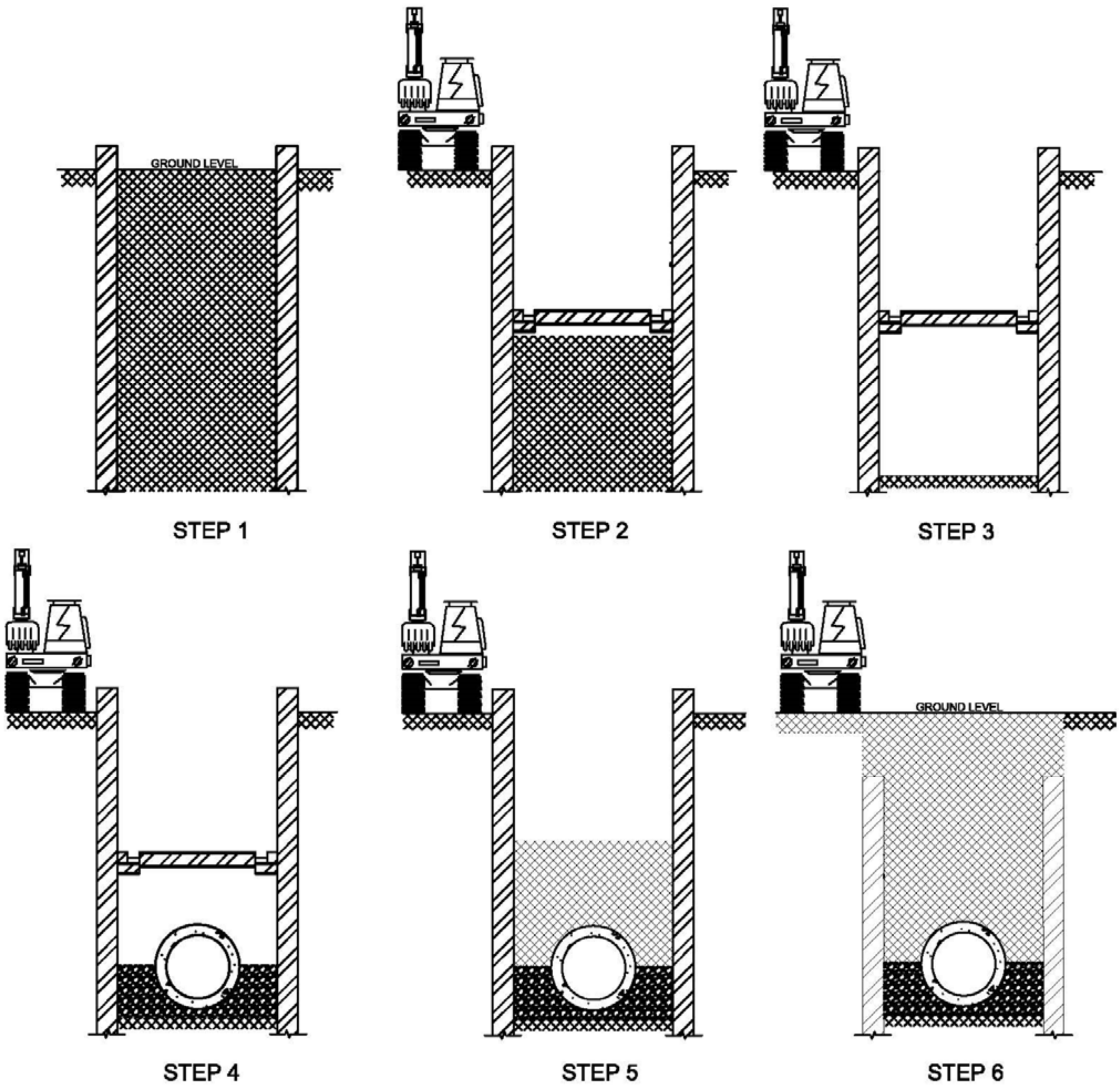
Pipe Diameter	Production Rate
≤15"	40'/day
Up to 24"	35'/day
Up to 36"	30'/day
Up to 72"	20'/day
Up to 84"	15'/day
>84"	10'/day

Table 14
Pipes > 36 Inches, Construction Duration

Location	Proposed Size	Linear Footage	Construction Duration
15th Street – Mission to Minna	72"	253'	13 days
15th Street – Minna to Capp	78"	119'	8 days
15th Street – Capp to South Van Ness	78"	295'	20 days
15th Street – South Van Ness to Shotwell	78"	296'	20 days
18th Street – Shotwell to Folsom	108"	288'	29 days
18th Street – Folsom to Treat	90"–108"	320'	32 days
18th Street – Treat to Harrison	60"	377'	19 days

17th Street – Treat to Harrison	90"	217'	22 days
14th Street – Folsom to Harrison	84"	620'	41 days
14th Street – Mission to South Van Ness	66"	581'	29 days
Folsom Street – 12th to 11th	48"	425'	21 days
11th Street – Folsom to Harrison	48"	630'	31 days
11th Street – Harrison to Division	75"	841'	56 days
17th Street – South Van Ness to Shotwell	102"	306'	31 days
17th Street – Shotwell to Folsom	102"	312'	31 days
17th Street – Folsom to Treat	102"	453'	45 days
South Van Ness – 18th to 17th	42"	508'	25 days

Figure 23
Pipe Construction Sequence



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7.0 CONCEPTUAL DESIGN: PIPES ≤ 36 INCHES

This chapter applies to the upstream components shown in Table 15, and includes pipe upsizing and construction of new pipes.

Table 15
Pipes ≤ 36 Inches

Location	Existing Size	Proposed Size	Linear Footage
South Van Ness @ 18th	N/A	36"	75'
Erie Street – South Van Ness to Folsom	12"–15"	12"–18"	395'
Trainor Street – 13th to 14th	12"	12"	303'
Folsom Street – 17th to 18th	15"	15"	294'
Folsom Street – 17th to 16th	12"	18"	154'
Folsom Street – 16th to 15th	12”	15”	90’
Shotwell Street – 19th to 18th	18"	18"	280'
19th Street – Folsom to Treat	12"	24"	298'
Mistral Street – Treat to Harrison	12"	12"	71'
Alabama Street – Mariposa to 17th	8"	12"–15"	430'
Harrison Street – 15th to Alameda	8"	12"	334'

7.1 Design Criteria

The design of pipes less than or equal to 36 inches diameter will meet the requirements set forth in this report and those listed in Table 16.

Table 16
Design Criteria for Pipes ≤ 36 Inches

Description	Criterion
Pipeline Design	
Pipe material	▪ Vitrified clay pipe (VCP) (ASTM C12, ASTM C700) ▪ High-density polyethylene pipe (HDPE) (ASTM D2321, ASTM D2774, ASTM F714, PPI TR-31)
Installation methods	Cut-and-cover
Pipeline size	Varies as per Table 15
Pipeline cover	4-foot minimum
Minimum velocity	2 ft/sec for average sanitary flow, where achievable
Geotechnical Engineering Design	
Depth of excavation (maximum)	5 feet – 15 feet
Depth to groundwater	Approximately 10 feet with seasonal fluctuations.
Excavation shoring: max. allowable movement	1 inch
Seismic design criteria	Per SFPUC General Seismic Requirements Pipe Function Class I, No Seismic Provisions

Drawings, specifications, and calculations will be prepared following the standards, codes, and guidelines, including, but not limited to, complying with the standards specified by Caltrans, the City, and other nationwide codes that are listed below, as applicable:

- American Association of State Highway and Transportation Officials, 12th Edition
- American Society for Testing and Materials
  - HDPE
  - VCP
- Caltrans
- 2016 California Building Code
- City and County of San Francisco Mechanical Code
- California Occupational Safety and Health Act
- Construction Specification Institute format

- Excavation Code of the San Francisco City and County
- American National Standards Institute
- National Fire Protection Association
- Uniform Building Code
- SFPUC Design Standards, Codes and References
  - General Seismic Requirements for Design for New Facilities and Upgrade of Existing Facilities, June 2014
  - Safe Design Guidelines, Version 2.0, March 2012
- Title 24 California Code of Regulations Sections 2-5301 et seq., Energy Conservation
- Other recognized standards where required to serve as guidelines for design, fabrication, and construction when not in conflict with the above-listed standards
- The codes and industry standards used for design, fabrication, and construction including all addenda, in effect as stated in contract documents
- City and County of San Francisco Subdivision Regulations
- City and County of San Francisco Standard Plans and Specifications

Drawings, specifications and calculations will be prepared following the applicable standards, codes, and guidelines, including:

- Excavation Code
- Cal/OSHA requirements

Should there be a conflict in the engineering design requirements, the more stringent requirement in the following compliance standards, codes, and guidelines will be adopted:

- Federal and state requirements
- City requirements
- Specific industry group or professional guidelines
- Accepted manufacturers' guidelines
- Project-specific guidelines (e.g., equipment clearance, spare equipment arrangement)

7.2 Civil

7.2.1 Alignment

The alignment of the new pipe will generally utilize the alignment of the existing infrastructure. Where an existing pipe alignment does not exist, the pipe alignment will be chosen to minimize subsurface utility conflicts.

Gravity sewers are designed with a minimum velocity of 2 ft/sec at average sanitary flows to promote self-cleaning velocities.

Gravity sewers are designed with a minimum of 4 feet of ground cover.

7.2.2 Manholes

Manholes will be located at intervals of no more than 350 feet; at every change in size, grade, or alignment; at all junctions of sewers; at ends of sewers; and where catchbasin culverts join pipe sewers.

For pipelines less than or equal to 36 inches, SFPW Standard Plans No. 87,181 – Precast Concrete Manhole for 12" to 24" Diameter Sewer and No. 87,182 – Standard Concrete Manhole for Pipe Sewers 27" to 48" Diameter will be used as reference for design and construction. SFPW Standard Plan No. 87,190 – Standard 26" Manhole Frame & Cover will also be referenced for design and construction.

7.2.3 Utility Support and Relocation

Utility facilities are generally within 5 feet of the ground surface; sewer facilities, on the other hand, are usually at depths closer to 10 to 15 feet below the ground surface. At locations of large box sewer infrastructure, there may be less than 5 feet of cover to allow utilities to pass through.

Where conflicts are unavoidable, the design team will coordinate with utility agencies to support and/or relocate their facilities as per standard utility notification procedures. Utilities that cross the sewer excavation can usually be supported in place; utilities that are parallel and within the shoring limits will likely need to be relocated prior to the excavation.

7.3 Geotechnical

The general geotechnical design criteria are based on past projects and practices. The detailed geotechnical investigation program is not expected to include the locations of pipelines less than or equal to 36 inches.

As per the SFPUC General Seismic Requirements, these pipelines should generally fall under Pipe Function Class I, described as “Pipelines that represent very low hazard to human life in the event of failure. Not needed for post earthquake system performance, response, or recovery.”

Pipe Function Class I pipelines need not be designed for seismic provisions.

7.4 Structural

The general sewer structural design criteria are based on the following load considerations:

- Dead load from the soil and pavement above the sewer, and surrounding soils
- Live load from traffic above the sewer, groundwater surrounding the sewer if applicable, and flow inside the pipe

7.4.1 Pipe Material and Coatings

For pipes ≤ 36 inches, PEP and VCP are considered for installation. FRP and RCP are ruled out due to lower cost effectiveness in these smaller pipe sizes.

High Density Polyethylene Pipe

HDPE goes through an extrusion process to make pipes as large as 50 feet long with a service life of approximately 50 years. Typically, contractors join HDPE pipe using electrofusion, then lower the long lengths that span from manhole to manhole into the sewer trench. HDPE is highly resistant to hydrogen sulfide gas and the low-concentration acid found in a sanitary sewer. The material's flexibility is beneficial in areas where soil movement is a concern. The material is heat-fused together to form a leak-free joint, which is preferable where groundwater infiltration is a concern. HDPE is lighter than typical sewer pipes like VCP, and floatation can be a concern when high groundwater is present. Mitigation measures can be taken to prevent floatation, if necessary. Bedding and backfill of HDPE pipes also requires special attention to ensure the pipe performs well and maintains its structural integrity and circularity.

Vitrified Clay Pipe

VCP is a rigid, inert material that is highly resistant to chemical attack and corrosion. Clay pipe has a tested useful life span of over 100 years and is the standard sewer main material for the City. Many of the City's existing clay main sewers and laterals are well over 100 years old. Clay pipe must be laid in several 7- to 8-foot segments to span the distance between manholes. Proper pipe placement is important to ensure the pipes are properly supported to avoid misaligned and leaking joints.

7.5 Construction

7.5.1 Construction Methods

General cut-and-cover construction methods will be used to construct pipes ≤ 36 inches. Five types of potential excavation support systems are considered for the project: speed shoring, interlocking sheet piles, conventional soldier pile and lagging (with dewatering), soil mixing, and soil mixing and jet grouting. For pipes ≤ 36 inches, due to their shallow to moderate depths, interlocking sheet piles or conventional soldier pile and lagging will likely be the contractor's chosen methods. Shoring design is typically provided by contractor to meet the needs at each project site.

A conceptual sequence of construction is described in more detail in Section 7.5.2.

7.5.2 Construction Sequence for Pipes ≤ 36 Inches

Although construction methods will vary, the following is a broad overview of the sequence of activities that a contractor could undertake for the construction of sewer pipes. Refer to Figure 24 for a schematic overview of the following sequence.

1. Install shoring system on both sides of the pipe alignment.
2. Excavate to depth of new sewer pipe.
3. Install bedding and pipe.
4. Backfill, remove shoring, and restore trench.

The figure shows a new pipe alignment with bedding for a rigid pipe. It can be easily adapted for the replacement of an existing pipe or for a flexible pipe. For brevity, these other cases are not shown.

7.5.3 Construction Duration

Construction duration for pipe installation is based on production rates of previous contracts, as shown in Table 17, and calculated for pipes less than 36 inches in Table 18. The total duration is approximately 65 working days, or approximately 3 calendar months. Construction activities may be shortened if multiple headings are constructed at the same time.

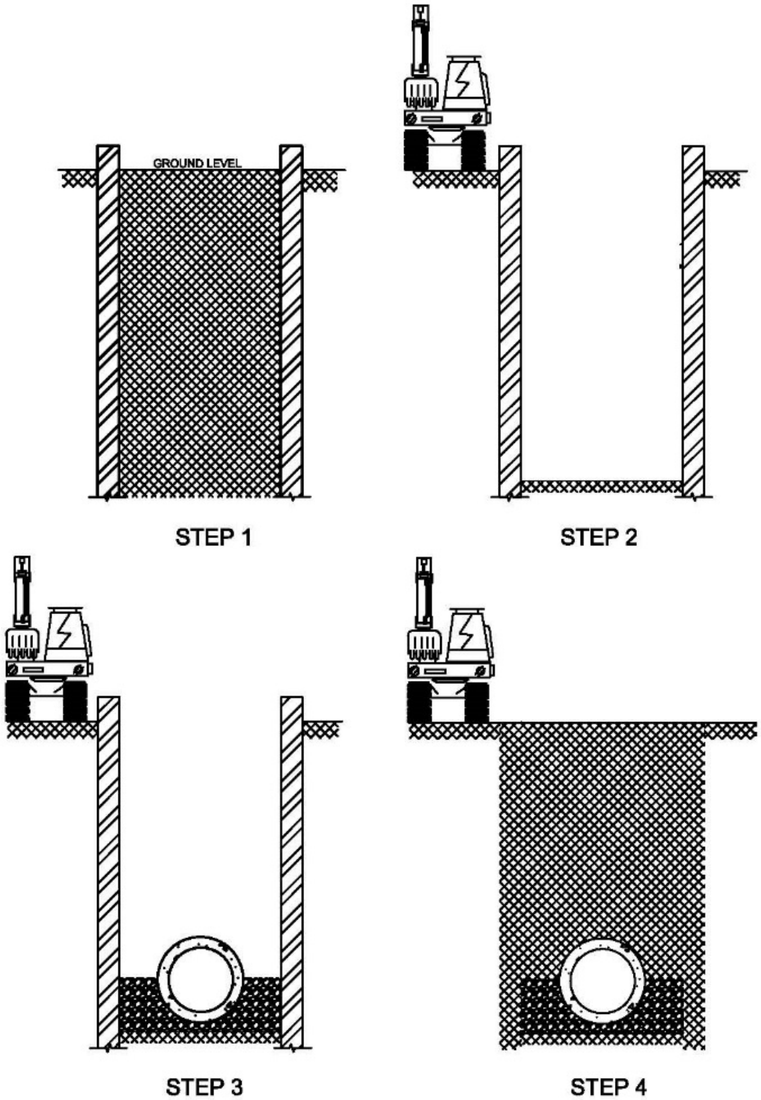
Table 17
Pipe Installation Production Rate

Pipe Diameter	Production Rate
≤15"	40'/day
Up to 24"	35'/day
Up to 36"	30'/day
Up to 72"	20'/day
Up to 84"	15'/day
>84"	10'/day

Table 18
Construction Duration, Pipes ≤ 36 Inches

Location	Proposed Size	Linear Footage	Construction Duration
South Van Ness @ 18th	36"	75'	3 days
Erie Street – South Van Ness to Folsom	12"–18"	395'	11 days
Trainor Street – 13th to 14th	12"	303'	8 days
Folsom Street – 17th to 18th	15"	294'	8 days
Folsom Street – 17th to 16th	18"	154'	5 days
Folsom Street – 16th to 15th	15”	90’	3 days
Shotwell Street – 19th to 18th	18"	280'	8 days
19th Street – Folsom to Treat	24"	298'	9 days
Mistral Street – Treat to Harrison	12"	71'	2 days
Alabama Street – Mariposa to 17th	12"–15"	430'	11 days
Harrison Street – 15th to Alameda	12"	334'	334 days

Figure 24
Pipe ≤ 36-Inch Construction Sequence



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8.0 CONCEPTUAL DESIGN: MODIFICATIONS TO EXISTING FACILITIES

This chapter applies to internal modifications to existing facilities, such as plugging existing sewers and modifying weir heights. The locations of these upstream components are not explicitly called out, but they may be necessary to direct flows.

8.1 Design Criteria

The design will meet the requirements set forth in this report and those listed in Table 19.

The work to modify existing structures is internal to the structure and will not include any excavation work. These modifications include:

- Adjustment of weir elevation
- Plugging of sewer

Table 19
Design Criteria for Internal Modifications to Existing Structures

Description	Criterion
Existing Structures	
Material	▪ Concrete ▪ Brick
Installation methods	Internal modification

Drawings, specifications, and calculations will be prepared following the standards, codes, and guidelines, including, but not limited to, complying with the standards specified by Caltrans, the City, and other nationwide codes that are listed below, as applicable:

- American Concrete Institute
  - ACI 201.2-08 (Guide to Durable Concrete)
  - ACI 210R-93 (Erosion of Concrete in Hydraulic Structures)
  - ACI 222.3R-11 (Guide to Design and Construction Practices to Mitigate Corrosion of Reinforcement in Concrete Structures)
  - ACI 224R-01 (Control of Cracking in Concrete Structures)
  - ACI 308R-01 (Guide to Curing Concrete)
  - ACI 318 (Building Code Requirements for Structural Concrete)
  - ACI 350 (Code Requirements for Environmental Engineering Concrete Structures and Commentary)
  - ACI 350.5-12 (Specifications for Environmental Concrete Structures)
  - ACI 365.1R-00 (Service Life Prediction)
- California Occupational Safety and Health Act
- Construction Specification Institute format

- American National Standards Institute
- SFPUC Design Standards, Codes and References
    - Safe Design Guidelines, Version 2.0, March 2012
- Other recognized standards where required to serve as guidelines for design, fabrication, and construction when not in conflict with the above-listed standards
- The codes and industry standards used for design, fabrication, and construction, including all addenda, in effect as stated in contract documents
- City and County of San Francisco Subdivision Regulations
- City and County of San Francisco Standard Plans and Specifications

Drawings, specifications, and calculations will be prepared following the applicable standards, codes, and guidelines, including:

- Excavation Code
- Cal/OSHA requirements

Should there be a conflict in the engineering design requirements, the more stringent requirement in the following compliance standards, codes, and guidelines will be adopted:

- Federal and state requirements
- City requirements
- Specific industry group or professional guidelines
- Accepted manufacturers' guidelines
- Project-specific guidelines (e.g., equipment clearance, spare equipment arrangement)

8.2 Civil

Weir modification. Weir heights can be modified to alter the amount of flow topping the weir. To lower a weir, existing bricks or concrete are removed. To raise a weir, typically, bricks are added to the top of the existing weir.

Sewer plug. Sewers are generally plugged either for abandonment or to redirect flow. Plugging of sewers shall be as per SFPW Standard Specifications Section 302.05.

8.3 Construction

All modifications to existing facilities are expected to occur within the infrastructure, using manual labor and/or power tools.

9.0 ENVIRONMENTAL AND REAL ESTATE

9.1 Environmental

The environmental review of the proposed project anticipates the need for a higher-level review, either a Mitigated Negative Declaration or an Environmental Impact Report, by the SFPUC Bureau of Environmental Management (BEM) under CEQA guidelines. Potential issues that would result in the higher-level review are air quality (NOx emissions), potential cultural sites, and the overall extent of the project.

The project team will continue to work with BEM to determine the appropriate level of review.

9.1.1 Conceptual Engineering Report Checklist

The Environmental Project Manager will assist the Project Manager and the Project Engineer in the preparation of the CER Checklist for the subject project. The Draft CER Checklist is attached as Appendix J.

9.2 Real Estate

9.2.1 Temporary and Permanent Easements

For the execution of the tunnel component, temporary and permanent easements are required. The project team has identified the likely easement needs, and a preliminary real estate valuation study has been performed, as shown in Appendix K. The possible easements include:

- **Block 3902, Lot 2 and 6 – SPCA.** Temporary staging, permanent subsurface, and permanent access easements are likely needed. Area for temporary staging easement is approximately 15,800 square feet, with a reduced footprint for the permanent subsurface easement and permanent access easement.
- **Caltrans ROW.** Permanent subsurface utility easement is likely needed. Extent of Caltrans ROW is currently unknown. Area needed is approximately 16,000 square feet.
- **Block 3904, Lot 1 – Byer.** Temporary staging easement is likely needed. Area needed is approximately 12,000 square feet.
- **Block 3923, Lots 2, 3, and 7 – Associated Limousine Operators, Beressi Fabrics Company, and DP 1550 Bryant LLC.** Permanent subsurface utility easement is likely needed. Area needed is approximately 6,000 square feet.
- **Block 3807, Lots 2, 4, and 8 – Recology.** Permanent subsurface utility easement is likely needed. Area needed is approximately 13,500 square feet.
- **Caltrain ROW.** Permanent subsurface utility easement is likely needed. Extent of Caltrain ROW is currently unknown.

Should any of the easements prove to be unobtainable, design workarounds are required for the successful completion of the project.

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10.0 COST AND SCHEDULE

10.1 Capital Cost

Table 20 summarizes standard cost estimating level descriptions, accuracy, and recommended contingencies based on the development level of the project. These data were compiled from the Association for the Advancement of Cost Engineering.

Table 20
Cost Estimating Guidelines

Cost Estimate Class[(1)]	Project Level Description	Estimate Accuracy Range	Recommended Estimate Contingency
Class 5	Planning	-30% to +50%	30% to 50%
Class 4	Conceptual (1% to 5% Design)	-15% to +30%	25% to 30%
Class 3	Preliminary (10% to 30% Design)	-10% to +20%	15% to 20%
Class 2	Detailed (40% to 70% Design)	-5% to +15%	10% to 15%
Class 1	Final (90% to 100% Design)	-5% to +10%	5% to 10%

(1) Per Association for the Advancement of Cost Engineering, 1997. International Recommended Practices and Standards.

The recommended improvements for this project have been developed to a preliminary level, with preliminary design criteria, conceptual plan and profile drawings, and a basic understanding of site conditions and limitations. Therefore, the level of accuracy for the capital cost estimates presented should be considered a Class 4 estimate, so an estimate contingency of 30% was applied to the opinion of probable construction cost.

Table 21 summarizes the preliminary opinion of probable construction cost for both the tunnel and upstream components. A more detailed cost estimate will be performed during the ensuing design phases. The total probable construction cost, escalated to mid-point of construction in 2021, is $214.6 million. Detailed estimates are provided in Appendix L.

Table 21
Opinion of Probable Construction Cost

Category	All Tunnel	Tunnel w/ Box
Tunnel construction cost (includes markup/profit)	$57,109,904.00	$59,051,338.00
Tunnel base construction cost (includes design/estimating contingency)	$74,242,875.20	$76,766,739.40
Tunnel total construction cost (includes construction contingency)	**$81,667,162.72**	**$84,443,413.34**
Upstream direct construction cost	$54,176,576.00	$54,176,576.00
Upstream base construction cost (includes markup/profit, design/estimating contingencies)	$84,515,458.56	$84,515,458.56
Upstream total construction cost (includes construction contingency)	**$92,967,004.42**	**$92,967,004.42**
Total construction cost (2018 dollars)	**$174,600,000**	**$177,400,000**
Total construction cost[(1)] (2021 dollars)	**$211,162,000**	**$214,548,000**

(1) Includes 1.26% for environmental mitigation/compliance during construction and 3.3% for security upgrades per Sewer System Improvement Project templates. Also includes escalation factor of 15.62%, escalated to midpoint of construction October 2021 at 4%/year.

Table 22 summarizes the total project cost, escalated to mid-point of construction in 2021. The total project cost in 2021 dollars is $273.6 million.

Table 22
Total Project Cost

Phase	Cost
Project management	$10,711,000
Planning	$1,449,000
Environmental	$164,000
Right-of-way	$340,000
Design	$9,228,000
Bid/award	$1,073,000
Construction management	$21,455,000
Construction	$214,548,000
Closeout	$1,073,000
Easement	$13,500,000
Total project cost (2021 dollars)	**$273,600,000**

10.2 Whole Life Cycle Cost

All project components are considered passive; therefore, there are no associated life cycle costs. Project components will be replaced at the end of their useful life. Materials will be chosen to prolong service life of the new infrastructure. The estimated life expectancy is a minimum of 75 years.

10.3 Implementation Schedule and Staffing Requirements

10.3.1 Project Schedule

The current project schedule showing key phase durations from planning through completion of the Project is shown in Table 23. This schedule depends on the proposal for consultant tunnel engineering services, environmental permitting, and easement acquisition.

Table 23
Preliminary Project Schedule

Phase Description	Start Date	Finish Date	Duration
Planning	3/2016	3/2018	24 months
Environmental	4/2018	12/2019	21 months
Land and right-of-way	4/2018	12/2019	21 months
Design	4/2018	12/2019	21 months
Bid and award	1/2020	6/2020	6 months
Construction management	7/2020	12/2022	30 months
Construction	7/2020	12/2022	30 months
Closeout	1/2023	6/2023	6 months

10.3.2 Staffing Requirements

The SFPUC is the project lead of this project and is also providing the following support services:

- Operations and collection system divisions – review and support of the project development process to ensure the facility meets their needs
- Project controls – budgeting and scheduling services
- Project management services
- Project engineering services
- Project support services – including communications and outreach, real estate services, and environmental review services for CEQA review

The Program Management Consultant is providing program and project management–level support, cost estimating, and technical quality assurance and quality control through the review of milestone documents and key technical activities.

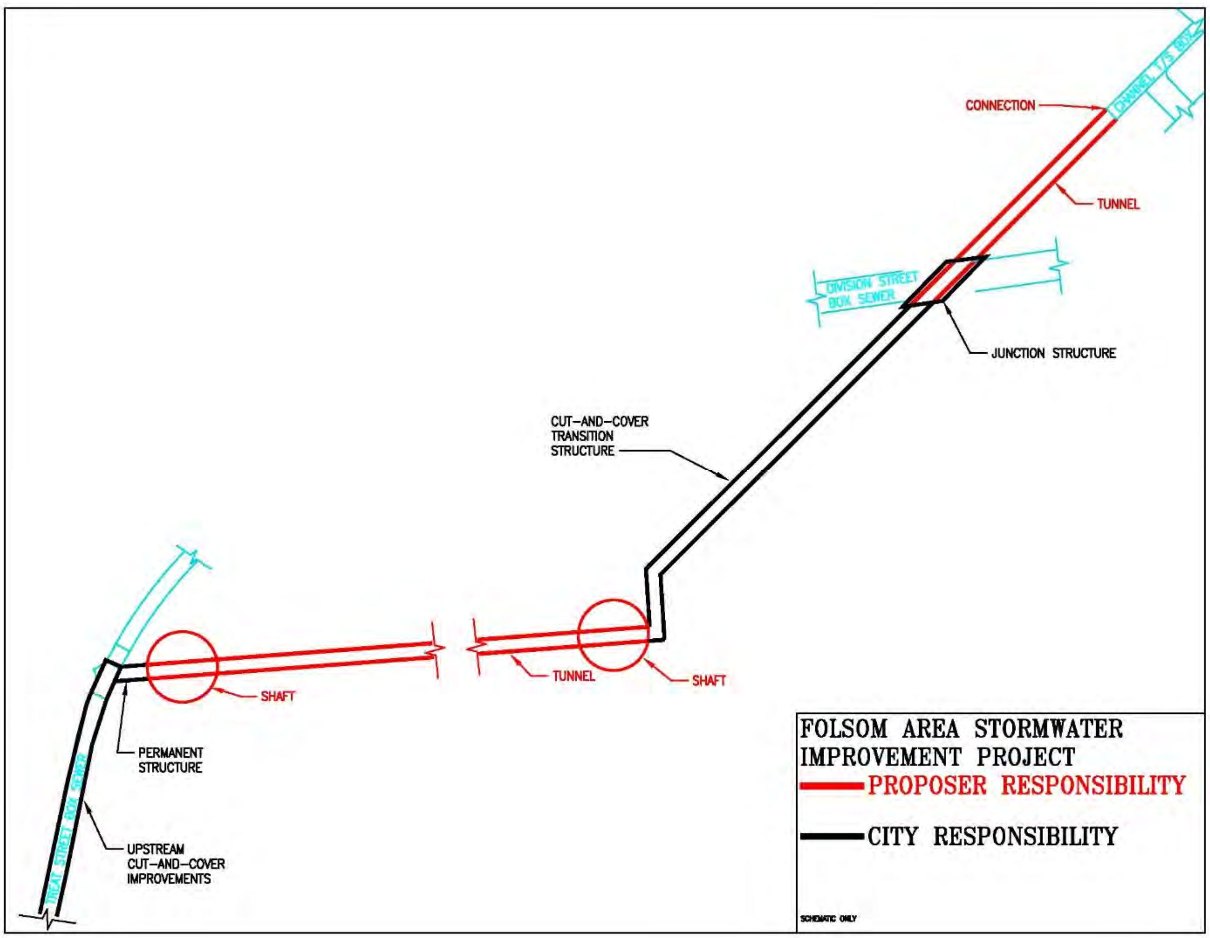
Consultant services will be acquired by SFPUC via a consultant services contract for the tunnel design, geotechnical, and seismic analysis work.

SFPW is carrying out the design for the upstream components and permanent structures for this project. Engineering disciplines will be engaged as needed, including the following:

- Hydraulics (technical lead)
- Structural
- Geotechnical
- Street use and mapping
- Site assessment remediation

The delineation of design work is as shown in Figure 25.

Figure 25
Delineation of Work



11.0 NEXT STEPS

11.1 Tunnel Engineering Consultant Service Contract

SFPUC is issuing a Request for Proposal to select and enter into an agreement with a professional services consultant to provide tunnel design and related services for this project, including tunnel engineering, geotechnical and hazardous materials investigations, plans, specifications, estimates, and schedule. The request was advertised in March 2018, with Notice of Award tentatively scheduled for August 2018. The tasks include:

1. Management and coordination
2. Quality assurance and quality control
3. Review background information
4. Develop supplemental information
5. Seismic, geotechnical, and hazardous materials investigation and site characterization
6. Permits and agreements
7. Advanced hydraulic numerical modeling
8. Tunnel engineering design and design support to City staff
9. Technology transfer and cross training
10. Communication and public outreach
11. Soil-Structure Interaction analyses for the remainder of the entire project
12. Bid phase services – optional task
13. Provide engineering support services during construction – optional task

11.2 Environmental Review

Environmental review will begin with the development of a detailed project description after approval of the CER. The SFPUC BEM will coordinate with the Project Team in the preparation of the environmental evaluation application and will provide information to the Environmental Planning Division as necessary to obtain CEQA approval for the project. This section describes the environmental review process and provides a preliminary assessment of the key environmental issues associated with construction and operation of the Folsom Area Stormwater Improvement Project.

11.2.1 California Environmental Quality Act Environmental Review Process

This Project will be subject to CEQA requirements prior to the authorization and approval of final design and construction by the SFPUC. CEQA requires review and analysis of physical and environmental effects of proposed activities and disclosure of this information to decision-makers. It also requires agencies to avoid or reduce the environmental effects by implementing feasible alternatives or mitigation measures. The San Francisco Planning Department, Environmental Planning Division, is the Lead Agency for CEQA compliance for public and private construction projects in San Francisco, and the SFPUC is the Project Sponsor. The SFPUC Environmental Project Manager will work with the Environmental Planning Division to prepare the Environmental Document; however, the Division will make the final determination of the appropriate environmental documentation required for CEQA compliance.

11.2.2 Environmental Issues

Table 24 summarizes the environmental issues associated with the construction and operation of the preferred engineering option. Topic areas reviewed include the following:

- Air quality and climate
- Utilities and public services
- Water quality and hydrology
- Hazards
- Cultural resources

In addition, the table includes possible control measures or mitigation strategies that could be incorporated into project planning and development to reduce potential environmental effects. The preliminary environmental assessment presented below is intended to provide early environmental input into project planning and design.

Table 24
Summary of Potential Environmental Issues

Potential Environmental Issues	Potential Control Measures or Mitigation Strategy
Air Quality and Climate	
▪ Temporary increase in dust nuisance and airborne particulate matter generated by earthmoving construction activities (e.g., excavation, handling and transport of trench spoil, backfill, and stockpiling). ▪ Exposure of sensitive receptors to temporary increase in dust from earthmoving activities and to other air contaminant emissions associated with construction vehicles and equipment. ▪ Potential of Naturally Occurring Asbestos	▪ Implement dust control measures as required by the Bay Area Air Quality Management District (BAAQMD), including daily watering of construction areas, covering all haul trucks, and daily sweeping of streets and access roads. ▪ The contract specifications will require the construction contractor to maintain all construction equipment and vehicles in good working order in compliance with BAAQMD air quality standards. ▪ The contract specifications may include language for Naturally Occurring Asbestos

Potential Environmental Issues	Potential Control Measures or Mitigation Strategy
Water Quality and Hydrology	
▪ Potential for construction debris to enter into the sewer system. ▪ Illegal release of water from dewatering activities.	▪ Include instructions in the contract specifications to prevent construction debris from entering the sewer system. ▪ Develop and implement a dewatering plan, including a water control and disposal plan. ▪ The construction contractor will be required to obtain and comply with appropriate permits for discharge of construction runoff or dewatering effluent to the combined sewer system (Article 4.1 of the San Francisco Public Works Code and Order No. 158170 of the San Francisco Public Works Department).
Hazards	
▪ Potential to encounter hazardous materials in existing contaminated soils and/or groundwater and associated public health impacts from exposure of workers and the public to hazardous materials. ▪ Potential for accidental spills of fuels or hazardous materials from construction activities. ▪ Potential for water quality impacts from dewatering in areas with groundwater contamination.	▪ A Management of Excavated Materials section and a Health and Safety criteria will be prepared and incorporated into the contract specifications. The construction contractor will be required to comply with applicable federal, state, and local hazardous materials regulations, including preparation and implementation of health and safety plans and adherence to appropriate soil and groundwater management procedures for storage, reuse, and disposal.

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12.0 REFERENCES

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SFPUC. 2015. *17th and Folsom Stormwater Management Technical Paper*. Draft. March.

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APPENDIX A

SSIP GOALS, LOS, AND STRATEGIES

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Sewer System Improvement Program (SSIP)
Goals, Levels of Service (LOS), Program and Phase 1 Strategies (Endorsed March 22, 2016)

Wastewater Enterprise Goals	Wastewater Enterprise Levels of Service	Sewer System Improvement Program Strategies ($6.9B)	Phase 1 Strategies ($2.9B)
1. Provide a Compliant, Reliable, Resilient, and Flexible System that can Respond to Catastrophic Events			
	1.1. Full compliance with State and Federal regulatory requirements applicable to the treatment and disposal of sewage and stormwater.	a. Reduce the annual long-term average of Combined Sewer Discharge (CSD) occurrences within the Central drainage basin (Channel and Islais Creek urban watersheds) by 2 (from 12 to 10), consistent with the NPDES permit.	Complete Planning and Environmental Review of the Central Bayside System Improvement Project, for Channel Force Main redundancy, to achieve a maximum long-term average of 10 CSD occurrences, consistent with the NPDES permit.
		b. Comply with Liquid and Biosolids wastewater treatment plant permit requirements.	Construct Liquid and Biosolids projects at SEP, OSP, and NPF for permit compliance (SEP: Headworks, Disinfection, Primary and Secondary Clarification, Oxygen Generation Plant, Biosolids, and Existing Digesters; OSP: Digester Gas Upgrades, Westside Pump Station; NPF: Outfall Rehabilitation, North Shore Pump Station). Rehabilitate, or replace, critical sewers based on condition assessment and prioritization within the budgeted amount.
		c. Improve combined sewer discharge (CSD) structures to increase floatables control, consistent with the NPDES permit.	Rehabilitate CSD structures (Beach St., Sansome St., Fifth St., Sixth St.-North, and Division St.) to increase floatables control, consistent with the NPDES permit.
	1.2. Critical functions are built with redundant infrastructure.	a. Construct redundancy of Channel, North Shore, and Westside Force Mains.	Complete Planning and Environmental Review of Central Bayside System Improvement Project, for Channel Force Main redundancy. Rehabilitate the remaining section of North Shore Force Main near The Embarcadero and Jackson Street.
		b. Ensure electrical redundancy to treatment facilities.	Provide redundant electrical feeds to SEP, OSP, and NPF.
		c. Rehabilitate and add redundant pumps, as necessary, at major pump stations.	Upgrade Westside, Bruce Flynn, and North Shore Pump Stations with the ability to pump peak flow with the largest pump out of service, and rehabilitate other pump stations (Griffith, Mariposa, and Hudson), as identified by condition assessment.
	1.3. Dry weather primary treatment, with disinfection, must be on-line within 72 hours of a major earthquake.	a. Design critical and new treatment facilities to withstand the following seismic events: Magnitude 7.8 earthquake on the San Andreas fault; and, Magnitude 7.1 earthquake on the Hayward fault.	Design new facilities at SEP (Headworks, Biosolids, Disinfection, Oxygen Generation Plant, Power Switchgear Building) to withstand 7.8 earthquake on the San Andreas fault and 7.1 earthquake on the Hayward fault.
			Provide seismic retrofits to SEP Building 042, to provide primary treatment of dry weather flows.
2. Integrate Green and Grey Infrastructure to Manage Stormwater and Minimize Flooding			
	2.1. Control and manage flows from a storm of a three hour duration that delivers 1.3 inches of rain (Level of Service storm).	a. Maximize protection of the City during the Level of Service storm.	Assess flood risk citywide and prioritize infrastructure needs. Implement projects in neighborhoods including: Kansas/Marin Streets, Cayuga Ave./Rousseau St., Wawona St./15th Ave., Victoria St./Urbano Dr., Joost Ave./Foerster St., and 17th St. /Folsom St. (Planning and Design only). Implement additional measures to reduce flood risk beyond the capacity of the collection system.
		b. Develop projects using an urban watershed approach which employs the Triple Bottom Line.	Complete the Urban Watershed Assessment plan. Apply Triple Bottom Line to applicable projects during the Alternatives Analysis phase.
		c. Identify, evaluate, and develop projects to reduce combined sewer discharge (CSD) occurrences on public beaches.	Complete Urban Watershed Assessment plan.
		d. Develop Design Standards for Green Infrastructure that are informed by the performance of the Early Implementation Projects (EIPs).	Construct EIPs and monitor performance.
3. Provide Benefits to Impacted Communities			
	3.1. Limit plant odors to within the treatment facility's fence lines.	a. Construct effective odor control systems at SEP, OSP, and NPF.	Design and construct the new Headworks and Biosolids facilities at SEP to meet 5 dilutions/threshold (D/T) odor criteria at the fence line.
		b. Use operational controls and infrastructure modifications to minimize odors from the Collection System (sewers).	Develop a Collection System Odor Model to identify potential areas of significant odor. Implement Cargo Way Flushing Line and repair of Westside Flushing Line to minimize odors.
	3.2. All projects will adhere to the Environmental Justice and Community Benefits policies.	c. Incorporate visual improvements into projects at the treatment plants and pump stations, where feasible and appropriate.	Incorporate visual and architectural improvements in the design and construction of the new Headworks and Biosolids projects at SEP.
		d. Provide community benefits including job creation, workforce development, contracting opportunities, and greening.	Provide green infrastructure contractor training and coordinate all jobs through the Contractors Assistance Center.
		e. Work with other City and County agencies on capital projects they have initiated to protect the value and function of wastewater facilities, maximize economic development, and minimize construction impacts and costs.	Coordinate and implement interdepartmental sewer projects (Central Subway, Van Ness BRT, Better Market Street, Geary BRT Phase 1 & 2, Masonic Ave, and Mission Bay Loop).
		f. Engage residents in locating green infrastructure where multiple benefits can be optimized using the Triple Bottom Line.	Utilize Triple Bottom Line and public process in development of EIPs.
4. Modify the System to Adapt to Climate Change			
	4.1. New infrastructure must accommodate expected sea level rise within the service life of the asset (i.e., 6 inches by 2030, 11 inches by 2050, 36 inches by 2100) and be consistent with the City's Guidance for Incorporating Sea Level Rise into Capital Planning.	a. Site new facilities to accommodate, or adapt to, expected sea level rise over the life of the asset.	Build new infrastructure at SEP (Headworks, Biosolids, Disinfection, Oxygen Generation Plant, Power Switchgear Building) and Mariposa Pump Station to accommodate expected sea level rise in 2100.
	4.2. Existing infrastructure that is impacted by sea level rise, within the service life of the asset, will be modified based on sea level rise projections.	b. Develop and implement an adaptation plan for existing infrastructure to address expected sea level rise within the service life of the asset.	Modify existing Bayside CSD structures that experience seawater intrusion. The following CSD structures are considered: Jackson St., Pierce St., Mariposa St., Beach St., Fifth St., Sixth St.-North., Division St., Howard St., Islais Creek-North, Marin St., Selby St., and Yosemite Ave.
5. Achieve Economic and Environmental Sustainability			
	5.1. Beneficial use of 100% of Biosolids.	a. Upgrade biosolids to treatment Class "A".	Upgrade SEP biosolids to treatment Class "A" which, contain no detectible levels of pathogens, and can be applied without restriction on food crops. Size the new Biosolids Digester Facilities to meet solids loading projections for the year 2045.
	5.2. Beneficialuse of 100% of methane generated by treatment facilities, during normal operation.	b. Provide cogeneration, or other beneficial methane use options, at SEP and OSP.	Construct cogeneration facilities at SEP and OSP for a total output of 5MW.
	5.3. Use non-potable water sources to meet WWE facilities non-potable water demands.	c. Incorporate conservation measures, recycled water, and other non-potable reuse facilities into projects, where feasible and appropriate.	In order to maximize use of non-potable water, upgrade the treated effluent pump system at SEP and incorporate its use into designs, where applicable. Accommodate space for recycled water treatment facilities at SEP and OSP.
6. Maintain Ratepayer Affordability			
	6.1. Combined sewer and water bill will be less than 2.5% of average household income for a single family residence.	a. Plan and phase projects to ensure affordability and predictability for ratepayers.	Plan and phase projects to ensure affordability and predictability for ratepayers.
			Identify and apply for Federal and State loans and grants to reduce the financial burden on ratepayers.

SEP: Southeast Treatment Plant; OSP: Oceanside Treatment Plant; NPF: North Point Wet Weather Facility; NPDES: National Pollutant Discharge Elimination System (US EPA)

APPENDIX B

HYDRAULIC ANALYSES MEMO

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Lesley Wong, P.E.
Hydraulic Engineering Manager

London Breed
Acting Mayor

Mohammed Nuru
Director

Patrick Rivera
Manager

Design & Engineering
1680 Mission St.
San Francisco, CA 94103
tel 415-554-8200

sfpublicworks.org
facebook.com/sfpublicworks
twitter.com/sfpublicworks

DRAFT TECHNICAL MEMORANDUM

To: C. Linh
Through: B. Shrestha
From: N. Birth
Date: 12/22/2017

Subject: Folsom Area Stormwater Improvement Project
Hydraulic Analysis for CER

Two follow up hydraulic analyses were requested at the CER kickoff meeting held on October 5, 2017:

1) a potential smaller size bottom drain for the proposed tunnel,
2) a surge-analysis of the proposed tunnel

Note: All elevations used in subsequent discussion is with reference to the San Francisco City Base. This datum is assumed to be 11.35 ft above the NAVD88.

1) Analysis of Smaller Diameter Bottom Drain

The 12 foot Alameda tunnel alignment was revised from the AAR phase, and the new alignment allows for potentially using a smaller diameter bottom drain on the downstream end of the tunnel. The bottom drain would connect from where the tunnel meets the Division Street sewer (Figure 1, location 2) to the stub of the TS box on Berry Street (location 1). Flows from the new tunnel in excess of the bottom drain capacity would overflow via the Division Street sewer, about 20 ft above the tunnel. The overflow connection would not need to be any larger than the proposed 12 foot diameter tunnel.

The range of sizes analyzed was determined based on constructability, from 7 to 12 feet diameter. The impact of the sizing (Figure 2 and 3) was highest at the locations closest to the bottom drain such as at Henry Adams St and at Division and Berry (location 2). At Division and Berry, the HGL rises by 0.75 ft if the bottom drain diameter is decreased from 12 ft to 7 ft for the LOS storm simulation. The higher HGL would be driven by the smaller size conveyance downstream from the overflow connection. Therefore, it is recommended to maximize the size of the bottom drain.

The HGL for this analysis was sensitive to the operation of the Division Street gates. In the model, the RTC causes the gates to open and shut rapidly, however this has not been observed in reality. To avoid this, the gates were kept open throughout the analysis.

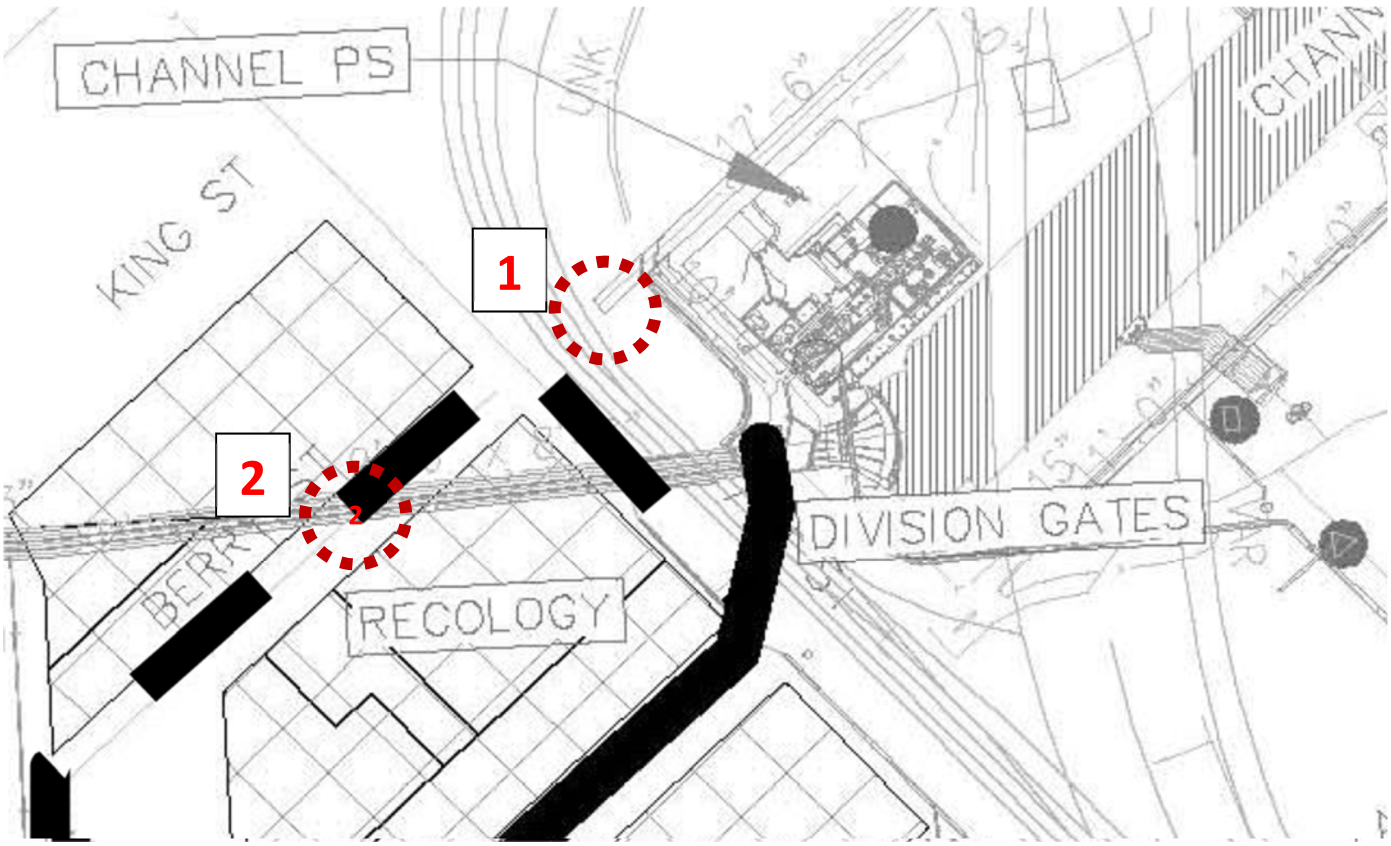


Figure 1: Revised tunnel alignment with bottom drain start/end points

	Existing Conditions	7ft drain	8ft drain	10ft drain	12ft drain
18th & Shotwell	14.32	9.76	9.77	9.77	9.76
17th & Folsom	11.75	7.74	7.75	7.75	7.74
Enterprise Alley	7.74	6.11	6.10	6.11	6.11
14th & Harrison	7.80	4.45	4.21	3.84	3.66
Henry Adams	2.02	1.27	1.15	0.86	0.59
Division and Berry	0.34	0.25	0.10	-0.21	-0.49

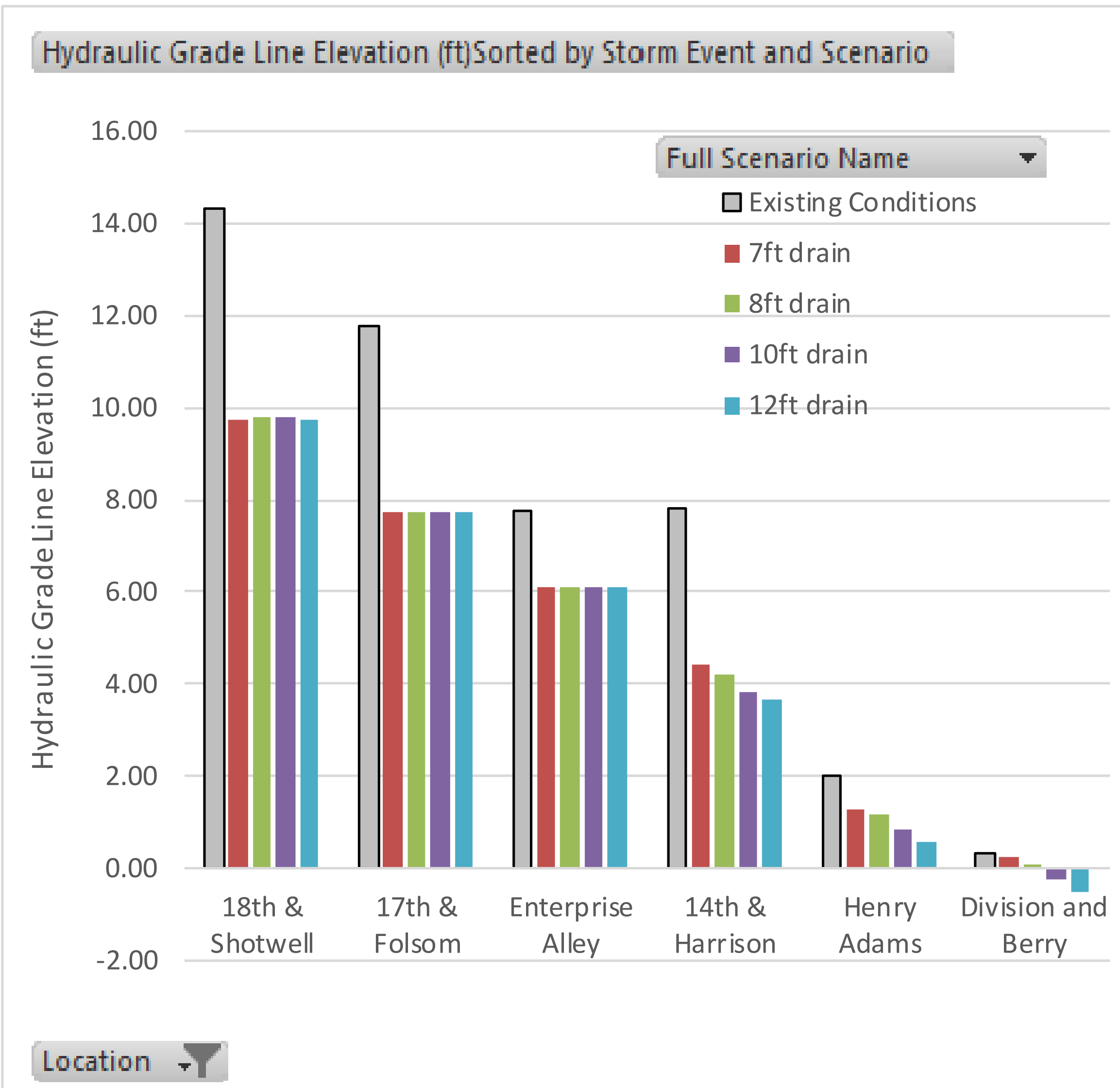


Figure 2: Bottom Drain Sizing Hydraulic Grade Line

	<0 ft	0-2 ft	2-4 ft	4-6 ft	6+ ft
Existing Conditions					
D05y03h	135	64	50	31	12
7ft drain					
D05y03h		28	110	80	73
8ft drain					
D05y03h		24	109	81	77
10ft drain					
D05y03h		20	109	82	80
12ft drain					
D05y03h		17	108	82	84

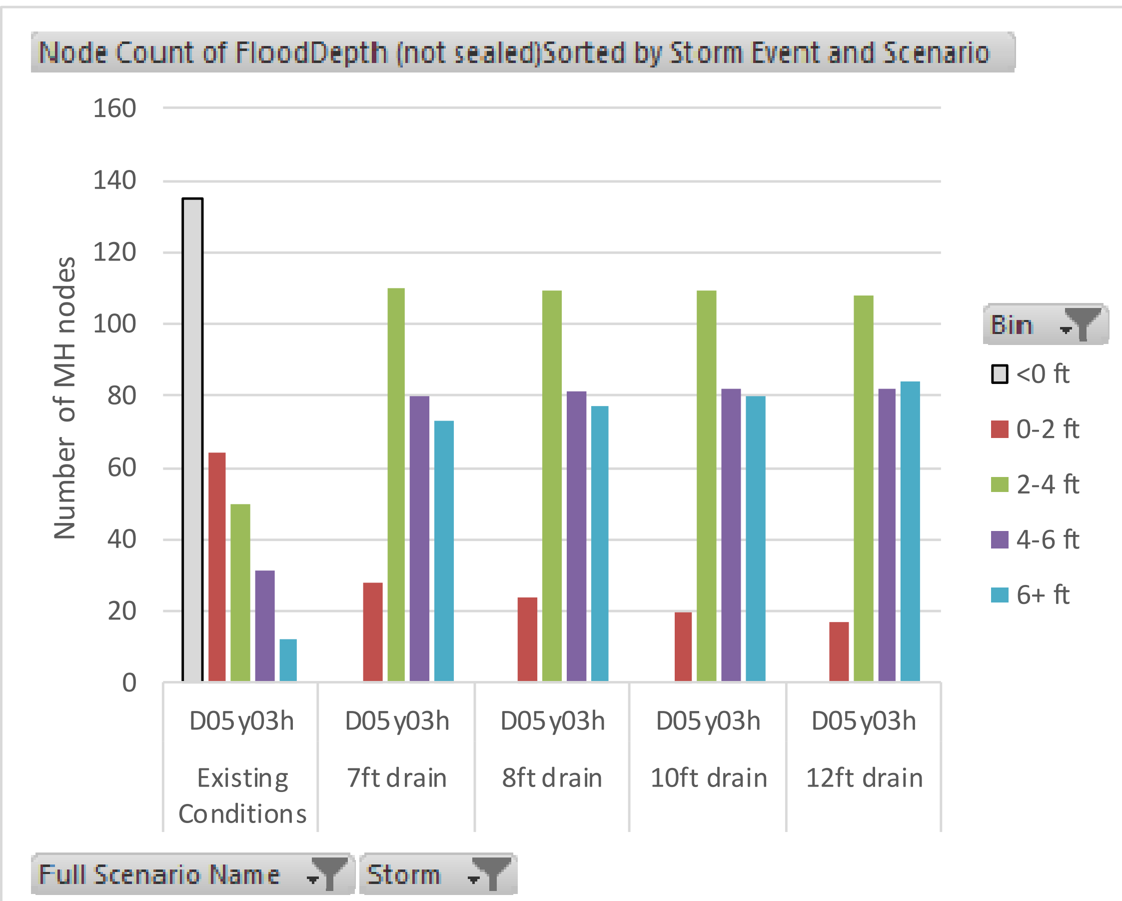


Figure 3: Bottom Drain Sizing Node Count

2) Surge Analysis

Tunnels used for conveying water or wastewater can experience surges of various forms. They are: 1) water-hammer effect, 2) travelling hydraulic bores, 3) air-entrainment, 4) air-entrapment. A brief discussion of each is included here.

Background

Treat Avenue Structure

- 10.5 ft x 15 ft x 1000 ft open cut box sewer
- Starting Invert -11 ft
- Ending Invert -21 ft

Alameda Tunnel

- 12' dia
- 4200 LF
- Elevations
  - u/s crown - 9.7 ft
  - u/s invert -21.7 ft
  - d/s crown -18.0 ft
  - d/s invert -30.0 ft

LOS Storm Hydraulics

- Max Flowrate 1200 cfs
- Max Velocity in tunnel 12 ft/s
- Froude Numbers
  - 1.5 for Treat Ave Structure
  - 0.9 for Alameda Tunnel

Discussion of various Operating Regimes

The tunnel receives flow from the 17th/Folsom sewer system and conveys it eastward to the Division Street outfall. The simplicity of this explanation, however, can be deceiving. The sewer system encompassing this tunnel is highly interconnected and requires consideration of multiple combinations of hydraulic operation scenarios that the tunnel will be subjected to during rain events.

The downstream end of the tunnel will be under the hydraulic influence of the Channel Outfall Consolidation system (COC). The downstream end of the tunnel is submerged when the water level in the COC rises to -18 ft.

The tunnel can be fully submerged by water when the level in the COC system rises to an elevation of -9.7 ft. When subjected to normal rain patterns, it is possible that the tunnel routinely fills up from the downstream end. It can also fill from the upstream end when the downstream end is under submergence. To keep the surge of air displacement by moving water from either combination of flow directions, sufficient openings will be required at both the ends of the tunnel to expose the tunnel to atmospheric pressure at all times.

Water Hammer

The water hammer effect is due to a sudden acceleration or deceleration of fluid in pressurized conduits. Such effect is taken into account in penstocks, head races, tail races of hydro-power generation dams and are generally addressed by adding surge chambers. The hydraulic head required to produce water-hammer effect ranges in hundred feet or more, and requires high velocities. It is not needed to be considered for the project where the depth, pressure, velocities are significantly lower than that needed to produce such water-hammer effect.

Travelling Hydraulic Bore

Travelling hydraulic bore is formed in a conduit conveying open channel flow in a supercritical regime when the downstream end is subjected to a restricted flow. A hydraulic jump forms at the downstream end which travels upstream until the forces of the two flow regimes come to an equilibrium state. It is possible such effect can occur in the tunnel during filling from the upstream end. In such a case, the air in the tunnel is displaced at the rate of filling of the tunnel. The maximum filling rate of the tunnel provides a first approximation of the requirement of vents.

Air-entrainment

Air-entrainment is a common phenomenon where fast moving flow in an open channel starts to entrain air as a result of air drag. Such effect is common in spillways of dams or in steep sewers. If the downstream flow in a tunnel does not have a location for release of incremental collection of air, large pockets of air can form which will be under pressure. The remedy for this is to keep the junction location where air entrainment occurs exposed to atmospheric pressure.

Air-entrapment

In deep and long tunnels where a sufficient number of intermittent shafts exposed to atmosphere is not available, rapid filling from multiple inflow locations can trap air which will be subjected to high pressure. Such pockets of pressurized air can cause surges of air and water at any available shafts with violent surge.

Observations

In San Francisco, the combined sewer system with numerous features, and of various topography, have provided experiences of some of these phenomenon. Some tunnels where air or air-water surges have been observed are Richmond Transport/Storage tunnel, Park Merced Tunnel, and the Lake Merced 3-compartment sewer crossing. All of these tunnels or sewers are subject to flow from high head of 50 feet or more.

On the Bay side, the Marina-North Point Tunnel has comparable hydraulic characteristics as the present project when the elevations, and the upstream and downstream hydraulic conditions are considered (refer to drawing

41109). The North Point Tunnel has four junction structures which were designed for the purpose of air-venting based on physical model tests.

Analysis of Alameda Street Tunnel

Using the alignment from AAR, the 12 ft tunnel was subdivided into 50 foot segments to allow for a profile graphic showing more detail then the model used in AAR. Based on review of the more detailed profile, including how flows enter from upstream sewers and how the flow discharges into the existing Transport/Storage box, there are no anticipated surge issues. The results are not expected to change under the new alignment, assuming the 12 ft size is used for the entire tunnel. This does not replace a detailed CFD analysis, but is potentially a precursor to CFD. A CFD analysis may be done during the design phase of the project for confirmation.

The profile alignment follows the red line shown in figure 4. Time series charts are provided in the attachment, showing the flow rates and tunnel filling level at the locations specified in figure 5. The chart currently shows water level at the downstream end only, but could be updated to show the water level at each end of the tunnel with the tunnel profile superimposed. This would show when the lower end is submerged and all venting will be through the upper end.

Notes on Tunnel Hydraulics

1. The maximum water pressure head is 30 ft, from the peak HGL to the invert of the tunnel.
2. The elevation drop for flows entering the tunnel is about 20 feet. In comparison, at the Richmond Transport Tunnel the incoming flow drops about 80 feet from the sewers in Lake Street.
3. The tunnel is submerged by the time the peak flow enters.
4. No sign of air pocket forming. This could happen when flows converge from both ends or when trapped air does not have enough head space above the water level to escape the tunnel, but these conditions were not observed
5. The tunnel connects at the downstream end to the T/S box and the bay waters downstream from the overflow structure, which will help to absorb and dissipate the energy of the incoming flow.
6. The tunnel profile shows a low point at the middle of the tunnel where HGL rises above ground level at approximately at Henry Adams Street. Vent structure should be avoided at such location.

Profile – LOS Storm (green) and 1-year 3-hour storm (purple)
https://youtu.be/HPDS4kIB8Gw

ICM Path
>Studies>SSIP>Folsom>Network Runs>CER>Surge test!

Folder Path
https://projects.parsons.com/sites/ssip/swaf/17F/90 Planning Phase/09.11.01 H and H Modeling/CER/

Figure 4: Limits of Tunnel Profile for Video

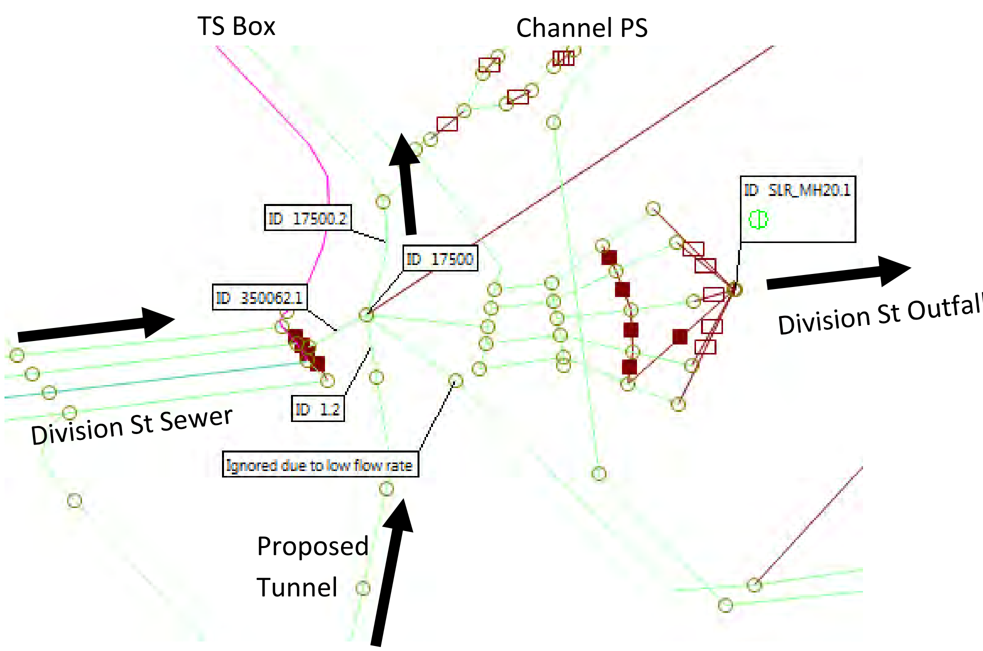


Figure 5: Flow Routing Diagram for Charts

Recommendations

Shaped Invert at Upstream end of Tunnel

A smooth vertical transition should be used at the upper end of the tunnel, where the flow from above enters the tunnel. This will minimize splashing and noise during small flows. The energy dissipation vanes used at the drop structure into the West Side Transport at Vicente Street provides an example. This structure has a similar purpose and elevation difference, refer to plans 42930.1 and 42905.

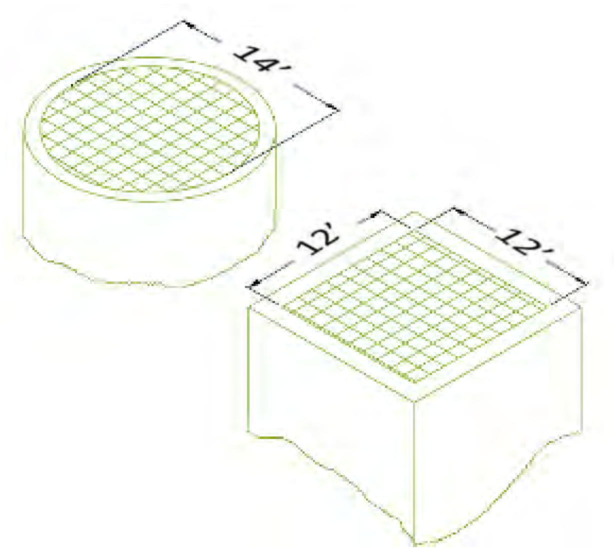
Venting

Venting to atmosphere will be needed on both ends of the proposed tunnel to allow air from the empty tunnel to be displaced without any unwarranted pressure build-up inside the tunnel as it fills with combined sewage during rain. A 12 ft x 12 ft vented cover should be used at each end, with a similar design as used in the Marina-North Point TS Tunnel. Refer to plan 41119.1

To determine approximate vent cross section, the peak flow rate of water in the tunnel was used as a first approximation to calculate air exhaust velocity. In the LOS storm, the peak flow rate is about 1200 cfs. Maximum permissible velocity to prevent pressurization of the tunnel is 100 ft/s, but a lower design velocity is used to avoid whistling or nuisance gusts at the street level vent grating. Velocity of 8 ft/s is recommended as a design criteria for the LOS storm, including ample margin for grating bar thickness. Vents determined using this criteria can be constructed at suitably located space available at the upstream and downstream ends of the tunnel. Since this size of vent will likely be much smaller than the tunnel construction shafts, the vented covers can be incorporated into the shaft after excavation of the tunnel is completed. Intermediate venting shafts are not recommended, simplifying the design.

It may appear attractive to decrease the area of the vent opening by allowing a higher velocity of air escape. This would increase the potential for mist to be carried up from the sewer along with the vented air, and is not recommended. Manholes geysering with a mixture of air and water have been observed at other locations within the sewer system in the City where insufficient venting had been provided.

		Dimension of Opening	
Air Velocity	Area	Length of square	Diameter of Circle
ft/s	sq ft	feet	feet
3	400	20	23
5	225	15	17
8	144	12	14
12	100	10	11
20	60	8	9
40	30	5	6
100	12	3	4



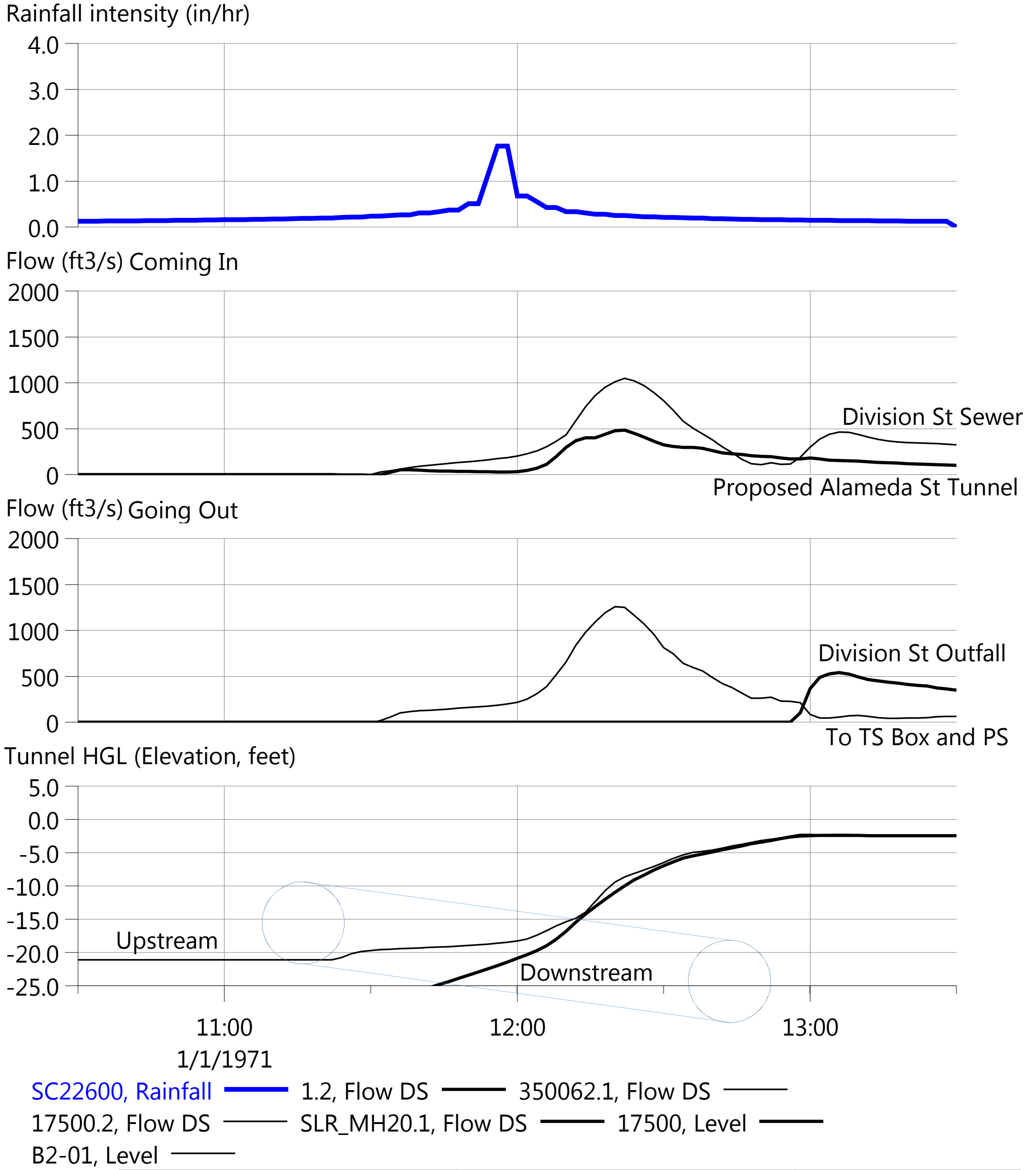
References

Davis, Handbook of Applied Hydraulics, 1969

Hydro Research Science, Hydraulic Model Study of the North Shore Outfalls Consolidation Project

- 14 ft Diameter Tunnel with New Design of Powell Inflow Structure, February 1979
- 17 ft Wide Channel and 9 ft Diameter Circular Tunnel with New Designs of Powell and Laguna Street Inflow Structures, October 1979

Sim : B1_AAR_subdivide 001y03h



	Rainfall			Flow DS			Level	
	Min (in/hr)	Max (in/hr)	Rainfall depth (in)	Min (ft3/s)	Max (ft3/s)	Volume (ft3)	Min (ft AD)	Max (ft AD)
Rain	0.000	1.763	0.783					
1.2				-5.281	482.703	1280558.6		
350062.1				-0.000	1047.103	2663512.9		
17500.2				-10.422	1256.241	2547398.7		
..._MH20.1				-0.000	538.424	831040.67		
17500							-27.081	-2.406
B2-01							-21.114	-2.236

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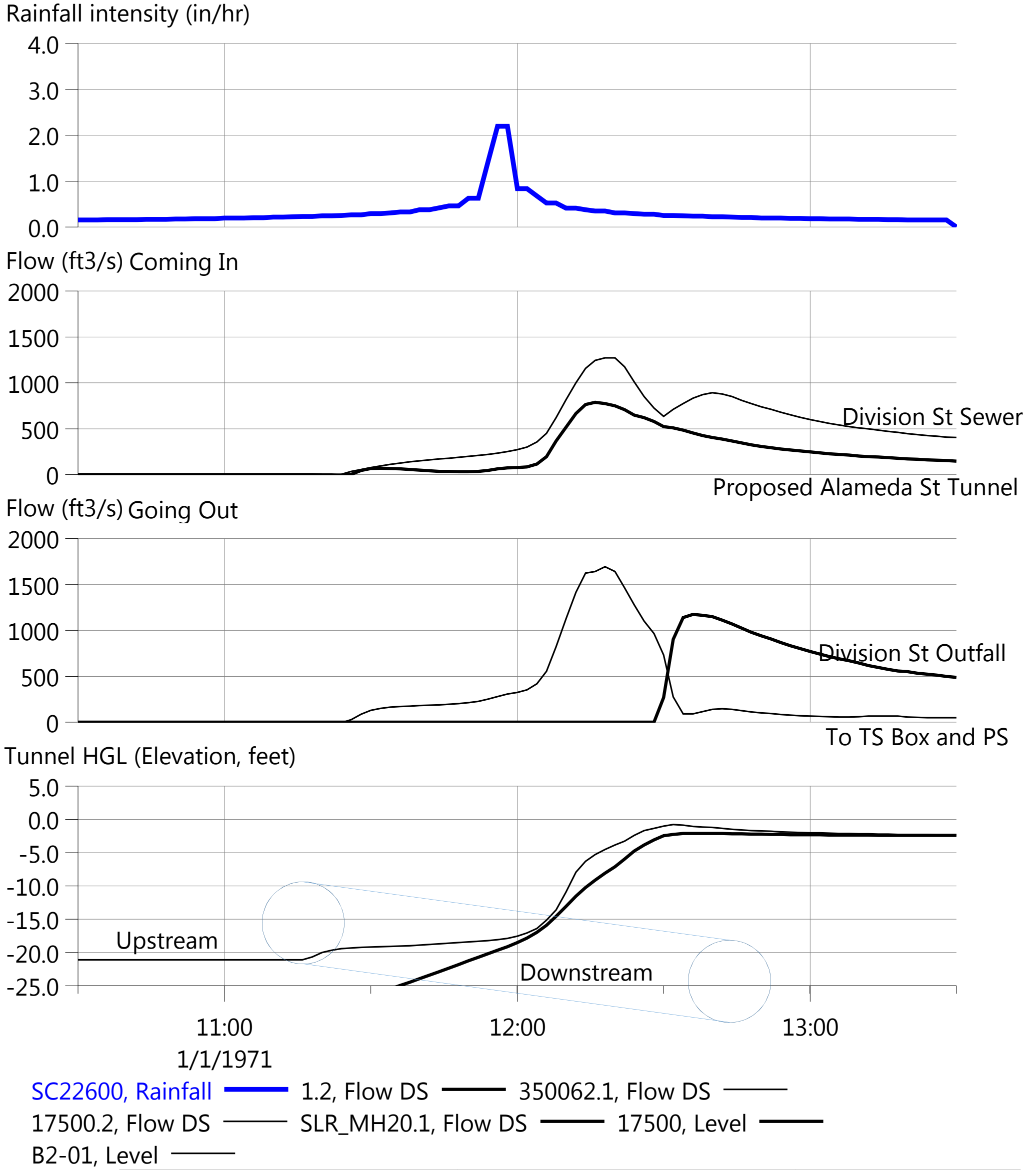

	Rainfall			Flow DS			Level	
	Min (in/hr)	Max (in/hr)	Rainfall depth (in)	Min (ft3/s)	Max (ft3/s)	Volume (ft3)	Min (ft AD)	Max (ft AD)
Rain	0.000	2.195	0.965					
1.2				-5.350	788.415	2043439.7		
350062.1				-0.000	1273.315	4090751.5		
17500.2				-8.699	1694.572	2737516.9		
..._MH20.1				-0.000	1173.001	2851236.3		
17500							-27.081	-2.093
B2-01							-21.114	-0.747

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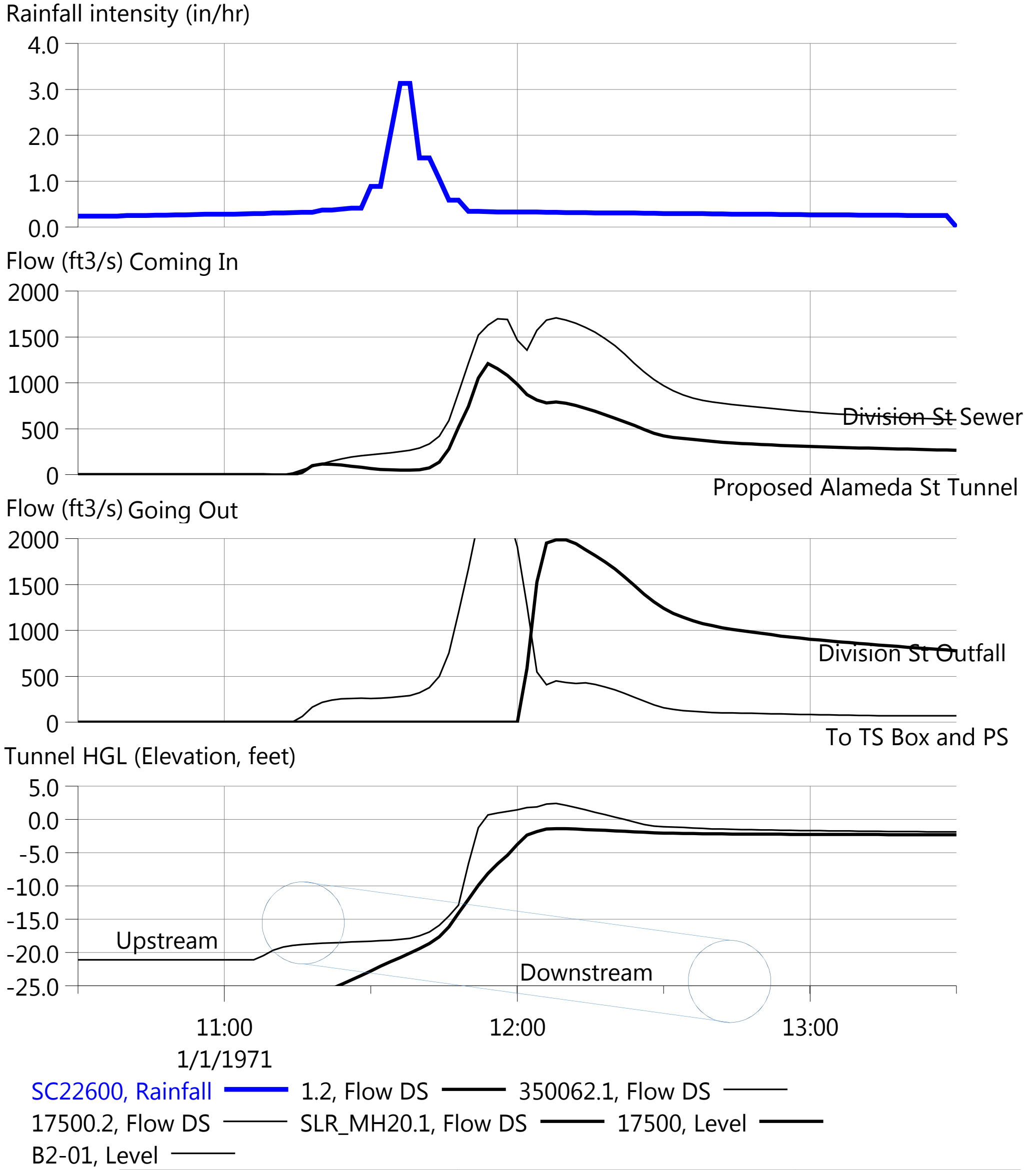

	Rainfall			Flow DS			Level	
	Min (in/hr)	Max (in/hr)	Rainfall depth (in)	Min (ft3/s)	Max (ft3/s)	Volume (ft3)	Min (ft AD)	Max (ft AD)
Rain	0.000	3.126	1.281					
1.2				-5.002	1210.394	3287033.9		
350062.1				-0.000	1705.883	6709160.4		
17500.2				-8.539	2357.498	3301834.4		
..._MH20.1				-0.000	1984.618	6169527.8		
17500							-27.081	-1.415
B2-01							-21.114	2.385

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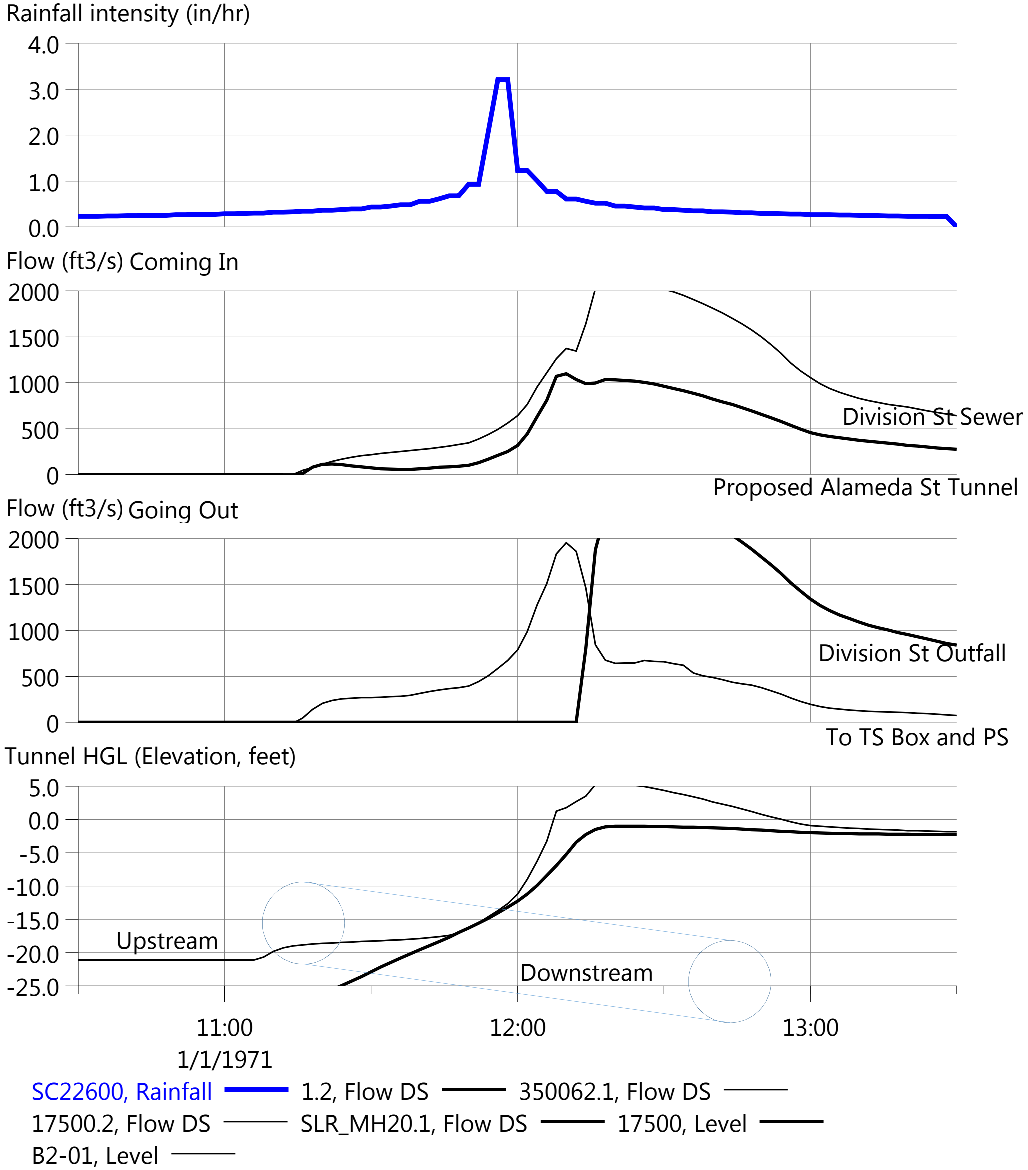


	Rainfall			Flow DS			Level	
	Min (in/hr)	Max (in/hr)	Rainfall depth (in)	Min (ft3/s)	Max (ft3/s)	Volume (ft3)	Min (ft AD)	Max (ft AD)
Rain	0.000	3.203	1.426					
1.2				-4.543	1098.581	3882863.0		
350062.1				-0.000	2046.232	7972719.7		
17500.2				-9.572	1955.649	3854410.8		
..._MH20.1				-0.000	2369.545	7485422.2		
17500							-27.081	-0.989
B2-01							-21.114	5.395

Scorecard for B1_CER_1

Base	B1	B1_sub	B1_7ft	B1_CER_1					

Brief Narrative: Higher priority projects extracted from B1_CER scenario

Simulation Design Storm: 5yr-3hr

Total Construction Cost by Element Type[1]

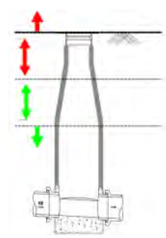
Element Type	Cost ($M)	$0M — $100M
New Sewer	7.2	
Upsize Existing Sewer		
Deepen Box Sewer	16	
Tunneling	50.8	
Detention		
CBSIP Main Tunnel		
Total Cost	84.6	

Key Locations for Alternatives Performance Assessment

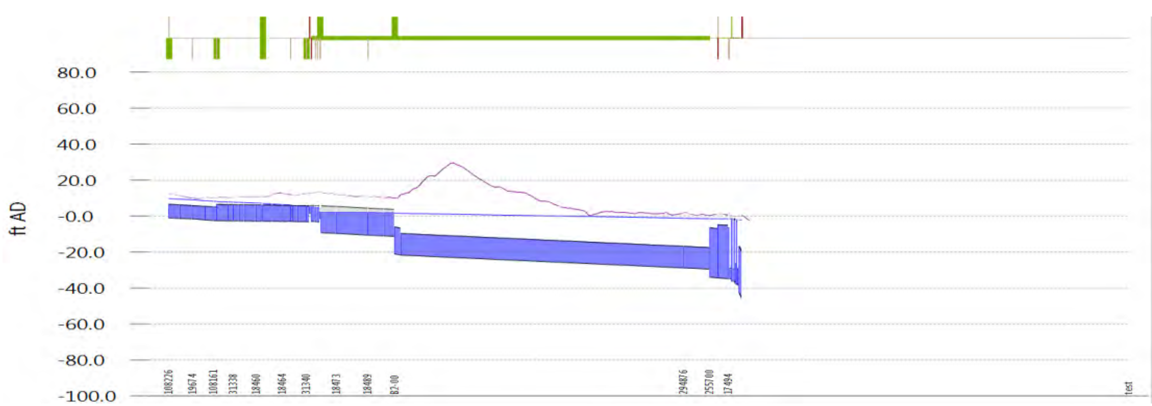
Location	Ground Elevation (ft)	Peak HGL Elevation (ft)	Freeboard (ft)
17th & Folsom	10.0	7.4	2.6
18th & Shotwell	12.1	9.8	2.3
Enterprise Alley	7.0	6.0	1.0
14th & Harrison	6.1	3.0	3.1
Henry Adams	2.2	0.3	1.9

Summary of Freeboard for Nodes within Analysis Area

	Depth to Ground	# of Nodes
Freeboard Not Met	-0 feet	11
	0-2 feet	34
Freeboard Met	2-4 feet	82
	+4 feet	169



Analysis Area Plan & Profile



Note 1 Total Construction Cost estimates shown in 2016 Dollars. New Sewer, Deepen Box Sewer, Upsize Existing Sewer, Pumping, and Detention project elements assume 10% Contractor General Conditions and Requirements, 6.5% Contractor Overhead and Profit, 2.5% Bonding and Insurance and 30 % Design & Estimating Contingencies. Total Construction Cost estimates for Tunneling project elements assume a 30% Contingency. Parametric cost estimates are shown. Actual cost estimates are provided as an Appendix in the CER.

APPENDIX C

UTILITY COMPOSITE DRAWINGS

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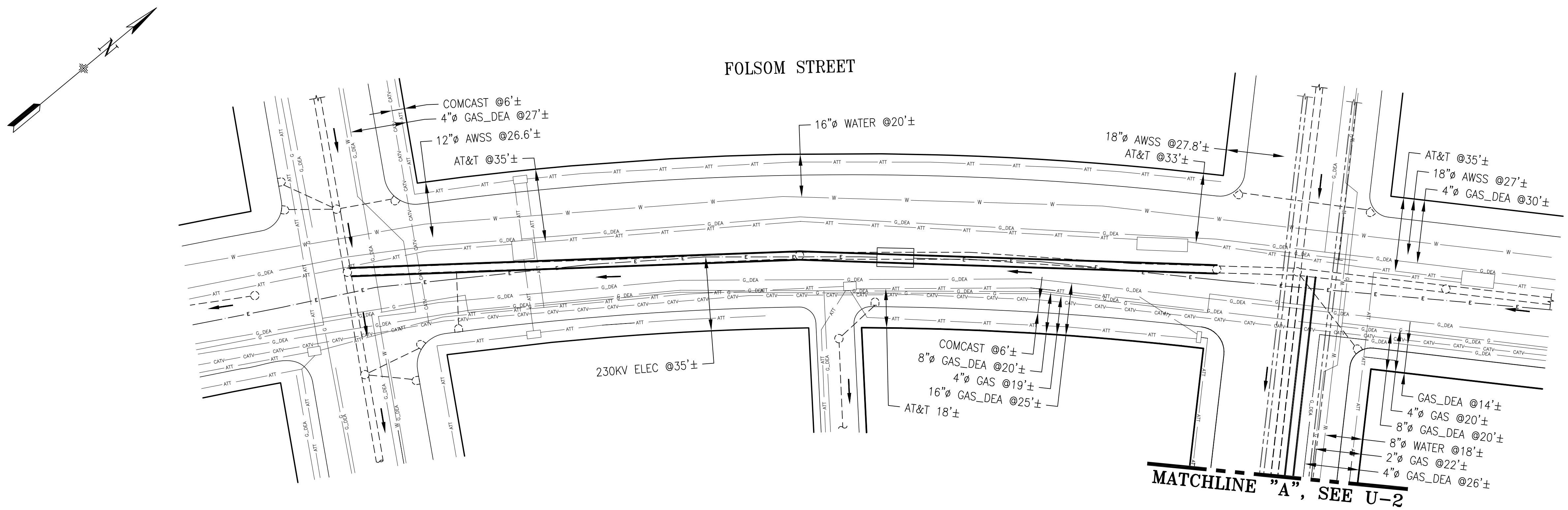

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

CAUTION

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ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

FOLSOM STREET SEWER REPLACEMENT
12TH STREET TO 11TH STREET
UTILITY OCCUPANCY PLAN

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN		
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED		
BUREAU MANAGER P.RIVERA	CHECKED		

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REVISIONS

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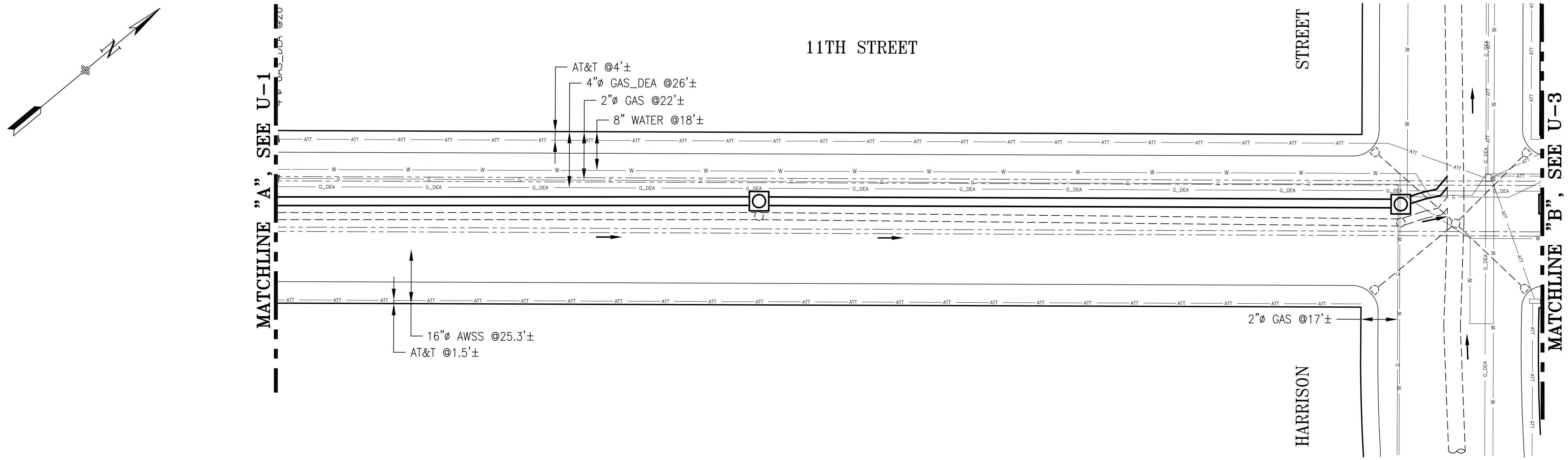

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SCALE: 1"=30'

LEGEND

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FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

11TH STREET SEWER REPLACEMENT
MATCHLINE "A" TO HARRISON STREET
UTILITY OCCUPANCY PLAN

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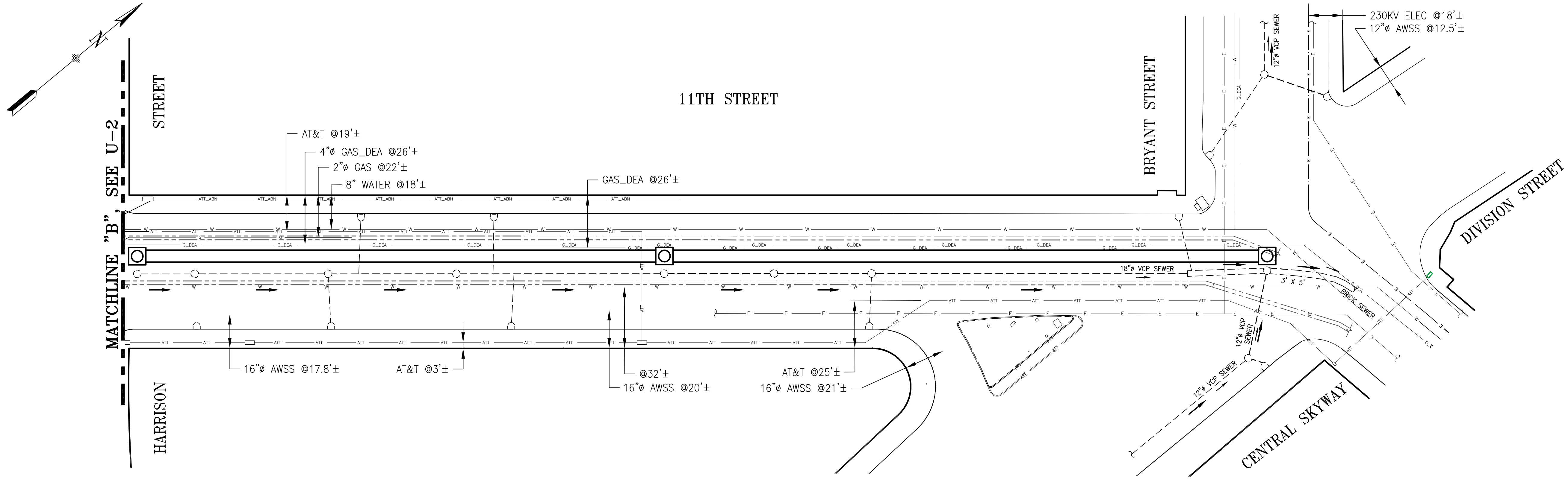

UTILITY OCCUPANCY PLAN

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HARRISON STREET TO DIVISION STREET
UTILITY OCCUPANCY PLAN

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DATUM
CITY

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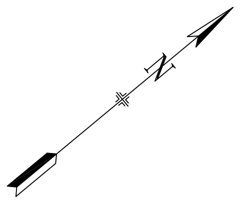

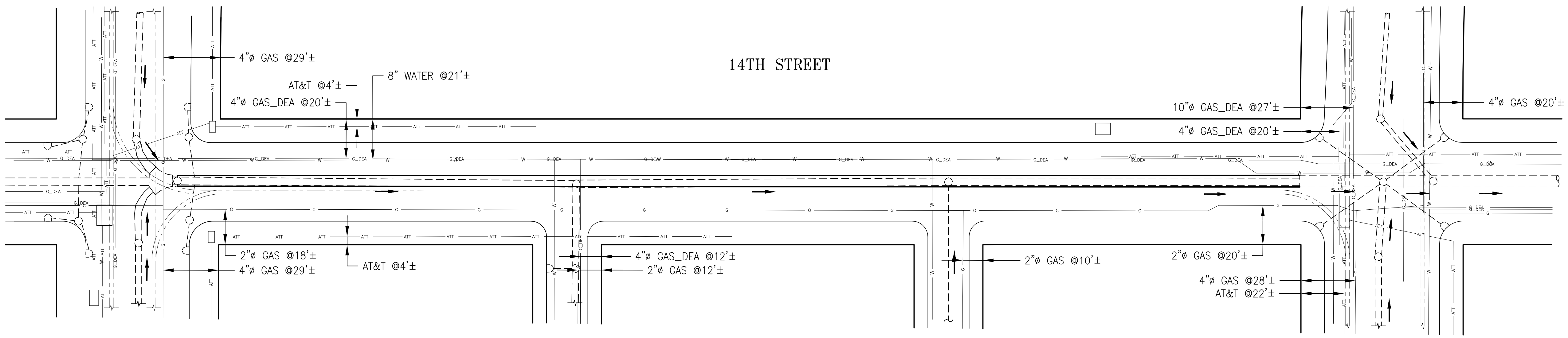

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

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BUREAU MANAGER	P.RIVERA	CHECKED	

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ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

14TH STREET SEWER REPLACEMENT
MISSION STREET TO SOUTH VAN NESS STREET
UTILITY OCCUPANCY PLAN

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SECTION MANAGER		DESIGNED	DATE
APPROVED		APPROVED	
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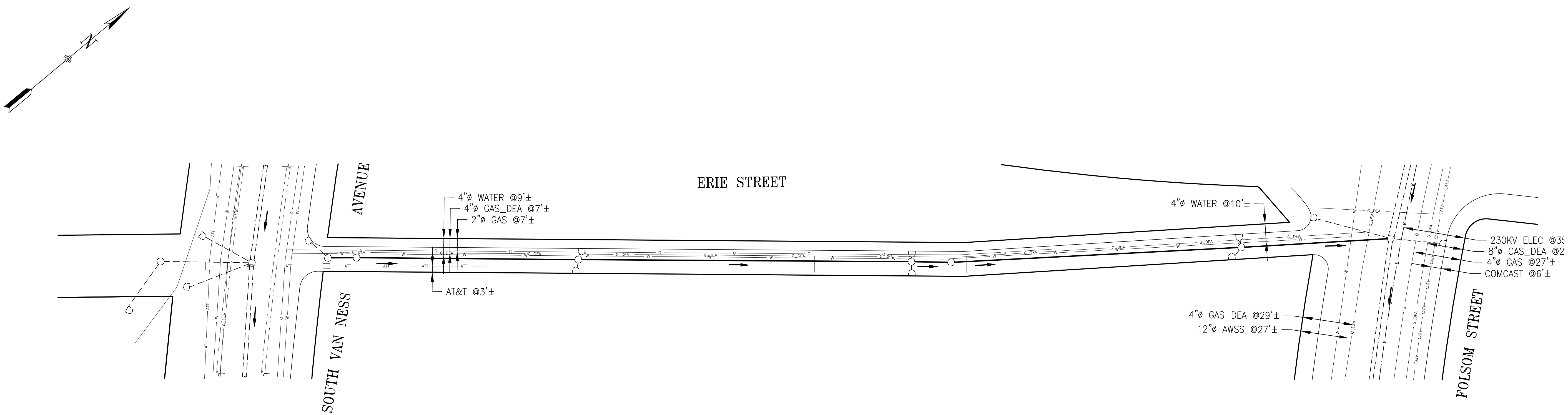

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

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CITY AND COUNTY OF SAN FRANCISCO
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INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

ERIE STREET SEWER REPLACEMENT
SOUTH VAN NESS AVENUE TO FOLSOM STREET
UTILITY OCCUPANCY PLAN

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APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

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OF		U-5	

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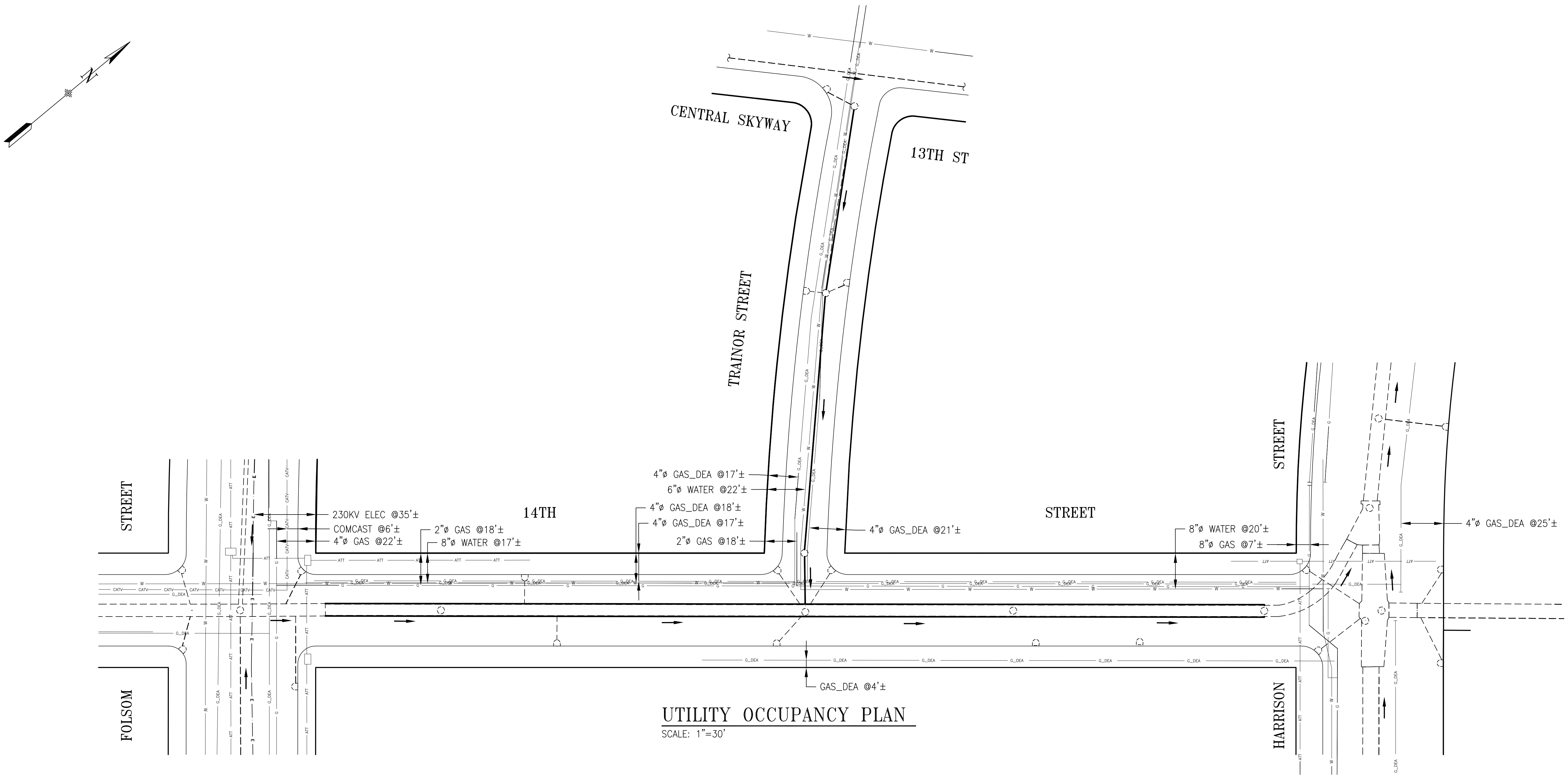

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

	(N) SEWER OR CULVERT
	(E) SEWER OR CULVERT
W	(E) WATER MAIN
	(E) AUXILIARY WATER SUPPLY SYSTEM
E	(E) PG&E ELECTRIC
G	(E) PG&E GAS
G_DEA	(E) PG&E ABANDONED GAS
CATV	(E) COMCAST
CATV	(E) COMCAST
ATT	(E) AT&T ABANDONED
ATT_ABN	(E) AT&T LINE
	(E) MUNI OVERHEAD WIRES

CAUTION

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FOR CONSTRUCTION DATA, SEE APPROPRIATE CONTRACT PLANS.

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ELEVATION DATUM CITY

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED
BUREAU MANAGER	P.RIVERA	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

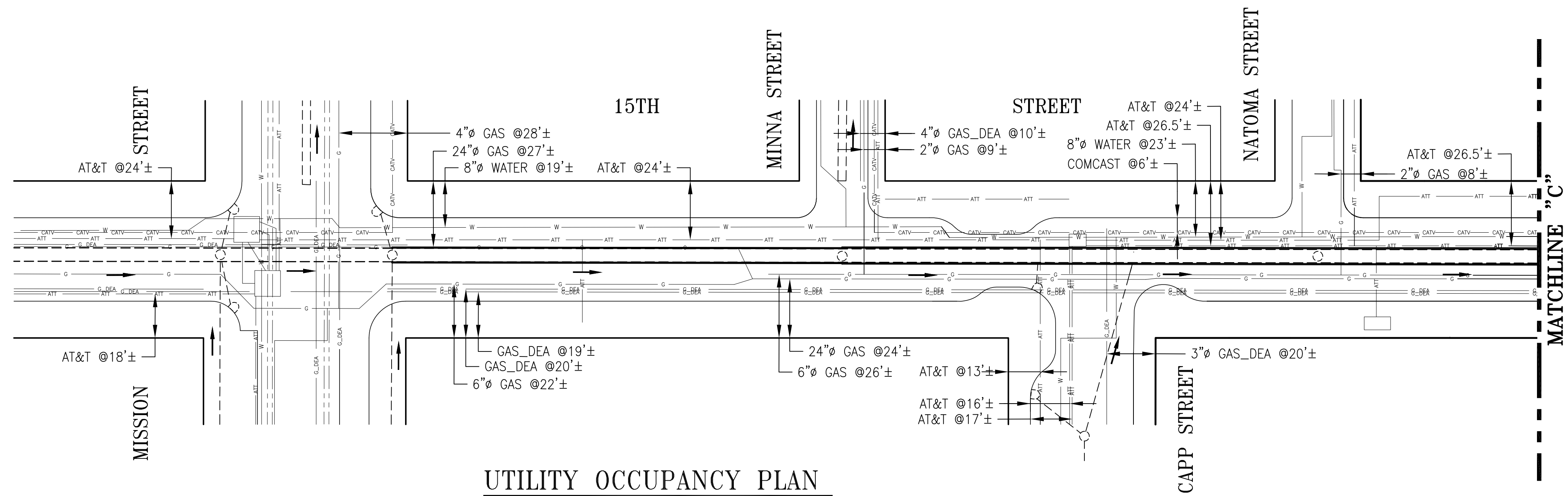
14TH STREET SEWER REPLACEMENT
FOLSOM STREET TO HARRISON STREET
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		U-6	

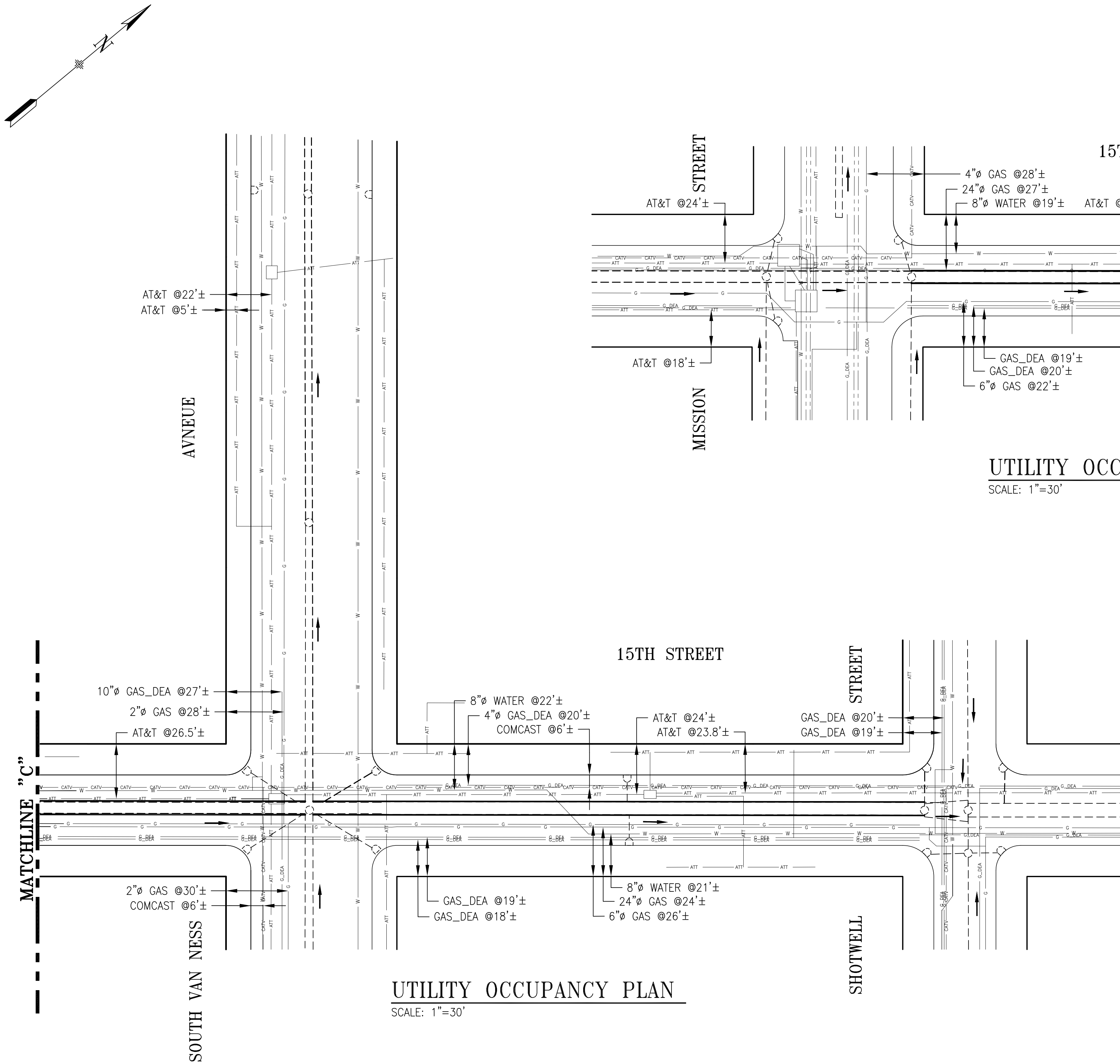
FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

(N) SEWER OR CULVERT
(E) SEWER OR CULVERT
(E) WATER MAIN
(E) AUXILIARY WATER SUPPLY SYSTEM
(E) PG&E ELECTRIC
(E) PG&E GAS
(E) PG&E ABANDONED GAS
(E) COMCAST
(E) COMCAST
(E) AT&T ABANDONED
(E) AT&T LINE
(E) MUNI OVERHEAD WIRES

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CONTRACT NO. WW–XXX

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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN		
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED		
BUREAU MANAGER P.RIVERA	CHECKED		

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

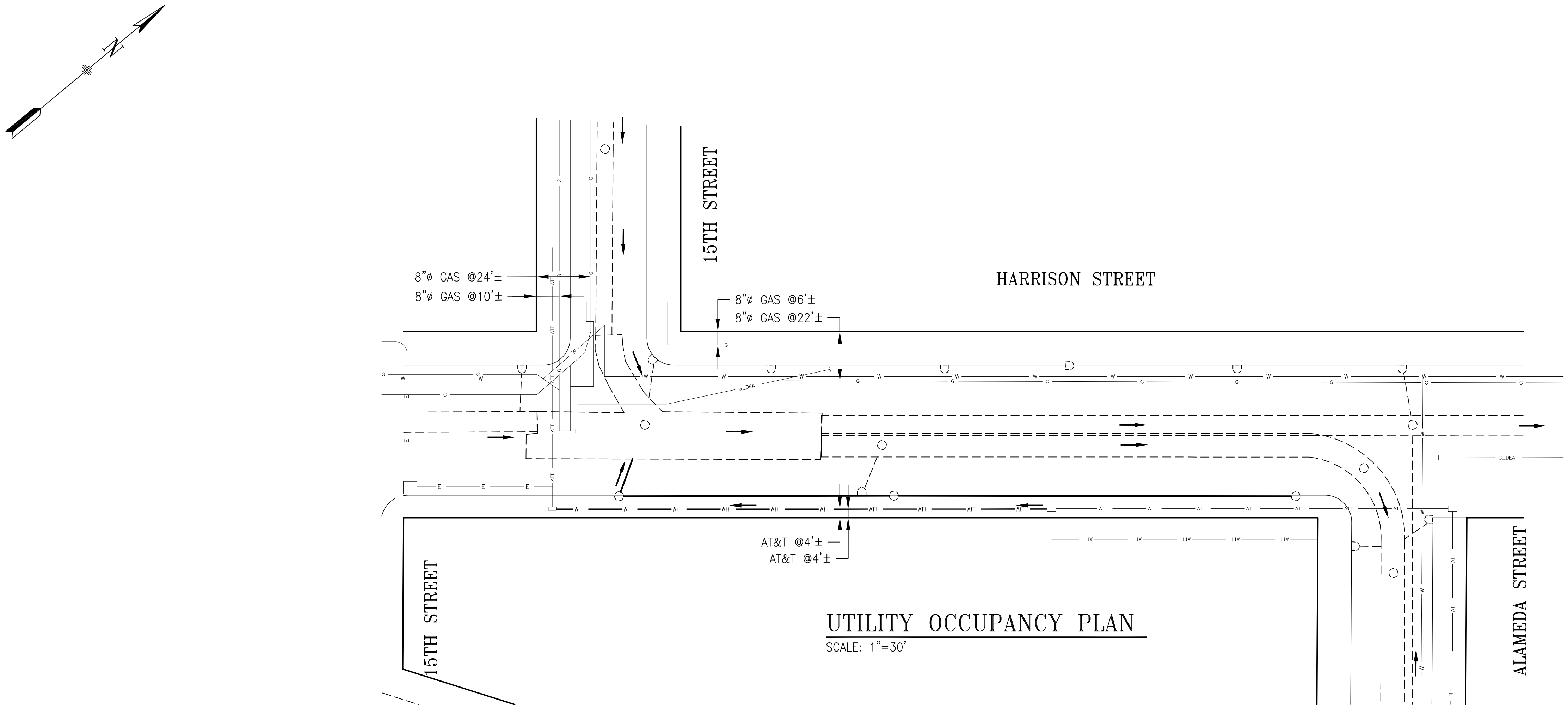
15TH STREET SEWER REPLACEMENT
MISSION STREET TO SHOTWELL STREET
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-7 / REVISION NO.

ELEVATION DATUM CITY

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

———————	(N) SEWER OR CULVERT
— — — — —	(E) SEWER OR CULVERT
—— W —— W ——	(E) WATER MAIN
	(E) AUXILIARY WATER SUPPLY SYSTEM
—— E —— E —— E ——	(E) PG&E ELECTRIC
—— G ——	(E) PG&E GAS
—— G_DEA ——	(E) PG&E ABANDONED GAS
— CATV — CATV — CATV — CATV — CATV —	(E) COMCAST
— CATV — CATV — CATV — CATV — CATV —	(E) COMCAST
—— ATT —— ATT —— ATT ——	(E) AT&T ABANDONED
—— ATT_ABN —— ATT_ABN ——	(E) AT&T LINE
= = = = = = =	(E) MUNI OVERHEAD WIRES

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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED
BUREAU MANAGER	P.RIVERA	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

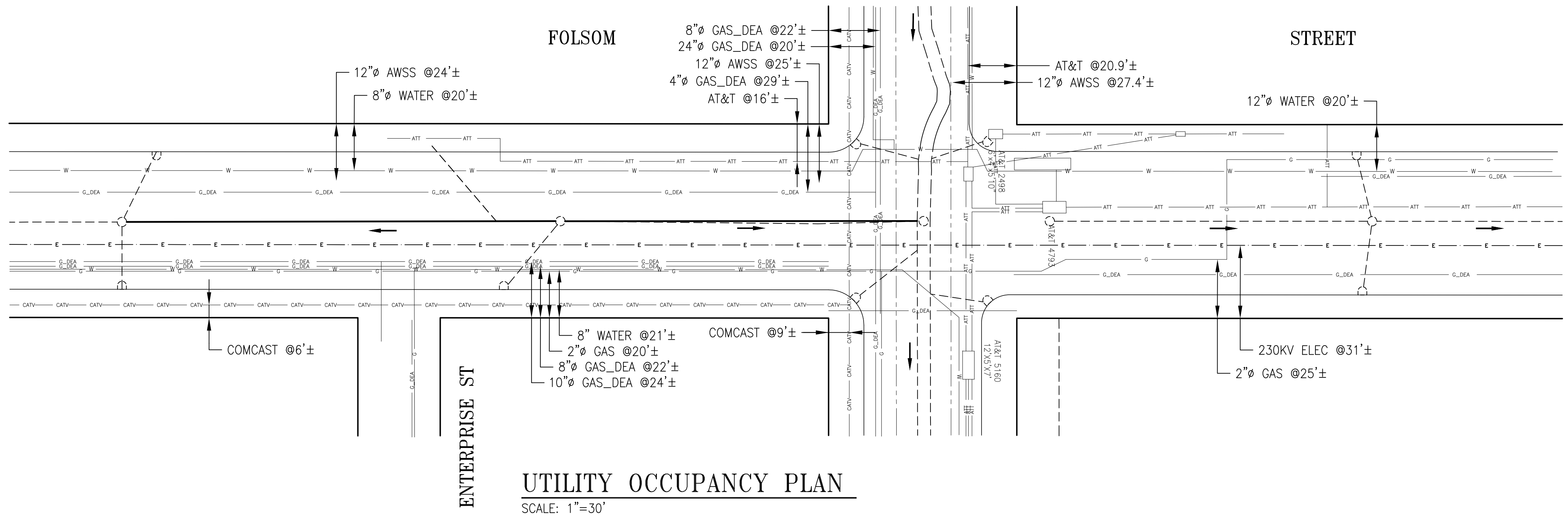
HARRISON STREET SEWER REPLACEMENT
15TH STREET TO ALAMEDA STREET
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		U-8	

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

FOLSOM STREET SEWER REPLACEMENT
ENTERPRISE STREET TO 16TH STREET
UTILITY OCCUPANCY PLAN

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

REFERENCES
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CIVIL
STATE OF CALIFORNIA

CHECKED / APPROVED		DRAWN	SCALE
SECTION MANAGER		DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-9	REVISION NO.

ELEVATION DATUM CITY

FILE:

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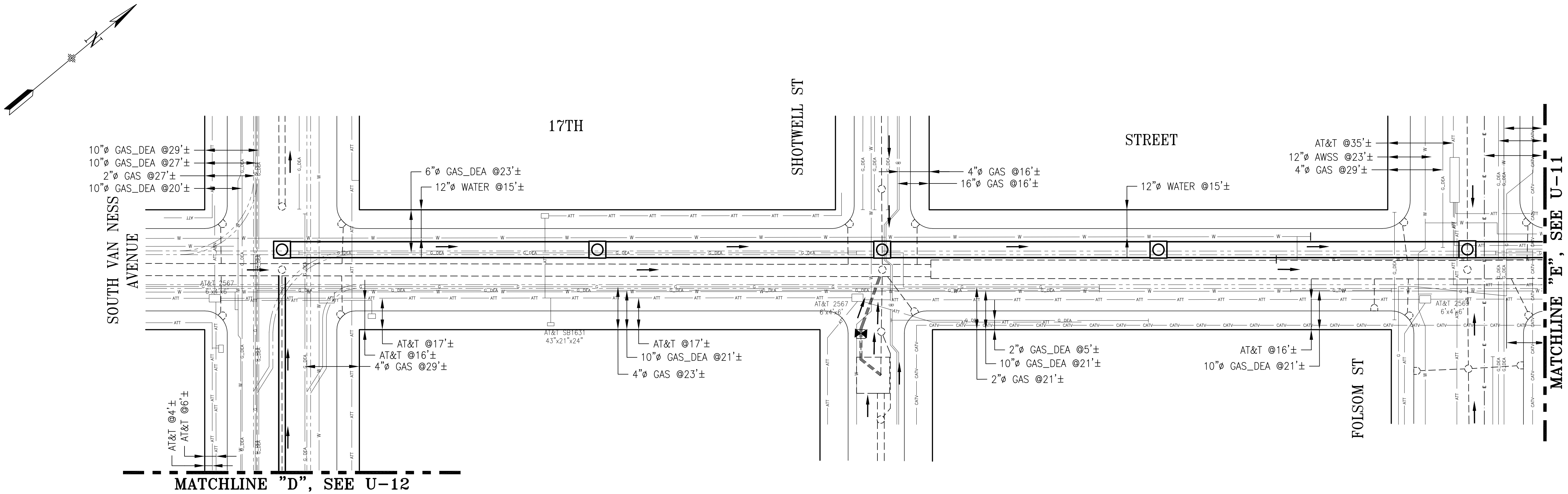

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

17TH STREET SEWER REPLACEMENT
SOUTH VAN NESS AVENUE TO FOLSOM STREET
UTILITY OCCUPANCY PLAN

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

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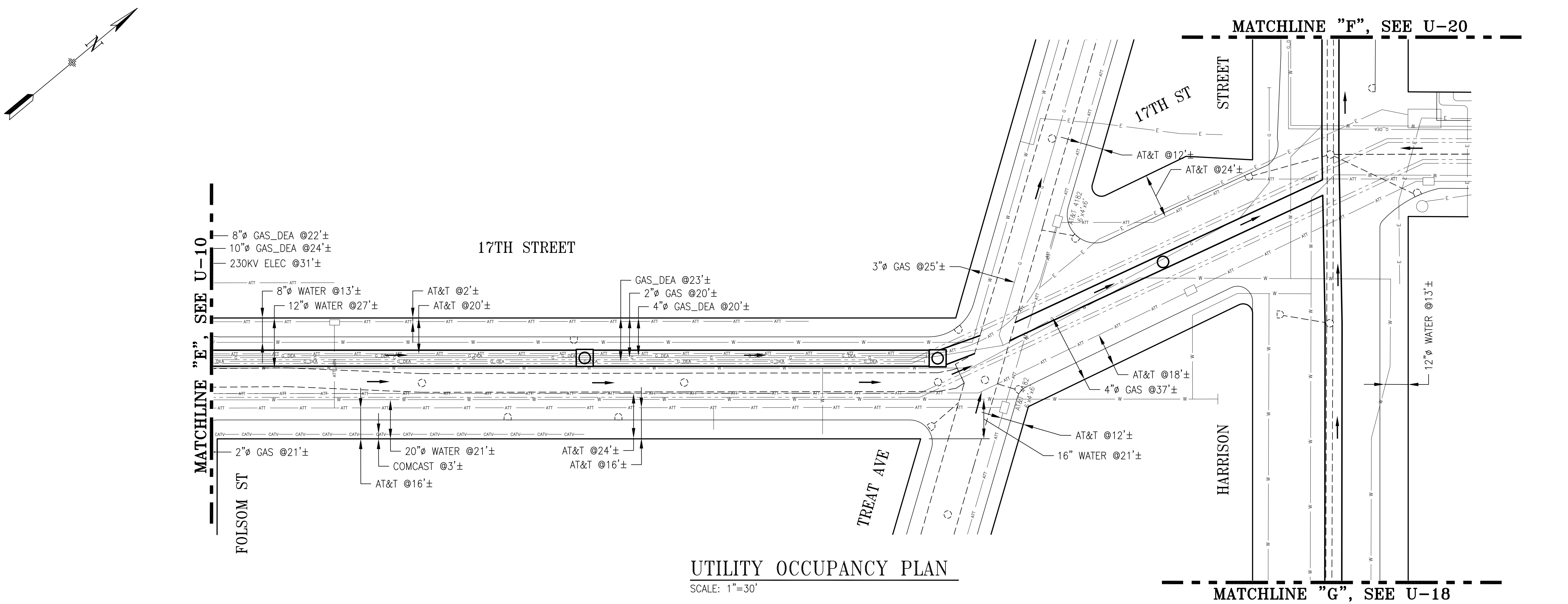
CIVIL
STATE OF CALIFORNIA

CHECKED / APPROVED		DRAWN	SCALE
SECTION MANAGER		DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-10	REVISION NO.

ELEVATION DATUM CITY

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

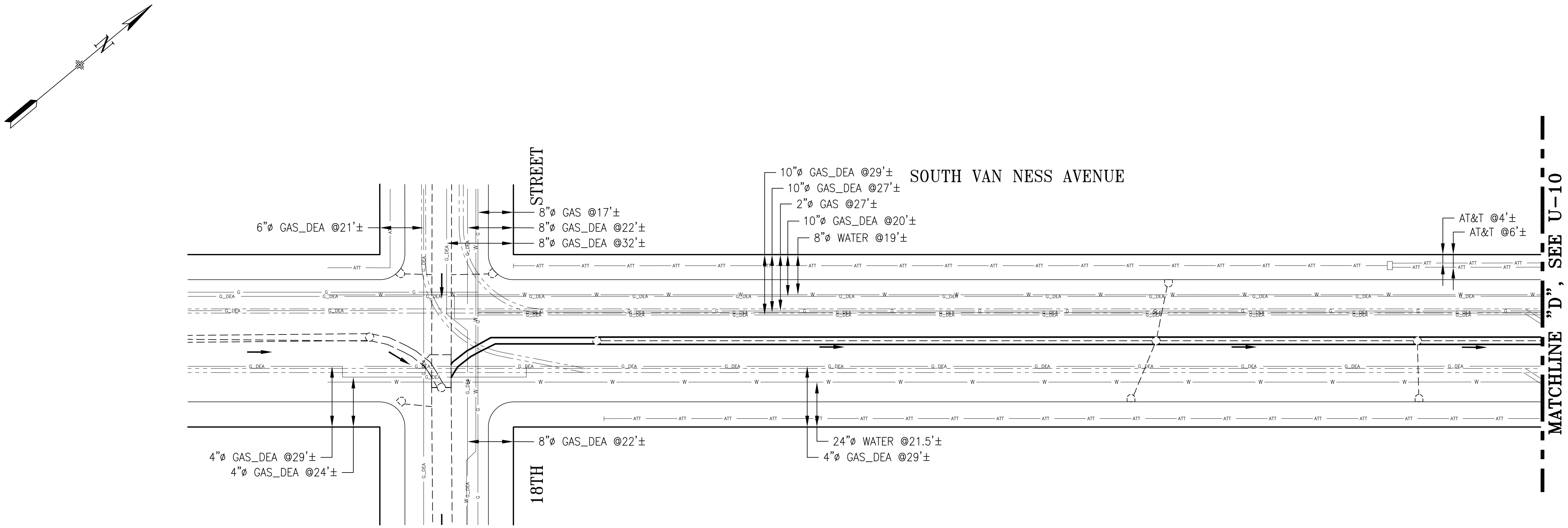
FOLSOM STREET SEWER REPLACEMENT
FOLSOM STREET TO HARRISON STREET
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-11 / REVISION NO.

ELEVATION
DATUM
CITY

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

(solid line)	(N) SEWER OR CULVERT
(dashed line)	(E) SEWER OR CULVERT
—W—	(E) WATER MAIN
	(E) AUXILIARY WATER SUPPLY SYSTEM
—E—	(E) PG&E ELECTRIC
—G—	(E) PG&E GAS
—G_DEA—	(E) PG&E ABANDONED GAS
—CATV—	(E) COMCAST
—CATV—	(E) COMCAST
—ATT—	(E) AT&T ABANDONED
—ATT_ABN—	(E) AT&T LINE
(double dashed line)	(E) MUNI OVERHEAD WIRES

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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED
BUREAU MANAGER	P.RIVERA	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW–XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

SOUTH VAN NESS AVE SEWER REPLACEMENT
18TH STREET TO MATCHLINE "D"
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		U–12	

ELEVATION
DATUM
CITY

FILE:

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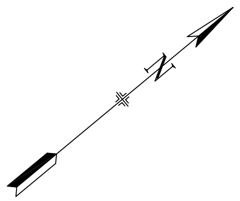

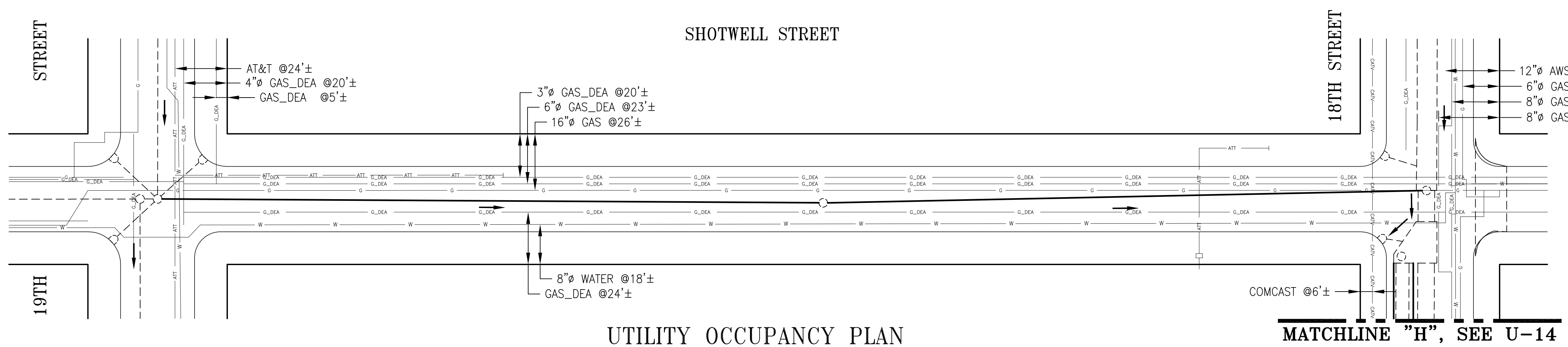

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

Symbol	Description
solid heavy line	(N) SEWER OR CULVERT
dashed line	(E) SEWER OR CULVERT
—W—	(E) WATER MAIN
	(E) AUXILIARY WATER SUPPLY SYSTEM
—E—	(E) PG&E ELECTRIC
—G—	(E) PG&E GAS
—G_DEA—	(E) PG&E ABANDONED GAS
—CATV—	(E) COMCAST
—CATV—	(E) COMCAST
—ATT—	(E) AT&T ABANDONED
—ATT_ABN—	(E) AT&T LINE
double dashed line	(E) MUNI OVERHEAD WIRES

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STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

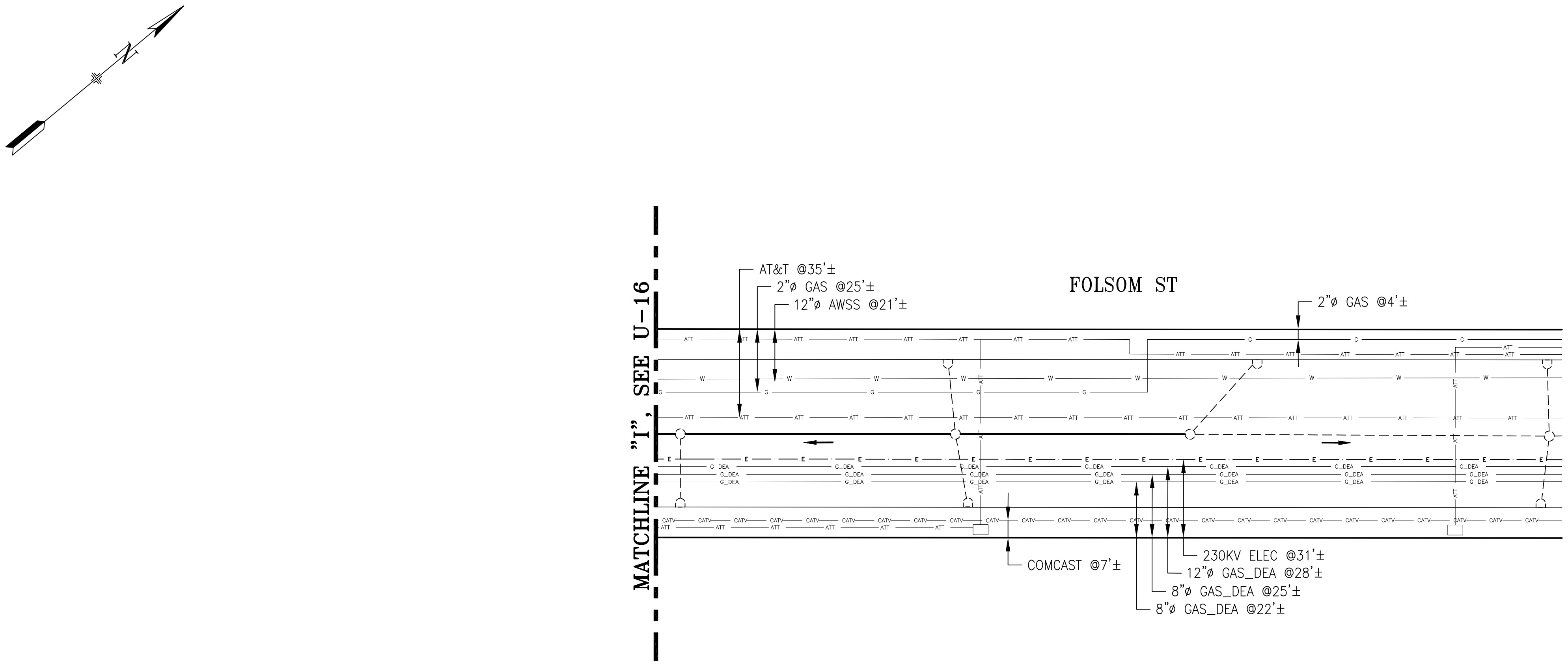
SHOTWELL STREET
19TH STREET TO 18TH STREET
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED		DRAWN	SCALE
SECTION MANAGER		DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-13	REVISION NO.

ELEVATION DATUM CITY

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

(N) SEWER OR CULVERT
(E) SEWER OR CULVERT
(E) WATER MAIN
(E) AUXILIARY WATER SUPPLY SYSTEM
(E) PG&E ELECTRIC
(E) PG&E GAS
(E) PG&E ABANDONED GAS
(E) COMCAST
(E) COMCAST
(E) AT&T ABANDONED
(E) AT&T LINE
(E) MUNI OVERHEAD WIRES

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DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED
BUREAU MANAGER P.RIVERA	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

FOLSOM STREET SEWER REPLACEMENT
MATCHLINE "I" TO 2120 FOLSOM ST
UTILITY OCCUPANCY PLAN

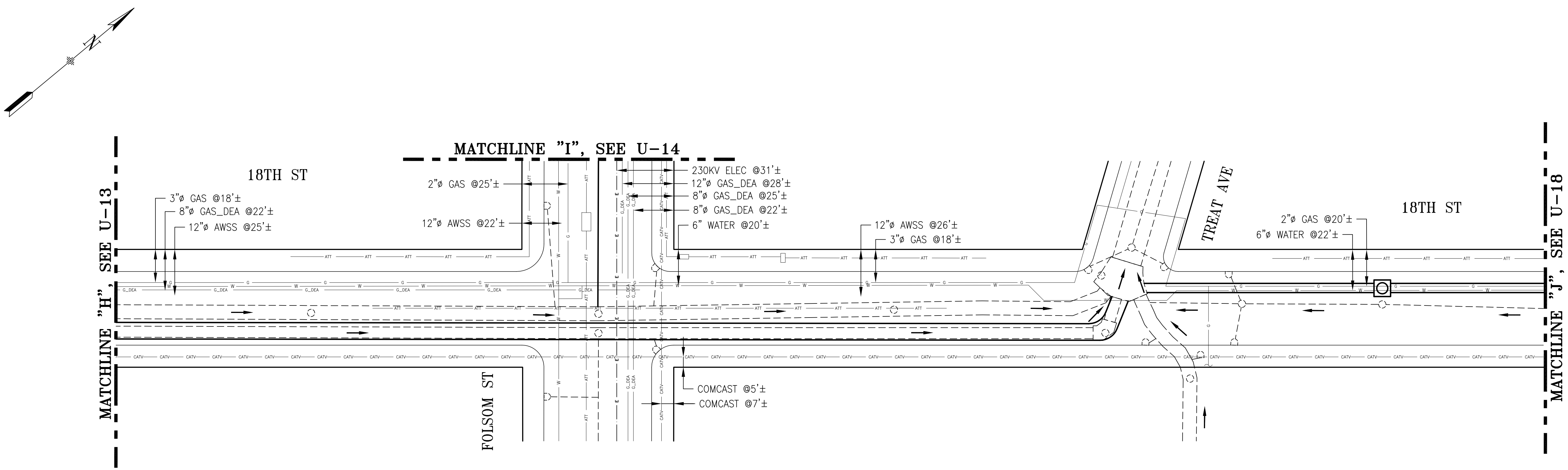
CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		U-14	

ELEVATION DATUM CITY

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

(solid line)	(N) SEWER OR CULVERT
(dashed line)	(E) SEWER OR CULVERT
W	(E) WATER MAIN
	(E) AUXILIARY WATER SUPPLY SYSTEM
E	(E) PG&E ELECTRIC
G	(E) PG&E GAS
G_DEA	(E) PG&E ABANDONED GAS
CATV	(E) COMCAST
CATV	(E) COMCAST
ATT	(E) AT&T ABANDONED
ATT_ABN	(E) AT&T LINE
	(E) MUNI OVERHEAD WIRES

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STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED
BUREAU MANAGER	P.RIVERA	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

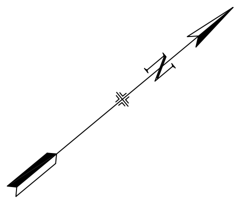
16TH STREET SEWER REPLACEMENT
MATCHLINE "H" TO MATCHLINE "J"
UTILITY OCCUPANCY PLAN

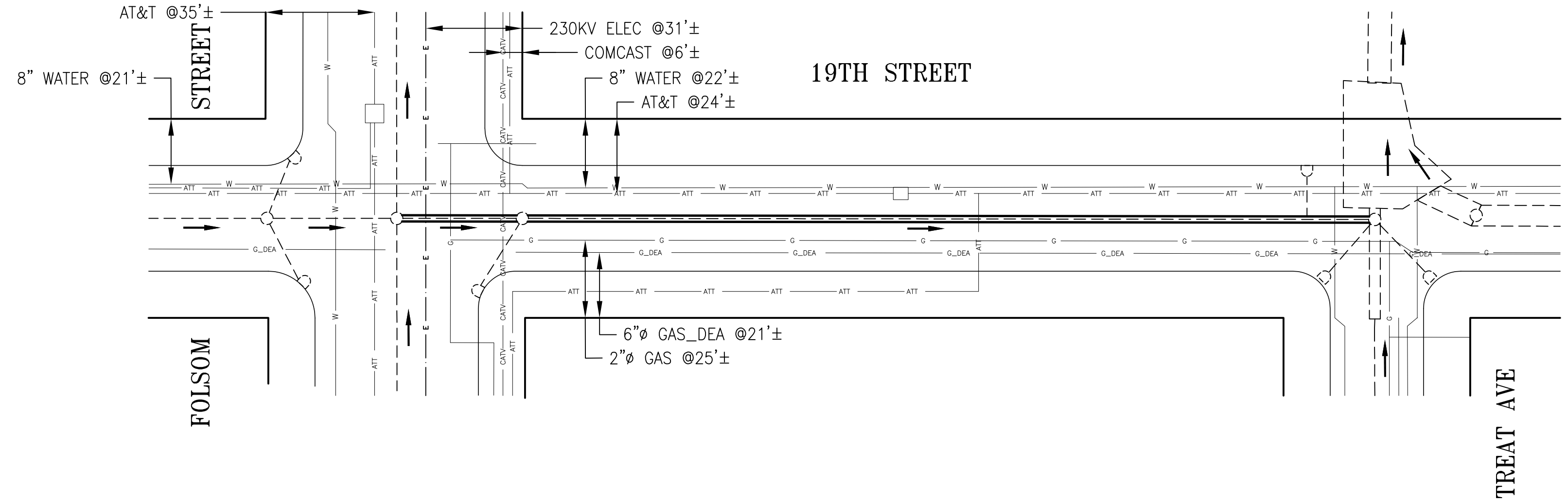
CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-15	REVISION NO.

ELEVATION DATUM CITY

FILE:

HYD JOB ORDER NO. 2817J





UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

CAUTION

THIS DATA IS COMPILED FROM INFORMATION FURNISHED BY THE VARIOUS UTILITY AGENCIES, AND THE CITY DOES NOT GUARANTEE ITS ACCURACY.

IT IS NOT A CONSTRUCTION DRAWING. IT IS INCLUDED ONLY FOR THE ASSISTANCE OF THE CONTRACTOR.

FOR CONSTRUCTION DATA, SEE APPROPRIATE CONTRACT PLANS.

CONTRACT NO. WW-XXX

10% SUBMITTAL
NOT FOR CONSTRUCTION

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

19TH STREET SEWER REPLACEMENT
FOLSOM STREET TO TREAT AVENEUE
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		U-16	

FILE:

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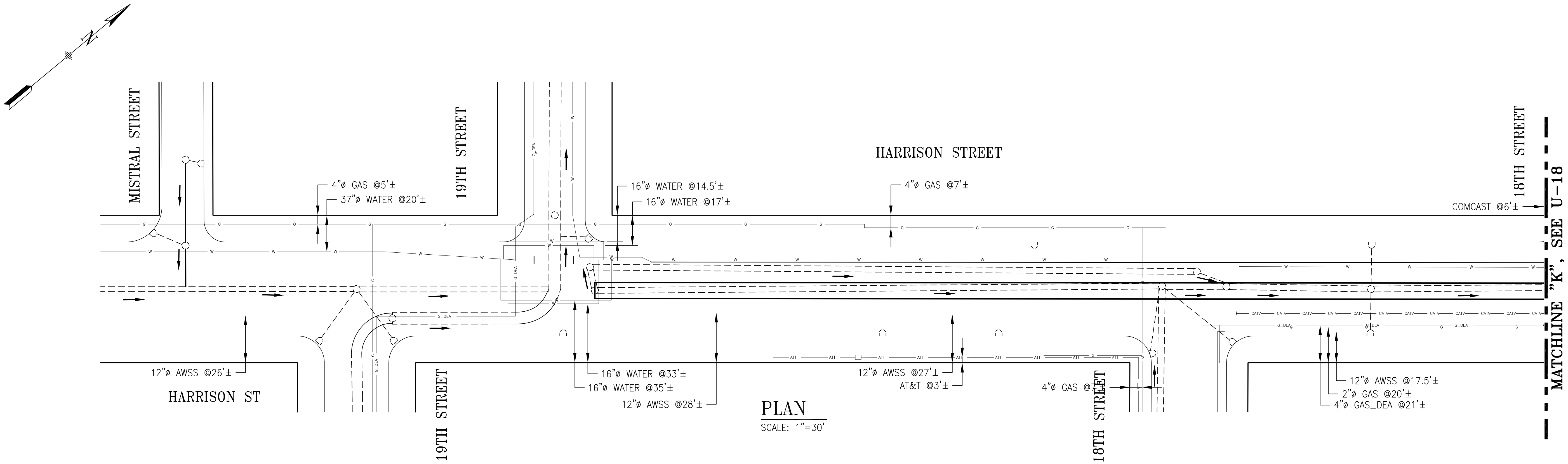

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

CAUTION

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10% SUBMITTAL
NOT FOR CONSTRUCTION

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

HARRISON STREET SEWER REPLACEMENT
MISTRAL STREET TO 18TH STREET
UTILITY OCCUPANCY PLAN

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CHECKED / APPROVED		DRAWN	SCALE
SECTION MANAGER		DESIGNED	DATE
APPROVED		APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU		ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-17	REVISION NO.

ELEVATION DATUM CITY

FILE:

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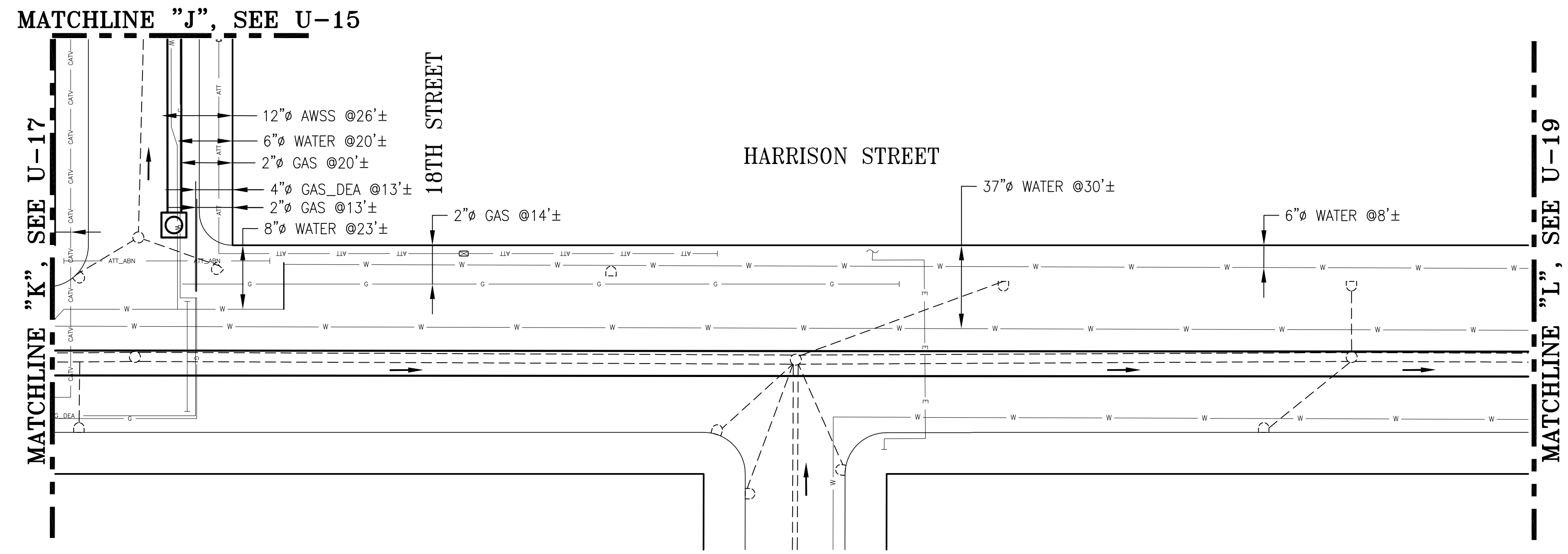

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

———————	(N) SEWER OR CULVERT
— — — — —	(E) SEWER OR CULVERT
—— W —— W ——	(E) WATER MAIN
	(E) AUXILIARY WATER SUPPLY SYSTEM
—— E —— E —— E ——	(E) PG&E ELECTRIC
—— G ——	(E) PG&E GAS
—— G_DEA ——	(E) PG&E ABANDONED GAS
— CATV — CATV — CATV — CATV — CATV —	(E) COMCAST
— CATV — CATV — CATV — CATV — CATV —	(E) COMCAST
—— ATT —— ATT —— ATT ——	(E) AT&T ABANDONED
—— ATT_ABN —— ATT_ABN ——	(E) AT&T LINE
= = = = = =	(E) MUNI OVERHEAD WIRES

CAUTION

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FOR CONSTRUCTION DATA, SEE APPROPRIATE CONTRACT PLANS.

10% SUBMITTAL
NOT FOR CONSTRUCTION

ELEVATION DATUM CITY

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER — CHUNG K. LINH — No. C69218 — CIVIL — STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED
BUREAU MANAGER	P.RIVERA	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

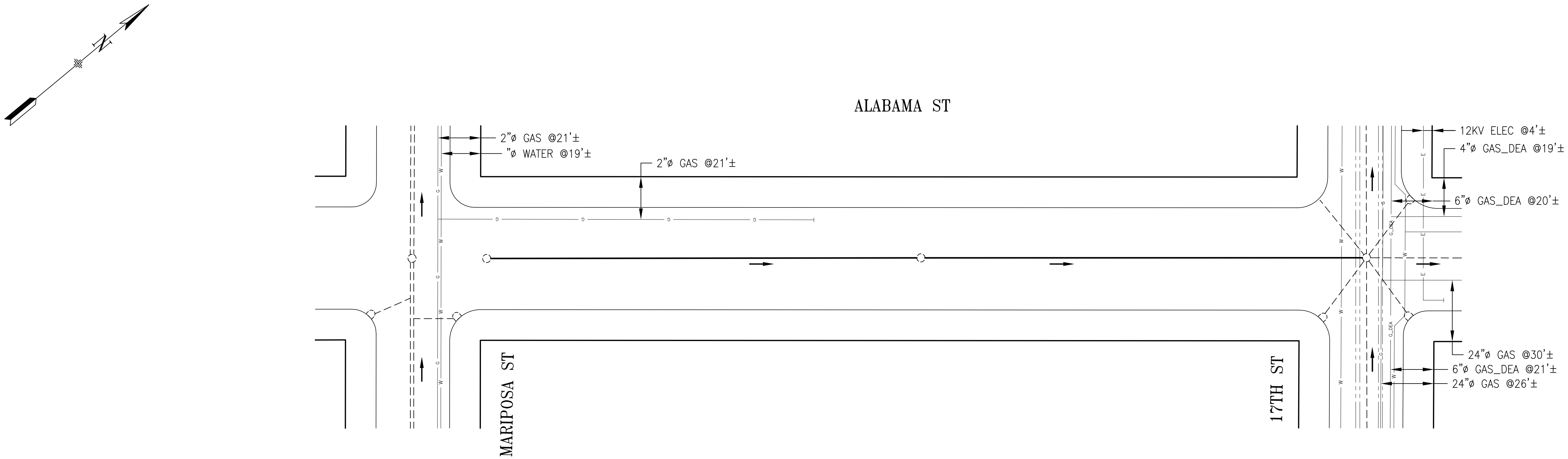
FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

HARRISON STREET SEWER REPLACEMENT
18TH STREET TO MATCHLINE "L"
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U-18 — REVISION NO.

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

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10% SUBMITTAL
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CONTRACT NO. WW–XXX

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CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

REVISIONS

NO.	DATE	DESCRIPTION	BY	APPR'D

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

ALABAMA STREET SEWER REPLACEMENT
MARIPOSA STREET TO 17TH STREET
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		U–19	

ELEVATION DATUM CITY

FILE:

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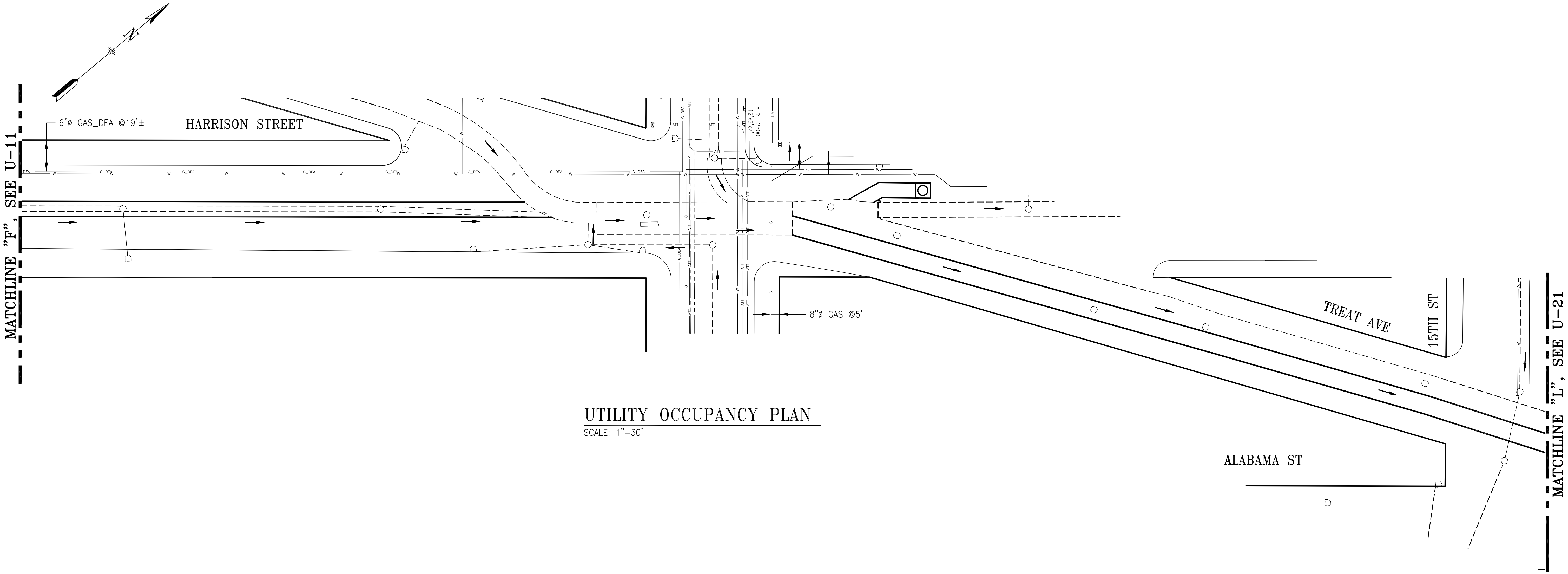

UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

———	(N) SEWER OR CULVERT
- - - -	(E) SEWER OR CULVERT
—W—W—	(E) WATER MAIN
	(E) AUXILIARY WATER SUPPLY SYSTEM
—E—E—E—	(E) PG&E ELECTRIC
—G—	(E) PG&E GAS
—G_DEA—	(E) PG&E ABANDONED GAS
—CATV—CATV—	(E) COMCAST
—CATV—CATV—	(E) COMCAST
—ATT—ATT—	(E) AT&T ABANDONED
—ATT_ABN—ATT_ABN—	(E) AT&T LINE
==:==	(E) MUNI OVERHEAD WIRES

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STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW–XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

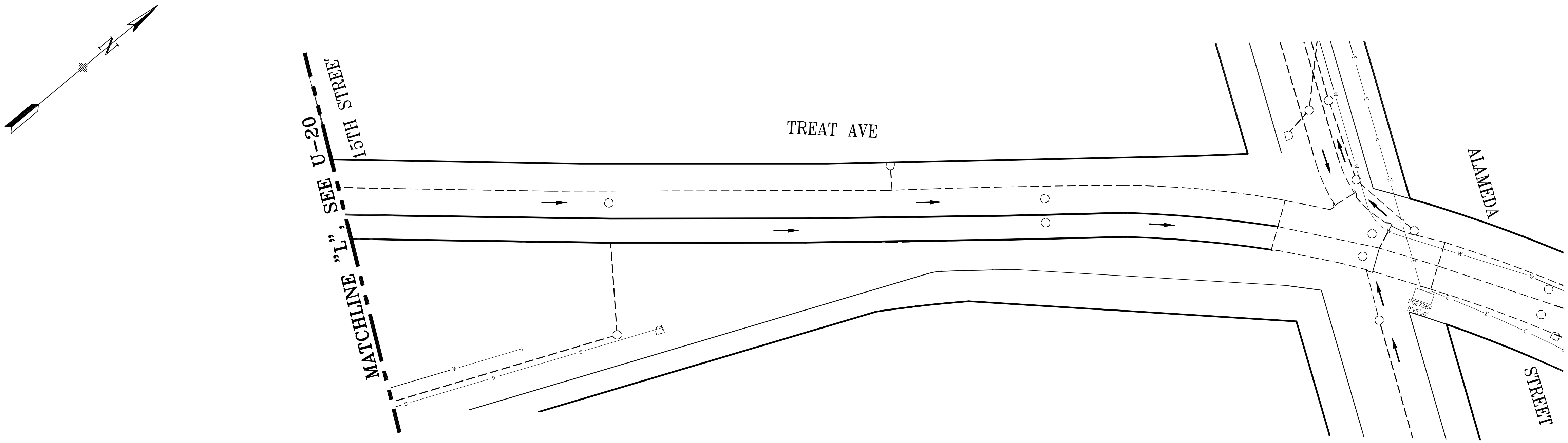
HARRISON ST –TREAT ST SEWER REPLACEMENT
MATCHLINE "F" TO MACHLINE "L"
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. U–20	REVISION NO.

ELEVATION DATUM CITY

FILE:

HYD JOB ORDER NO. 2817J



UTILITY OCCUPANCY PLAN

SCALE: 1"=30'

LEGEND

- (N) SEWER OR CULVERT
- (E) SEWER OR CULVERT
- (E) WATER MAIN
- (E) AUXILIARY WATER SUPPLY SYSTEM
- (E) PG&E ELECTRIC
- (E) PG&E GAS
- (E) PG&E ABANDONED GAS
- (E) COMCAST
- (E) COMCAST
- (E) AT&T ABANDONED
- (E) AT&T LINE
- (E) MUNI OVERHEAD WIRES

CAUTION

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REFERENCES
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REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

TREAT STREET SEWER REPLACEMENT
15TH STREET TO ALAMEDA STREET
UTILITY OCCUPANCY PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		U-21	

ELEVATION
DATUM
CITY

FILE:

HYD JOB ORDER NO. 2817J

APPENDIX D

10% DESIGN DRAWINGS

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PLAN AND DRAWING INDEX

DRAWING NO.	SHEET NO.	DRAWING TITLE
		GENERAL DRAWINGS
G-1	1	LOCATION MAP AND VICINITY MAP
G-2	2	DRAWING INDEX
G-3	3	LEGEND, ABBREVIATIONS, GENERAL NOTES AND DETAILS FOR SEWER WORK
		SEWER REPLACEMENT PLANS
SW-1	4	FOLSOM STREET SEWER REPLACEMENT – 12TH STREET TO 11TH STREET PLAN
SW-2	5	11TH STREET SEWER REPLACEMENT – MATCHLINE "A" TO HARRISON STREET PLAN
SW-3	6	11TH STREET SEWER REPLACEMENT – HARRISON STREET TO DIVISION STREET PLAN
SW-4	7	14TH STREET SEWER REPLACEMENT – MISSION STREET TO SOUTH VAN NESS AVENUE PLAN
SW-5	8	ERIE STREET SEWER REPLACEMENT – SOUTH VAN NESS AVENUE TO FOLSOM STREET PLAN
SW-6	9	14TH STREET SEWER REPLACEMENT – FOLSOM STREET TO HARRISON STREET PLAN
SW-7	10	15TH STREET SEWER REPLACEMENT – MISSION STREET TO SHOTWELL STREET PLAN
SW-8	11	HARRISON STREET SEWER REPLACEMENT – 15TH STREET TO ALAMEDA STREET PLAN
SW-9	12	FOLSOM STREET SEWER REPLACEMENT – ENTERPRISE STREET TO 16TH STREET PLAN
SW-10	13	17TH STREET SEWER REPLACEMENT – SOUTH VAN NESS AVENUE TO FOLSOM STREET
SW-11	14	FOLSOM STREET SEWER REPLACEMENT – FOLSOM STREET TO HARRISON STREET PLAN
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SW-15	18	16TH STREET SEWER REPLACEMENT – MATCHLINE "H" TO MATCHLINE "J" PLAN
SW-16	19	19TH STREET SEWER REPLACEMENT – FOLSOM STREET TO TREAT AVENUE PLAN
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SW-18	21	HARRISON STREET SEWER REPLACEMENT – 18TH STREET TO MATCHLINE "L" PLAN
SW-19	22	ALABAMA STREET SEWER REPLACEMENT – MARIPOSA STREET TO 17TH STREET PLAN
SW-20	23	HARRISON ST – TREAT ST SEWER REPLACEMENT – MATCHLINE "F" TO MATCHLINE "L" PLAN
SW-21	24	TREAT STREET SEWER REPLACEMENT – 15TH STREET TO ALAMEDA STREET PLAN
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C-2	26	PLAN AND PROFILE STA. 9+00 TO STA. 18+00
C-3	27	PLAN AND PROFILE STA. 18+00 TO STA. 27+00
C-4	28	ALL TUNNEL ALTERNATIVE – PLAN AND PROFILE STA. 27+00 TO STA. 36+00
C-5	29	ALL TUNNEL ALTERNATIVE – PLAN AND PROFILE STA. 36+00 TO STA. 39+01.45
C-6	30	CUT-AND-COVER ALTERNATIVE – PLAN AND PROFILE STA. 27+00 TO STA. 36+00
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DRAFT

ELEVATION DATUM CITY (NOT HPN)

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED JK
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

DRAWING INDEX

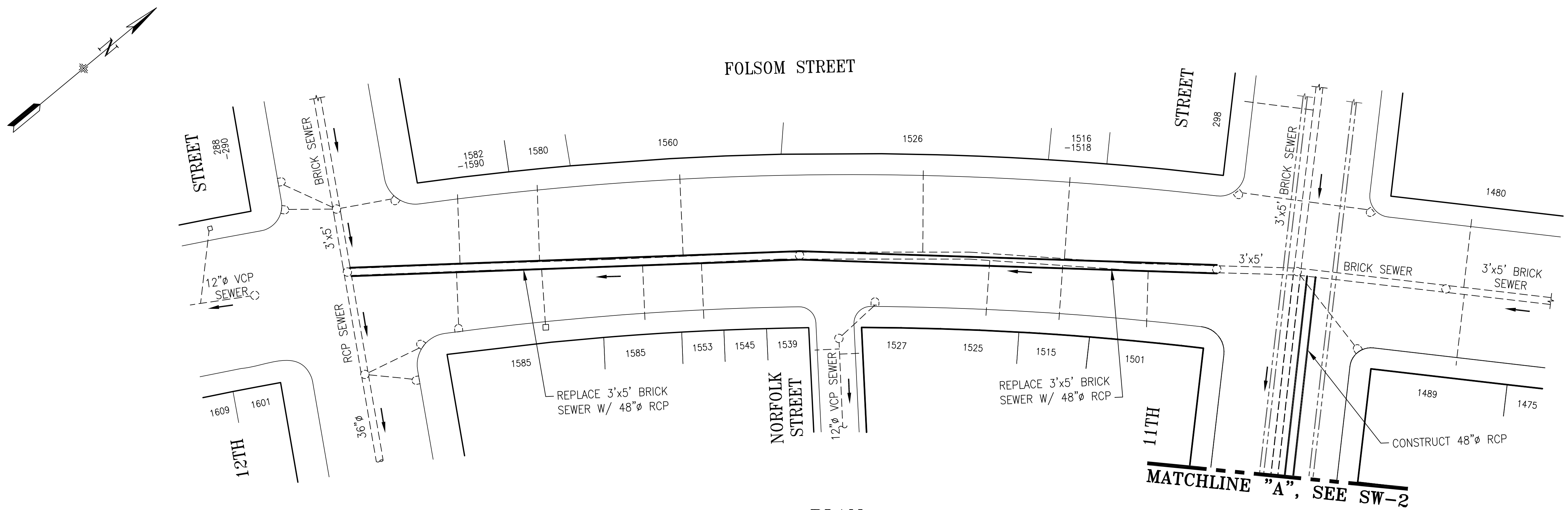
SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE

APPROVED MANAGER

APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
02	104,472	G-2	0

EHY JOB ORDER NUMBER: 1260J



PLAN

SCALE: 1"=30'

ELEVATION DATUM CITY

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

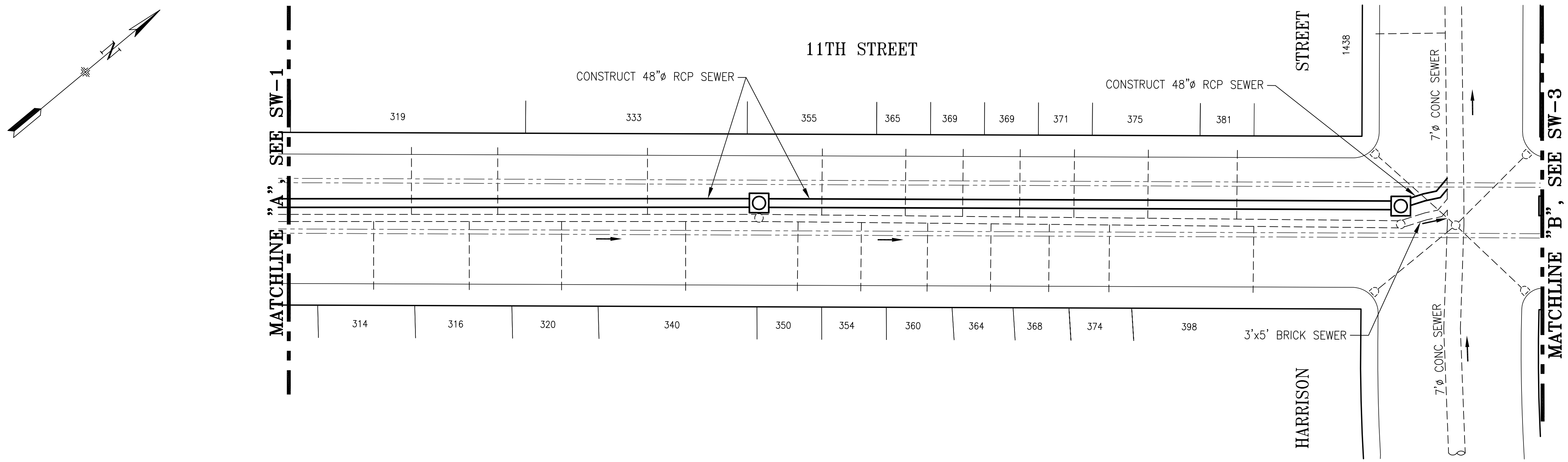
FOLSOM STREET SEWER REPLACEMENT
12TH STREET TO 11TH STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-1	

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

10% SUBMITTAL
NOT FOR CONSTRUCTION

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

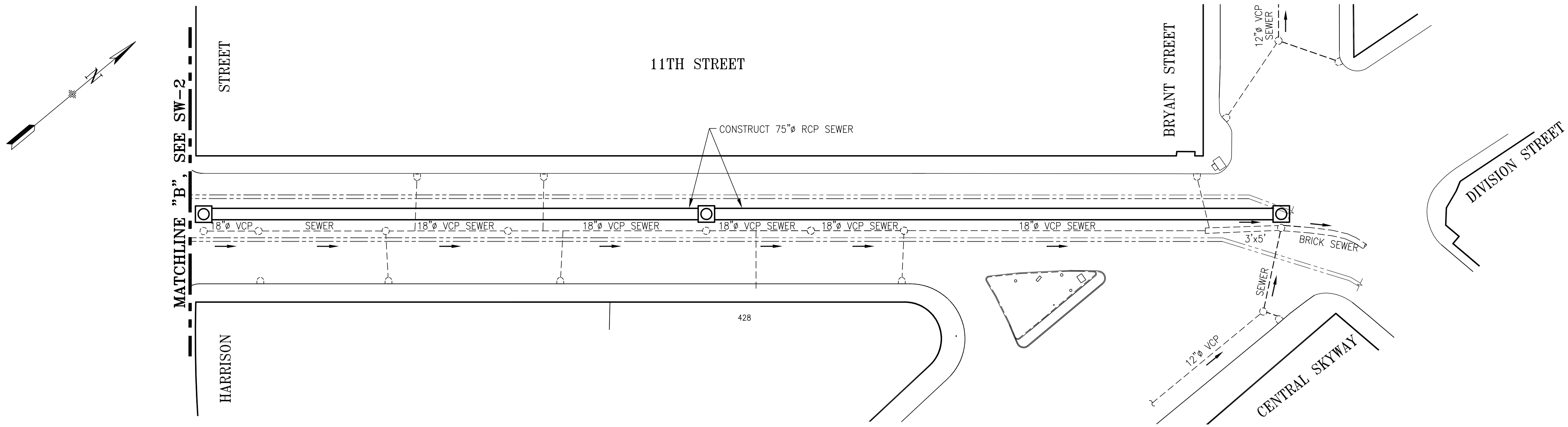
FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

11TH STREET SEWER REPLACEMENT
MATCHLINE "A" TO HARRISON STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. SW-2 / REVISION NO.

FILE:

HYD JOB ORDER NO. 2817J



PLAN

SCALE: 1"=30'

30' 0 30' 60' — HORIZONTAL SCALE: 1"=30'

10' 0 10' 20' — VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER — CHUNG K. LINH — No. C69218 — CIVIL — STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

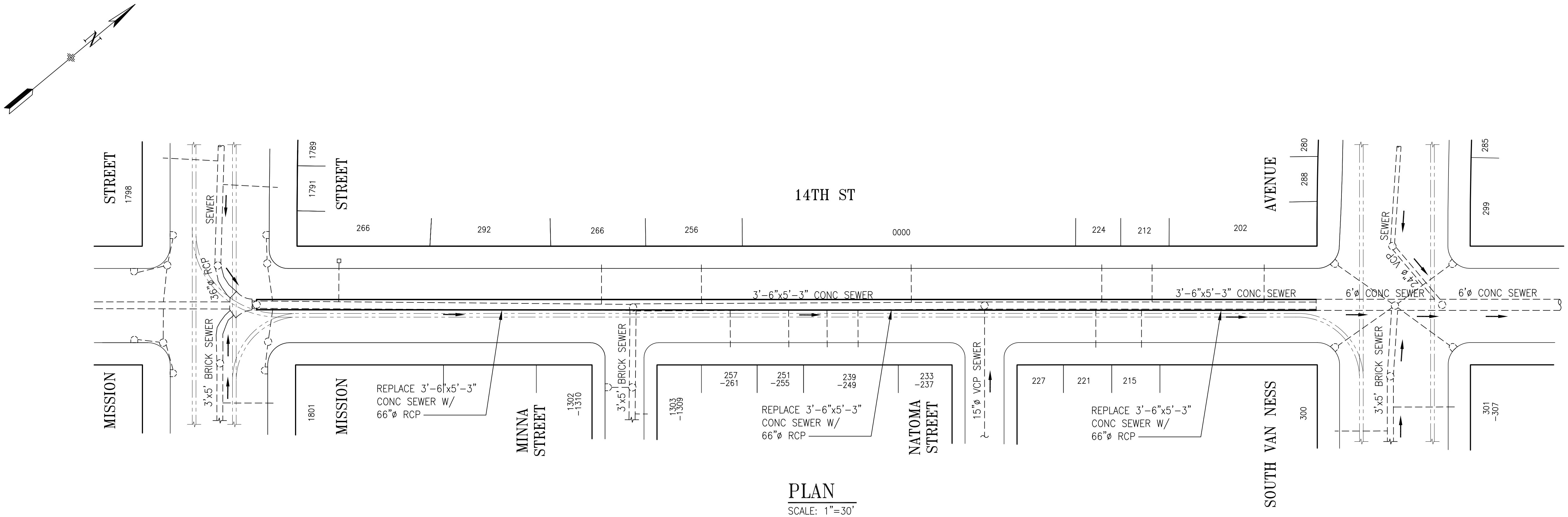
FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

11TH STREET SEWER REPLACEMENT
HARRISON STREET TO DIVISION STREET
PLAN AND PROFILE

CHECKED / APPROVED		DRAWN	SCALE
SECTION MANAGER		DESIGNED	DATE
APPROVED		APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU		ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. SW-3	REVISION NO.

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
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REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

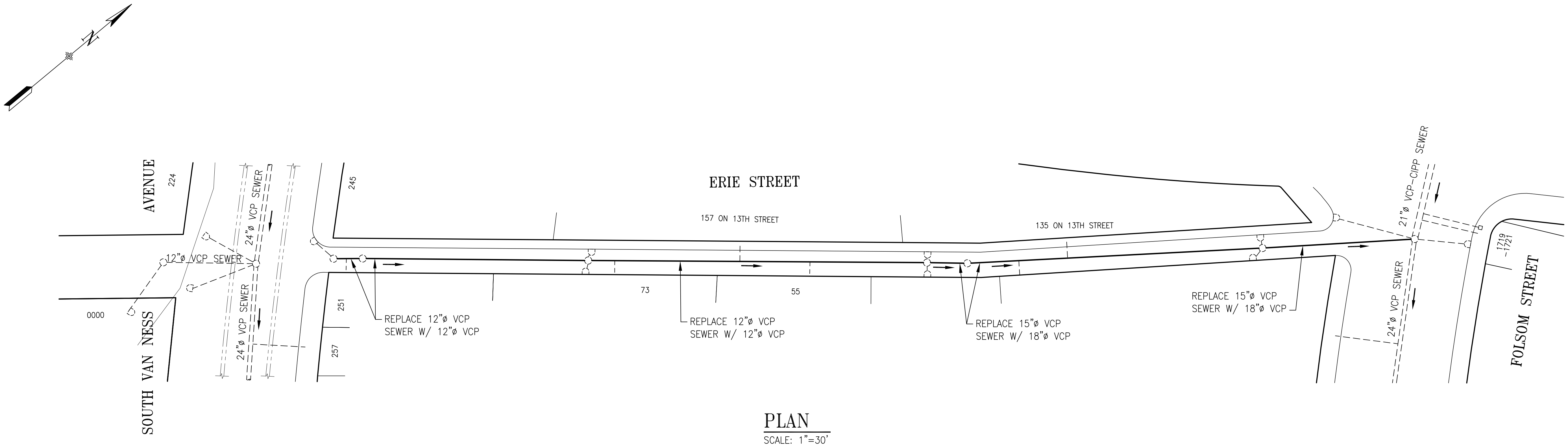
FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

14TH STREET SEWER REPLACEMENT
MISSION STREET TO SOUTH VAN NESS STREET
PLAN AND PROFILE

CHECKED / APPROVED		DRAWN	SCALE
SECTION MANAGER		DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. SW-4	REVISION NO.

FILE:

HYD JOB ORDER NO. 2817J



ELEVATION DATUM CITY

30' 0 30' 60' — HORIZONTAL SCALE: 1"=30'

10' 0 10' 20' — VERTICAL SCALE: 1"=10'

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED
BUREAU MANAGER	P.RIVERA	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

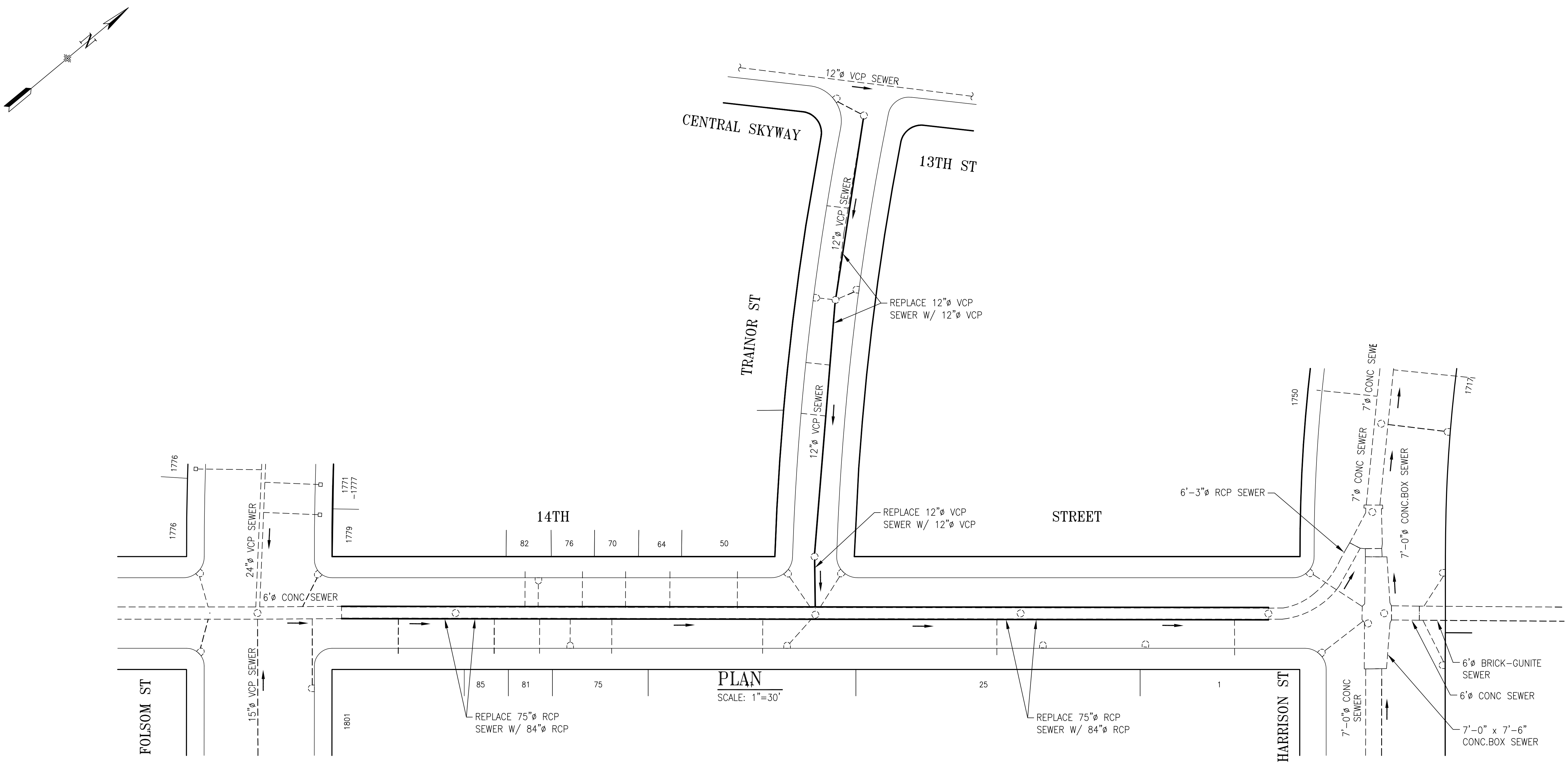
ERIE STREET SEWER REPLACEMENT
SOUTH VAN NESS AVENUE TO FOLSOM STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-5	

FILE:

HYD JOB ORDER NO. 2817J



ELEVATION DATUM CITY

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
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REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN		
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED		
BUREAU MANAGER P.RIVERA	CHECKED		

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

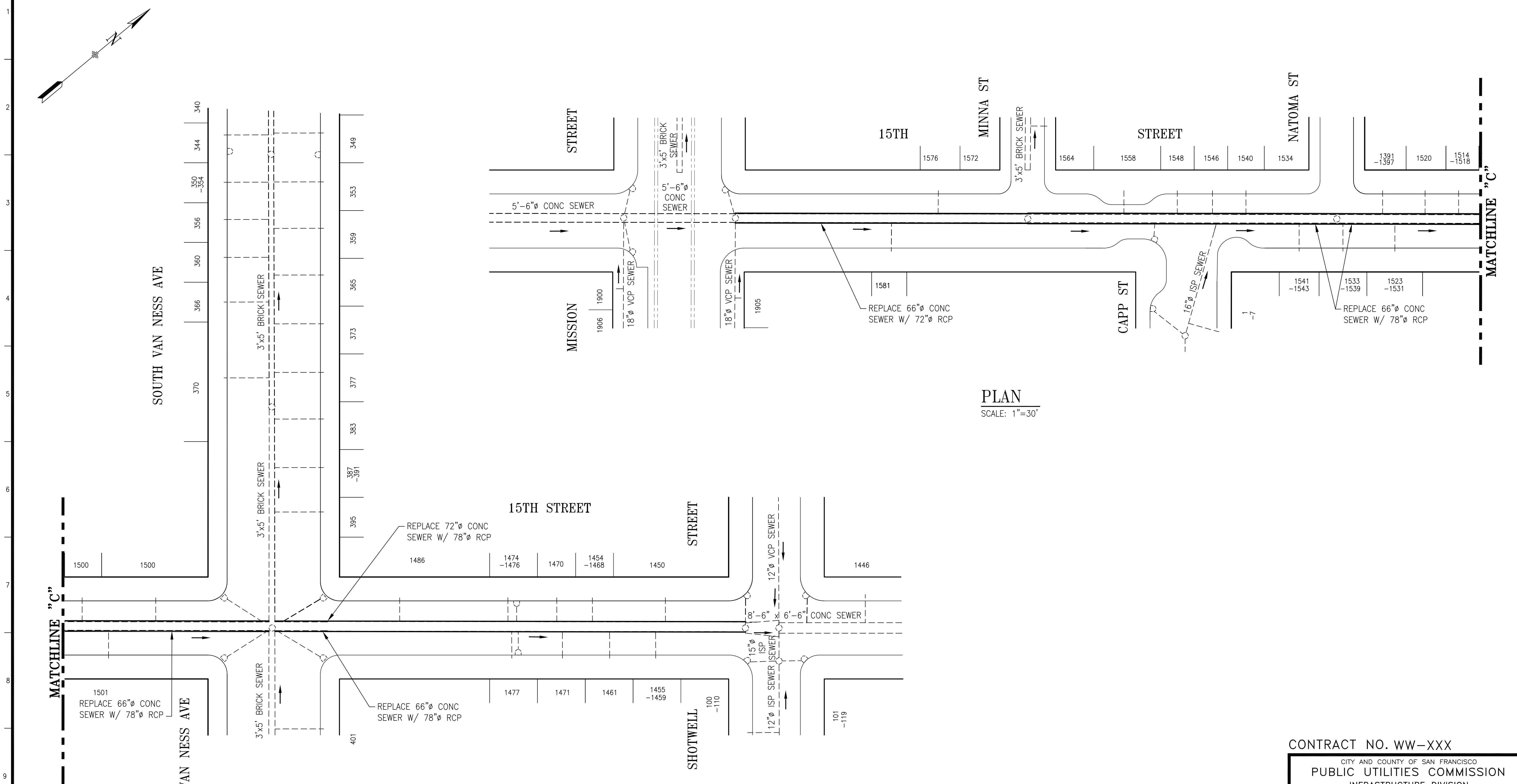
14TH STREET SEWER REPLACEMENT
FOLSOM STREET TO HARRISON STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-6	

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

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CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

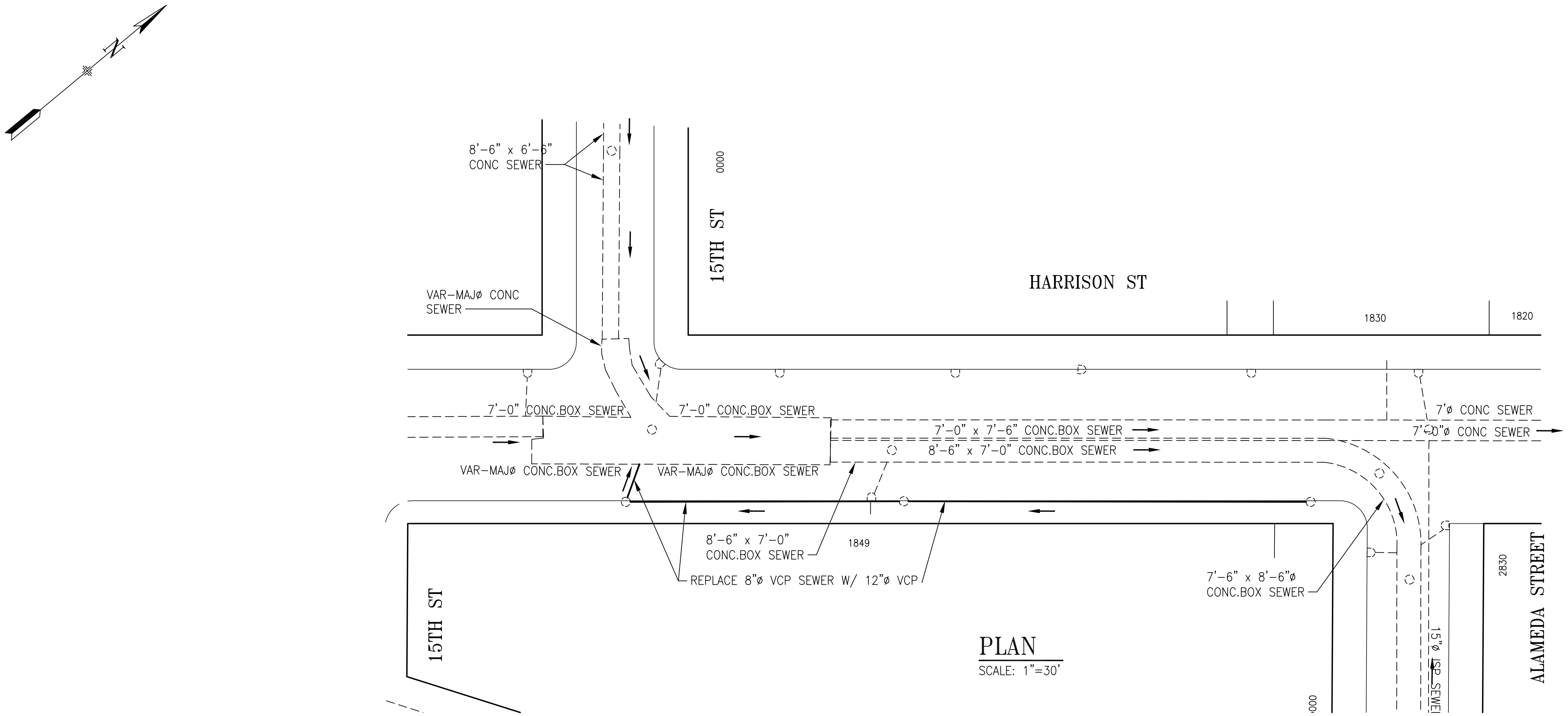
15TH STREET SEWER REPLACEMENT
MISSION STREET TO SHOTWELL STREET
PLAN

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-7	

FILE:

HYD JOB ORDER NO. 2817J



PLAN
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HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

REFERENCES
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CIVIL
STATE OF CALIFORNIA

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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

HARRISON STREET SEWER REPLACEMENT
15TH STREET TO ALAMEDA STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-8	

FILE:

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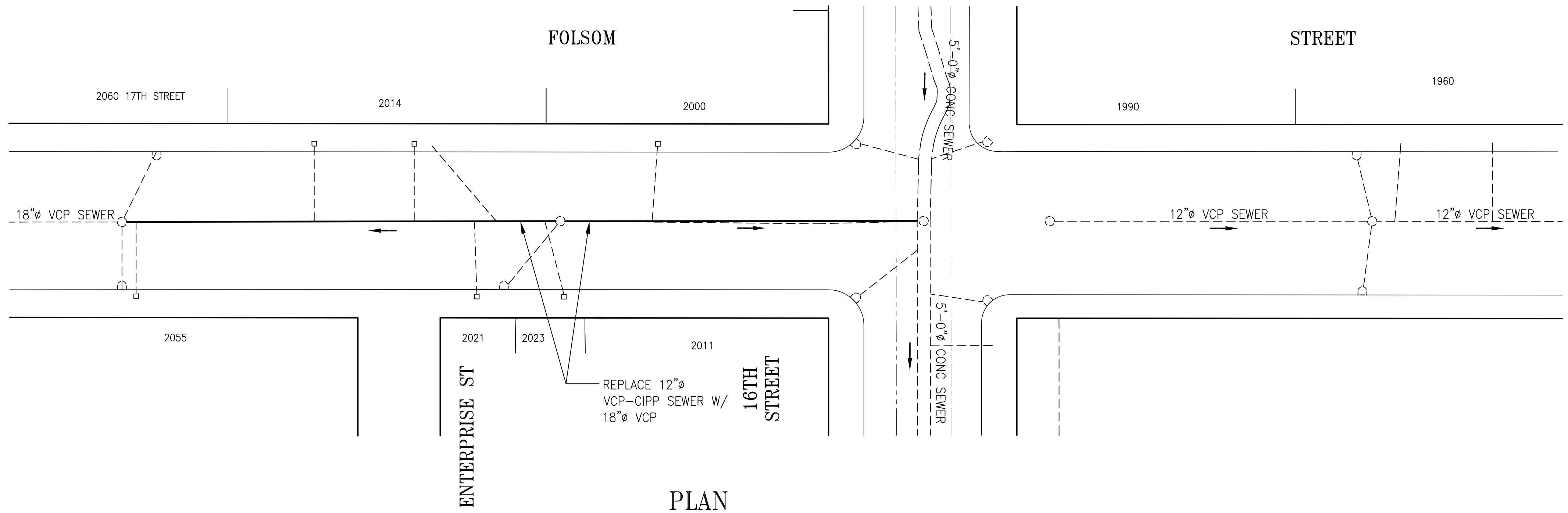

PLAN
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30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
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REFERENCES
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STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

FOLSOM STREET SEWER REPLACEMENT
ENTERPRISE STREET TO 16TH STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-9	

FILE:

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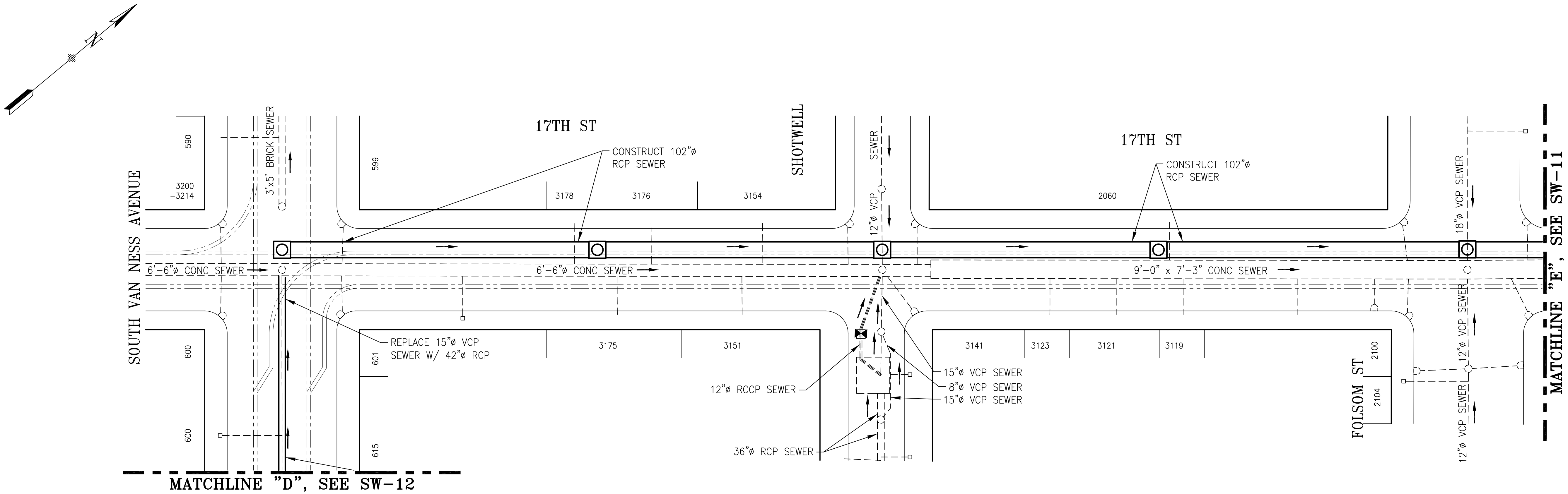


PLAN
SCALE: 1"=30'

HORIZONTAL SCALE: 1"=30'

VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG | DRAWN
DEPUTY BUREAU MANAGER I.DHAPA | DESIGNED
BUREAU MANAGER P.RIVERA | CHECKED

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

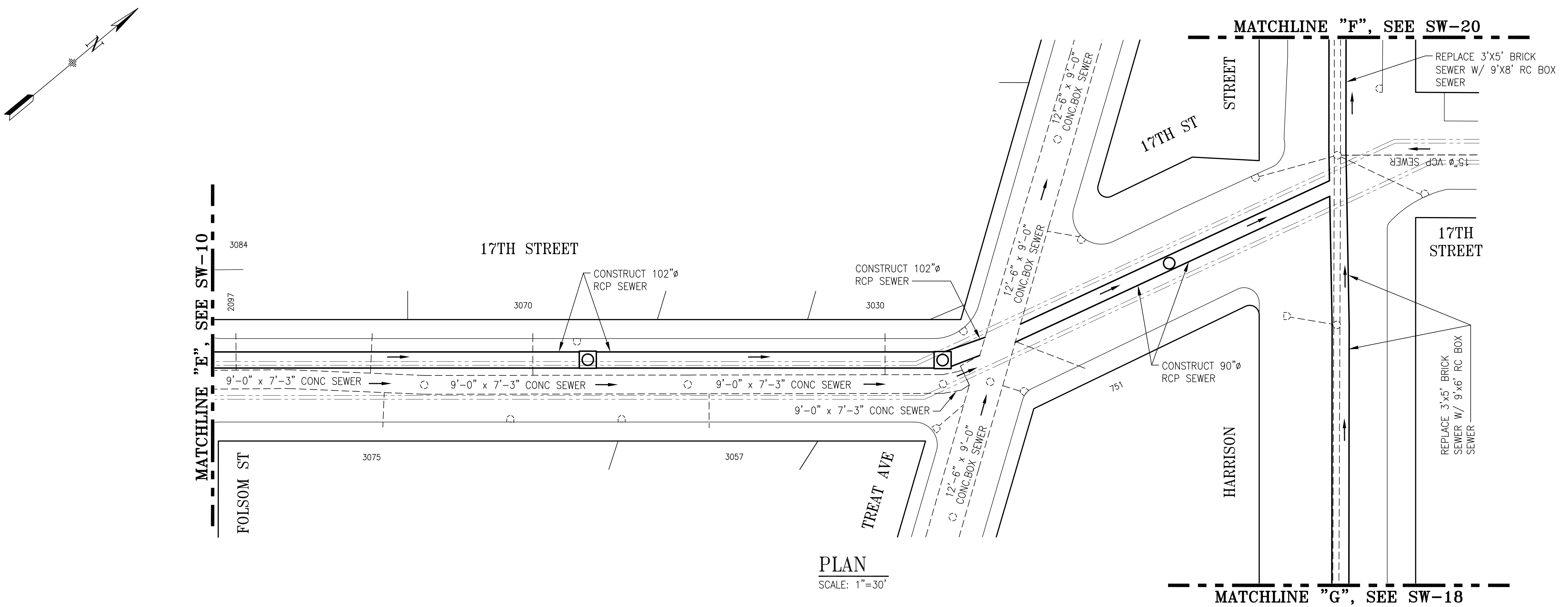
17TH STREET SEWER REPLACEMENT
SOUTH VAN NESS AVENUE TO FOLSOM STREET
PLAN AND PROFILE

CHECKED / APPROVED | DRAWN | SCALE
SECTION MANAGER | DESIGNED | DATE
APPROVED | APPROVED
MANAGER, ENGINEERING MANAGEMENT BUREAU | ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET OF | PLAN NO. | DRAWING NO. SW-10 | REVISION NO.

FILE:

HYD JOB ORDER NO. 2817J



PLAN

SCALE: 1"=30'

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

10% SUBMITTAL
NOT FOR CONSTRUCTION

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

FOLSOM STREET SEWER REPLACEMENT
FOLSOM STREET TO HARRISON STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN		SCALE
SECTION MANAGER	DESIGNED		DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE		
SHEET OF	PLAN NO.	DRAWING NO. SW-11	REVISION NO.

FILE:

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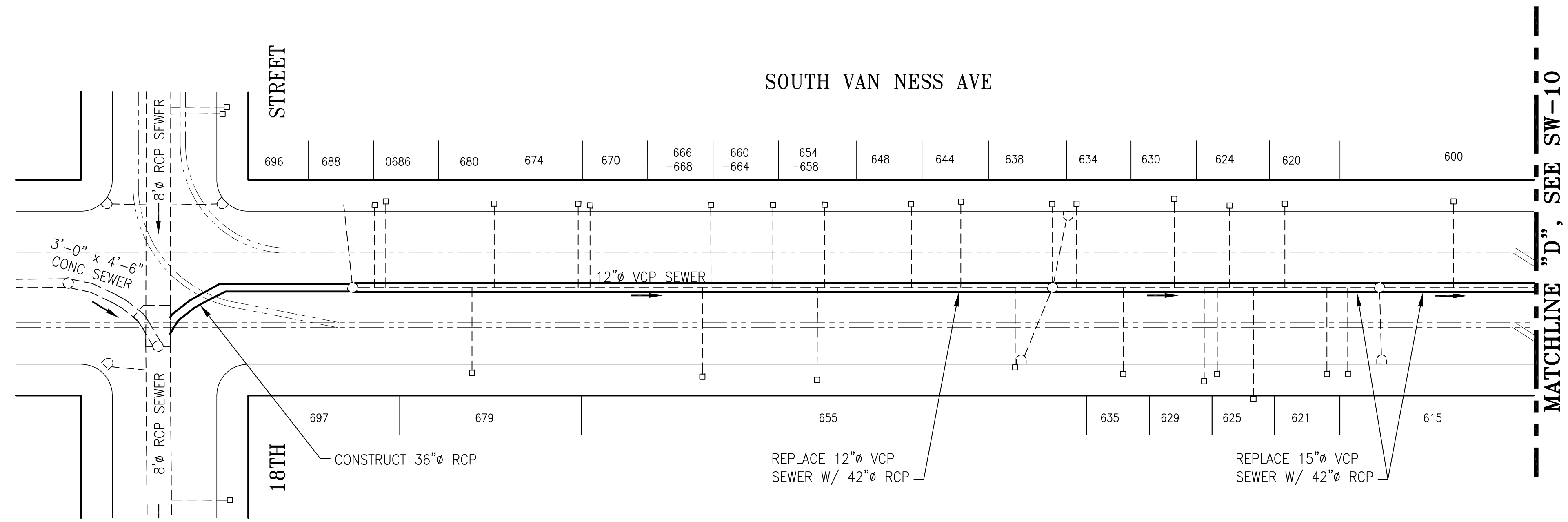

PLAN

SCALE: 1"=30'

HORIZONTAL SCALE: 1"=30'

VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
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CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

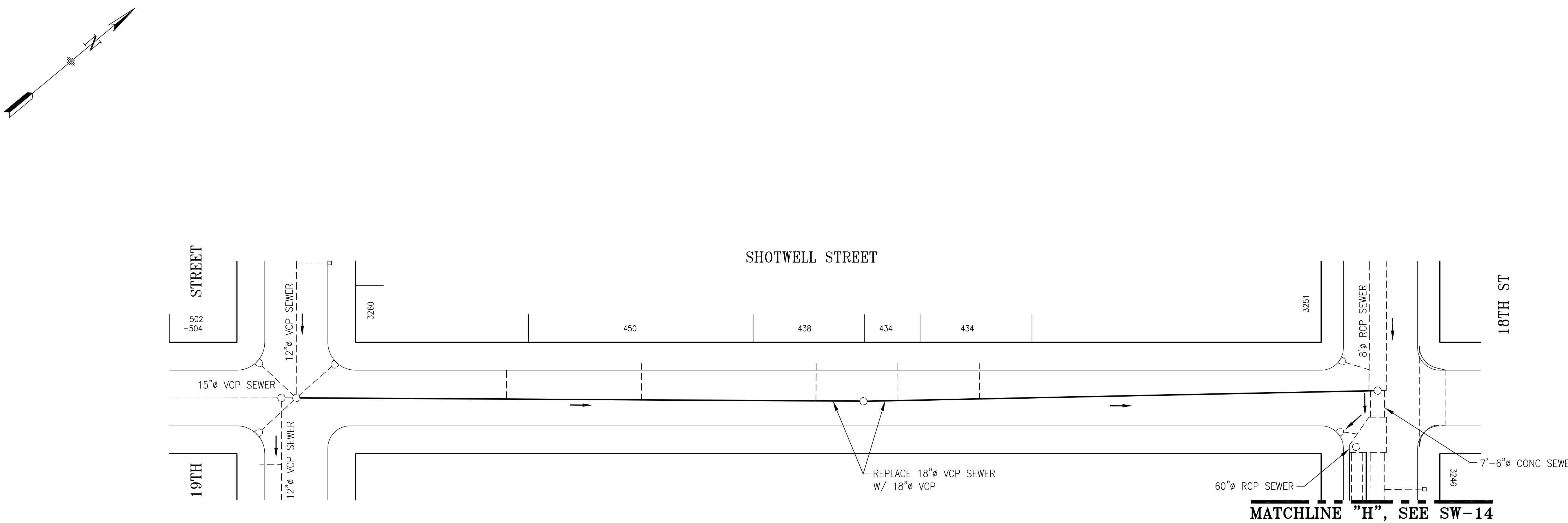
SOUTH VAN NESS AVE SEWER REPLACEMENT
18TH STREET TO MATCHLINE "D"
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-12	

FILE:

HYD JOB ORDER NO. 2817J



PLAN

SCALE: 1"=30'

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HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
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CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

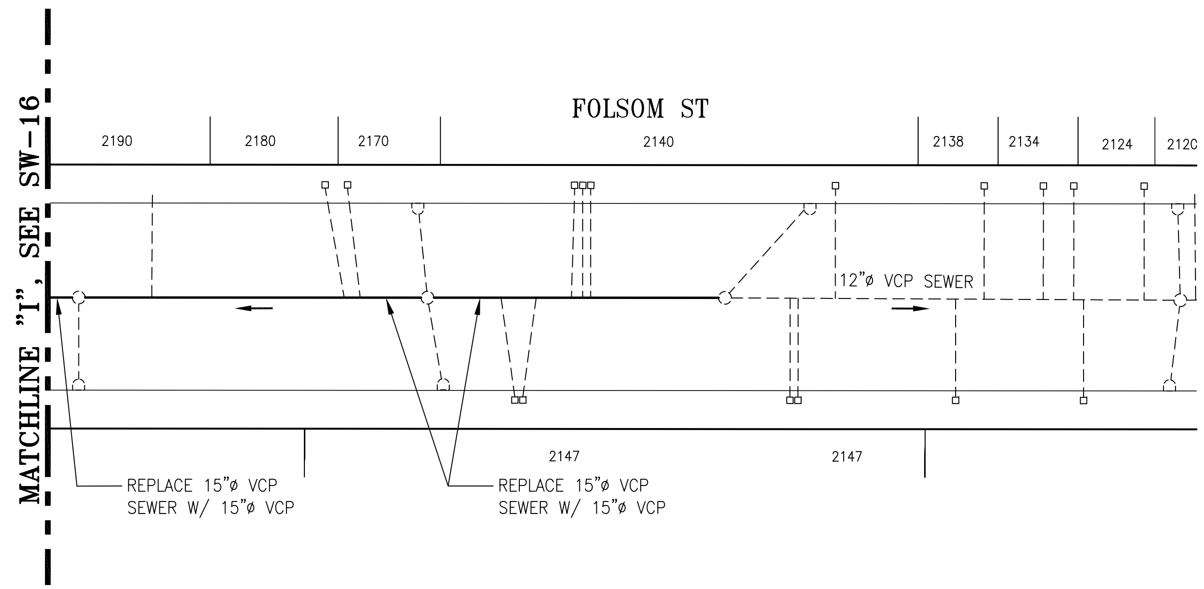
SHOTWELL STREET
19TH STREET TO 18TH STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-13	

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

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STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

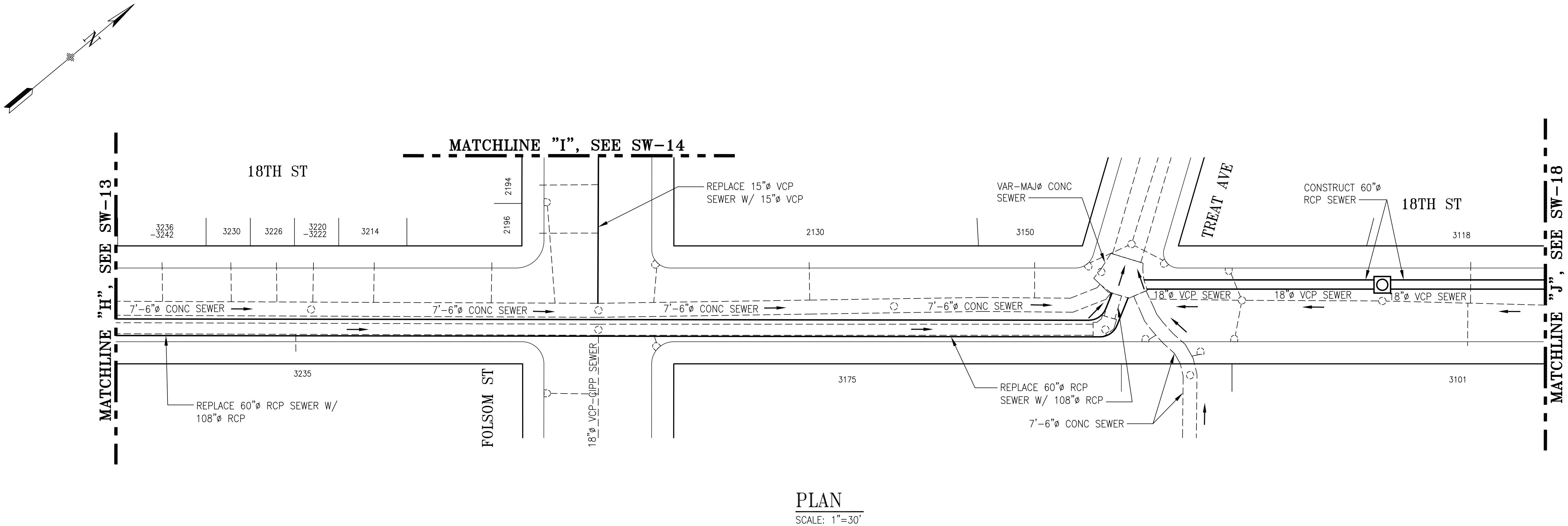
FOLSOM STREET SEWER REPLACEMENT
MATCHLINE "I" TO 2120 FOLSOM ST
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-14	

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

ELEVATION DATUM CITY

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

REFERENCES
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CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

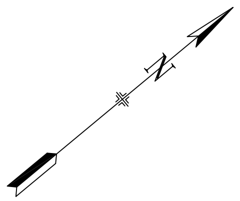
16TH STREET SEWER REPLACEMENT
MATCHLINE "H" TO MATCHLINE "J"
PLAN AND PROFILE

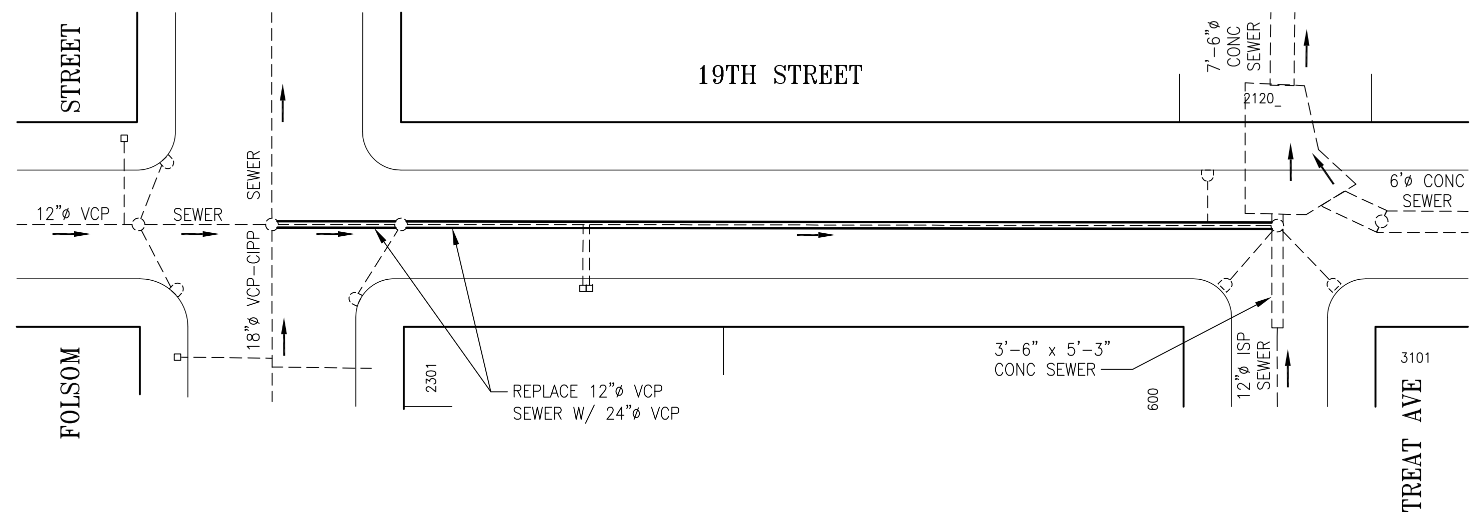
CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-15	

FILE:

HYD JOB ORDER NO. 2817J





PLAN

SCALE: 1"=30'

ELEVATION
DATUM
CITY

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
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STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

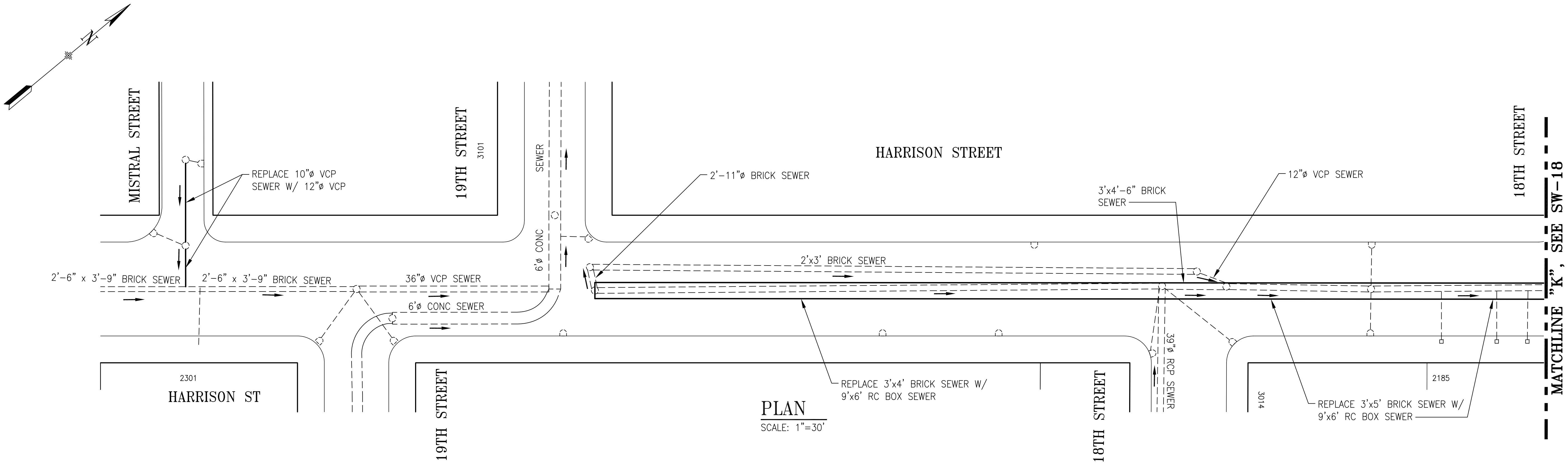
19TH STREET SEWER REPLACEMENT
FOLSOM STREET TO TREAT AVENEUE
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-16	

FILE:

HYD JOB ORDER NO. 2817J



CONTRACT NO. WW-XXX

10% SUBMITTAL
NOT FOR CONSTRUCTION

ELEVATION DATUM CITY

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

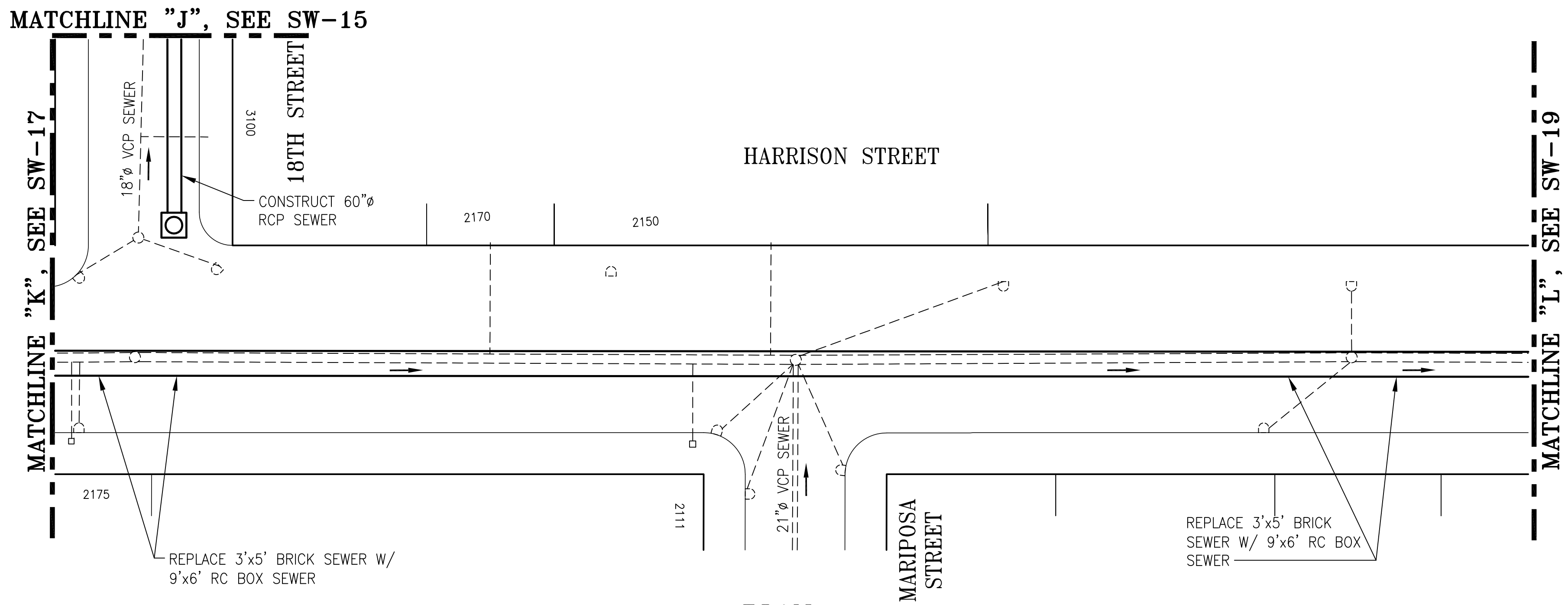
FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

HARRISON STREET SEWER REPLACEMENT
MISTRAL STREET TO 18TH STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. SW-17	REVISION NO.

FILE:

HYD JOB ORDER NO. 2817J



PLAN

SCALE: 1"=30'

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

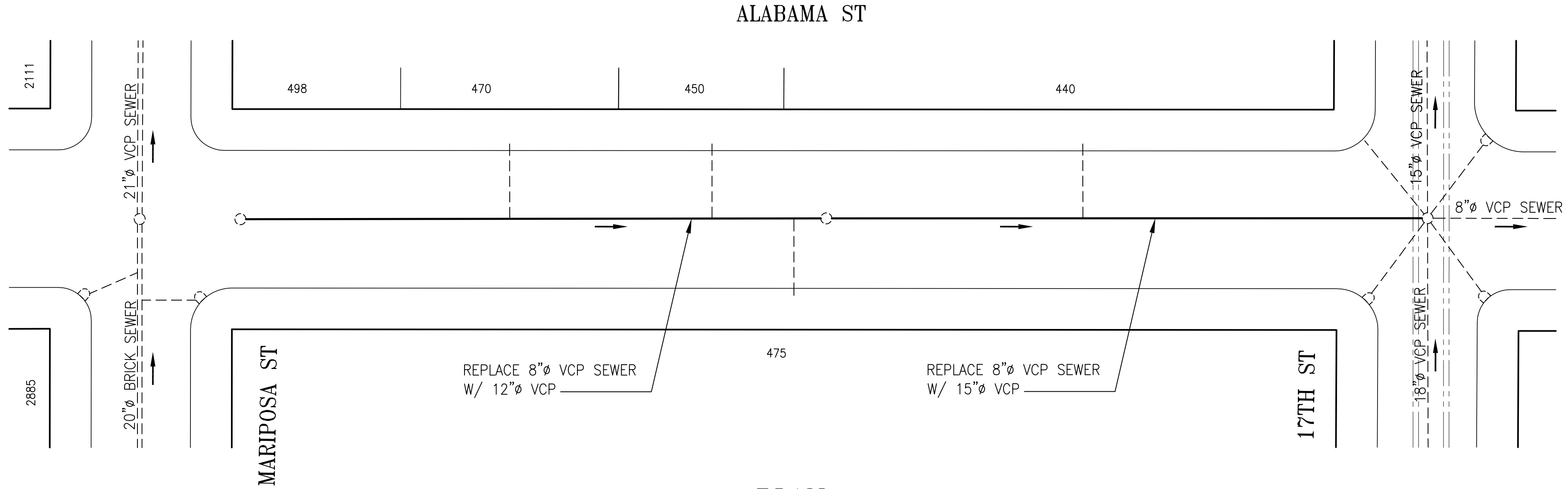
HARRISON STREET SEWER REPLACEMENT
18TH STREET TO MATCHLINE "L"
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-18	

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER L.WONG	DRAWN	
DEPUTY BUREAU MANAGER I.DHAPA	DESIGNED	
BUREAU MANAGER P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW–XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

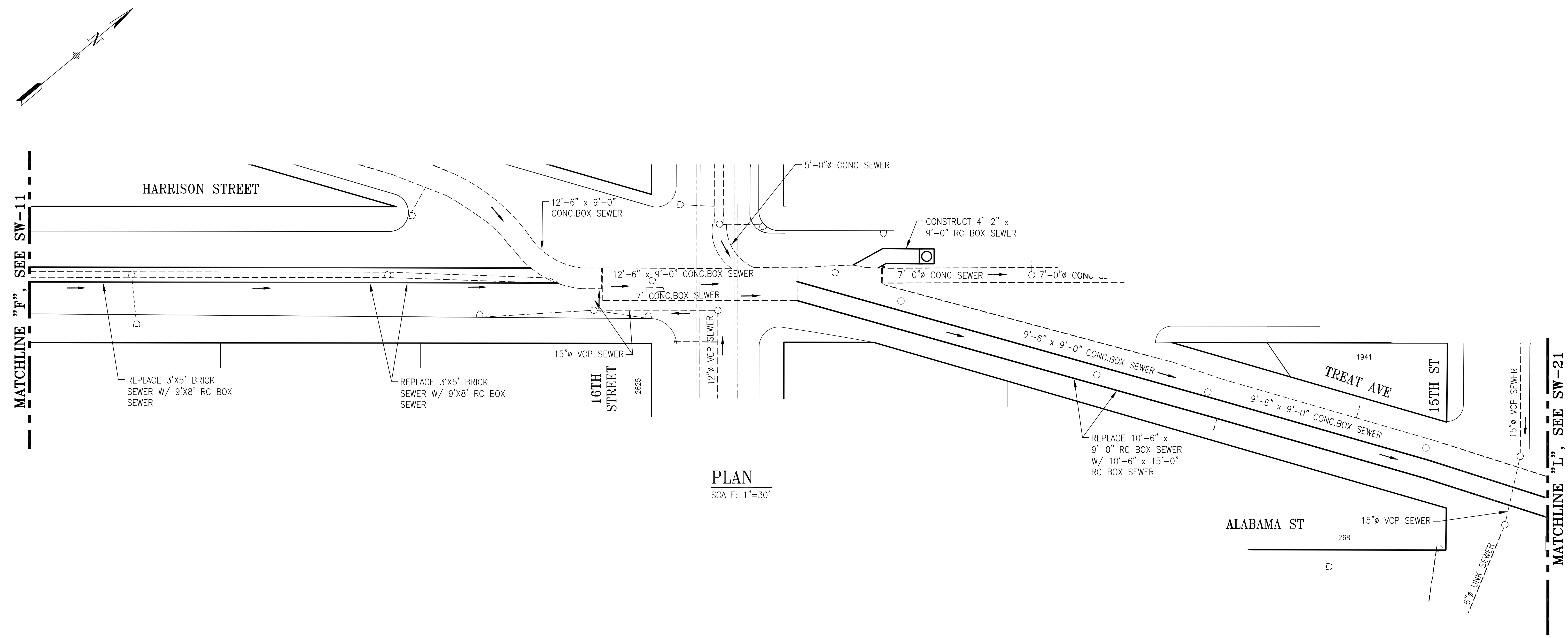
ALABAMA STREET SEWER REPLACEMENT
MARIPOSA STREET TO 17TH STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW–19	

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

ELEVATION DATUM CITY

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

10% SUBMITTAL
NOT FOR CONSTRUCTION

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

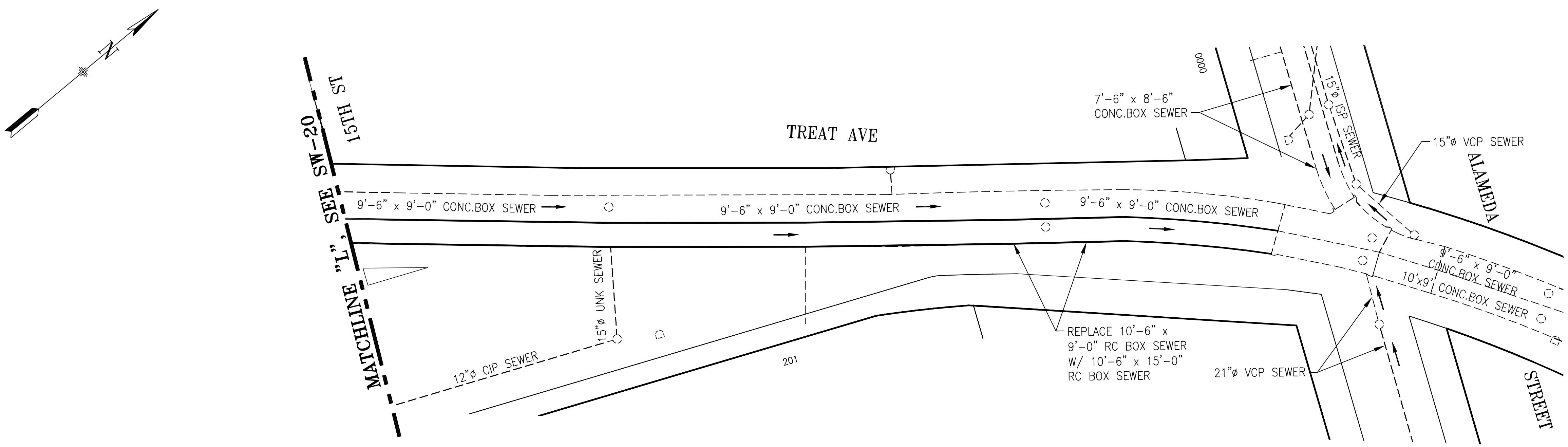
FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

HARRISON ST -TREAT ST SEWER REPLACEMENT
MATCHLINE "F" TO MACHLINE "L"
PLAN AND PROFILE

CHECKED / APPROVED		DRAWN	SCALE
SECTION MANAGER		DESIGNED	DATE
APPROVED		APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU		ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET OF	PLAN NO.	DRAWING NO. SW-20	REVISION NO.

FILE:

HYD JOB ORDER NO. 2817J



PLAN
SCALE: 1"=30'

30' 0 30' 60'
HORIZONTAL SCALE: 1"=30'

10' 0 10' 20'
VERTICAL SCALE: 1"=10'

ELEVATION DATUM CITY

10% SUBMITTAL
NOT FOR CONSTRUCTION

REFERENCES
GATE BOOK PAGES, PLANS, SURVEY NOTES, ETC. USED

REGISTERED PROFESSIONAL ENGINEER
CHUNG K. LINH
No. C69218
CIVIL
STATE OF CALIFORNIA

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	L.WONG	DRAWN	
DEPUTY BUREAU MANAGER	I.DHAPA	DESIGNED	
BUREAU MANAGER	P.RIVERA	CHECKED	

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT

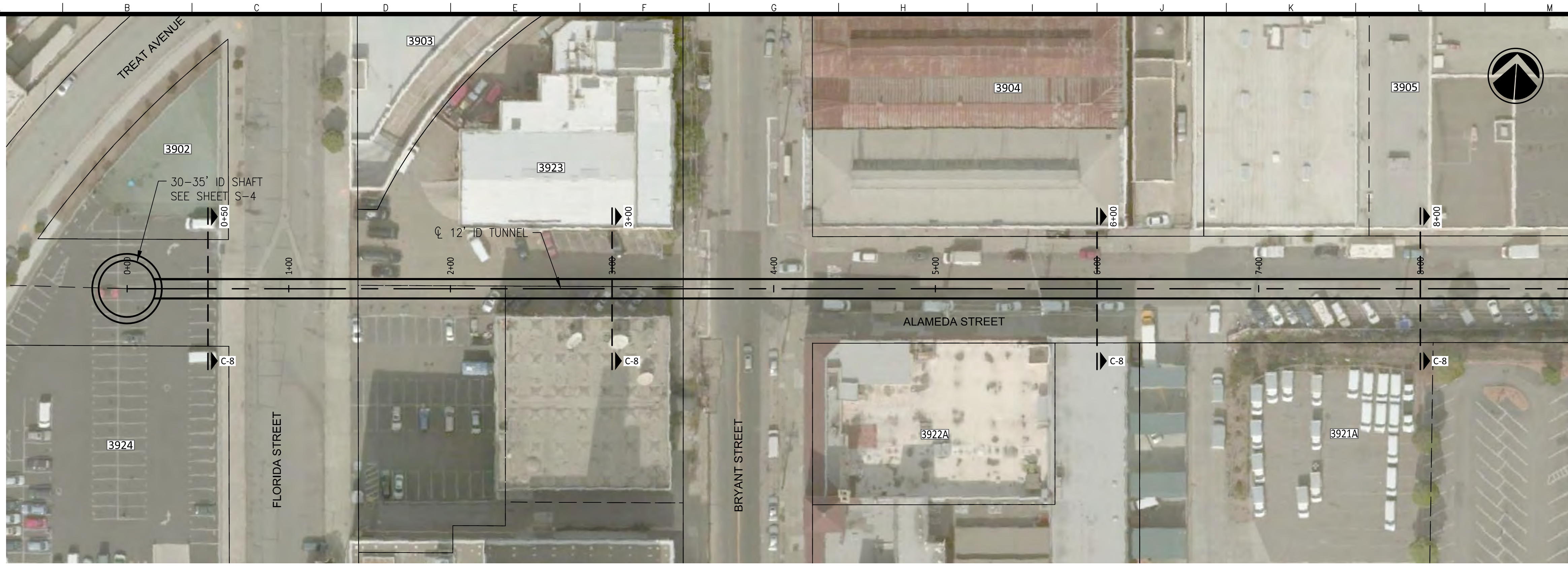
TREAT STREET SEWER REPLACEMENT
15TH STREET TO ALAMEDA STREET
PLAN AND PROFILE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	

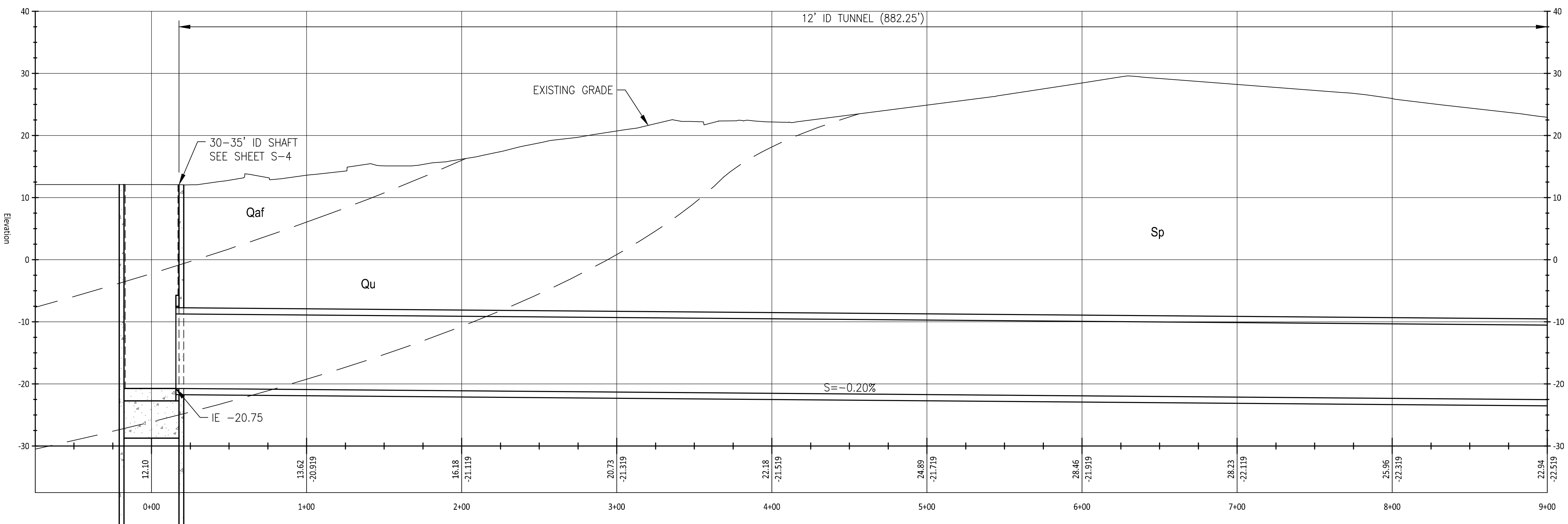
SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF		SW-21	

FILE:

HYD JOB ORDER NO. 2817J



PLAN VIEW
SCALE: 1"=40'



PROFILE VIEW
HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1" =10'

GEOLOGIC LEGEND

Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND (COLMA)
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX - SERPENTINITE

CONTRACT NO. WW–XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

PLAN AND PROFILE
STA. 0+00 TO STA. 9+00

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER | DRAWN DW
DEPUTY DIVISION MANAGER | DESIGNED JK
DIVISION MANAGER | CHECKED

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

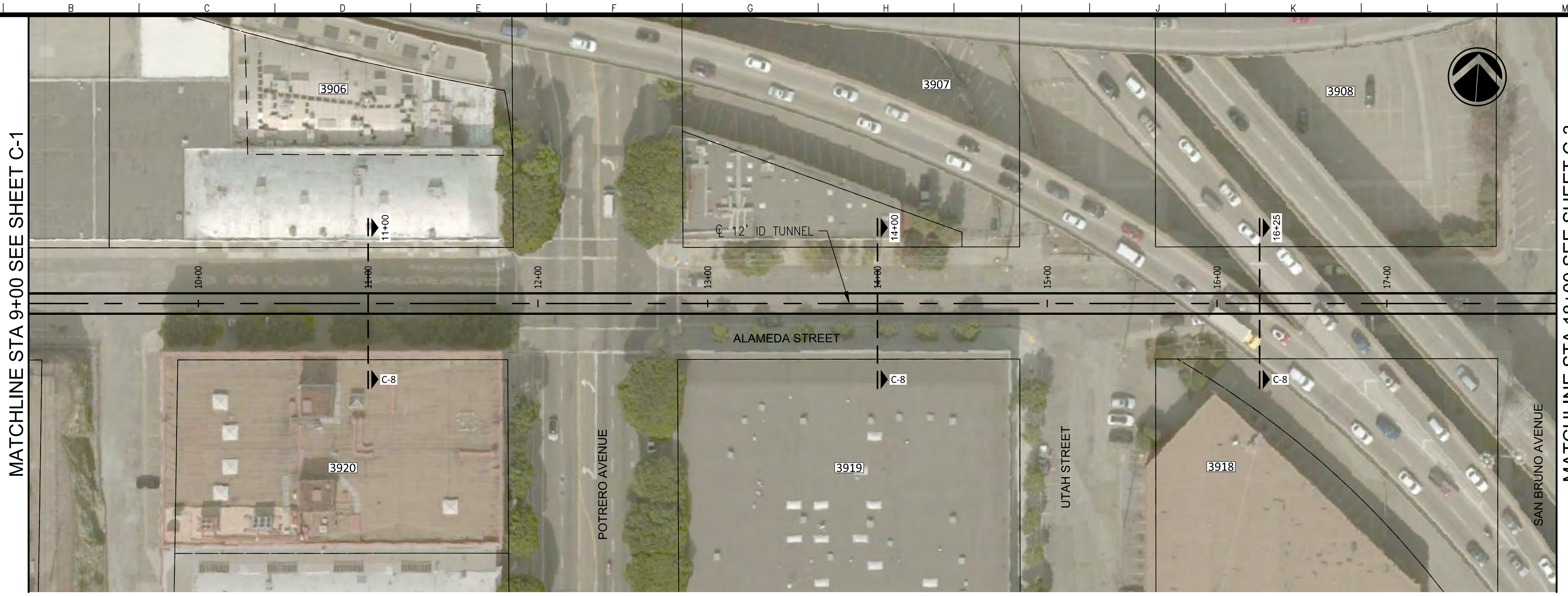
SECTION MANAGER | CHECKED | DRAWN | SCALE NONE
DIVISION MANAGER | RECOMMENDED | DESIGNED | DATE
APPROVED MANAGER | APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET XX | PLAN NO. 104,472 | DRAWING NO. C–1 | REVISION NO. 0

ELEVATION DATUM CITY (NOT HPN)

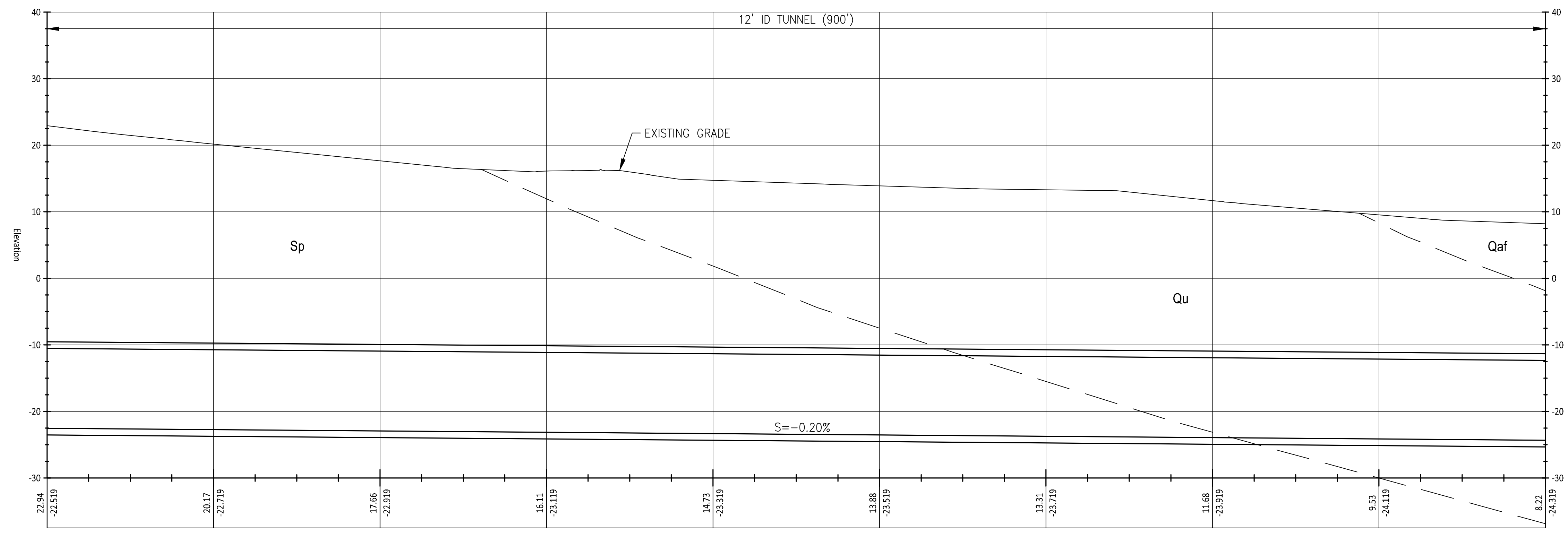
DRAFT

EHY JOB ORDER NUMBER: 1260J



PLAN VIEW

SCALE: 1"=40'



PROFILE VIEW

HORIZONTAL SCALE: 1"=40'

VERTICAL SCALE: 1" =10'

GEOLOGIC LEGEND

Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND (COLMA)
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX - SERPENTINITE

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

PLAN AND PROFILE
STA. 9+00 TO STA. 18+00

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER | DRAWN DW
DEPUTY DIVISION MANAGER | DESIGNED JK
DIVISION MANAGER | CHECKED

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

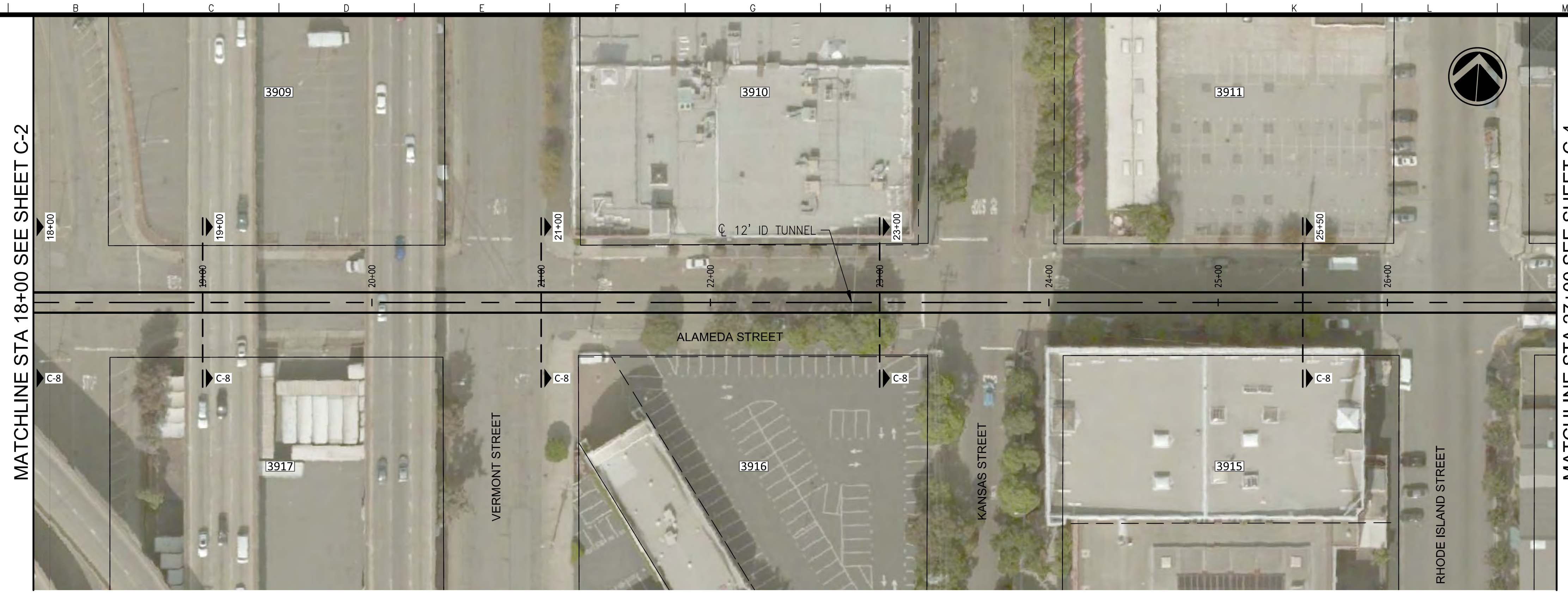
SECTION MANAGER | CHECKED | DRAWN | SCALE NONE
DIVISION MANAGER | RECOMMENDED | DESIGNED | DATE
APPROVED MANAGER | APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET XX | PLAN NO. 104,472 | DRAWING NO. C-2 | REVISION NO. 0

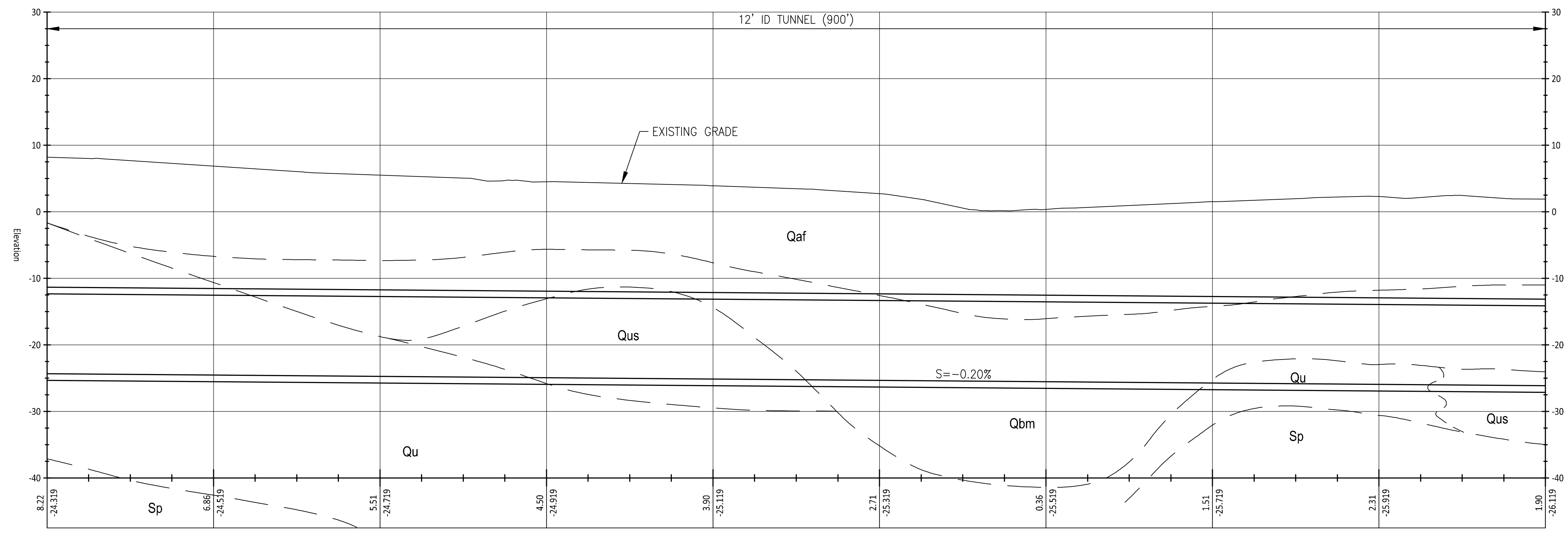
ELEVATION DATUM CITY (NOT HPN)

DRAFT

EHY JOB ORDER NUMBER: 1260J



PLAN VIEW
SCALE: 1"=40'



PROFILE VIEW
HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1" =10'

GEOLOGIC LEGEND

Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND (COLMA)
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX - SERPENTINITE

CONTRACT NO. WW–XXX

DRAFT

ELEVATION DATUM
CITY
(NOT HPN)

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER | DRAWN DW
DEPUTY DIVISION MANAGER | DESIGNED JK
DIVISION MANAGER | CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER
IMPROVEMENT PROJECT

PLAN AND PROFILE
STA. 18+00 TO STA. 27+00

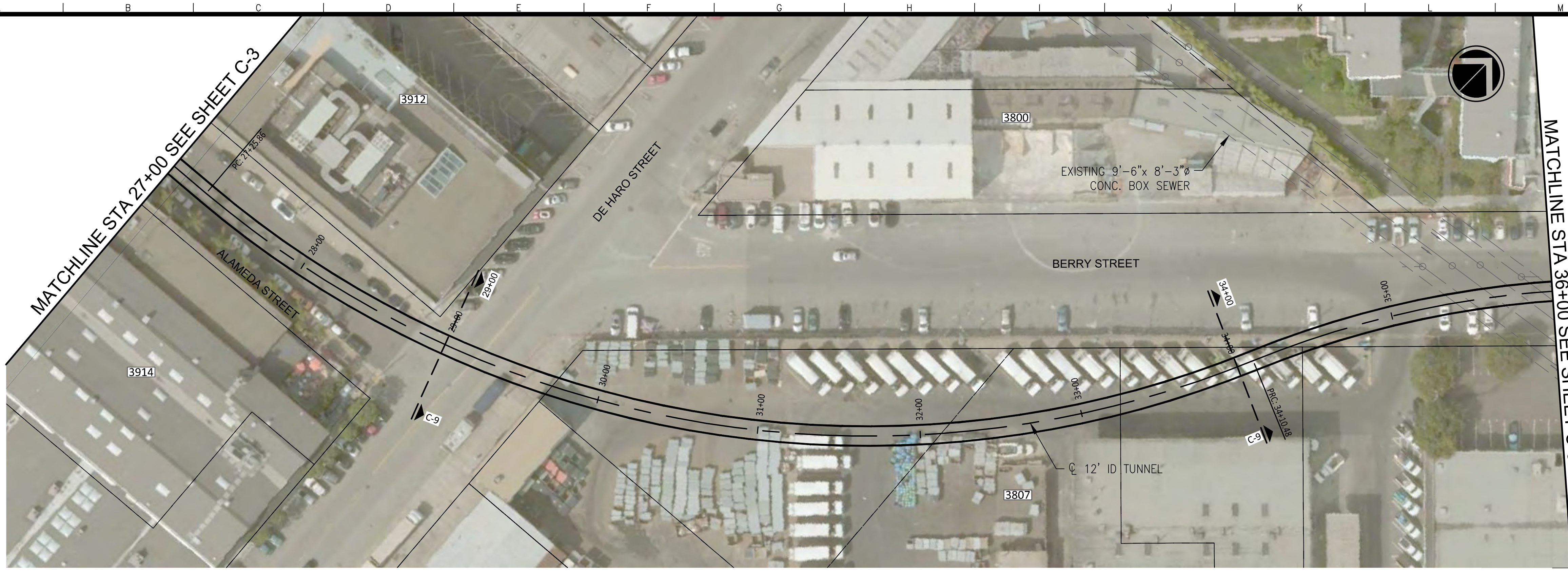
SECTION MANAGER | CHECKED | DRAWN | SCALE NONE
DIVISION MANAGER | RECOMMENDED | DESIGNED | DATE

APPROVED
MANAGER

APPROVED
ASSISTANT GENERAL MANAGER
WASTEWATER ENTERPRISE

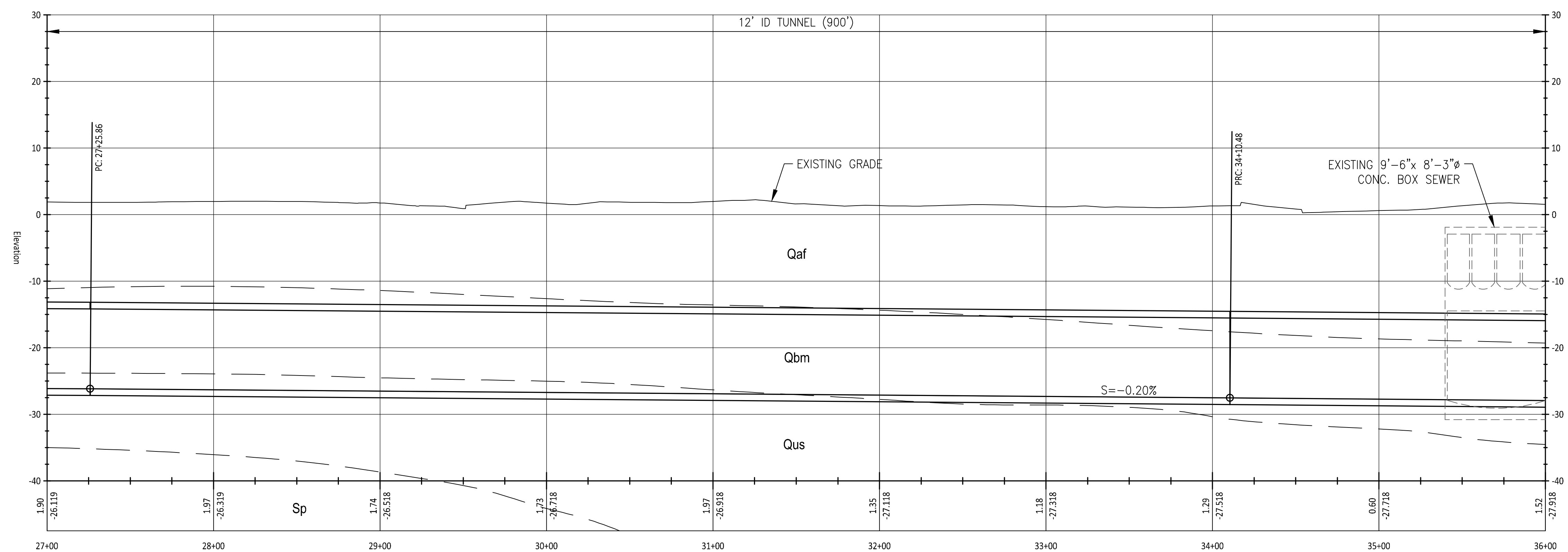
SHEET XX | PLAN NO. 104,472 | DRAWING NO. C-3 | REVISION NO. 0

EHY JOB ORDER NUMBER: 1260J



PLAN VIEW

SCALE: 1"=40'



PROFILE VIEW

HORIZONTAL SCALE: 1"=40'

VERTICAL SCALE: 1" =10'

GEOLOGIC LEGEND

Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND (COLMA)
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX - SERPENTINITE

CONTRACT NO. WW-XXX

DRAFT

ELEVATION DATUM CITY (NOT HPN)

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED JK
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

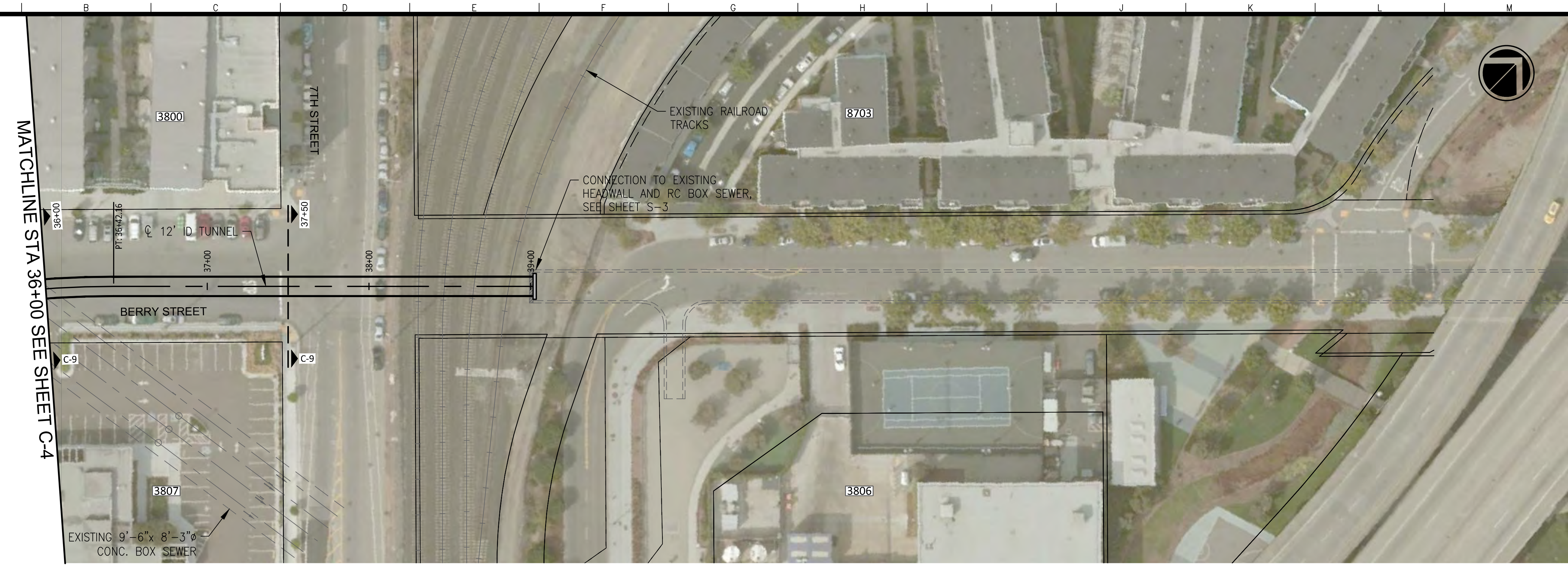
CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

ALL TUNNEL ALTERNATIVE - PLAN AND PROFILE STA. 27+00 TO STA. 36+00

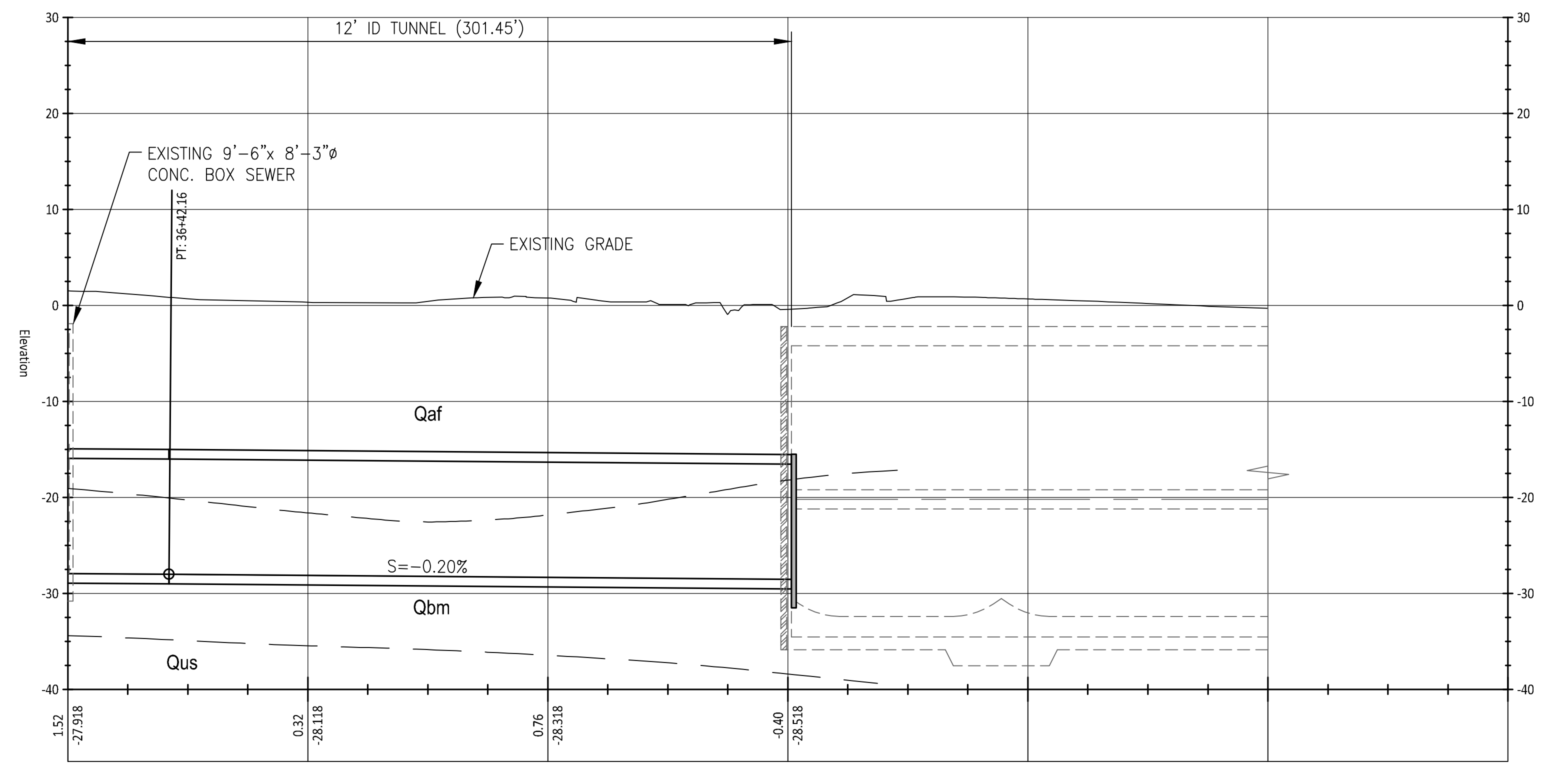
SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE
APPROVED MANAGER		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET XX	PLAN NO. 104,472	DRAWING NO. C-4	REVISION NO. 0

EHY JOB ORDER NUMBER: 1260J



PLAN VIEW

SCALE: 1"=40'



PROFILE VIEW

HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1" =10'

GEOLOGIC LEGEND

Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND (COLMA)
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX - SERPENTINITE

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

ALL TUNNEL ALTERNATIVE – PLAN AND PROFILE STA. 36+00 TO STA. 39+01.45

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER | DRAWN DW
DEPUTY DIVISION MANAGER | DESIGNED JK
DIVISION MANAGER | CHECKED

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

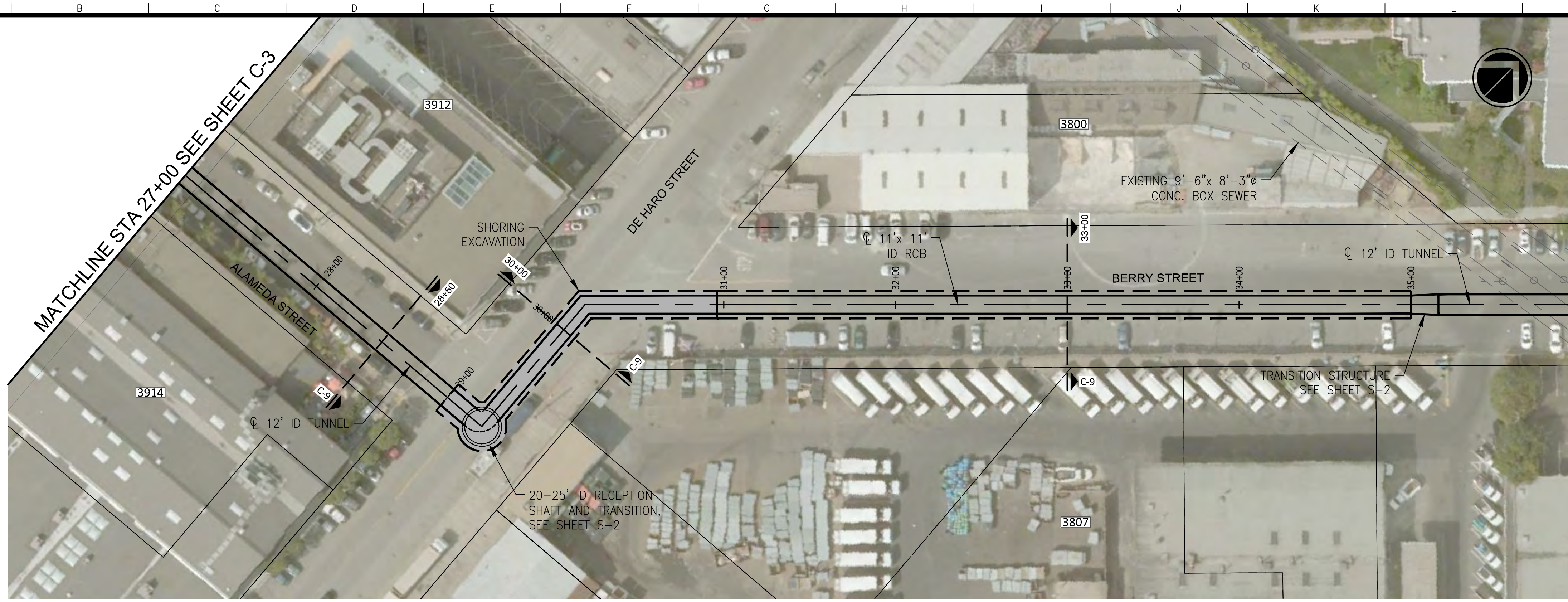
SECTION MANAGER | CHECKED | DRAWN | SCALE NONE
DIVISION MANAGER | RECOMMENDED | DESIGNED | DATE
APPROVED MANAGER | APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET XX | PLAN NO. 104,472 | DRAWING NO. C-5 | REVISION NO. 0

ELEVATION DATUM CITY (NOT HPN)

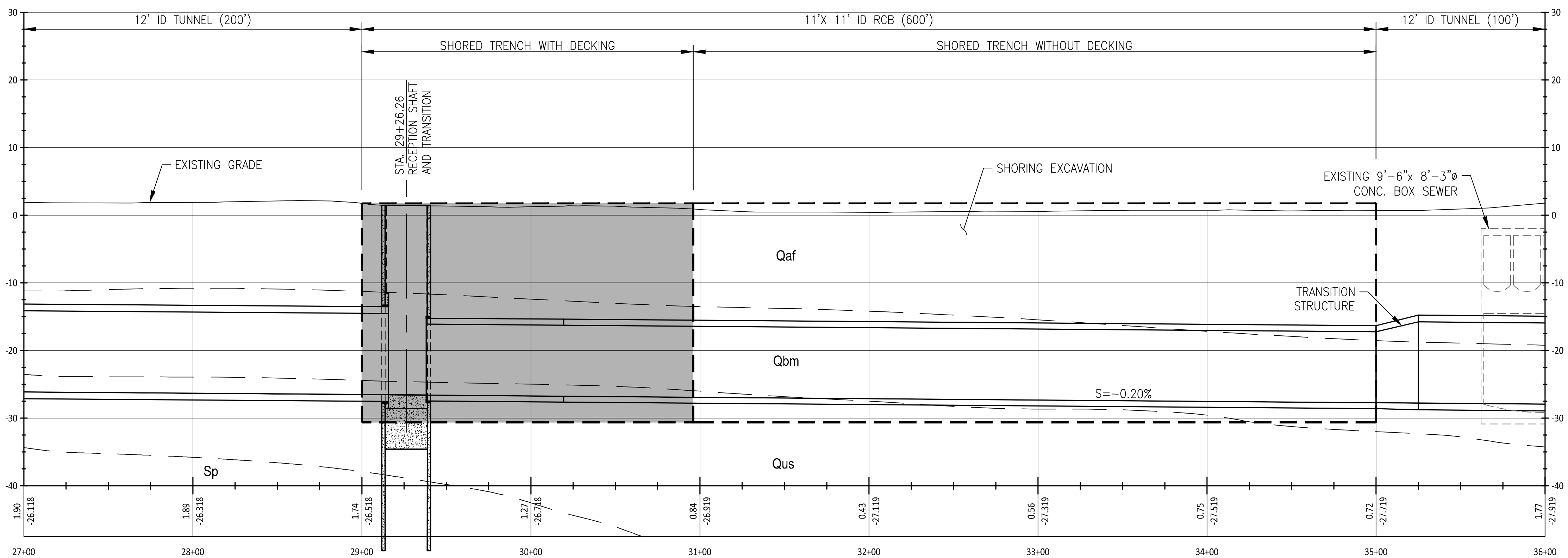
DRAFT

EHY JOB ORDER NUMBER: 1260J



PLAN VIEW

SCALE: 1"=40'



PROFILE VIEW

HORIZONTAL SCALE: 1"=40'

VERTICAL SCALE: 1" =10'

GEOLOGIC LEGEND

Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND (COLMA)
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX - SERPENTINITE

CONTRACT NO. WW-XXX

DRAFT

ELEVATION DATUM CITY (NOT HPN)

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED JK
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

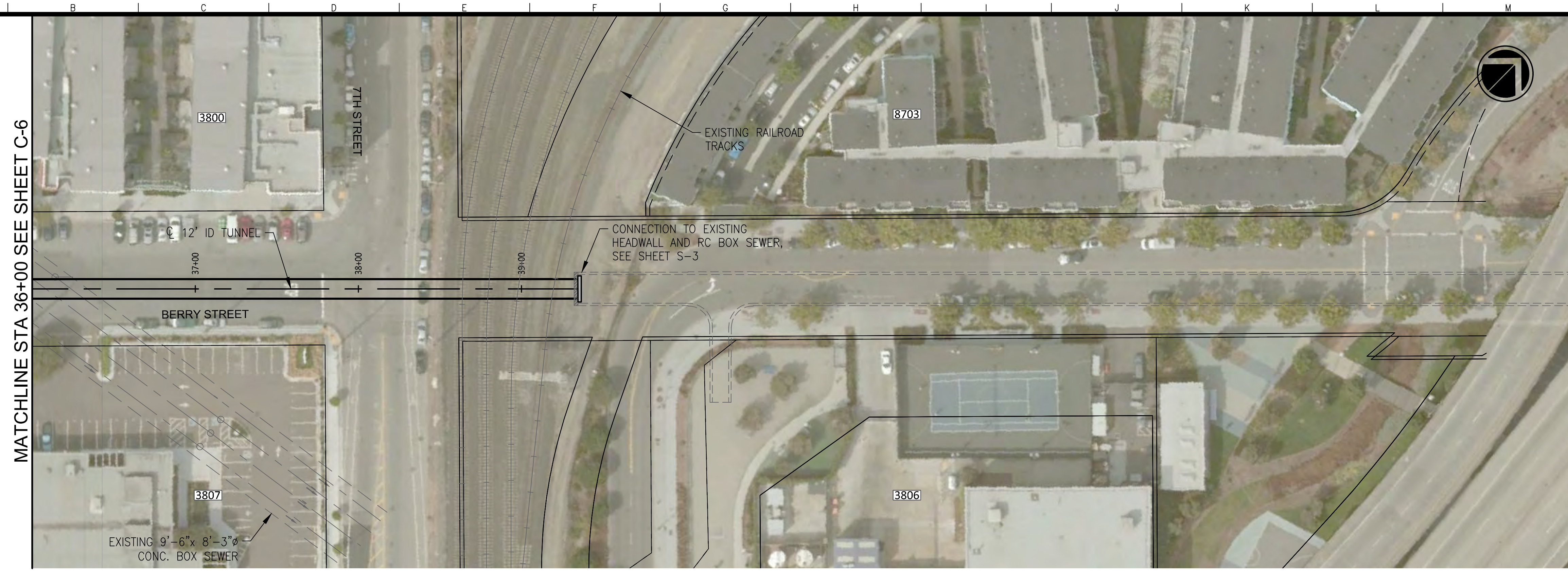
CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

CUT-AND-COVER ALTERNATIVE - PLAN AND PROFILE STA. 27+00 TO STA. 36+00

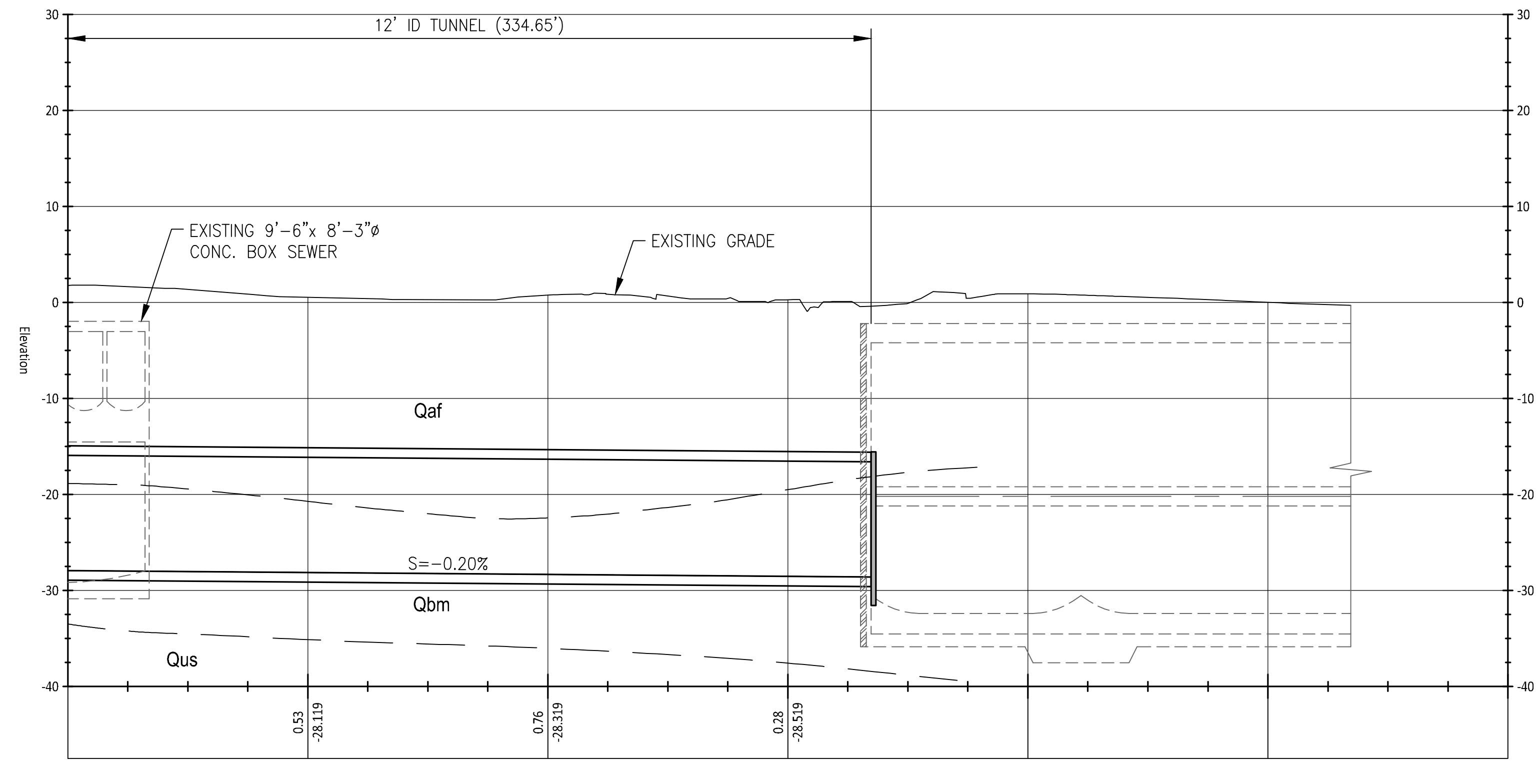
SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE
APPROVED MANAGER		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET XX	PLAN NO. 104,472	DRAWING NO. C-6	REVISION NO. 0

EHY JOB ORDER NUMBER: 1260J



PLAN VIEW

SCALE: 1"=40'



PROFILE VIEW

HORIZONTAL SCALE: 1"=40'

VERTICAL SCALE: 1" =10'

GEOLOGIC LEGEND

Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND (COLMA)
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX - SERPENTINITE

CONTRACT NO. WW-XXX

DRAFT

ELEVATION DATUM CITY (NOT HPN)

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER — DRAWN DW
DEPUTY DIVISION MANAGER — DESIGNED JK
DIVISION MANAGER — CHECKED

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

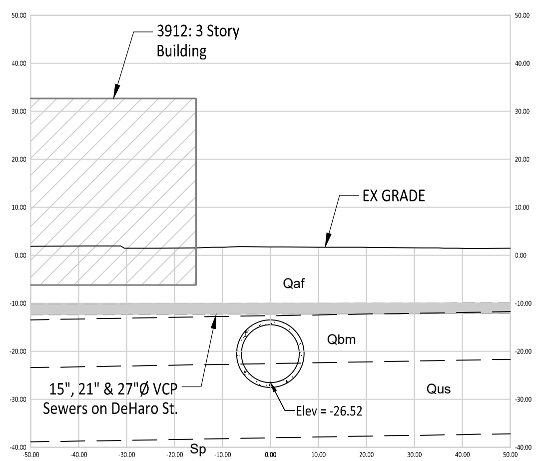
CUT-AND-COVER ALTERNATIVE - PLAN AND PROFILE STA. 36+00 TO STA. 39+34.65

SECTION MANAGER | CHECKED | DRAWN | SCALE NONE
DIVISION MANAGER | RECOMMENDED | DESIGNED | DATE
APPROVED — MANAGER | APPROVED — ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

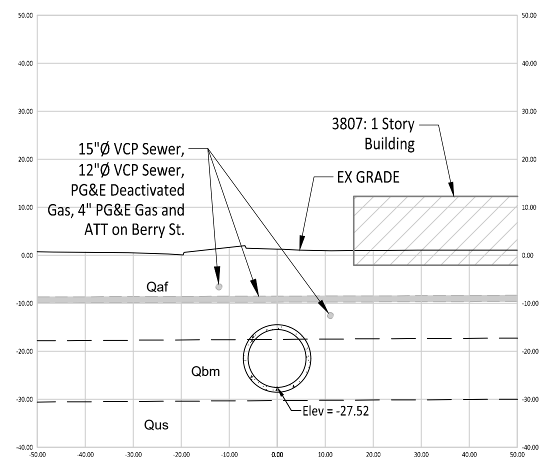
SHEET XX | PLAN NO. 104,472 | DRAWING NO. C-7 | REVISION NO. 0

EHY JOB ORDER NUMBER: 1260J

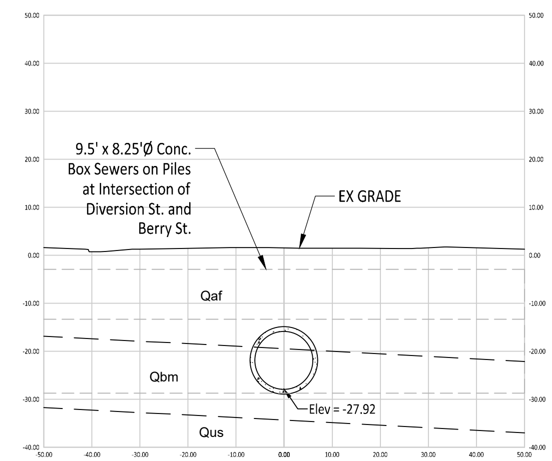
29+00 / C-4



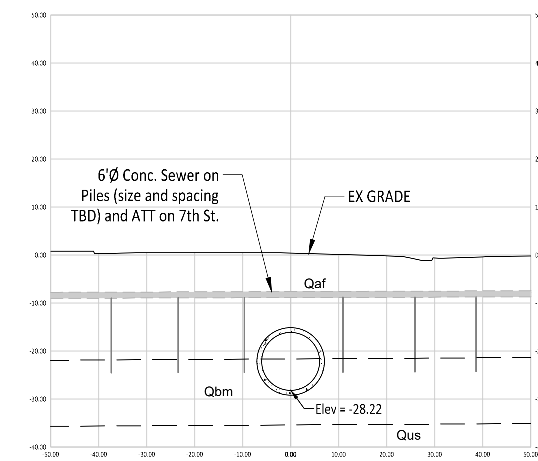
34+00 / C-4



36+00 / C-5

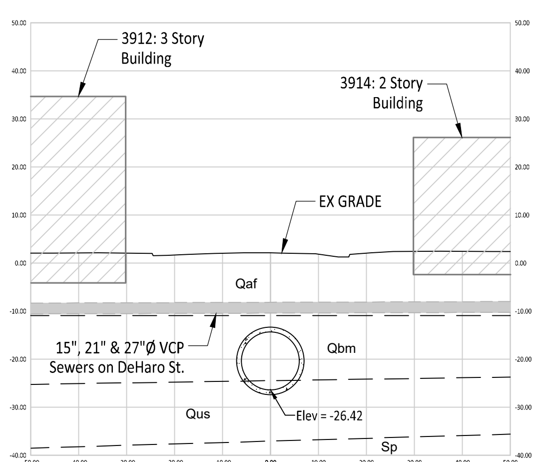


37+50 / C-5

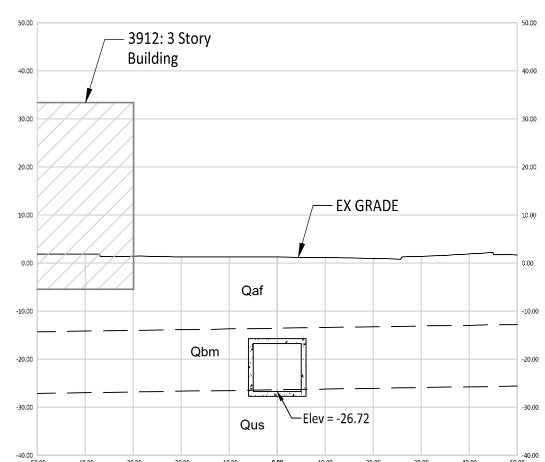


ALL TUNNEL ALTERNATIVE

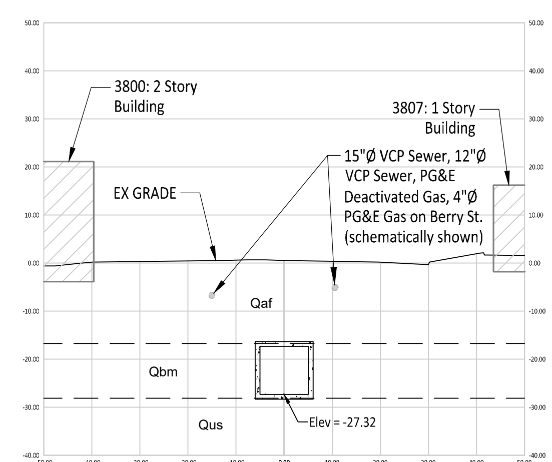
28+50 / C-6



30+00 / C-6



33+00 / C-6



CUT-AND-COVER ALTERNATIVE

Block #	Structure Type	Location
3923 North	2 - Story Building	Northwest corner of Alameda St. and Bryant St.
3923 South	2 - Story Building	Southwest corner of Alameda St. and Bryant St.
3904	1 - Story Building	Northeast corner of Alameda St. and Bryant St.
3922A	2 - Story Building	Southeast corner of Alameda St. and Bryant St.
3905	2 - Story Building	North of Alameda St. - Between Bryant St. and Potrero Ave.
3906	3 - Story Building	Northwest corner of Alameda St. and Potrero Ave.
3920	3 - Story Building	Southwest corner of Alameda St. and Potrero Ave.
3907	2 - Story Building	Northeast corner of Alameda St. and Potrero Ave.
3919	1 - Story Building	Southeast corner of Alameda St. and Potrero Ave.
3912	3 - Story Building	Northwest corner of Alameda St. and DeHaro St.
3914	2 - Story Building	Southwest corner of Alameda St. and DeHaro St.
3807	1 - Story Building	East corner of Berry St. and 7th St.
3800	2 - Story Building	West corner of Berry St. and 7th St.

NOTES:

1. Type and depth of buildings' foundations are shown schematically. Exacct depth to be determined and type of foundations to be verified. For CER stage, conservatively reasonable assumptions have been made in impact assessment.
2. Depth of utilities to be determined. For CER stage, conservatively reasonable assumptions have been made in impact assessment.
3. Only cross-sections between 29+00 and 34+00 are shown here for Alternative 2. All other cross-sections and affected structures and utilities will remain the same.
4. Station 28+50 is still bored tunnel but while buildings located on blocks 3912 and 3914 will be impacted differently compared to bored tunnel (due to construction of launching shaft and C&C tunnel), this station is also depicted differently for C&C alternative.
5. There is a 1-story building on Block 3913 which may be impacted by the construction of the receiving shaft. This building is not shown on any of the tunnel's cross-sections.

DRAFT

CONTRACT NO. WW-XXX

20' 0 20' 40'
SCALE: 1"=20'

ELEVATION DATUM CITY (NOT HPN)

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER | DRAWN DW
DEPUTY DIVISION MANAGER | DESIGNED JK
DIVISION MANAGER | CHECKED

NO. | DATE | DESCRIPTION | BY | APPR'D
REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

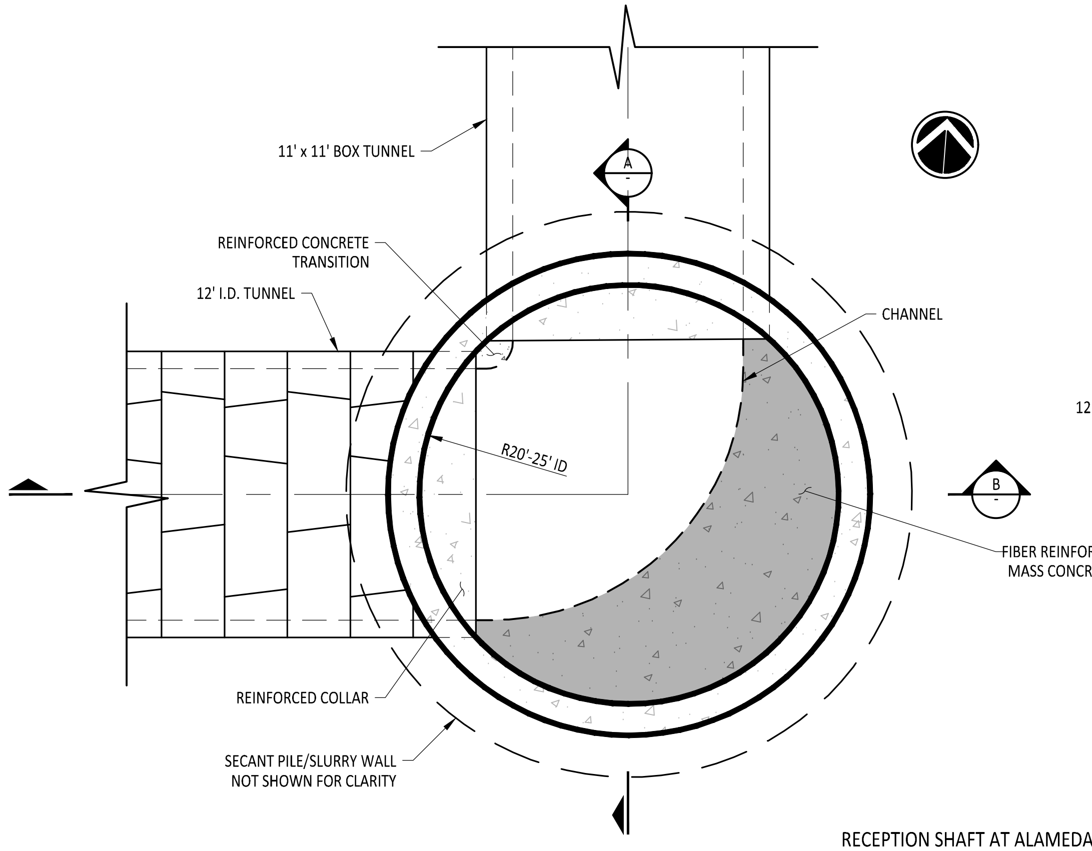
FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

ALL TUNNEL AND CUT-AND-COVER ALTERNATIVES IMPACTED STRUCTURES AND UTILITIES - SECTIONS

SECTION MANAGER | CHECKED | DRAWN | SCALE NONE
DIVISION MANAGER | RECOMMENDED | DESIGNED | DATE
APPROVED MANAGER | APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

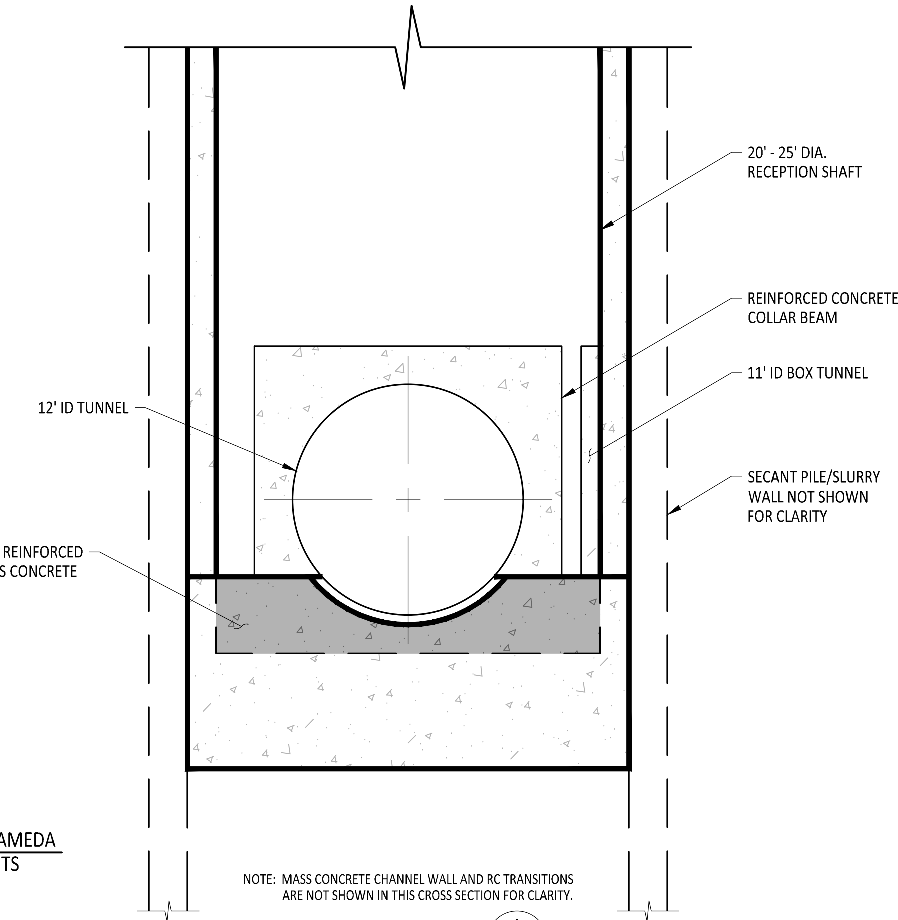
SHEET X | PLAN NO. 104,472 | DRAWING NO. C-9 | REVISION NO. 0

EHY JOB ORDER NUMBER: 1260J



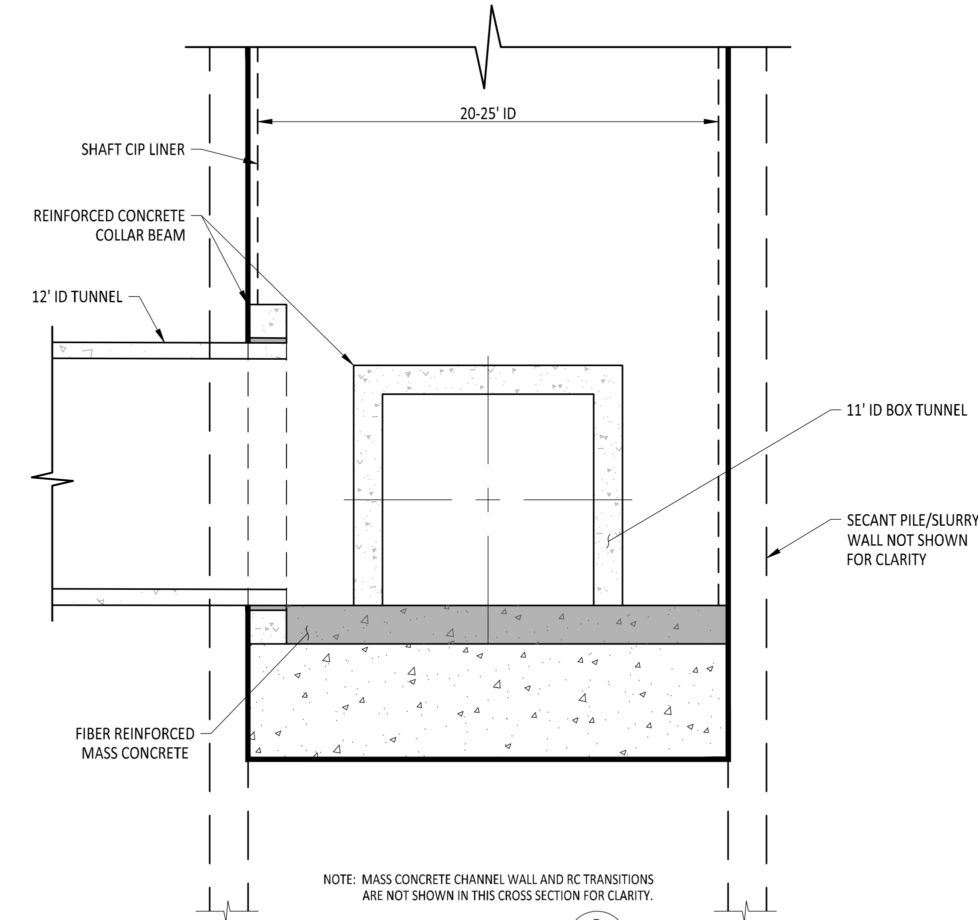
RECEPTION SHAFT AT ALAMEDA AND DeHARO STREETS

SHAFT PLAN 1
SCALE: 1" = 5'



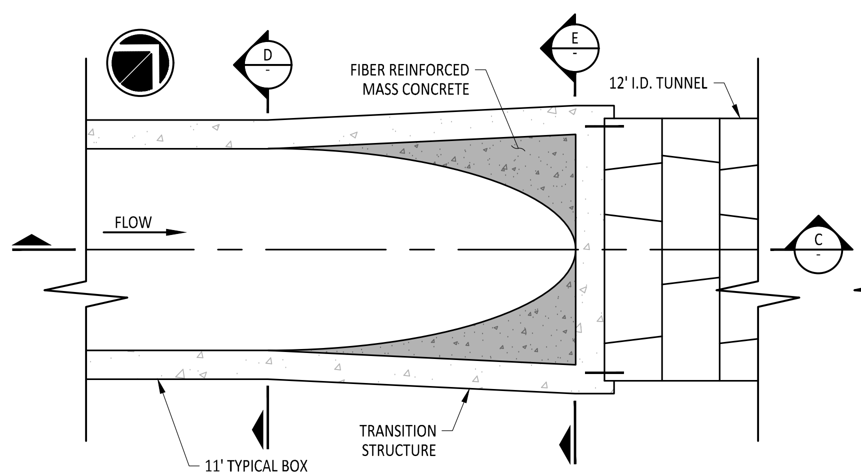
NOTE: MASS CONCRETE CHANNEL WALL AND RC TRANSITIONS ARE NOT SHOWN IN THIS CROSS SECTION FOR CLARITY.

SECTION A
SCALE: 1" = 5'



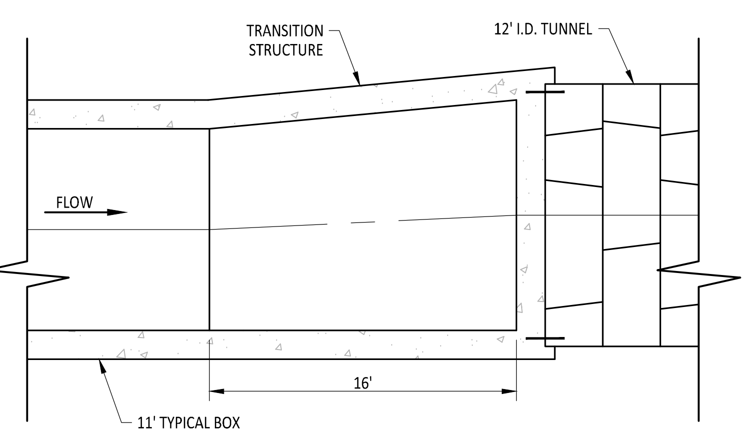
NOTE: MASS CONCRETE CHANNEL WALL AND RC TRANSITIONS ARE NOT SHOWN IN THIS CROSS SECTION FOR CLARITY.

SECTION B
SCALE: 1" = 5'

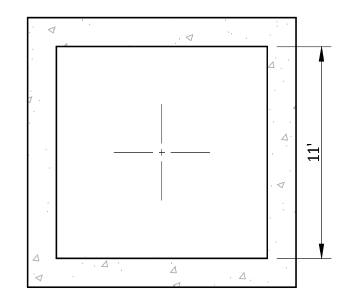


TRANSITION FROM 11' BOX TO 12' TUNNEL AT ALAMEDA AND DeHARO STREETS

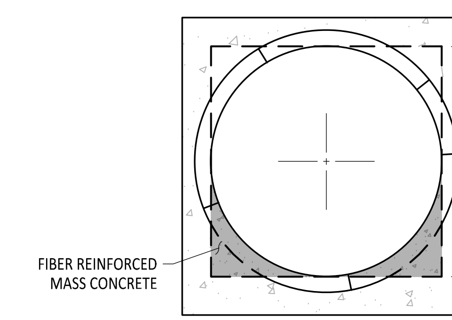
TRANSITION PLAN 2
SCALE: 1" = 5'



SECTION C
SCALE: 1" = 5'



SECTION D
SCALE: 1" = 5'



SECTION E
SCALE: 1" = 5'

DRAFT

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

CUT-AND-COVER ALTERNATIVE
RECEPTION SHAFT AND TRANSITION STRUCTURE

SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE

APPROVED
MANAGER

APPROVED
ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
X	104,472	S-2	0

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

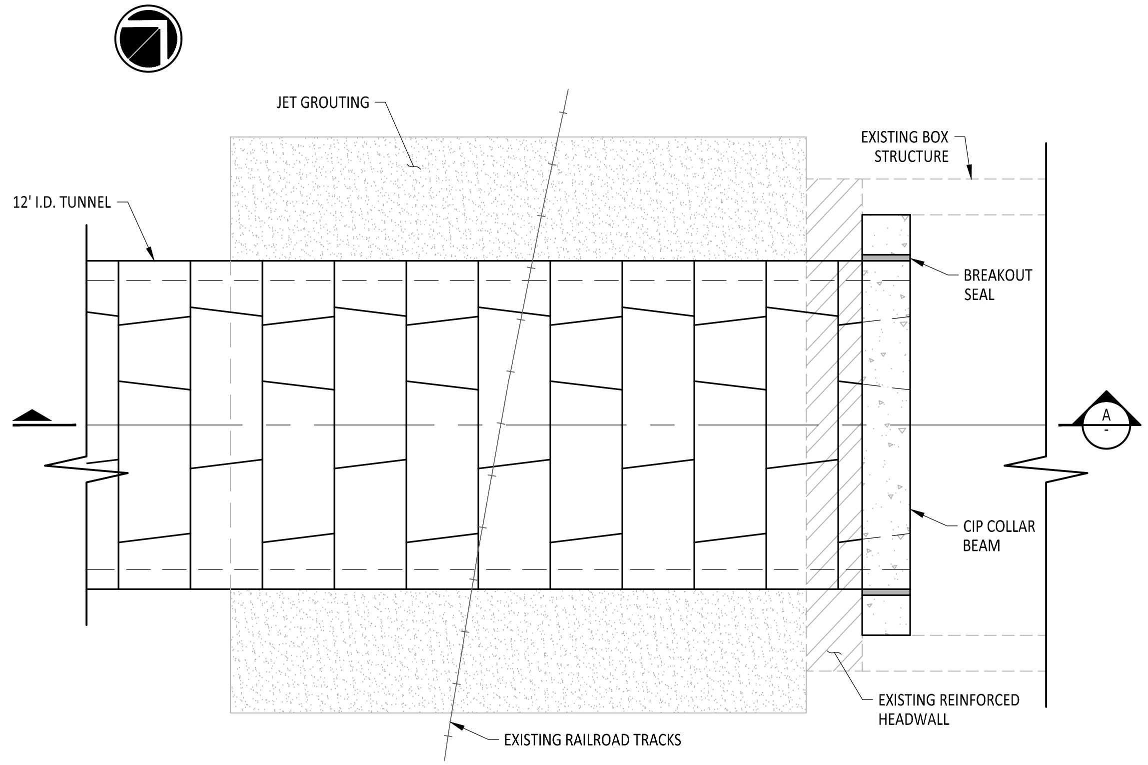
SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED JK
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

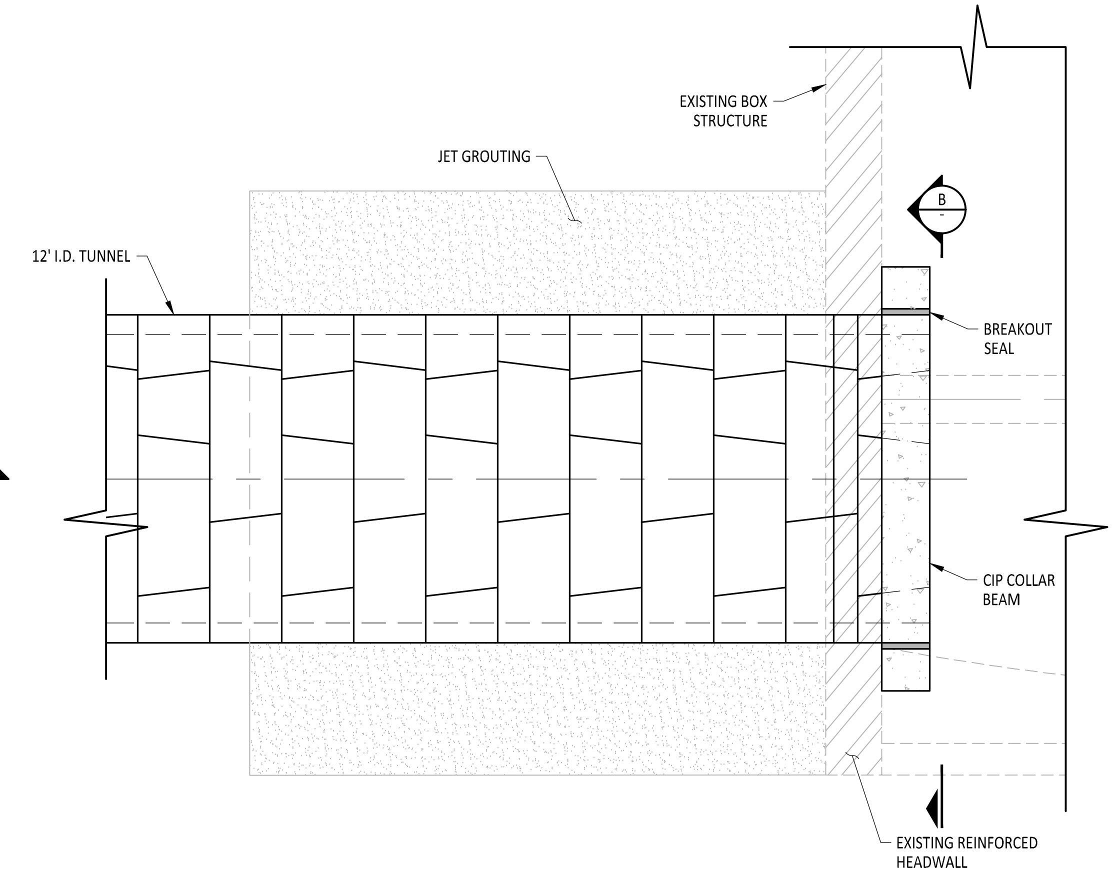
REVISIONS

ELEVATION DATUM
CITY
(NOT HPN)

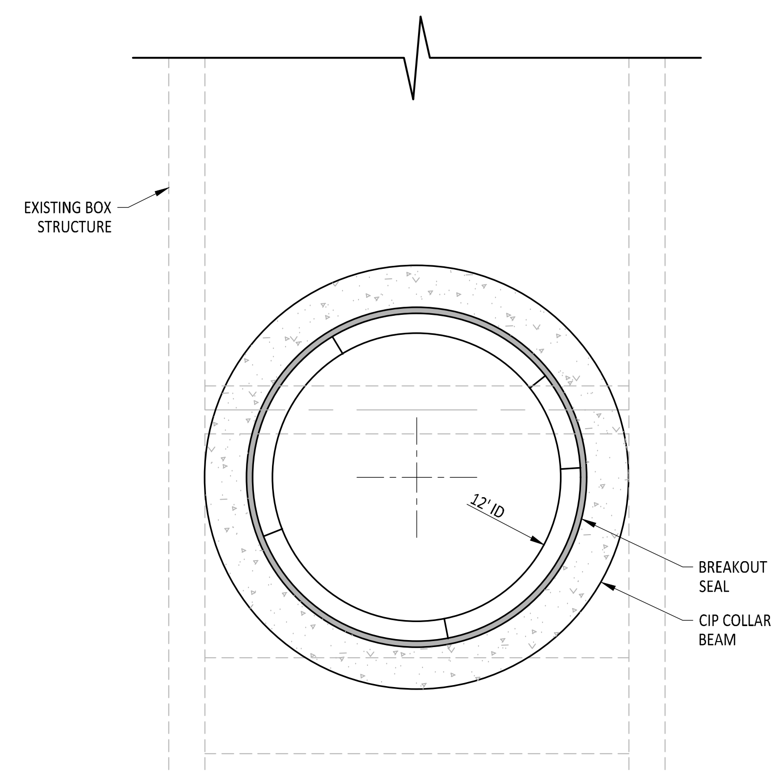
EHY JOB ORDER NUMBER: 1260J



CONNECTION PLAN 1
SCALE: NTS



SECTION A
SCALE: NTS



SECTION B
SCALE: NTS

DRAFT

ELEVATION DATUM CITY (NOT HPN)

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED JK
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

CONNECTION OF BORED TUNNEL AND EXISTING RC BOX SEWER

SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE

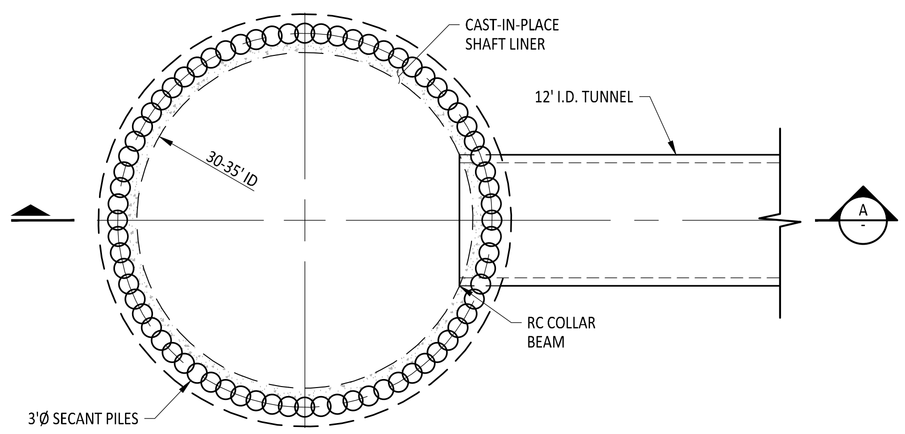
APPROVED MANAGER	APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET X	PLAN NO. 104,472	DRAWING NO. S-3	REVISION NO. 0

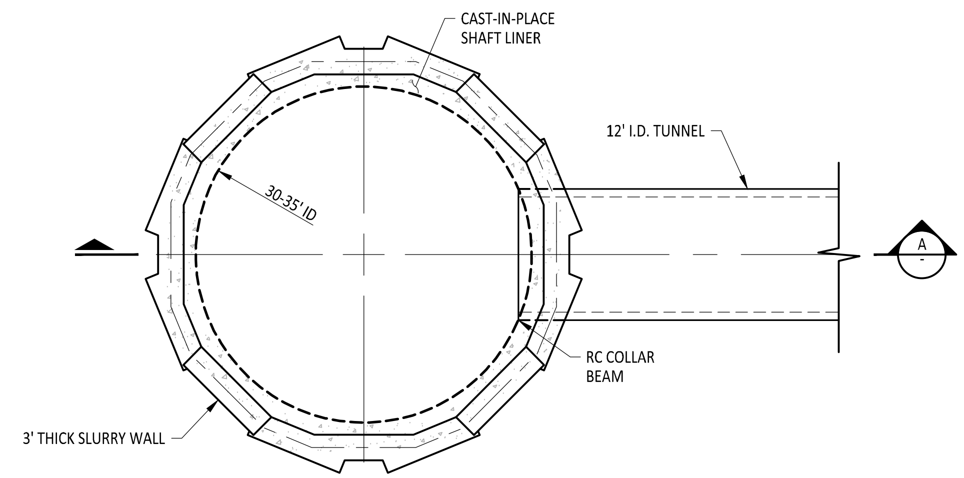
EHY JOB ORDER NUMBER: 1260J

NOTES:

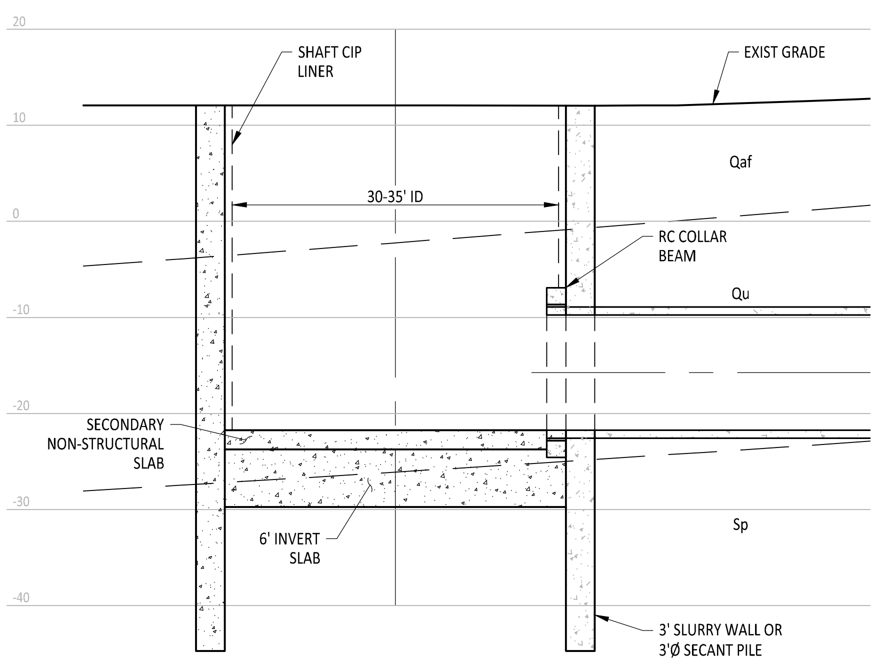
1. FOR THE SECANT PILES OR SLURRY WALL PANELS WITH THEIR TOE INTO BEDROCK, THE BOTTOM OF PILES/PANELS SHALL BE AT LEAST 10 FEET BELOW THE BOTTOM OF EXCAVATION.
2. FOR THE SECANT PILES OR SLURRY WALL PANELS WITH THEIR TOE INTO SOIL, THE BOTTOM OF PILES/PANELS SHALL BE AT LEAST 15 FEET BELOW THE BOTTOM OF EXCAVATION.



SECANT PILE WALL PLAN 1 -
SCALE: NTS



SLURRY WALL PLAN 2 -
SCALE: NTS



SECTION A -
SCALE: NTS

DRAFT

CONTRACT NO. WW–XXX

ELEVATION DATUM CITY (NOT HPN)

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED PA
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

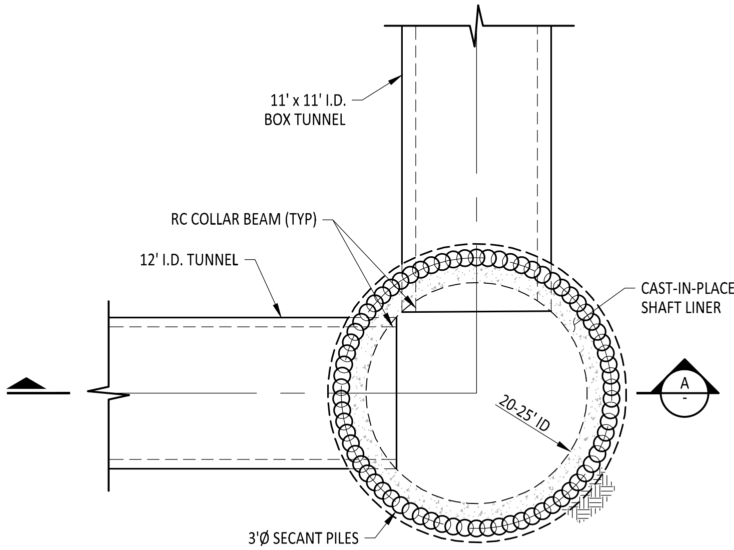
SUPPORT OF EXCAVATION – DRIVE SHAFT; SECANT PILE/SLURRY WALL

SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE

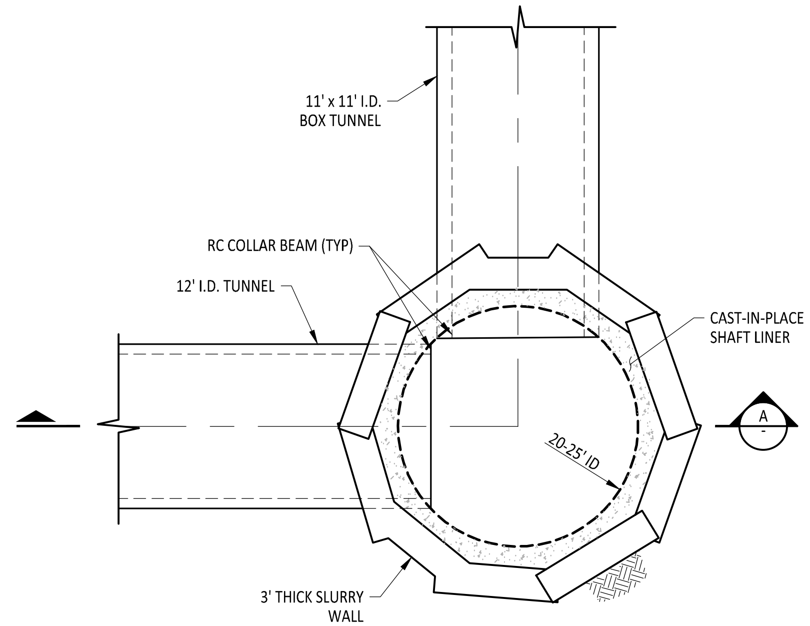
APPROVED MANAGER
APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
X	104,472	S–4	0

EHY JOB ORDER NUMBER: 1260J



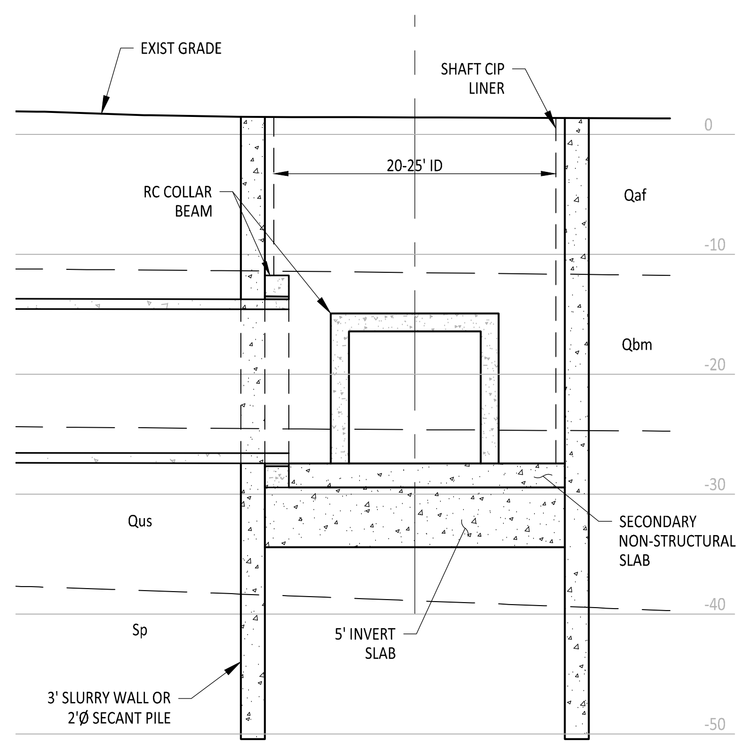
SECANT PILE WALL PLAN 1
SCALE: NTS



SLURRY WALL WALL PLAN 2
SCALE: NTS

NOTES:

1. FOR THE SECANT PILES OR SLURRY WALL PANELS WITH THEIR TOE INTO BEDROCK, THE BOTTOM OF PILES/PANELS SHALL BE AT LEAST 10 FEET BELOW THE BOTTOM OF EXCAVATION.
2. FOR THE SECANT PILES OR SLURRY WALL PANELS WITH THEIR TOE INTO SOIL, THE BOTTOM OF PILES/PANELS SHALL BE AT LEAST 15 FEET BELOW THE BOTTOM OF EXCAVATION.



SECTION A
SCALE: NTS

DRAFT

ELEVATION DATUM CITY (NOT HPN)

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED PA
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

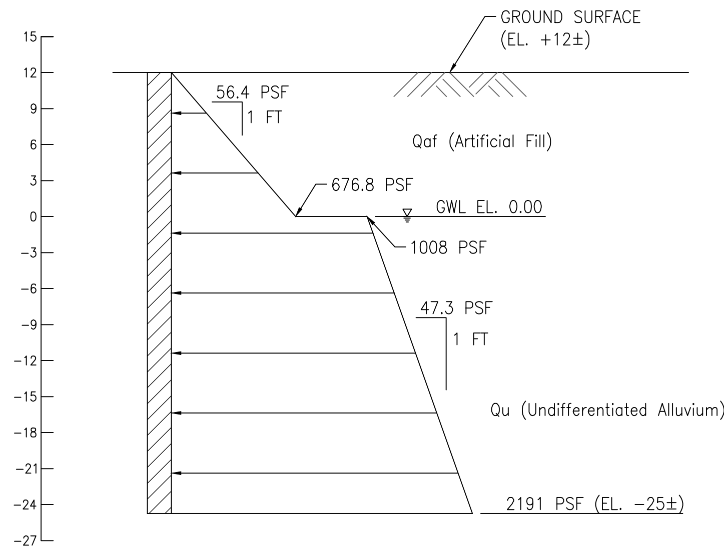
SUPPORT OF EXCAVATION
CUT-AND-COVER ALTERNATIVE: RECEIVING SHAFT; SECANT PILE/SLURRY WALL

SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE
APPROVED MANAGER		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET X	PLAN NO. 104,472	DRAWING NO. S-5	REVISION NO. 0

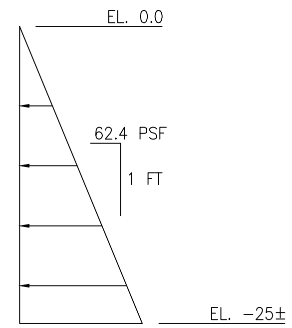
EHY JOB ORDER NUMBER: 1260J

NOTES:

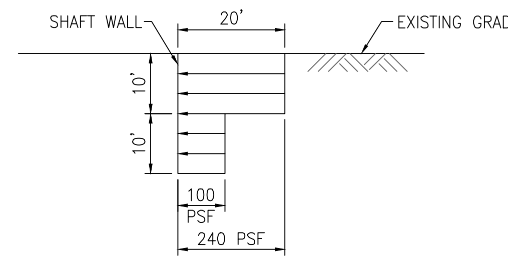
1. LATERAL EARTH PRESSURES AND HYDROSTATIC PRESSURE ARE FUNCTION OF SUBSURFACE GROUND PROFILE AND GROUNDWATER TABLE. THESE SHALL BE VERIFIED BEFORE FINAL DESIGN WITH GEOTECHNICAL SITE INVESTIGATIONS.
2. FOR CUT-AND-COVER BOX, LATERAL EARTH PRESSURE IS A FUNCTION OF SOE. THREE TYPES OF LOAD DISTRIBUTIONS ARE SHOWN FOR RIGID, FLEXIBLE AND BRACED SOE SYTEM. THE TYPE OF SOE TO BE SELECTED DURING FINAL DESIGN OR AS A MEANS-AND-METHOD OF THE CONTRACTOR.
3. FLEXIBLE SOE SYSTEM ATTRACTS LESS LOADS BUT CAUSES MORE GROUND DEFORMATIONS BEFORE MOBILIZATION OF ACTIVE EARTH PRESSURE. THUS, THIS SYSTEM, IF SELECTED, SHALL BE USED WITH CAUTION DUE TO HIGH IMPACTS ON EXISTING ADJACENT STRUCTURES/UTILITIES.



LATERAL EARTH PRESSURE

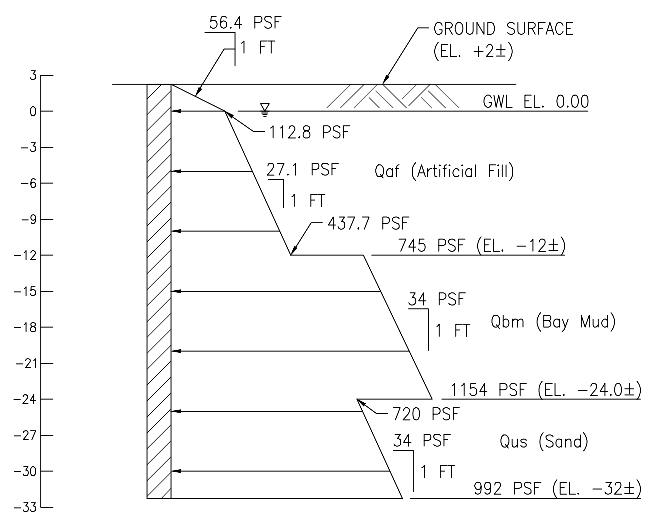


HYDROSTATIC PRESSURE

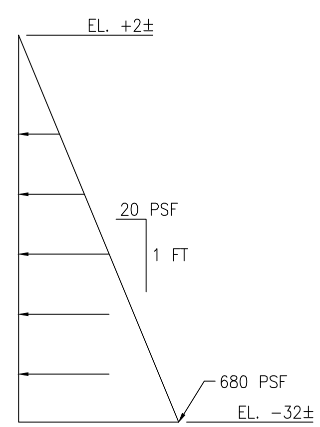


LATERAL SURCHARGE PRESSURE

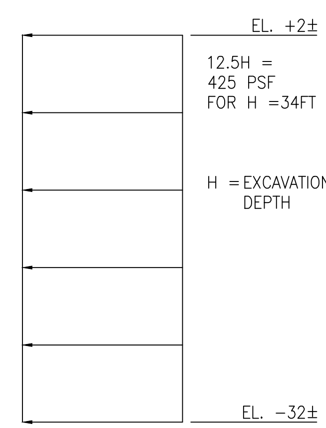
DRIVE SHAFT



RECEPTION SHAFT AND RIGID SOE FOR CUT-AND-COVER BOX

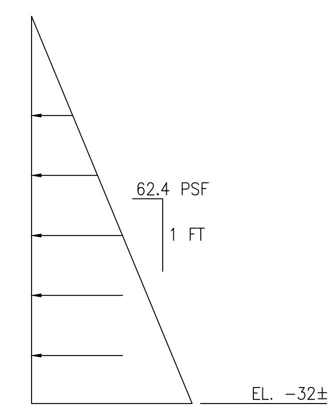


FLEXIBLE SOE FOR CUT-AND-COVER BOX



BRACED SOE FOR CUT-AND-COVER BOX

LATERAL EARTH PRESSURE



RECEPTION SHAFT AND CUT-AND-COVER BOX

HYDROSTATIC PRESSURE

TEMPORARY SHORING – LOADING DIAGRAMS (1/–)
SCALE: NONE

DRAFT

ELEVATION DATUM CITY (NOT HPN)

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED PA
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

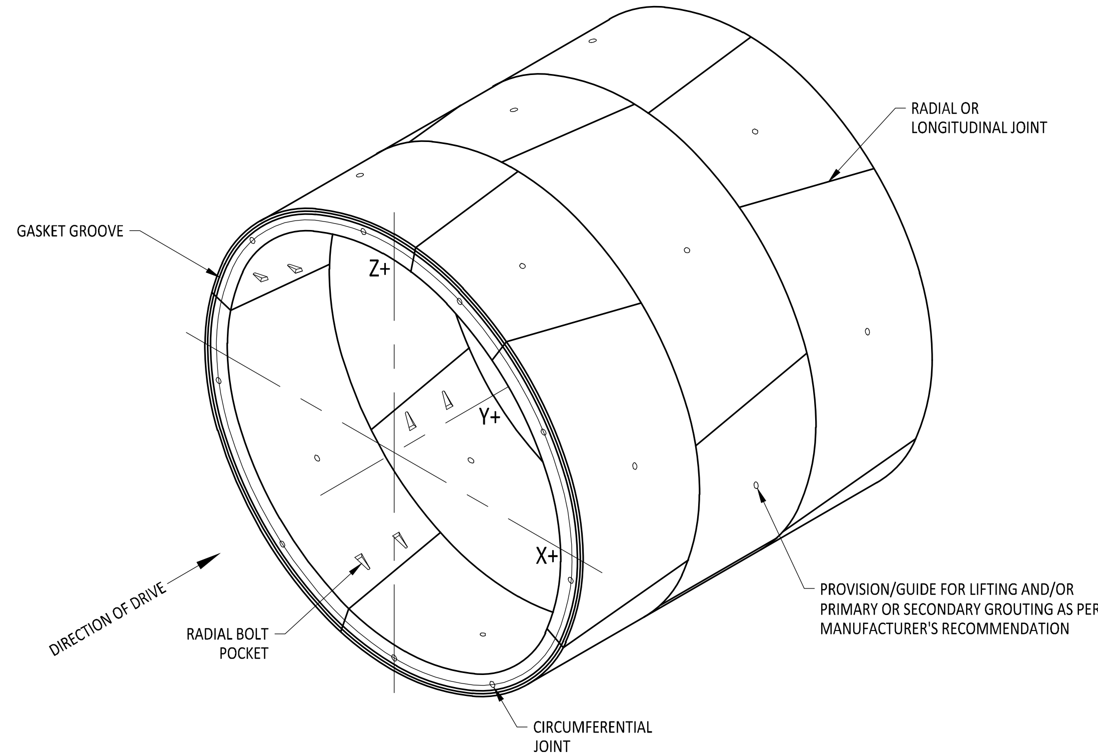
TEMPORARY SUPPORT DESIGN CRITERIA

SECTION MANAGER	CHECKED	DRAWN	SCALE AS NOTED
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE

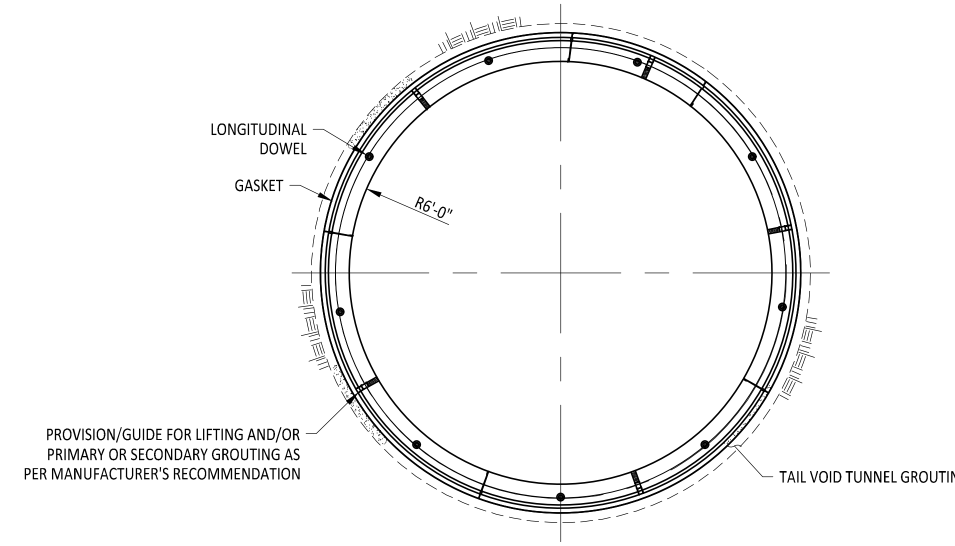
APPROVED: MANAGER — APPROVED: ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE

SHEET XX | PLAN NO. | DRAWING NO. S-6 | REVISION NO. 0

EHY JOB ORDER NUMBER: 1260J



ISOMETRIC VIEW

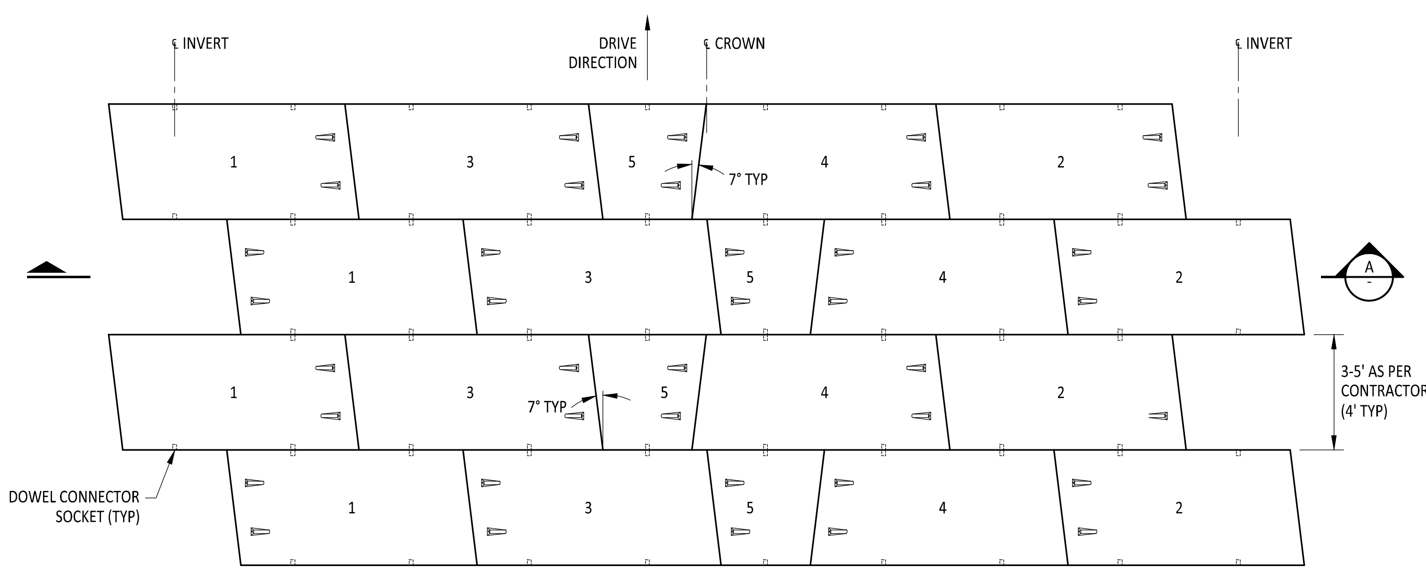


ONE PASS LINER

UNIVERSAL RING SECTION (LOOKING IN DRIVE DIRECTION) A -

NOTES:

1. LOOSE FITTINGS PER RING: 10-RADIAL JOINT BOLT ASSEMBLIES, 9-LONGITUDINAL DOWEL ASSEMBLIES.
2. EACH RING CONSISTS OF 5 TAPERED UNIVERSAL SEGMENTS.
3. DRAWINGS DO NOT SHOW RING TAPER. TAPER AS SELECTED BY THE CONTRACTOR.
4. DETAILS OF SEGMENT LIFTING SOCKETS AND/OR HARDWARE ARE NOT SHOWN. THE METHOD OF SEGMENT HANDLING AND INSTALLATION ARE DETERMINED BY THE CONTRACTOR.
5. ALL SEGMENTS TO BE INDELIBLY LABELED WITH IDENTIFICATION LABEL (MOULD NUMBER AND SEGMENT TYPE) AND CASTING DATE ON INSIDE SURFACE.



DEVELOPED LINING PLAN (VIEW FROM OUTSIDE)

DRAFT

CONTRACT NO. WW-XXX

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

FOLSOM AREA STORM SEWER IMPROVEMENT PROJECT

TUNNEL - PRECAST SEGMENT; RING ASSEMBLY DETAILS

CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO PUBLIC WORKS
DESIGN AND ENGINEERING

SECTION MANAGER	DRAWN DW
DEPUTY DIVISION MANAGER	DESIGNED JK
DIVISION MANAGER	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D
REVISIONS				

SECTION MANAGER	CHECKED	DRAWN	SCALE NONE
DIVISION MANAGER	RECOMMENDED	DESIGNED	DATE
APPROVED MANAGER		APPROVED ASSISTANT GENERAL MANAGER WASTEWATER ENTERPRISE	
SHEET X	PLAN NO. 104,472	DRAWING NO. S-7	REVISION NO. 0

ELEVATION DATUM CITY (NOT HPN)

EHY JOB ORDER NUMBER: 1260J

APPENDIX E

LIST OF LIKELY SPECIFICATIONS

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List of Likely Specifications

The Technical Specifications for this project should follow the Construction Specifications Institute MasterFormat. The following is a list of Technical Specifications that will likely be required for this project:

DIVISION 2 - EXISTING CONDITIONS

02 21 50	EXCAVATION, FILLING AND BACKFILL FOR STRUCTURES
02 41 00	DEMOLITION
02 81 00	ENVIRONMENTAL MANAGEMENT OF EXCAVATED MATERIAL

DIVISION 3 - CONCRETE

03 10 00	CONCRETE FORMING AND ACCESSORIES
03 15 00	POST-INSTALLED ANCHORS
03 15 13	WATERSTOPS
03 20 00	CONCRETE REINFORCING
03 20 15	DRILLED REBAR DOWELS AND ANCHORS
03 30 00	CAST-IN-PLACE CONCRETE
03 35 00	CONCRETE SHAFT COVERS
03 40 00	PRECAST CONCRETE
03 45 00	ANNULAR BACKFILL AROUND TUNNEL LINER

DIVISION 5 – METALS

05 10 00	STRUCTURAL STEEL

DIVISION 7 – WATERPROOFING

07 14 16	COLD FLUID-APPLIED WATERPROOFING

DIVISION 31 - EARTHWORK

31 23 00	EXCAVATION AND FILL
31 23 19	GROUNDWATER DEWATERING
31 23 33	TRENCHING AND BACKFILLING
31 23 34	PAVEMENT CUTTING AND EXCAVATION
31 40 00	SHORING AND BRACING
31 70 00	TUNNELING AND MINING
31 71 00	TUNNEL EXCAVATION
31 72 00	TUNNEL SUPPORT SYSTEMS
31 73 00	TUNNEL GROUTING

DIVISION 32 – EXTERIOR IMPROVEMENTS

DIVISION 33 – UTILITIES

APPENDIX F

ROCK QUALITY EVALUATION AND GEOTECHNICAL BORINGS

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Rock Quality Evaluation
Alameda Street
Folsom Tunnel Alignment

F.0 Introduction

Geologic scan line mapping was performed on a rock outcrop located on the south side of Alameda Street, between York and Hampshire. This location across the street from 2460 Alameda Street between approximately sta. 7+00 to sta. 10+00 of the Folsom Tunnel Alignment. At the corner of Hampshire and Alameda the outcrop consists of Franciscan serpentinite and holds a near vertical face. The purpose of the evaluation is estimate the quality of rock at tunnel depth which is planned for 30 to 40 feet below Alameda Street at this location.

F.1 Nearby Geotechnical Borings

Geotechnical soil borings for other projects have been drilled and logged at various parcels along the proposed Alameda Street tunnel alignment, Alternative B1/B1a. Key boring logs and maps showing their locations were obtained from the San Francisco Department of Building Inspection (DBI) permit records office. Boring logs for geotechnical drill holes drilled for the Highway 101 viaduct crossing of Alameda Street were also obtained from Caltrans.

Two sets of boring logs are available for parcels across Alameda Street from the scan line location:

- Six boring logs for a geotechnical investigation (Geolabs, 2006) at 2460 Alameda Street, the property directly across the street from the outcrop, show bedrock at very shallow depth (1.5 to 3 feet below grade). The rock is identified as damp, soft shale and highly weathered serpentinite. Based on blow counts and drilling resistance, the rock is described as moderately hard at depths of 9 to 10 feet. The boring closest to the alignment is about 83 ft north of the center line. These results generally confirm the attached conceptual profile which indicates the rock cover above the 12 ft diameter tunnel in this part of Alameda Street to be approximately 35 feet.

- Five boring logs are available for the parcel adjacent to the east and across Alameda Street (66 Potrero Ave., Harding Lawson Assoc., 1982). These borings logs show rock at depths from 0.2 ft to 8 ft. The rock is described as blue-green serpentinite with low hardness, friable to weak, and weathered. The closest boring is about 128 feet north of the center line.

Selected pages of the above two geotechnical reports and other reports for parcels along the Folsom tunnel alignment are provided in a separate appendix to the CER.

F.2 Geologic Scan Line

On November 8, 2017, Parsons performed geologic scan line mapping of the rock outcrop that forms the near vertical natural wall across the street from 2460 Alameda Street. About 15 feet above the street and extending south from the rock face is a parking lot currently used by a U-Haul rental business. Figure F-1 shows two adjacent views of the outcrop facing generally south.

The rock type observed in the outcrop is Franciscan serpentinite. Serpentinite is a low-grade metamorphic rock which is typically altered with soft minerals (e.g. clay, chlorite, talc, chrysotile, etc.). The observed condition of the outcrop rock mass is best described as “moderately blocky and seamy” in the rock load classification system of Terzaghi (1946).

The field technique for the scan line involved extending a 300 ft measuring tape from east to west at a height of 3 feet using pins nailed into the rock face or attached to fencing. A geologic map was prepared based on observations, measurements, photographs, and notes of the features observed along the tape. Attitudes of rock joints and fracture planes were recorded and plotted.

F.3 Rock Discontinuities

Attitudes of joints and fracture planes are shown on the geologic scan line map (Attachment 1). Also included in the attachment is a stereographic projection plot of poles to measured joint planes.

The most prominent through-going joints (Set A) have an average strike of 10 NW and average dip of 77W. Set C is less common and has a similar northerly orientation: average strike 25 NW and dip 65NE. These joint sets typically have coatings, often show shearing striations, and are sometimes open. Since they are steep to near vertical and perpendicular to the tunnel axis, the orientation is regarded as “very favorable” for tunneling.

The stereographic plot shows that in addition to Sets A and C, there are two other commonly observed groups of discontinuities (Sets B and D) and several other prominent individual planes whose poles are plotted.

Sets B and D are oriented within 20 degrees of the tunnel alignment and both have average dips steeper than 45 degrees. This orientation is regarded as “very unfavorable” to tunneling (Bieniawski, 1984, Table 6.10). These sets appear to be more localized, tend to be closed rather than open, and less weathered and sheared. They often occur closely-spaced and most abundant near the corner of Hampshire and Alameda.

Figure F-1
Rock Outcrop on Alameda Street
(facing south, U-Haul parking lot above)

F.4 Rock Quality

The rock quality of the outcrop rock was evaluated according to the Rock Mass Rating system (RMR) of Bieniawski (1989). The RMR consists of scores given to the rock mass for various parameters estimated and observed in the field: rock strength (based on hammer blows and knife scratching), RQD (continuity of rock cores), joint spacing, joint conditions (i.e. roughness, openness, coatings, etc), and joint orientation. As shown in Table F-1, the rock was rated and scored at 17 measurement locations. Measurement locations were spaced at 10 foot intervals in the eastern half scan line. In the western half of the scan line, measurement locations were typically at 15 foot intervals and there were several gaps (e.g. at 150 to 180 feet and 215 to 230 feet) in which loose soil and vegetation prevented rock quality observations. Descriptive terms for ground conditions and physical rock properties are provided in Tables A-1 and A-2 in Attachment 1.

Table F-1
Rock Mass Rating Scores for Site Outcrop

	Rock Mass Rating by Scan Line Station																		
	<<= east								Station Numbers with RMR scores										west =>>
photo center	5		25		45		60	77	86, 90	90	105	120	130	140		190	200	225	240
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70- 80	80-90	90-100	100-110	110-125	125-135	135-150	150-180	180-195	195-205	205-230	230-255
RMR Parameters																			
Strength	7	7	7	7	12	7	2	4	2	2	1	7	7	7	unknow	2	1	unknown	1
RQD	8	8	17	20	20	13	3	17	17	17	13	8	8	8	due to	13	8	due to	3
Discontinuities (emphasizing eye height,	5	5	10	10	15	15	5	15	15	15	10	10	10	15	poor	5	10	lack of	5
Condition of Discontinuities	25	25	25	20	10	25	10	10	20	20	10	20	20	15	exposur	10	0	exposure	0
Groundwater	10	10	10	10	10	10	10	10	10	10	10	10	7	10		10	10		10
Strike & Dip Orientation Effect (see Table 6.10, Bieniawski)	-12	-12	-12	-12	-12	-12	-12	0	-5	-5	0	0	-5	-5		-5	-5		-5
Total Score	43	43	57	55	55	58	18	56	59	59	44	55	47	50	--	35	23	--	14
RMR Class	III	III	III	III	III	III	V	III	III	III	III	III	III	III	--	IV	IV	--	V
Description	fair	fair	fair	fair	fair	fair	very poor	fair	fair	fair	fair	fair	fair	fair	--	poor	poor	--	very poor

The rock is generally moderately hard and strong to moderately strong with moderate weathering. However, in some portions of the outcrop, weathering is deep and strength and hardness are somewhat lower. All discontinuities are coated and oxidized; some are sheared. Joints of the most prominent set are typically tens of feet apart, but the rock mass between the major discontinuities is typically moderately fractured (0.5 ft to 1.0 ft spacing). The rock may be generally described as moderately blocky and seamy to very blocky and seamy with moderately spaced fractures.

Based on the above tabulation, the rock mass is given an overall RMR system rating of III (Fair). There were some instances of IV (Poor) and V (Very Poor). In the RMR system this rock could be expected to have unsupported standup time of 1 week for a 5-meter (16 ft.) span. This indicates that a variety of tunneling methods may be used successfully.

J.5 Serpentinite Environmental Concern

Serpentinite is a low-grade metamorphic rock, typically altered with soft minerals such as chlorite, talc, and asbestos. Naturally occurring asbestos (NOA) minerals are commonly present in serpentinite at low concentrations. If concentrations exceed 1%, which is the CalEPA DTSC hazardous level, rock waste would need to be disposed as Class II waste or specially permitted to be used in confined backfill (isolated from contact with the environment). Presence of NOA may also affect permitting requirements for tunnel air quality and ventilation. Metals such as chromium, lead, nickel, and vanadium can also be present in serpentinite and serpentinite-derived soils at concentrations that restrict waste disposal. It is planned to assess the occurrence of NOA minerals and metals in bedrock as a component of the Phase 2 environmental investigation.

F.6 Groundwater Observations

The following are groundwater observations based on review of geotechnical investigation reports in the project vicinity.

- A group of borings for the Recology area (south of alignment) have groundwater at depths of 4 to 6 ft. measured in April 1981. The surface elevations on the logs are 0 ft. and 1 ft. (not likely surveyed).
- Two excellent quality DTX borings also at the downstream end (CCB-54 at sta.37+50 Berry and 7th and CCB-53 across the tracks), show groundwater at depth of 7 ft. (May 2005 not stabilized) and 4 ft. (September 2005, stabilized) respectively.
- Borings for 1 Henry Adams, the 5-story apartment building between Rhode Island and Henry Adams (B-2, B-3, and CPT4), show groundwater at depths of 6 to 8 ft. in June 2000.
- The Caltrans information has nothing on groundwater.
- Borings at Potrero & Alameda near Station 12+00 show stabilized groundwater at 10 and 12 ft. depth in soil above rock, but they are about 100 ft. north of the tunnel, closer to Division Street than to Alameda Street.
- Borings (6) for 2460 Alameda at about Station 8+00 at scanline: Five say groundwater not encountered. One says water at top of rock; depth 20 ft.
- Borings (4) for site adjacent to north side of SPCA: Groundwater at depths of 8 ft., 16 ft., and 17 ft. (February1984). One borehole collapsed preventing measurement.

ATTACHMENT 1

Rock Outcrop Geologic Scan Line

Discontinuity Pole Plot

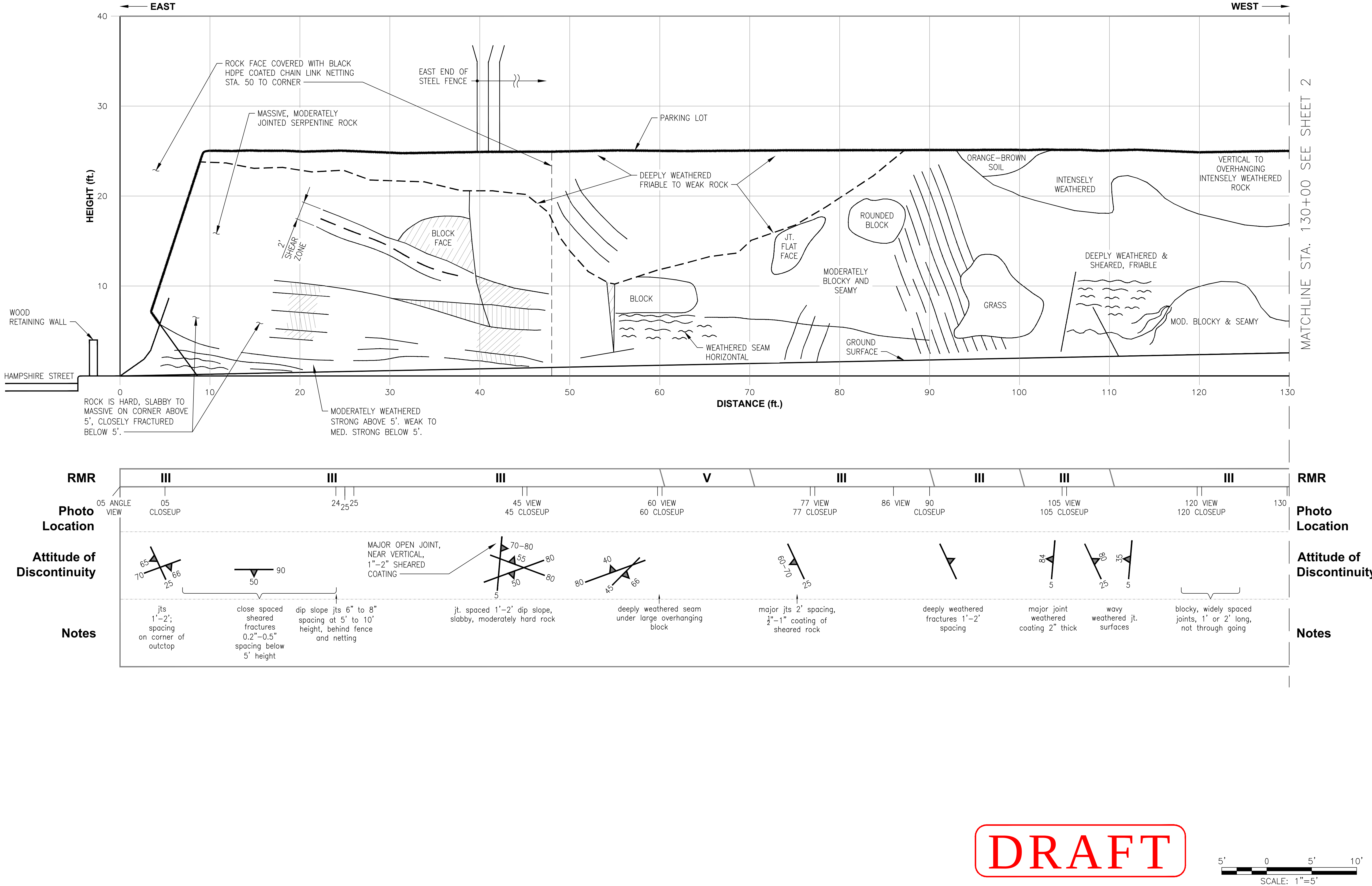
Tables – Explanation of Ground Conditions and Terms for Rock Description

ATTACHMENT 2

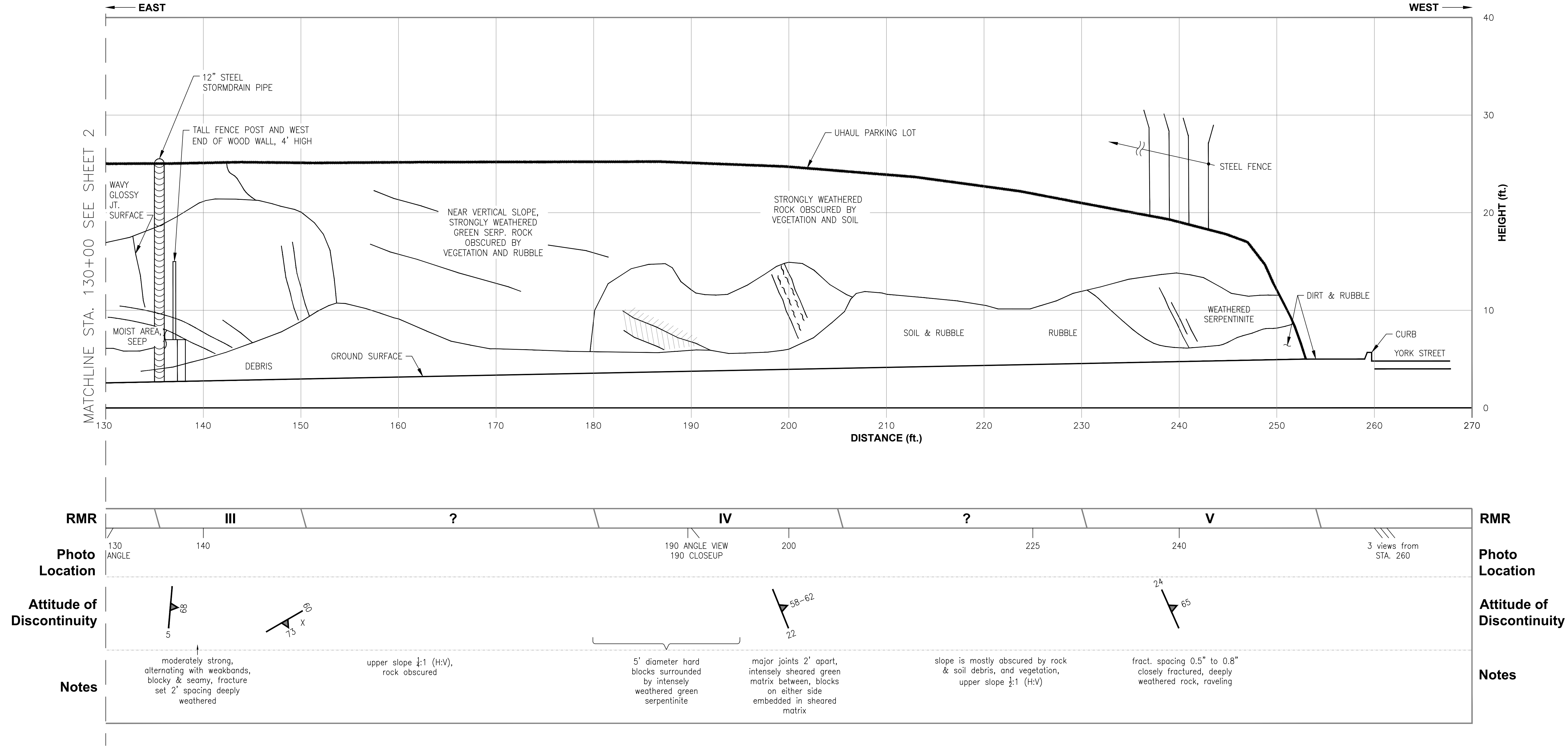
Tunnel Alignment Plan and Profile

Boring Location Maps (2 sheets)

FOLSOM TUNNEL CER: GEOLOGIC SCAN LINE 1 OF 2



FOLSOM TUNNEL CER: GEOLOGIC SCAN LINE 2 OF 2



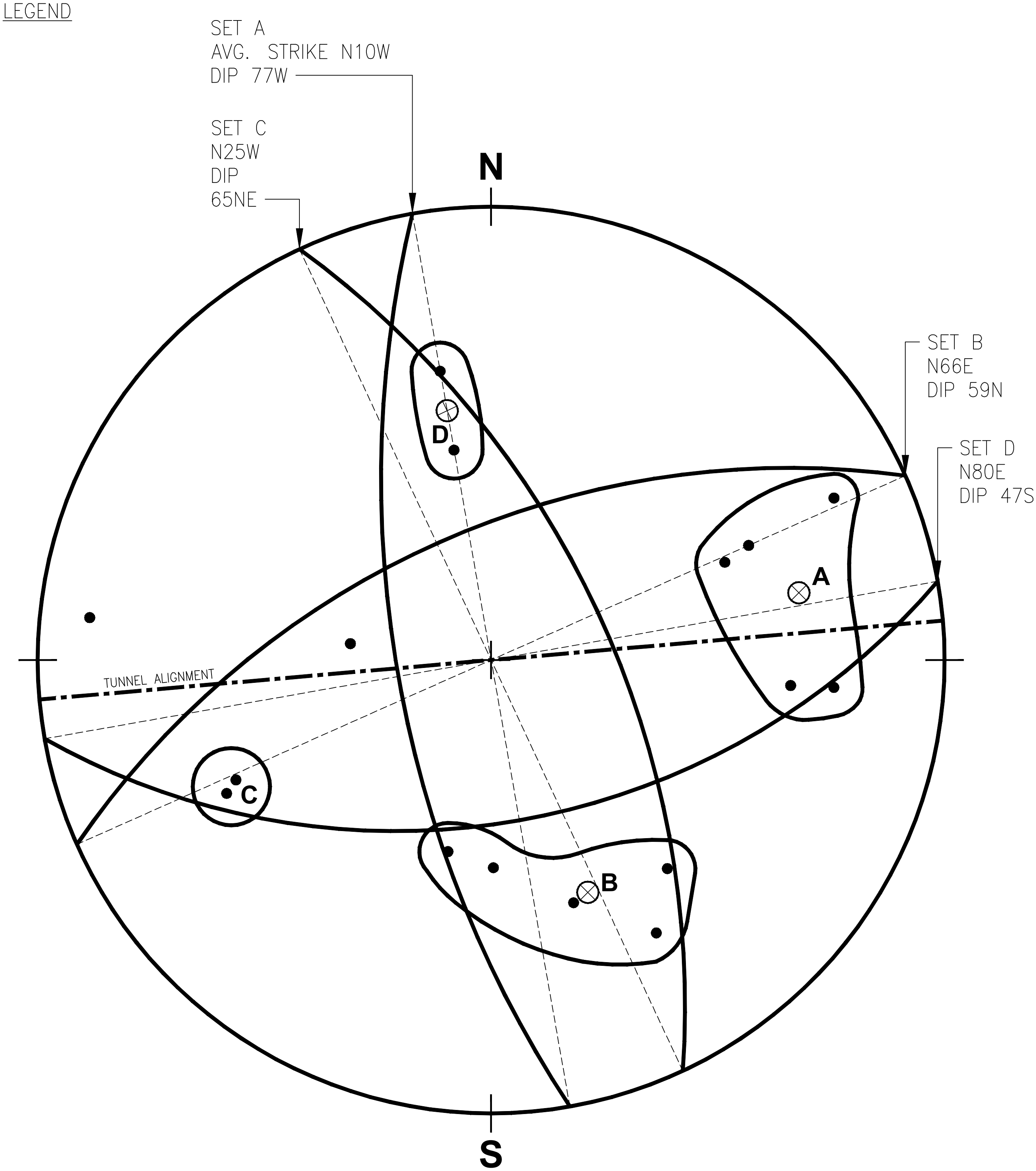
DRAFT

5' 0 5' 10'

SCALE: 1"=5'

FOLSOM TUNNEL CER: ATTITUDES OF JOINTS AND SHEAR PLANES

LEGEND



LEGEND

- ● POLES TO PLANES, LOWER HEMISPHERE STEREONET PROJECTION
- ⨂ AVERAGE POLE OF JOINT SET

DRAFT

TABLE A-1
EXPLANATION OF GROUND CONDITION TERMS

Firm rock or soil is a material which will stand unsupported in a tunnel for several days or longer. The term includes a great variety of materials: sands and sand-gravels with clay binder, stiff unfissured clays at moderate depths, and massive rock.

Massive, moderately jointed rock contains joints and cracks, but the blocks between joints are locally grown together or are so intimately interlocked that vertical surfaces do not require lateral support.

Blocky and seamy rock consists of chemically intact or nearly intact rock fragments, separated from each other by joints or other discontinuities that are imperfectly interlocked. In such rock, vertical surfaces may require support. When individual blocks are larger than one foot, the rock is called moderately blocky; when blocks are smaller than one foot, the rock is called very blocky and seamy.

Crushed rock consists of chemically intact rock fragments that have the character of crusher run. Individual particles are of gravel size or smaller. This material behaves like gravel or sand.

Squeezing ground slowly advances into the tunnel without perceptible volume increases. Squeezing conditions are associated with a higher percentage of microscopic and sub-microscopic particles of micaceous minerals or of clay minerals with a low swelling capacity. A prerequisite for squeeze is an overstress of the material close to the tunnel opening, hence for a given material the overburden stress is an important parameter.

Swelling ground advances into the tunnel chiefly on account of expansion. The capacity to swell seems to be limited to those rocks which contain clay minerals such as montmorillonite, with a high swelling capacity.

Raveling ground is used to describe a material which gradually breaks up into chunks, flakes, or angular fragments after the ground has been exposed in the tunnel. The process is time-dependent and materials may be classified by the rate of disintegration as fast or slow raveling. If the raveling process starts within a few minutes, the ground is fast raveling. Otherwise, it is referred to as slow raveling. Examples are fine moist sand, and gravels with some clay binder, stiff fissured clays, jointed rocks, and weak rocks.

Running ground indicates a material which will invade the tunnel until a stable slope is formed at the face. Stand-up time is zero or nearly zero. Examples are clean medium to coarse sands and gravels above the groundwater level. If running ground has a trace of cohesion, then the run is preceded by a brief period of progressive raveling. Materials intermediate between running and raveling are described as cohesive-running.

Flowing ground acts as a thick liquid and differs from running ground in that it invades the tunnel not only from above and from the sides, but also though the bottom. If the flow is not arrested, it continues until the tunnel is completely filled.

Modified from Terzaghi in Proctor and White (1977), Heuer (1974), and Deere et al (1969), Terzaghi (1950).

TABLE A-2
KEY FOR PHYSICAL DESCRIPTION OF ROCK

The physical condition describes the physical characteristics of the rock, which are important for engineering considerations such as fractures, hardness, strength, and weathering.

Definitions of terms used are as follows:

Fracturing	Size Range of Pieces	Remarks
Crushed	-5 microns to 0.1’	Contains clay
Intensely fractured	0.05’ to 0.1’	Contains no clay
Closely fractured	0.1’ to 0.5’	
Moderately fractured	0.5’ to 1.0’	
Little fractured	1.0’ to 3.0’	
Massive	4.0’ and larger	

Joints and fractures are treated the same for the physical description, and both are referred to as fractures.

<u>Hardness</u> (Note that the scale of “hardness” is different for rocks than for soils.)

- Soft – reserved for plastic material.
- Friable – easily crumbled or reduced to powder by fingers.
- Low hardness – can be gouged deeply or carved with a pocket knife.
- Moderately hard – can be readily scratched by a knife blade; scratch leave heavy trace of dust.
- Hard – can be scratched with difficulty; scratch produces little powder and is often faintly visible.
- Very hard – cannot be scratched with a knife blade.

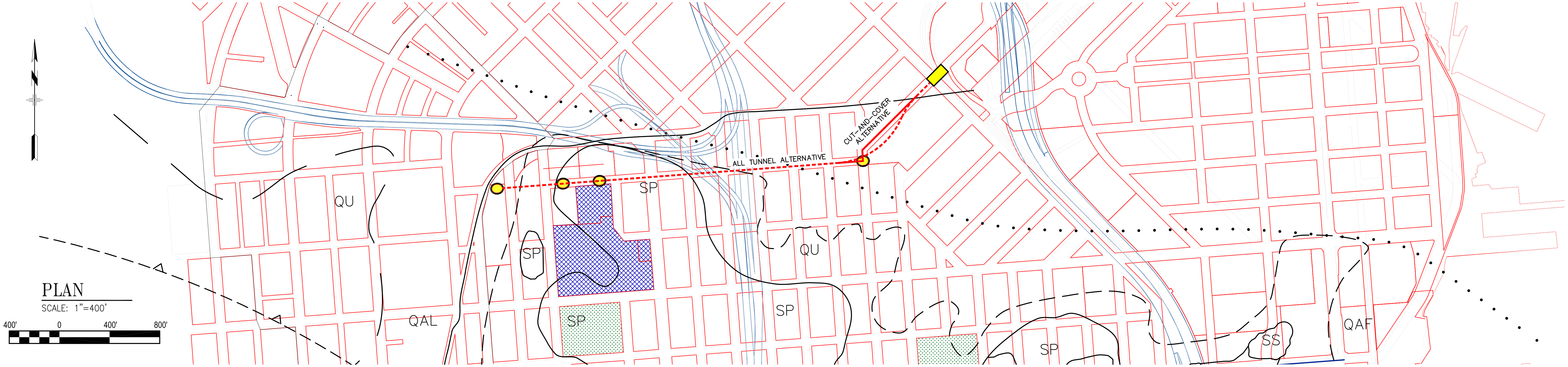
<u>Strength</u>

- Plastic – easily deformable with finger pressure.
- Friable – crumbles by rubbing with fingers.
- Weak – an unfractured outcrop of such material would crumble under light hammer blows.
- Moderately strong – outcrop would withstand a few firm blows before breaking.
- Strong – outcrop would withstand a few heavy ringing hammer blows but will yield large fragments.
- Very strong – outcrop would resist heavy ringing hammer blows and will yield with difficulty only dust and small fragments.

<u>Weathering</u>

	Decomposition	Discoloration	Fracture Condition
Deep	Moderate to complete alteration of minerals, feldspars altered to clay, etc.	Deep and thorough.	All fractures extensively coated with oxides, carbonates, or clay.
Moderate	Slight alteration of minerals, cleavage surfaces lusterless and stained.	Moderate or localized and intense.	Thin coatings or stains.
Little	No megascopic alteration of minerals.	Slight and intermittent and localized.	Few stains on fracture surfaces.
Fresh	Unaltered, cleavage surface glistening.	No discoloration.	

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT - GEOTECHNICAL PLAN AND PROFILE



PLAN LEGEND

DRIVE SHAFT (ALTERNATIVE LOCATIONS)

RECEIVING STRUCTURE (7TH & BERRY)

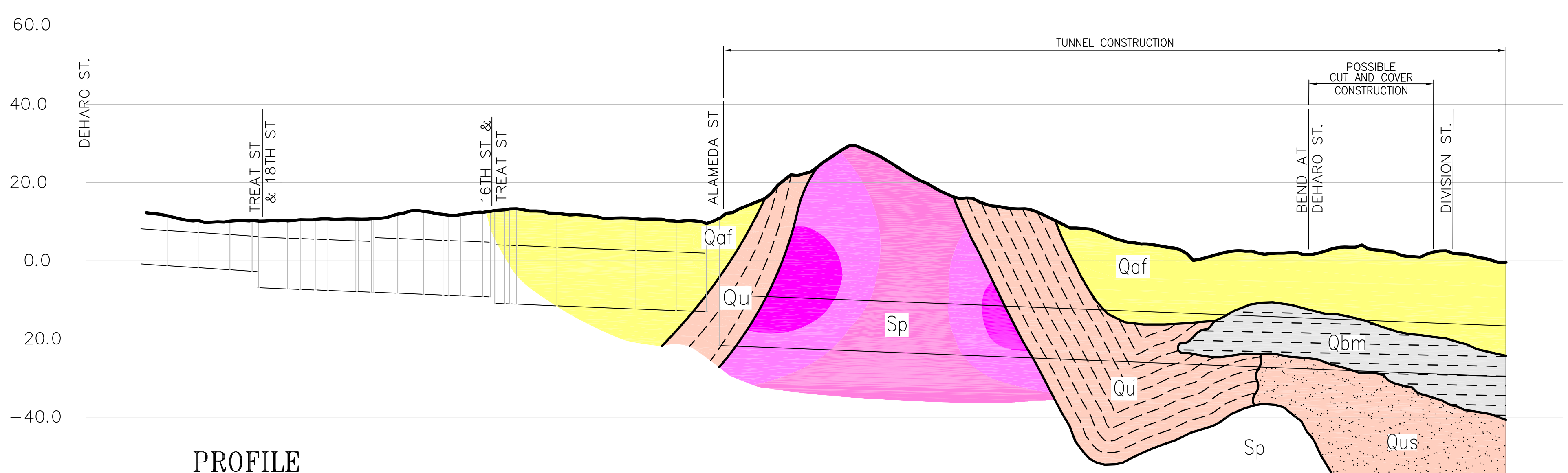
GEOLOGIC LEGEND

Symbol	Description
Qaf	ARTIFICIAL FILL
Qu	UNDIFFERENTIATED ALLUVIUM
Qbm	BAY MUD
Qus	SAND
Qbc	OLD BAY CLAY
Sp	FRANCISCAN COMPLEX – SERPENTINITE
Jspm	FRANCISCAN COMPLEX – MASSIVE SERPENTINITE
SS	FRANCISCAN COMPLEX – MASSIVE SANDSTONE

BEDROCK THRUST FAULT

NORTH SIDE OF HUNTERS POINT SHEAR ZONE (DEEPLY BURIED)

GEOLOGIC PROFILE INFORMATION BASED ON BLAKE, GRAYMER, AND JONES (2000), JACOBS (2015), AND MWH/URS (2014) BORING LOGS FROM SFDBI FILES, DTX, AND CALTRANS



STATIONING / ROCK QUALITY	2+00	15+50	25+00	40+00
ROCK ID AT TUNNEL DEPTH	Qu	Sp	Qu & Qus	Qaf & Qbm
RMR CLASS	alluvium	III – V	alluvium & sand	fill & bay mud
RATING DESCRIPTION	–	FAIR TO VERY POOR	–	–

0+00 10+00 20+00 30+00 40+00

DRAFT

20 0 20' 40'
SCALE: 1"=20'

PLOT DATE: 3/1/2018

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT - GEOTECHNICAL BORING PLAN 1

PLAN

SCALE: 1"=80'

DRAFT

80' 0 80' 160'

SCALE: 1"=80'

PLOT DATE: 3/2/2018

FOLSOM AREA STORMWATER IMPROVEMENT PROJECT - GEOTECHNICAL BORING PLAN 2

PLAN

SCALE: 1"=80'

DRAFT

80' 0 80' 160'

SCALE: 1"=80'

PLOT DATE: 3/2/2018

APPENDIX G

TUNNEL TECHNOLOGIES AND CASE HISTORIES IN MIXED-FACE SOILS AND ROCK

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G.0 Introduction

Excavation of tunnels through rock/soil mixed face conditions require controlled-face and/or pressurized face tunneling techniques. Typical methods which meet these criteria for this project include slurry TBM, Earth Pressure Balanced TBM (EPBM), or hybrid methods which may be a combination of slurry and EPBM methods. Slurry TBM methods pump a bentonite slurry to the excavation face and excavation chamber as the cutter wheel advances, and remove the excavated material by pumping the mixture of slurry and soils back to the shaft. Typically, slurry TBM methods are used for coarse grained materials with high permeability. EPBM methods use a screw conveyor to control the excavation face and remove material from the excavation chamber, and is typically are used for finer grained materials such as clays and silts with lower permeability. The two technologies are merging creating hybrid technologies; one example includes connecting of slurry pumps to the screw conveyor. In a hybrid TBM, the traditional "flat" cutterhead with high open/close ratio normally installed on an EPB machine is replaced by a rock-type cutterhead that could be equipped with either cutting discs or soft ground tools. Different pressurized face TBM technologies are discussed in more details in the following sections of this appendix followed by a survey of case histories with similar challenges in Section G-7.

G.1 TBM Methods

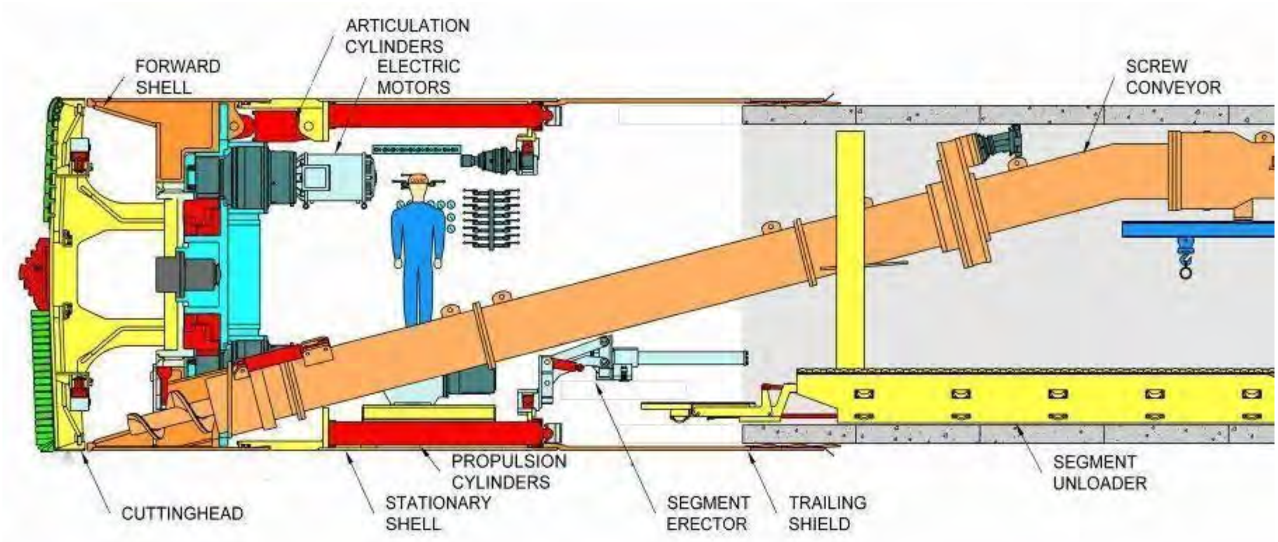
Because of the soft ground tunneling conditions and rock expected on the alignment pressurized face TBMs that include earth pressure balance tunnel boring machines (EPBM), slurry pressure balance tunnel boring machines (Slurry TBMs), or a hybrid types of the two (Hybrid TBMs) were considered suitable for the expected ground conditions. The choice between these three pressurized-face TBM types is influenced by several factors, including grain size distribution; soil and rock strength; ground permeability; and feasibility of soil separation and muck disposal. The main characteristics of these pressurized-face TBM methods are discussed in the following sections.

G.2 EPBM

EPBMs are designed to counterbalance the external ground and hydrostatic pressures at the tunnel face by maintaining an adequate pressure on the excavated material in the cutterhead chamber. A screw conveyor connected to the cutting chamber provides friction losses that counteracts and dissipates the face pressure. EPBMs can provide face pressures approximately one-half bar of ambient pressure.

EPBM details are shown in Figure G-1. Excavated spoils are discharged onto a conveyor belt through a slide gate at the rear of the screw auger and then into muck cars. Slide gates are provided along the screw conveyor to remove obstructions such as rock clasts or cobbles.

Figure G-1: Schematic of an EPBM

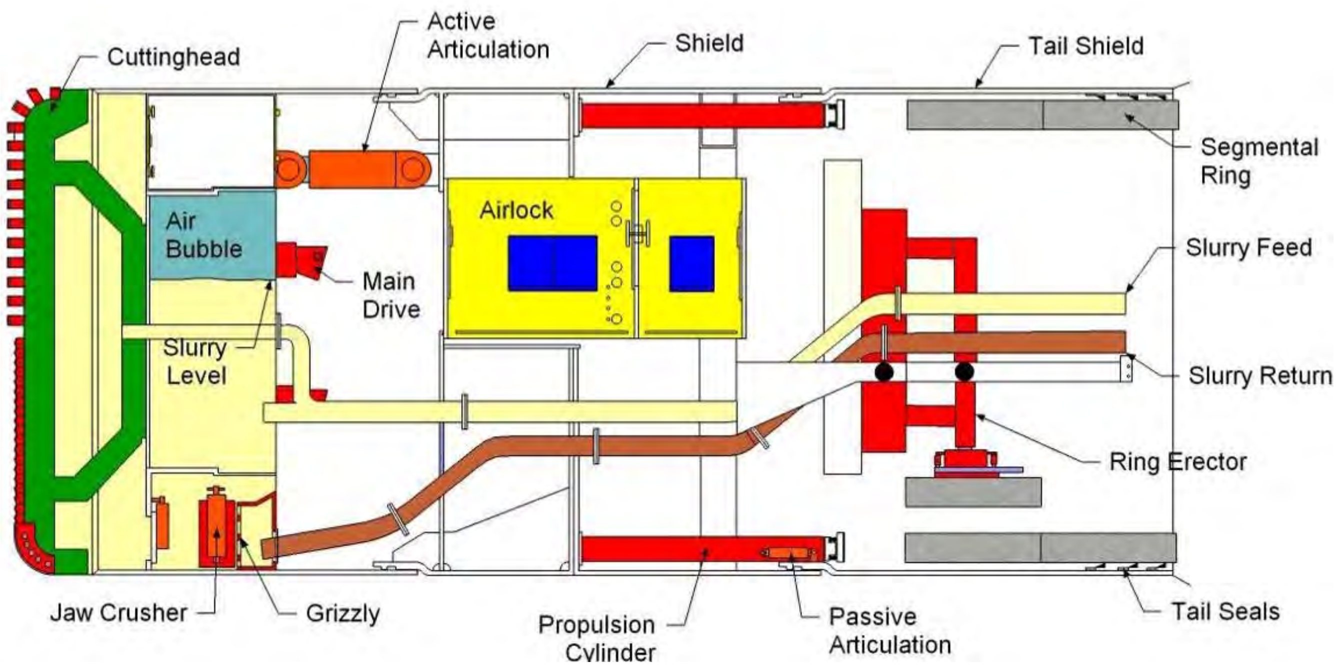


G.3 Slurry TBM

Slurry TBMs rely on bentonite slurry to apply a positive pressure to the tunnel face, which counterbalances the external earth and hydrostatic pressures. This is achieved by a filter cake or “impermeable” membrane that forms on the tunnel face as excavation proceeds. In slurry tunneling, the use of bentonite can be minimized or omitted if the ground contains adequate clay-sized particles. The excavated material is suspended in the slurry and pumped through a closed piping system to a slurry separation plant at the ground surface. The muck removed at the separation plant is disposed of off-site, while the slurry is reconditioned and pumped back to the tunnel face. In addition to counterbalancing the external pressures at tunnel face, the slurry also helps lubricate cutterhead and reduce cutting tool abrasion, and make spoil inert for ease in solid removal.

Slurry TBMs are available in two main categories, depending on whether an air cushion is used for fine regulation of the face-support pressure. TBMs that incorporate an air cushion system are known as mixshield TBMs. The distinguishing feature of the mixshield TBM is a partial bulkhead or buffer wall, separating the fluid-filled excavation chamber from a pressure chamber, containing an air cushion (or bubble curtain) above the slurry surface. This air-cushion system reduces the pressure fluctuations that can develop during slurry TBM operation and the chance of over pressurizing the face with a possible uncontrolled release of slurry. The amount of over pressuring of the face that could occur is a function of the machine slurry pump injection and control systems and can be well in excess of several bars. In cohesive soils or in rocky conditions, which do not require such a sensitive support mechanism, a mixshield TBM can be used as a simple slurry machine (*i.e.*, without the air cushion). A longitudinal section of a slurry-shield TBM with air chambers is shown in Figure G-2.

Figure G-2: Schematic of Slurry TBM



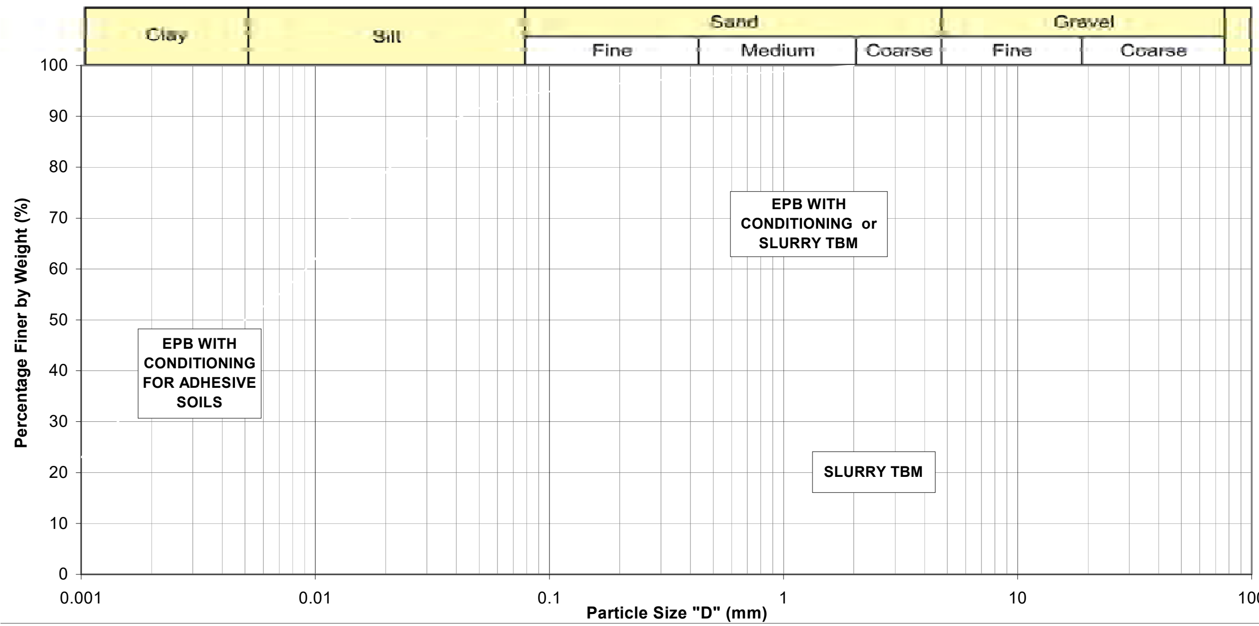
G.4 Hybrid TBM

Hybrid TBMs are seeing increased use in the tunneling industry. Hybrid TBMs were used on two major North American underground projects that are subject to high water pressures, Port of Miami Highway Tunnel and the Southern Nevada Water Authority's Intake No. 3. Hybrid TBMs incorporate the best features of both EPB and slurry TBMs for varying and difficult ground conditions. These TBMs use a screw auger to remove muck from the earth plenum and a slurry pipe and pumping system for muck transportation to ground surface, which avoids off-gassing from contaminated soils in muck cars and eliminates the need for slurry separation plant. On some Hybrid TBMs like the SNWA project, the slurry mode is used when mining rock in pressurized face mining, while the screw conveyor is used when mining the weak "punky" ground in non-EPB (open) mode using a belt conveyor to remove the muck. Hybrid TBMs may also be equipped with an air cushion or a bubble chamber when operating in slurry mode.

G.5 Application of Tunneling Methods

Ground conditions in which EPB and slurry TBMs would be best suited have been outlined by Langmaack (2001) and Maidl (2007) and are presented in the shaded regions in Figure G-3. As indicated, the limits of the EPB applications overlap with the traditional slurry TBM limits. Slurry TBMs have been used in soils that would normally be considered more appropriate for EPB methods. In either case, special conditioning of the tunnel muck or slurry additives such as surfactant foam, cohesive foam, polymers and clay dispersants among other additives are required to reach these limits.

Figure G-3: EPB and Slurry TBM Application



The gray area on the left side of this figure represents fine grained and generally cohesive materials that are best suited for EPBM technology. Soil materials that are too sticky will require conditioning to break soil adhesion to make the muck more flowable. The brown area in the central portion of the figure identifies an area that is a common operating area for both technologies in terms of grain sizes. More conditioning is required for the EPB technology as the curves approach the slurry TBM area (lack of fines) to provide enough plasticity to form a plug that can balance the water pressure. Conversely, when a slurry TBM is used for soils close to the limit of EPB technology, conditioning agents such as anti-plugging dispersant agents will be required to facilitate muck transportation to the ground surface and muck removal at the separation plant. Finally, the tan area on the right-hand side of the figure is suited for slurry TBMs. For soils in this area, polymer conditioners may be required to prevent the slurry migration into more permeable and coarser-grained materials.

While EPB and slurry TBMs are two ends of the spectrum in machine technology, the single heading alignment may require the machine manufacturer and the contractor to make compromises in optimum machine performance and hence, as discussed above, the contractor might choose to use a hybrid TBM.

G-6 Cutterhead Configuration Considerations

For slurry and EPB TBMs, the face is excavated with a bi-rotational cutterhead equipped with cutting tools to remove the intact ground and draw the loosened material into the cutterhead. The cutterhead is designed to handle both soft ground and weak rock with hard inclusions or boulders, known as a “mixed ground” cutterhead. A mixed ground cutterhead is a compromise, with tooling and opening configurations that can be modified for the majority of ground expected while mining through all of the ground types along a tunnel alignment. This is done by equipping the cutterhead with flexible back loading saddles or cutter boxes, which permit the use of both disc cutters for hard rock and ripper style tools for soils (Figure G-4). Additionally, replaceable scraper and bucket tools are configured in either case to gather and direct cuttings toward the openings. The compromise with a mixed-ground cutterhead is that the inclusion of the saddles reduces its rigidity, and unless the openings used for muck removal are reduced to permit more section for the cutterhead structure, unacceptable distortions may result. Reducing the opening area makes mixed ground cutterheads poorer performers in a soft ground where the opening area plays a large part in avoiding blockages and optimizing advance rates. Conversely, the tool and opening configuration of mixed ground cutterheads may not be optimal for a pure hard rock situation, as the cutterhead is typically not designed for high thrust capacity disc cutters or full disc scribing of the tunnel heading; however, they remain capable of reasonable performance and adaptable to unforeseen changes in the ground types throughout a given tunnel alignment. Generally, disc cutters should be used when the unconfined compressive strength of the material exceeds 5000 to 7000 lb/in.^{2}; otherwise, rippers should be sufficient.

Figure G-4: Disc Cutter (L) and Scraper (R)

The cutterhead needs to be designed for both conditions of soils and weak rock with stronger inclusions. This will involve a combination of scrapers/rippers that bring loosened material into the cutterhead openings with interchangeable rippers or disc cutters (back-loaded for safety). Through rock reaches, stabilizer pads or rollers need to be incorporated in the upper quadrant of the forward section of the shield, and they are deployed in order to reduce vibrations and torque reaction that occurs when the TBM encounters rock.

G-7 Case Histories of Mixed-face Rock/Soil Tunnel Projects

Many projects, which involve rock and soil and under high external pressures, considered slurry or hybrid methods with various consequences and lessons learned. Optimizing the cutterhead configuration to be as universal as possible for excavating/cutting hard rock and soft soils requires different cutter tooling. Finding locations for interventions to change tooling of the cutterhead underground is another issue. Also, the (open/non-pressurized or closed/pressurized) mode of tunneling for slurry, EPBM, or hybrid methods can drastically affect the efficiency of excavation, advance rate, machine wear, and amount of settlement. A survey of case histories with similar challenges is provided in Table G-1 for consideration when implementing the final design.

Table G-1
Similar Mixed Face Rock and Soil Tunnel Projects

Project Name & Location	Length [feet]	Diameter [feet]	Depth [feet]	Head [bar]	TBM Type	Geology; Mixed-face Mining Condition	Average Advance Rate	Comments or Lessons Learned	Refs #
Schuylkill River Crossing, Reading, PA, USA	436	5	5 to 35	0.5	Slurry MTBM Steel casing as support	Began with a mixed face of non-cohesive gravel in the top of the heading overlaying fractured dolomitic rock at the bottom; half way in to the drive, transitioned to a full face of fractured dolomitic rock approximately. Rock UCS up to 34.3 ksi.	14 ft/day	• With a full face of rock, MTBM face intervention is possible under normal atmospheric conditions. • Access to the MTBM cutter wheel for tool changes is critical to successful rock micro-tunneling	1
HEPP Machu Picchu Tailrace-Tunnel, Cuzco, Peru	Twin tunnels; 460	10	160	5	Slurry TBM	Rock at the beginning and at the end of the tunnels, in between river sediments of clay, silt and sand with very variable permeability.	-	• Active face support with Slurry-TBM and pipe jacking. • After 215 ft advance, the drive came to a halt due to excessive friction around the perimeter of the forward string section causing 2 months of interruption.	4
LNG Kwang River Crossing, South Korea	1,450	6	80	1.7	MTBM; Iseki TCC 1500	Alluvial soil to mixed face then granite	33 to 94 ft/day	• Cutters: Button bit plus kerf • No cutter changes	7, 8
Horden Outfall, England, UK	1,800	8	147	2	MTBM; HK AVN 1800D	Magnesian, brecciated limestone and mixed-face	-	• Cutters: disc cutters plus scrapers • Outfall drive included two vertical curves and down grade up to 14%	7, 9, 10
Clark Drive Sanitary Sewer, Vancouver, BC Canada	850	3.25	33	0.7	MTBM: Iseki Discmole	Sandstone, mixed face	7 to 14 ft/day	• Cutters: button bit cutters	7, 11
Billings Airport, Logan, Montana, USA	1,600	3.33	26	0.4	MTBM; Soltau RVS 350AS	Sandstone, mixed face	-	• Cutters: button bit plus kerf cutters • MTBM performed well	7, 12
Perry Taggart, Sanitary Sewer Delaware Co, Ohio, USA	1,300	5.25	40	1	MTBM; Lovat MTS 1000	Limestone and mixed face	5 ft/day	• Cutters: disc cutters plus scrapers • Stuck-unable to advance more than 5 ft/day in harder fulG-face limestone	7, 13
Barclay/4th/Chase MIS Replacement Project, Milwaukee, WI, USA	10,736	4 & 6	20 to 65	2	Slurry Shield MTBM RCP as support	Stiff to hard silty clay to clayey silt glacial till with scattered cobbles and boulders. Some outwash and lacustrine silt, sand and gravel layers and organic estuarine were also encountered. A mixed-face to full face rock tunneling was at a 400-foot-long dolomite rock ridge.		• The most significant risks included a stuck TBM due to boulder or cobble-boulder nest obstructions and inadequate thrust and torque to bore through bouldery ground, mixed-face and fulG-face rock. • Steering problems occurred in the soil/rock mixed-face. The tendency of MTBM to rise could likely have been mitigated by slowing the advance rate and pointing the machine downward before reaching the mixed-face segment. The steering problems contributed to cracking of one of the pipes which needed to be pushed through at the end of one of the two drives in full to mixed-face bedrock.	14

Project Name & Location	Length [feet]	Diameter [feet]	Depth [feet]	Head [bar]	TBM Type	Geology; Mixed-face Mining Condition	Average Advance Rate	Comments or Lessons Learned	Refs #
Circle Line Stage 3, Contract 853 (C853), Singapore CCL Drive: MRM-BSH	Twin tunnels; 4,100	19	50 to 145	1 to 4	Slurry TBM	Bukit Timah granite formation of different weathering grades from residual soil to moderately weathered granite. The interface between highly to completely weathered granite constitutes mixed face ground.	-	• Completed successfully, without any undesirable incidents, by the adoption of an excavation management system using dry soil volumes. • The TBM operating pressure 1.8 to 4.6 bar. • 10 cutter head intervention per TBM. • Volume loss of about 0.5%	2, 3
Circle Line Stages 1 to 5, Contracts C825, C828, C823, C822, C852. C853, C854, C855 and C856 in Singapore	Over. 100,000 in total	ID = 19 OD = 22	Var.	Var.	• Slurry: C853 • Slurry shield: C854 • Mixed shield: 2/3 of C855 • EPBM: others	• C825: Old Alluvium Jurong & FCBB • C828 and C823: Kallang Formation • C822: Kallang formation, Old Alluvium & Bukit Timah Granite • C852: Old Alluvium & Graniite • C853 BSH-LRC: Granite & Old Alluvium • C854: Mainly Bukit Timah Granite and fill • C855: Jurong Formation & Granite • C856: Jurong formation with overlaying F2, Marine Clay, Estuarine and fill material	9 to 30 ft/day	• Of the contracts, only one opted to use slurry TBM exclusively, with two contracts using both slurry and EPBM, with the choice of slurry coinciding with the Bukit Timah Granite. Evidently one of the driving factors in this choice was to deal with the mixed face conditions with the ability to increase the face pressure instantaneously and control the mixed face. Choosing a slurry machine does introduce an additional potential complication to the tunnelling process, that of the slurry composition and the plant required to produce and deliver the slurry to the tunnel face.	15
Circle Line Stage 4, Contract 854 (C854), Singapore	Twin tunnels 21,000	OD = 22	Ave. 80	Ave. 2	Slurry Shield TBM	Almost entirely within the Bukit Timah Granite Formation, and encountered sections of full face rock and residual soils together with significant sections of mixed face conditions. In some localized areas, the Bukit Timah Granite is overlain by weaker soil, Fluvial Sands and Clays, of the Kallang Formation.	12 ft/day	• Determine locations for planned interventions and confirm suitability with SI borehole. • Sufficient SI boreholes to identify the variances in the rockhead level. • Allow for frequent cutterhead interventions planned and unplanned.	16
Seven Various Major Projects, Singapore (15 cases of large settlement/sinkhole due to mixed faces of rock, or hard cohesive soil, and granular soil)	Var.	Var.	Var.	Var.	Pressurized Face TBM	Bukit Timah granite, which covers a suit of igneous rocks, and some metamorphosed granitic rocks. Apart from granite, the suite of rocks includes (inter alia) granodiorite, micro-granite, adamellite and gneiss. The broad term 'Bukit Timah granite' therefore covers a wide variety of materials in terms of the composition and size of the mineral grains.	Var.	• There is a risk for excessive loss of ground when tunneling through a mixed face both during normal excavation and during the, often frequent, interventions. • Detailed site investigation, to identify the location of interfaces and alignment design to minimize the length of the tunnel in mixed face conditions could reduce the overall risk.	5
North-East Line, Singapore	65,000	21	Var.	Var.	EPBM or Open Face Shield TBM	Passing through following formations with several mixed-face areas: (1) Kallang Formation--recent deposits of soft clays and fluvial sands; (2) Jurong Formation—sedimentary series, varying degrees of weathered sandstone from competent rock to highly fractured/friable hard clay to medium stiff clay; (3) Bukit Timah Formation	Var.	• The six contracts involving the use of bored tunnel methods have a total of 11 twin-bored tunnel drives using EPB machines and one twin-bored tunnel drive (from River Valley to Dhoby Ghaut) using semi-mechanical open-face machines.	17
Crystal Springs Bypass Tunnel, San Francisco, CA, USA	4,200	12.2	50 to 140	1 to 4	Hitachi-Zosen Shield TBM with HK Cutter	The site is underlain by "Sheared Rock" composed of Franciscan Complex Mélange matrix with blocks of sandstone and greenstone. The mélange matrix is composed of shale and claystone that have been crushed tectonically to a point that they behave more like hard clays than rock. Tunnel alignment passes Mélange matrix with minor (cobble sized) and major (1,198 ft) blocks of sandstone, siltstone, greenstone, serpentine.	60 ft/day	• Significant environmental restrictions and challenging ground conditions. • The detailed ground investigation established reliable baseline conditions. • The rigorous instrumentation and monitoring of potential ground and groundwater changes, noise, and vibration resulted in minimal disturbance to the surrounding community and to the environment.	18

Project Name & Location	Length [feet]	Diameter [feet]	Depth [feet]	Head [bar]	TBM Type	Geology; Mixed-face Mining Condition	Average Advance Rate	Comments or Lessons Learned	Refs #
Central Subway Tunnel, San Francisco, CA, USA	9,000	17.8 ID Exc. Dia. Of 20.7	40 to 200	Var.	EPBM (Hybrid)	Tunnel passes through Artificial Fill, Dune Sand, Bay Mud/Marsh Deposits, Undifferentiated Deposits, Colma Formation, Undifferentiated Old Bay Deposits, Colluvium, and Franciscan Complex Bedrock, which is variable Jurassic and Cretaceous unit containing sandstone, meta-sandstone, sandstone breccia, shale, and siltstone ranging from a soft, highly weathered, friable condition to a fresh and moderately strong but fractured condition. The Franciscan unit was encountered over the middle third of the tunnels.	Up to 130 ft/day	• The contractor used a hybrid TBM design—the traditional "flat" cutterhead with high open/close ratio normally installed on an EPB machine was replaced by a rock-type cutterhead that could be equipped with either cutting discs or soft ground tools. This hybrid design was chosen because of the mixed conditions along the alignment. • The selected EPBMs were welG-suited to the ground condition and contributed to the project's success.	19
Hallandsås Project, Sweden	18,000 by TBM	Excav. Dia = 35	Var.	Var.	Dual mode hard rock Mix-Shield TBM	The Hallandsås Ridge is situated within the southern part of the Fennoscandian Shield, within a major tectonic zone called the Tornquist Zone. The highly variable rock mass of the Hallandsås ridge includes quite a few engineering geological hazards (loose wedges, raveling ground/slaking, running ground and flowing ground).	10 ft/day	• Cost of operating in closed mode is about double that of open mode. • Slurry system, cutter and cutterhead wear is much higher than expected. • Controlling ground water remains the most important challenge for the Hallandsås Project. The two tools; ground treatment by pre-excavation grouting and barrier con-struction are combined in order to optimize the TBM progress through water bearing zones	20
Sunnydale CSO Tunnel, San Francisco, CA, USA	4,000	8 to 12	25	0.6	EPBM	Mixed face conditions with an uneven transition with ground ranging from Franciscan Complex (consisting mainly of a chaotic tectonic mixture of variably sheared shale and sandstone containing resistant rock masses largely of greenstone, chert, graywacke, and serpentinite) to Coloma sand and Bay Mud.	-	• The crossings are also the transition zones of geology—transitioning from fill, Bay Mud, and Colma Sand into residual soil and Franciscan Complex bedrock. • With the goal of balancing the cost benefit of mitigating risks, an EPBM tunnel was recommended.	21
SNWA Lake Mead Intake No. 3, Nevada, USA	16,000	24		>10	Slurry/Hybrid	Amphibolite, basalt flow. Muddy Creek weak mudstone		• Open mode in good ground, use muck ring and screw conveyor to remove from material from mixing chamber • Large inflows in open mode	-
DC 02/03 Phase 1, Tunnel No. 3, Missouri, USA	600	10		0.5	Slurry	Clay over limestone	10 ft./day	• Little to no settlement under busy intersection with many utilities.	-

G-8 Conclusions

The driving factors in choosing pressurized face tunneling is to deal with the mixed face conditions with the ability to increase the face pressure instantaneously and control the mixed face. This appendix discussed different pressurized face TBMs in details including EPBM, Slurry TBM and the hybrid TBM. A survey of case histories with similar challenges is provided in Table G-1 for consideration when implementing the final design.

For Folsom Area Stormwater Improvement Project's tunnel, a pressurized face TBM is essential for excavation through the soft ground as well as the mixed-face portions of the tunnel. Once in the serpentinite reach, it is expected that open mode (non-pressurized face) tunneling can be employed and low groundwater infiltration is expected. A Hybrid pressurized face TBM seems to be an efficient and practical option.

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APPENDIX H

CONSTRUCTION SETTLEMENT IMPACT ANALYSIS

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H.1 Introduction

This appendix investigates the impacts of the project's construction activities on the existing facilities including buildings and utilities.

As explained in more details in the main body of this Conceptual Engineering Report (CER), the project includes a bored tunnel with an Internal Diameter (ID) of 12 feet starting from the launch shaft at the SPCA parking lot and ending at the existing Southeast Outfall Box end wall. The tunnel is to be bored using a closed-face Tunnel Boring Machine (TBM) or a hybrid TBM, which will be closed-face while excavating through soft ground. In the settlement analysis, we conservatively considered Outside Diameter (OD) of the liner is 13'-8", while the excavated diameter is 15 feet.

The launching shaft will have a finished ID of 35 feet. Considering a cast-in-place final liner with thickness of 18 inches and a support of excavation (SOE) to be either slurry wall or secant pile with thickness of 30 inches, the excavation diameter of the shaft would be 43 feet. The top of the invert slab has depth of 45 feet. Considering 20 feet to be the total of the invert slab's thickness and the embedment of the SOE below the bottom of the excavation, the toe of SOE will be at depth of 65 feet.

A Cut-and-Cover (C&C) option is also being considered which has the same launching shaft and 12-ft-ID bored tunnel but with the following differences:

- A receiving shaft at intersection of De Haro Street and Alameda Street with internal diameter of approximately 25 feet. Considering the thickness of SOE and cast-in-place liner, the excavation diameter of the shaft can be as large as 33 feet. The top of the invert slab has depth of 30 feet. Considering 20 feet to be the total of the invert slab's thickness and the embedment of the SOE below the bottom of the excavation, the toe of SOE will be at depth of 50 feet.
- C&C box tunnel with internal width of 11 feet between Stations 29+00 and 34+00. Considering the thickness of SOE and the final structure, the width of excavation is estimated to be 16 feet.

The construction impacts of the C&C option have been investigated in Section H.7 of this Appendix.

H.2 Geology and Subsurface Ground Condition

Figure H.1 below presents subsurface ground profile along the tunnel alignment. It divides the tunnel into the following four different reaches based on the type of grounds through which the tunnel will be excavated:

- Reach 1 – Station 0+00 to Station 2+00 – Passing through Alluvium
- Reach 2 – Station 2+00 to Station 15+50 – Passing through Serpentinite
- Reach 3 – Station 15+50 to Station 25+00 – Passing through Alluvium and Sand
- Reach 4 – Station 25+00 to the End – Passing through Fill and Bay Mud

We retrieved and reviewed some of the geotechnical site investigations which were performed for the structures near the tunnel alignment as well as the nearby projects.

Table H.1 summaries our estimation of shear strength and deformability of different ground layers.

Figure H.1
Subsurface Ground Profile Along the Tunnel Alignment

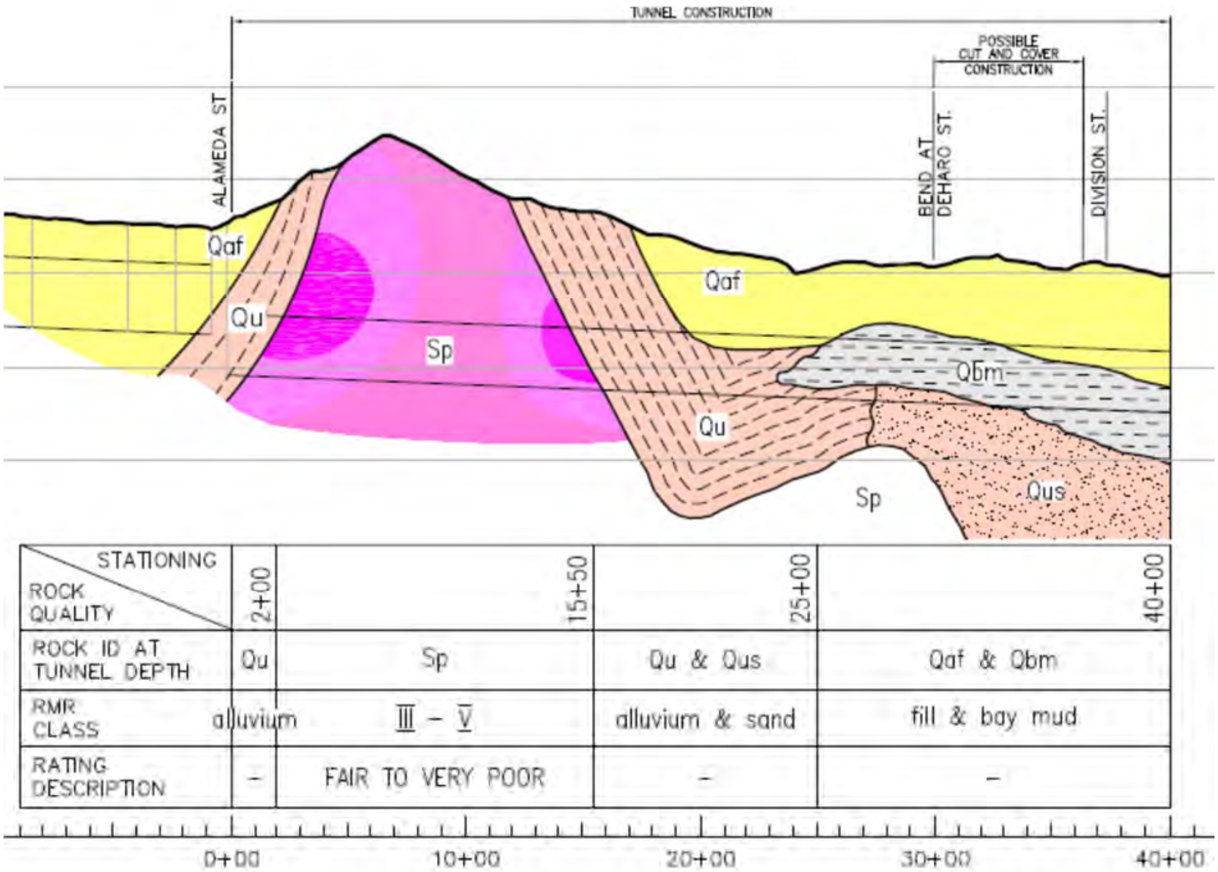


Table H.1
Estimated Ground Properties

Layer	Unit Weight [pcf]	Undrained Shear Strength [ksf]	Friction Angle [degrees]	Young's Modulus [ksf]
Qu – Alluvium	120	2	-	800
Sp – Serpentinite	152	3	-	6,000
Qaf – Fill	120	-	31	300
Qbm – Bay Mud	95	1.7	-	200
Note: Serpentinite's shear strength and deformability was estimated considering, intact rock uniaxial compressive strength of 1828 psi, tensile strength of 462 psi; and rock mass Geological Strength Index (GSI) of 20.				

H.3 Tunneling Induced Settlement

The most commonly used empirical method for interpreting surface settlements is the one proposed by Peck (1969) and Schmidt (1969). This method suggests that the transverse settlement trough due to tunneling can be described by a Gaussian curve (see Figure H.2):

$$1_1 = 1_{1\ 11}\exp(-\frac{1^1}{21^1})$$

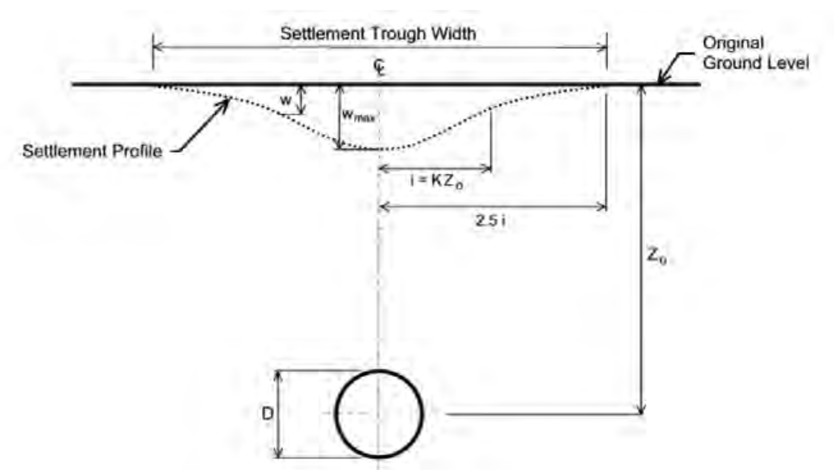
Where S_x is settlement at distance of x from the centerline of the tunnel; and i is the settlement trough distance. The maximum surface settlement, S_{max}, can be calculated using the following equation:

$$1_{1\ 11} = \frac{1_1 1\ (\frac{1}{2})^1}{2.51}$$

D is the tunnel diameter; for our tunnels D = 15 feet (excavation diameter). V_L is the volume of ground loss during tunneling excavation.

In this appendix, we call 2.5i as the Zone of Influence (ZOI).

Figure H.2
Typical Settlement Profile



This empirical method is widely accepted by the tunneling industry and provides reasonably accurate estimates of ground deformation if the volume loss and the settlement trough distance being properly estimated, which can be considered as the limitation of this empirical method. Typically, the volume loss percentage and the settlement trough distance provided in literature are from previous projects in which new advancements of TBMs are not considered. In addition, the literatures provide those values based on ground type and/or ground behavior rather than ground deformability. Numerical analysis (using Finite Element Method or Finite Difference Method) can overcome those limitations. Therefore, in this section, we first estimated V_L and i for each Reach by literature review and, then, verified or calibrated our estimation using Finite Element Analyses performed using Plaxis 2D.

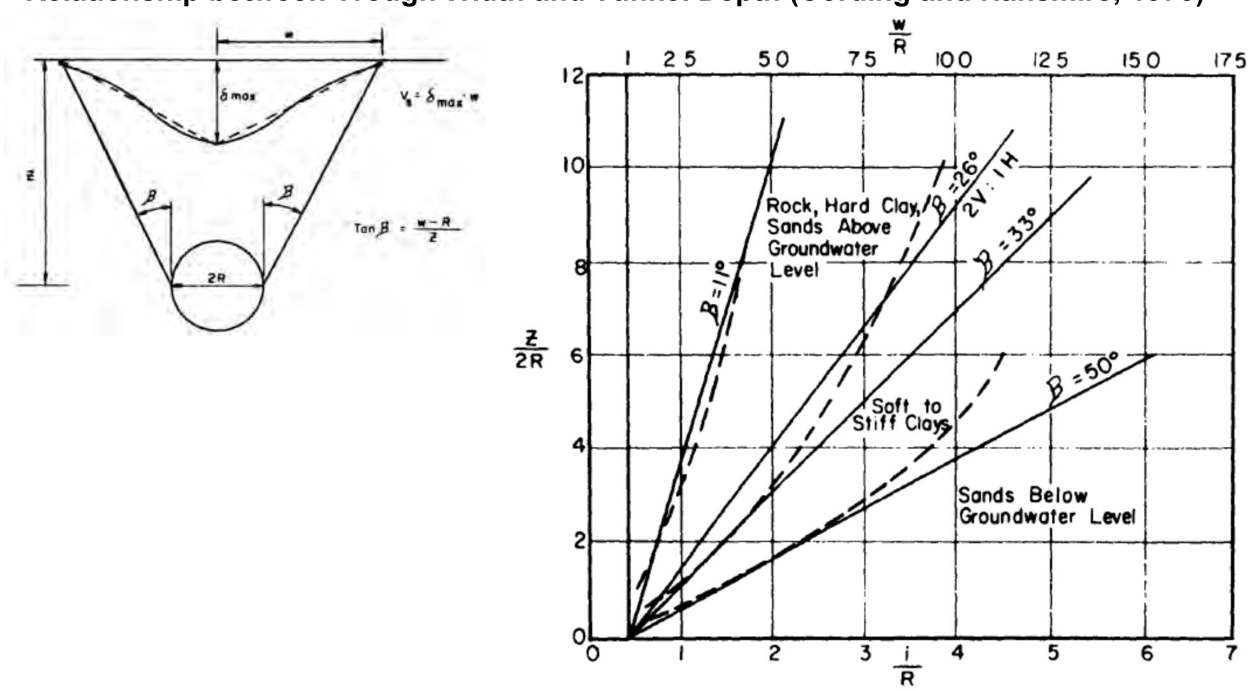
Table H.2 presents relationship between volume loss and construction practice and ground conditions after FHWA Manual for Design and Construction of Road Tunnels (FHWA-NHI-10-034).

Table H.2
Volume Loss versus Construction Practice and Ground Conditions

Case	V_L [%]
Good practice in firm ground; tight control of face pressure within closed face machine in slowly raveling or squeezing ground	0.5
Usual practice with closed face machine in slowly raveling or squeezing ground	1
Poor practice with closed face in raveling ground	2
Poor practice with closed face machine in poor (fast raveling) ground	3
Poor practice with little face control in running ground	4 or more

After reviewing Peck (1969), Attewell (1978) and Cording and Hamsmire (1975), we picked Cording's and Hansmire's approach to correlate the trough width and tunnel depth as presented in Figure H.3.

Figure H.3
Relationship between Trough Width and Tunnel Depth (Cording and Hansmire, 1975)



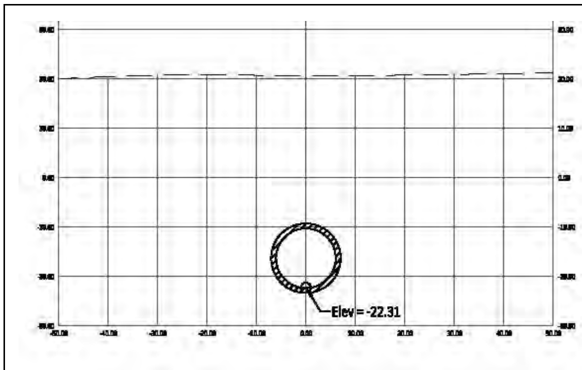
Considering Table H.2 and Figure H.3, with some engineering judgment, we estimated volume loss and settlement tough width for each reach as summarized in Table H.3. It should be noted that angle β for Reach 2 was selected to be 33 degrees considering the poor to very poor nature of the rock mass as well as the fact that depth to diameter ratio is less than 3.

Table H.3
Volume Loss and β for Different Reaches (Literature Review)

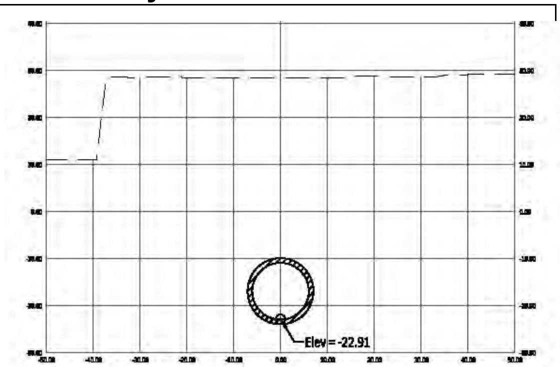
Reach #	V_L [%]	β [degrees]
1	1	45
2	0.5	33
3	1	45
4	2	45

As the next step, we performed FEM analysis to verify or calibrate values presented in Table H.3. The analyses were performed using Plaxis 2D version 2015.02. One cross-section was selected for each reach and 2D plane strain model was built at each cross-section. Figure H.4 presents the analyzed cross-sections with their invert elevations and ground surface.

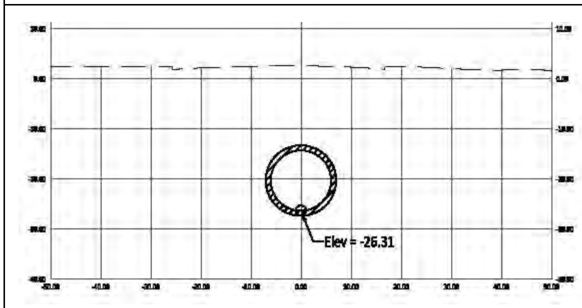
Figure H.4
Cross-sections for Plaxis FEM Analyses



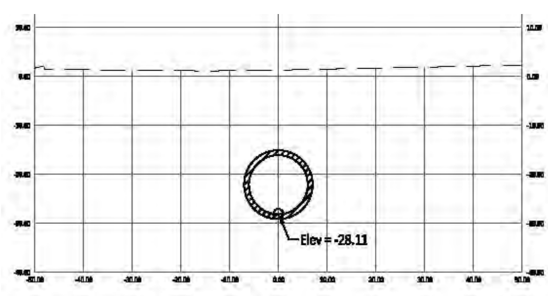
Reach 1 @ 2+00; Ground Surface EL 21’



Reach 2 @ 6+00; Ground Surface EL 29’



Reach 3 @ 23+00; Ground Surface EL 3’

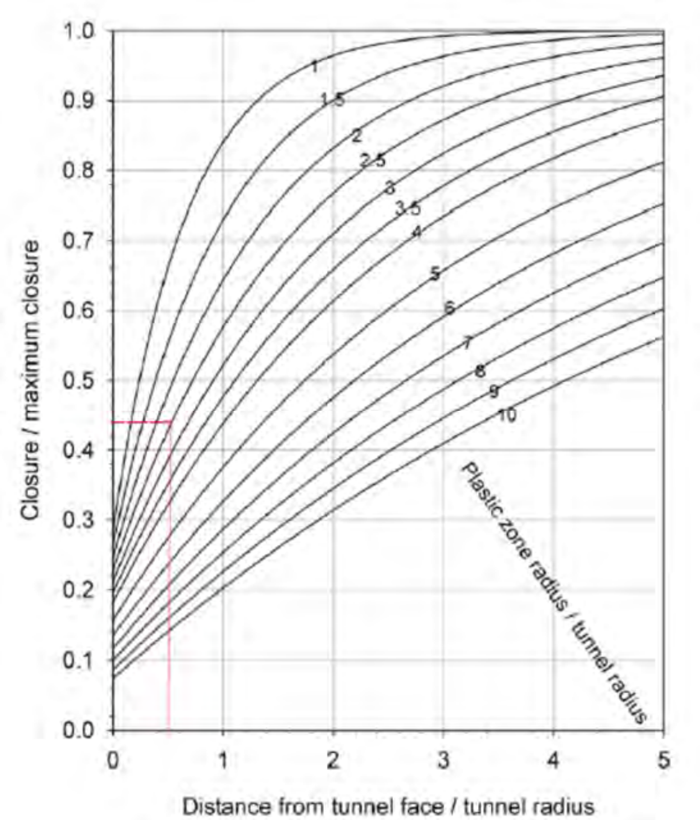


Reach 4 @ 32+00; Ground Surface EL 2’

Reasonable assumptions were made for Plaxis analyses some of which are mentioned in this paragraph. At-rest lateral pressure coefficient of all soil/rock layers were assumed to be 0.5. This is reasonable value for rock and sand. For Bay Mud which is young and typically normally consolidated, we expect the K_0 to be higher than 0.5 but less than 1. For alluvium clay, we would expect K_0 to be closer to 1. In our settlement analyses, assuming K_0 of 0.5 for all layers mean more vertical stress and, in turn, more vertical displacement. Therefore, our selection of K_0 is reasonably conservative. In addition, the ground surface was assumed to be horizontal and no building or surcharge loads were simulated. Moreover, the tunnel liner was assumed to be concrete with compressive strength of 5ksi and thickness of 10 inches.

The Plaxis analyses were performed in three phases: (1) initial phase to model ground condition before tunnel excavation; (2) tunnel excavation with ground relaxation; (3) tunnel support. The ground relaxation is to model the 3D effect of tunnel construction and the lagging between the tunnel liner installation and the excavation. The ground relaxation is simulated in Plaxis using stage reduction factor approach. Pressurized face TBMs can minimize the closure before support installation up to almost zero distance between excavation and support installation. Although our TBM will be either pressurized-face or hybrid, in this preliminary CER analysis, we would like to conservatively assume liner to be installed at one-diameter distance from the cutterhead. Figure H.5 illustrates the relevant closure percentage.

Figure H.5
3D Effect of Tunnel Excavation in 2D Analysis Vlachopoulos. and Diederichs (2009)



It should be noted that for the model at Reach 1, we performed sensitivity analysis for ground relaxation using 100%, 90%, 80%, 75% and 50% closures before support installation. It was concluded that the selected closure percentage does not change the ZOI and only changes the maximum settlement above the tunnel axis.

For Reach 1, considering the fact that the plastic zone radius is slightly higher than the two times of the tunnel radius, a closure of 80% was considered for ground relaxation. Figure H.6 compares settlement trough obtained from Plaxis and Empirical method. Table H.4 compares Plaxis and Empirical Method results.

The results are very close to each other specifically as far as the volume loss. This indicates that the 1% volume loss recommended by the literature for this kind of ground is mainly for open-face TBM. For this CER analysis, we will use Empirical method results in our impact assessments of Reach 1 since they are conservative. It should be noted that although Plaxis has wider ZOI, the settlement after 45 feet is less than 0.1 inch and negligible. The narrower selection of ZOI maximizes the predicted distortion and, thus, is on the safe side.

Figure H.6
Settlement Profile from Plaxis and Empirical Method @ Station 2+00 (Reach 1)

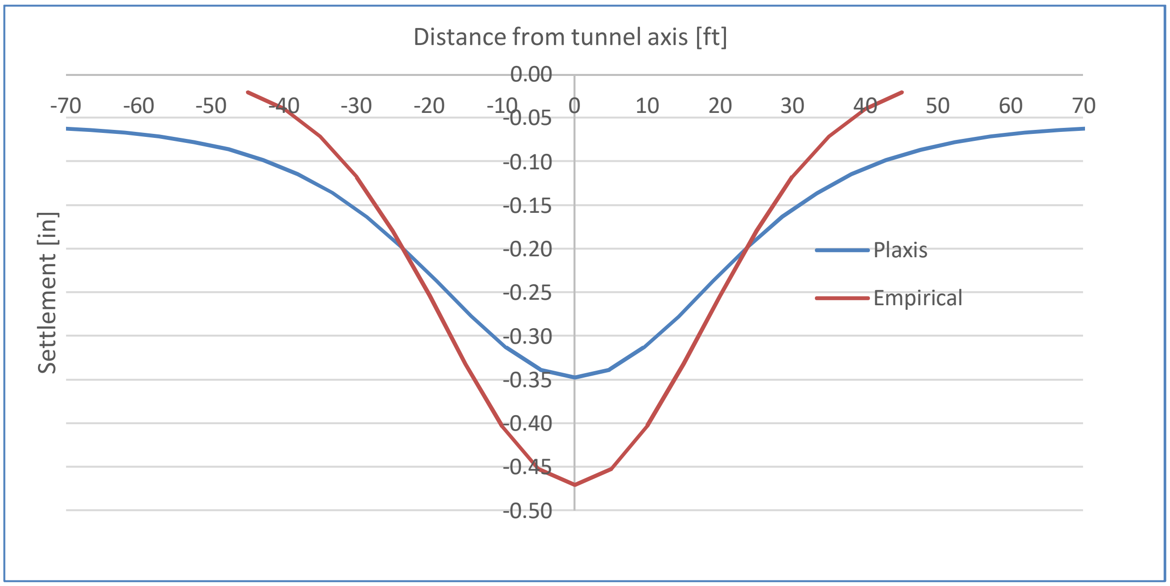


Table H.4
Plaxis versus Empirical Method Results at Reach 1

Parameter	Plaxis	Empirical
ZOI	63 feet	45 feet
S_{max}	0.35 inch	0.47 inch
V_L	Back-calculated = 1%	Assumed = 1%

Similar analyses were performed for other Models/Reaches and results are summarized in Table H.5.

Table H.5
Plaxis versus Empirical Method Results at Reaches 2, 3 and 4

Parameter	Reach 2		Reach 3		Reach 4	
	Plaxis	Emp.	Plaxis	Emp.	Plaxis	Emp.
ZOI (feet)	75	37	25	31	35	32
S_{max} (inch)	0.11	0.29	0.7	0.7	1	1.3
Back-calculated_V_L (%)	0.4	-	0.8	-	1.7	-

Comparing the results of Plaxis and Empirical method, we verified or calibrated our original assumptions for volume loss and ZOI. Only changes that we made compared to Table H.3 values were the decrease in the volume loss of Reach 2 from 2% to 1.7% since 2% corresponds to poor face control which should not be the case passing through Bay Mud. Table H.6 summarizes the calibrated/verified volume loss and angle β.

Table H.6
Volume Loss and β for Different Reaches (Verified/Calibrated with Plaxis)

Reach #	V_L [%]	*B* [degrees]
1	1	45
2	0.5	33
3	1	45
4	1.7	45

Using V_L and β of Table H.6, we calculated the maximum settlement, distortion and ZOI for the whole alignment in Table H.7. Distortion is defined as follows:

$$1\ 11111111 = \frac{1}{1} = \frac{1_{1\ 11}}{1\ 1\ 1}$$

For the impact assessment, the tunnel alignment is divided into the following 3 different categories:

- Category 1 – Stations 0+00 to 15+50:
  - ZOI = 50 feet & S_{max} = 0.5 inch
- Category 2 – Stations 15+50 to 25+00:
  - ZOI = 30 feet & S_{max} = 0.7 inch
- Category 3 – Stations 25+00 to End:
  - ZOI = 30 feet & S_{max} = 1.2 inch

Table H.7
Zone of Influence (ZOI) and Maximum Settlement along the Tunnel

Station	Depth of Tunnel Axis [feet]	*ZOI* [feet]	S_{max} [Inch]	*Distortion*
2+00	37.31	45	0.47	1/1149
6+00	45.91	37	0.29	1/1531
8+00	43.31	36	0.29	1/1490
11+00	35.91	31	0.34	1/1094
14+00	32.51	29	0.37	1/941
16+25	30.96	38	0.56	1/814
21+00	24.91	32	0.66	1/582
23+00	23.31	31	0.68	1/547
25+50	22.81	30	1.20	1/300
32+00	24.11	32	1.13	1/340
37+50	23.21	31	1.16	1/321

Our previous experience as well as results of Plaxis analyses show that the maximum vertical settlement increases with depth from the ground surface up to the tunnel crown. The vertical movement at tunnel crown can be calculated by obtaining the convergence of the given volume loss. The ZOI changes accordingly. Using this approach, Figures H.8, H.9 and H.10 are presenting settlement profile at ground surface and tunnel crown elevation for our three different categories.

Figure H.7
Tunnel Induced Settlement Profile for Category 1

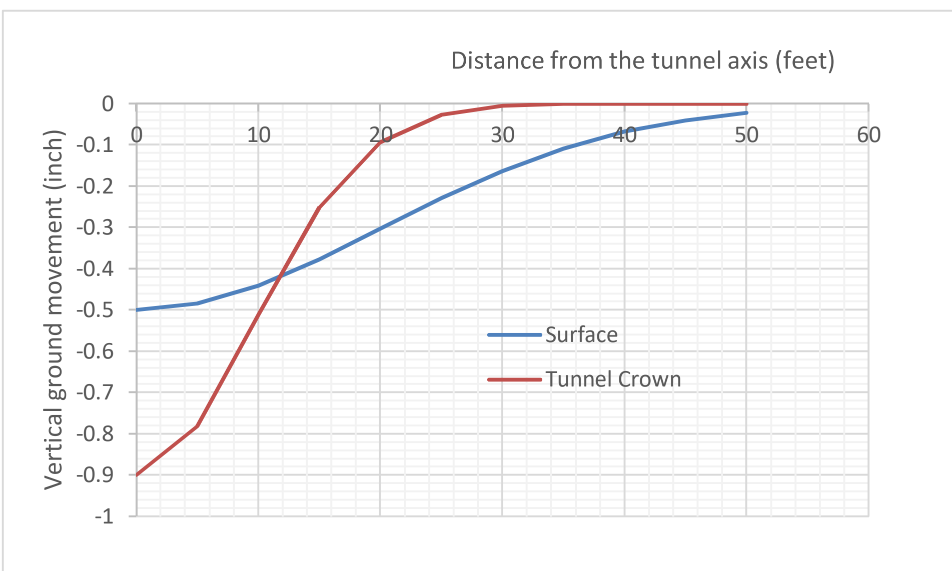


Figure H.8
Tunnel Induced Settlement Profile for Category 2

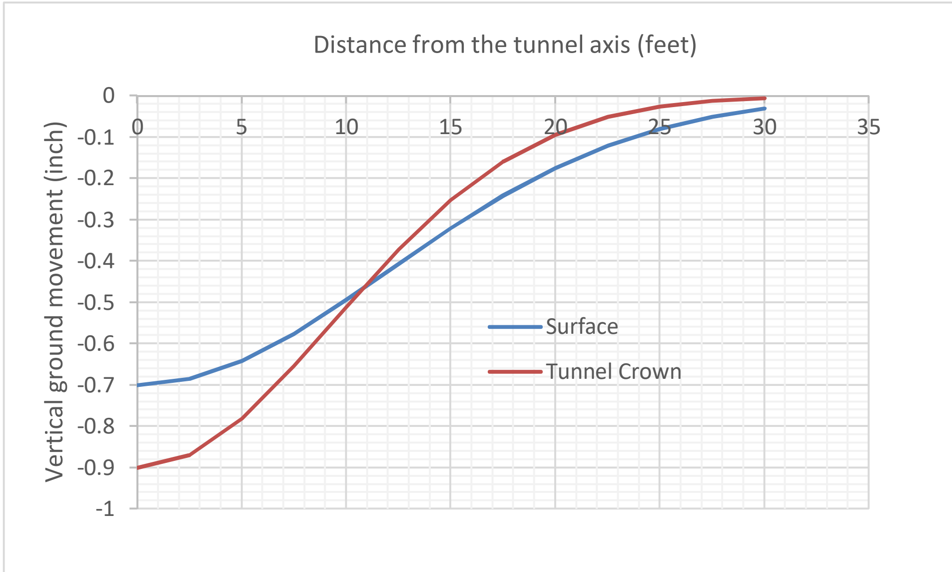
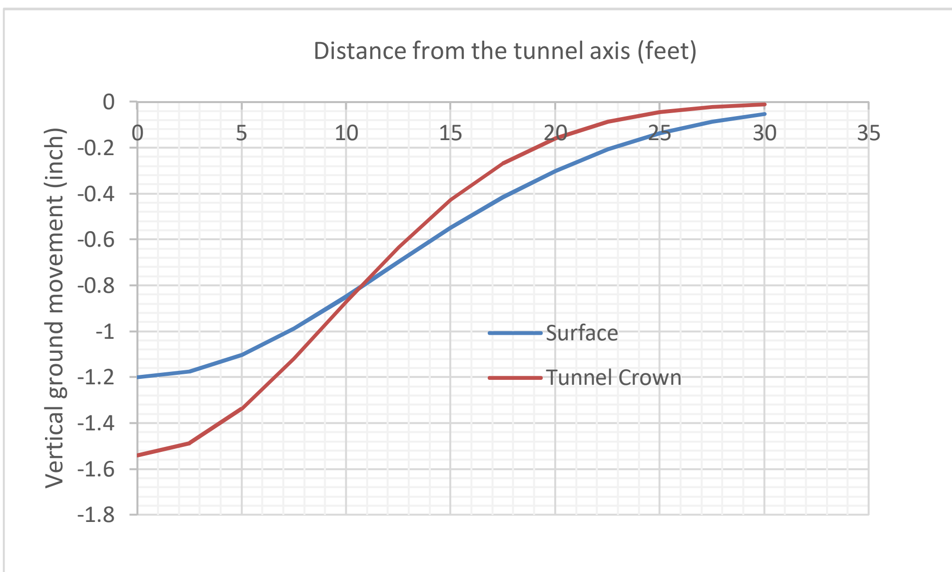


Figure H.9
Tunnel Induced Settlement Profile for Category 3



H.4 Settlement Induced by Shaft Construction

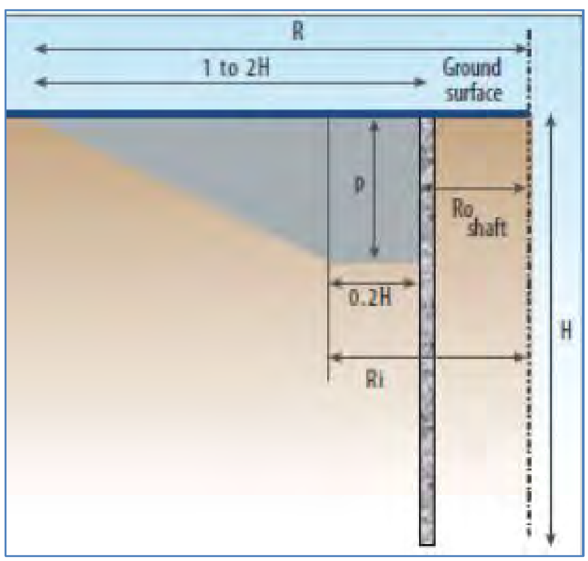
The launching shaft will have either slurry wall panels or secant piles as support of excavation. This system is typically rigid and will not induce much settlement during the shaft excavation. The main ground deformation would be during panel excavation and dewatering, if any. Whether there will be dewatering or not, depends on means-and-methods of the contractor who will decide to do shaft excavation in dry or wet. We did not consider dewatering induced ground deformations in this CER. This shall be addressed during final design, if necessary.

A common conservative method being used for the shaft settlements employs an empirically-based settlement profile that is scalable based on the wall depth and the maximum horizontal movement occurring during panel/bored pile construction. The following assumptions were made to develop the empirical settlement profile (see Figure H.10):

- The distance from the shaft at the ground surface to where the settlement is zero is 1.5 times the depth (H) of the slurry wall panel or secant pile.
- The maximum settlement can occur at the edge of the shaft or out to 0.2H away from the shaft.
- The maximum vertical settlement is 0.05%H.
- The maximum horizontal ground movement is twice of the maximum vertical movement.

Considering the panel depth of 65 feet, the maximum vertical settlement would be 0.4 inch; the maximum horizontal ground movement would be 0.8 inch; the ZOI (R in Figure H.7) would be 120 feet; the zone of maximum settlement (Ri in Figure H.7) would be 35 feet.

Figure H.10
Settlement Profile for Shaft Construction



H.5 Risk Categories – Limits of Settlement and Distortion

According to Rankin (1988), maximum settlements of less than 0.4 inch and distortions of less than 1/500 are considered negligible with superficial damage being unlikely. Maximum settlement between 0.4 inch and 2 inches or maximum slope of building between 1/500 and 1/200 are described as slight risk with possible superficial damage which is unlikely to have structural significance. Wahls (1981) considers distortion more than 1/750 being danger to machinery sensitive to settlement and more than 1/600 to be danger to frames with diagonals. It defines distortion of 1/500 as the safe limit for no cracking of building and distortion of 1/300 as first cracking of panel walls.

Considering above mentioned criteria from literatures, we would like to define the following tighter risk categories for this project's adjacent structures:

- Negligible: $S_{max} \leq 0.1$ inch or Distortion < 1/750
- Slight: $0.1 < S_{max} \leq 0.2$ inch or 1/750 < Distortion < 1/500
- Moderate: $0.2 < S_{max} \leq 0.4$ inch or 1/500 < Distortion < 1/300
- High: $S_{max} > 0.4$ inch or Distortion > 1/300

We selected much tighter criteria to account for possible previous settlements/distortions that structures might have experience due to other construction activities or other causes. In addition, at this CER stage, the analyses are preliminary and based on some [reasonable] assumptions for ground information. These criteria shall be modified during final design as necessary considering building conditions and the 3rd parties' (their owner's) requirements.

According to Rankin (1988), distortions over 1/200 have potential damage to rigid pipeline and distortions over 1/50 have potential damage to any pipeline. Considering these limits and those given by Wahls (1981), we define the following risk categories for this project's affected existing utilities:

- Slight: Distortion < 1/500
- Moderate: 1/500 < Distortion < 1/300
- High: Distortion > 1/300

Tighter criteria were adopted for the same reason explained above. In addition, we consider all utilities to be at least in "Slight" risk category because their load bearing capacity is unknown (for example, amount for reinforcements in concrete, if any). Moreover, although distortion is the most critical component of impacts on utilities, they typically experience more settlements compared to building due to their depth and distance from the tunnel axis.

Below is our definition of risk categories:

- Negligible: no further analysis or mitigation is essential;
- Slight: at least, more detailed analysis is needed;
- Moderate: in addition to further analysis, monitoring is needed with proper mitigation measures to be employed if action limit passes; and
- High: in addition to further analysis and monitoring, mitigation measures are most probably needed, which is to be verified and specified during final design.

H.6 Impact Assessment

Figures H.11 and H.12 presents the zone of influence on tunnel alignment. Figure H.13 depicts the block numbers for further discussions.

Figure H.11
Tunnel and Shaft Construction – Zone of Influence – 1 of 2

Figure H.12
Tunnel and Shaft Construction – Zone of Influence – 2 of 2

Figure H.13
Block Numbers

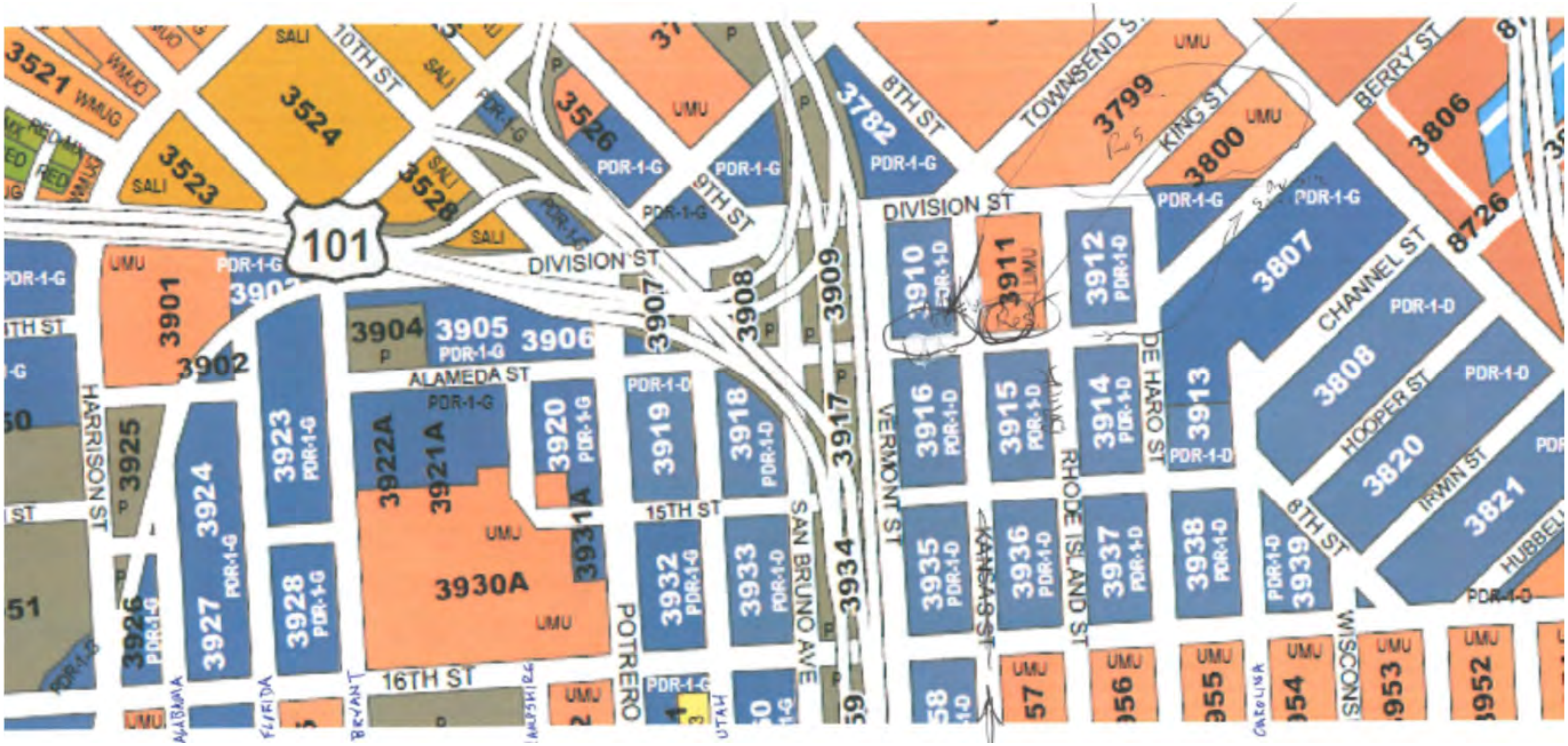


Table H.8 summarizes the estimated maximum settlement and distortion for all buildings and structures within the zone of influence together with their risk category. If foundation information is not available, reasonable or conservative assumptions have been made. The settlement profile associated with each category was used with some engineering judgment and conservatism. For example, for bridges' column, the most critical settlement profile at the given distance from tunnel axis was considered.

Table H.8
Impacts on Different Buildings/Structures within ZOI

Block #	Type of Structure	Closest Distance to Tunnel Axis	Maximum Settlement	Maximum Distortion	Risk Category
3902	Parking	-	-	-	Negligible
3924	Parking within ZOI	-	-	-	Negligible
3923 North	Building	~ 35 feet	0.1 inch	1/1800	Negligible
3923 South	Building	~ 15 feet	0.38 inch	1/1100	Moderate
3904, 3905 & 3906	Buildings	~ 40 feet	0.08 inch	1/1500	Negligible
3922A	Building	~ 30 feet	0.16 inch	1/1500	Slight
3921A	Parking	-	-	-	Negligible
3920	Building	~ 25 feet	0.2 inch	1/1360	Slight
3907	Building	~ 40 feet	0.08 inch	1/1500	Negligible
3919	Building	~ 25 feet	0.2 inch	1/1360	Slight
3918 & 3908	Rt101 Bridge's Column within ZOI	> 30 feet	< 0.1 inch	< 1/3600	Negligible
3917 & 3909	I80 Bridge's Column within ZOI	> 30 feet	< 0.1 inch	< 1/3600	Negligible
3910 & 3916	Not within ZOI	-	-	-	Negligible
3911 & 3915	Not within ZOI	-	-	-	Negligible
3912	3-story Building	~ 15 feet	0.6 inch	1/300	**High**
3914	Not within ZOI	-	-	-	Negligible
3807	1-story Building	~ 15 feet	0.6 inch	1/300	**High**
3800	Not within ZOI	-	-	-	Negligible

Table H.9 discusses the impacts on major identified utilities within the ZOI. The impact on the utilities on Treat Avenue are due to the construction of the launch shaft. As mentioned earlier, the shaft construction may cause maximum vertical and horizontal movements of 0.4 and 0.8 inch, respectively. Considering the distance of those utilities from the shaft and both horizontal and vertical movements, we anticipate a maximum movement of 0.55 inch may be experienced on Treat Ave utilities.

Table H.9
Impacts on Major Identified Utilities within ZOI

Street Name	Utilities	Maximum Settlement	Maximum Distortion	Risk Category
Treat Ave.	9’ ϕ Conc. Box Sewers PG & E Electric 21” ϕ VCP Sewer	0.55 inch	1/1100	Slight
Florida St.	24” ϕ VCP Sewer UNK ϕ UNK Sewer	0.5 inch	1/1200	Slight
Bryant St.	12” ϕ VCP Sewer PG & E Electric Auxiliary Water Supply Muni Overhead Wires	0.5 inch	1/1200	Slight
Potrero Ave.	14” ϕ VCP Sewer 15” ϕ VCP Sewer 6” ϕ 110 kV PG & E Electric Auxiliary Water Supply	0.5 inch	1/1200	Slight
Utah St.	27” ϕ VCP Sewer	0.6 inch	1/800	Slight
San Bruno Ave.	2’ x 3’ ϕ Conc. Sewer 24” ϕ ISP Sewer 6” ϕ 115 kV Transmission	0.6 inch	1/700	Slight
Vermont St.	18” ϕ VCP Sewer 8” ϕ VCP Sewer	0.65 inch	1/600	Slight
Kansas St.	18” ϕ VCP Sewer 20” ϕ HDPE Sewer 8” ϕ ISP Sewer 14” ϕ ISP Sewer Auxiliary Water Supply	0.7 inch	1/500	Moderate
Rhode Island St.	4.5’ ϕ Conc. Sewer 3.5’x5.25’ ϕ Conc. Sewer 14” ϕ ISP Sewer	1.2 inch	1/300	**High**
De Haro St.	15”, 21” & 27” ϕ VCP Sewers	1.2 inch	1/300	**High**
Berry St.	15” ϕ VCP Sewer 12” ϕ VCP Sewer PG&E Deactivated Gas 4” ϕ PG&E Gas; and ATT	1.2 inch	1/300	**High**
Diversion St. @ Berry St.	9.5’x8.25’ ϕ Conc. Box Sewers	[1]		**High**
7th St.	6’ ϕ Conc. Sewer; and ATT	1.2 inch	1/300	**High**

[1] Considering the intersection of the tunnel and existing sewer box, the impact is in high category. Special construction staging will be utilized; see construction methodology in the main body of CER.

A conclusion that both Tables H.8 and H.9 share is the fact that after Station 25+50 (intersection of Rhode Island St. and Alameda St.) some mitigation measures shall be utilized to minimize and control the impacts on existing facilities and utilities. The reasons are passing through the weaker ground (Bay Mud and Fill) and the shallower depths. Comprehensive instrumentation and monitoring is essential to successfully excavate this portion of the tunnel. Pressurized-face TBM is needed with good workmanship. Local ground improvement such as jet grouting may be needed to keep the ground movement in acceptable range of structures and utilities. The necessity and type of ground improvement to be determined in the final design.

H.7 Cut-and-Cover Option (Between Stations 29+00 and 34+00)

For the receiving shaft, considering the panel depth of 50 feet, the maximum vertical settlement would be 0.3 inch; the maximum horizontal ground movement would be 0.6 inch; the ZOI (R in Figure H.7) would be 90 feet; the zone of maximum settlement (Ri in Figure H.7) would be 25 feet.

For the cut-and-cover portion, the analysis method is an empirically based settlement profile that is scalable based on the excavation depth and the maximum horizontal movement occurring during construction. The following assumptions were made to develop the empirical settlement profile:

- The distance from the wall at the ground surface to where the settlement is zero is 2 times the depth (H) of the excavation (Clough and O'Rourke, 1990) considering the ground being sand or soft to medium clay in the C&C portion.
- The maximum settlement can occur at the edge of the excavation or out to 0.75H away from the excavation (Clough and O'Rourke, 1990).
- The maximum horizontal settlement is 0.17%H (Long, 2001) and the maximum settlement is 0.5 times the maximum horizontal movement (Clough and O'Rourke, 1990).

Considering the maximum depth of tunnel invert to be 30 feet and assuming 5 feet of additional excavation to make room for subgrade preparation and the invert slab, we will have H equal to 35 feet. Then, the maximum vertical settlement can be as high as 0.35 feet close to the SOE and up to distance of 34 feet from the tunnel axis. This settlement will reduce gradually up to distance of 78 feet from the tunnel axis, where the settlement will be zero due to construction of C&C tunnel.

This change will change the construction impacts on structures located on blocks 3912, 3914, 3913, 3807 and 3800 as well as utilities on De Haro Street and Berry's street.

For the building at 3912, the change in the bored tunnel alignment, puts the building out of zone of influence of the bored tunnel. However, the corner of the building is approximately 50 feet from the shaft axis and may experience 0.25 inch of settlement due to shaft construction. It is also, 40 feet from the C&C tunnel axis and may experience up to 0.3 inch from the tunnel construction. This will be a total settlement of 0.55 inch.

For the building at 3914, the corner of the building is approximately 45 feet from the shaft axis and may experience 0.28 inch of settlement due to shaft construction. It should be noted that there is patio at that corner of the building at 3914. Thus, we categorize the risk as slight since the actual structure is much farther from the shaft axis.

The building at 3913 was not in ZOI of bored tunnel but will be impacted by the shaft construction of the C&C Option. The building is approximately 40 feet from the shaft axis and may experience 0.3 inch of settlement due to the shaft construction.

At 3807, there is a big parking lot and a building inside the block. The building is out of ZOI of the shaft and the C&C tunnel. Thus, impact on the building is negligible. However, since the shoring system is not designed yet, we consider this building as a slight risk to be analyzed in more detailed during final design stage.

The building at 3800 is approximately 40 feet from the tunnel axis and may experience 0.3 inch of settlement due to shaft construction.

The utilities on De Haro Street and Berry's Street remain in high category risk. Although some of them may need [temporary] relocation during construction and some may experience slightly different movements (vertical and/or horizontal), the magnitude of the movement that they experience keeps them in the high category risk.

Table H.10 summarizes impacts on existing structures and utilities for the C&C Option.

Table H.10
Impacts on Different Structures and Utilities within ZOI for C&C Option

Block # or Utilities	Type of Structure	Maximum Settlement	Risk Category
3902, 3924, 3923 North, 3923 South, 3904, 3905, 3906, 3922A, 3921A, 3920, 3907, 3919, 3918, 3908, 3917, 3909, 3910, 3916, 3911 & 3915	See Table H.8		
3912	3-story Building	0.55 inch	**High**
3914	Building & Patio	0.28 inch	Slight
3913	Building	0.3 inch	Moderate
3807	1-story Building	< 0.1 inch	Slight
3800	Building	0.3 inch	Moderate
Utilities	See Table H.9		

H.8 References

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Peck, B. "Deep excavations and tunneling in soft ground." Proceedings of 7th International Conference on Soil Mechanics and Foundation Engineering. Mexico city, 1969: 225-290.

Schmidt, B. "Settlements and ground movements associated with tunneling insoil.", Ph.D. Thesis, University of Illinois, 1969.

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APPENDIX I

TUNNEL VIBRATION AND CONSTRUCTION NOISE IMPACTS

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I.0 Summary

This memorandum gives a summary assessment of noise and vibration impacts from three potential sources: 1. ground vibrations due to operation of a tunnel boring machine (TBM), 2. ground vibrations due to sinking an access shaft by conventional excavation methods (i.e. excavation and shoring followed by possible rock breaking or deepening the bottom of the shaft by drill and blast method), and 3. noise due to construction equipment to be used at the ground surface for excavation of the launch shaft, for support of tunneling operations, and for joining the downstream receiving stub.

I.1 Introduction

Ground vibration induced by a TBM can be an important environmental issue for tunnel construction in an urban area. Construction schedule and cost may be affected by the extent of vibration impacts on adjacent properties during construction. Mechanized tunneling is essentially continuous, and vibrations from tunneling have the potential to be disturbing to humans and/or damaging to structures.

The planned 12-foot diameter sewer tunnel will be constructed beneath Alameda Street starting from a shaft centered approximately 50 ft. east of Treat Street and heading eastward to near the intersection of Alameda and De Haro Street. From Alameda and De Haro, the tunnel alignment makes a northeastward bend with a 100 to 200 ft. radius. The bend section of the alignment (sta. 28+50 to sta. 32+50) crosses beneath the Recology property and passes near several light commercial/operational buildings on that property. The downstream end of the S-bend section is beneath Berry Street approximately at sta. 35+50.

Cut-and-cover construction is being considered as an alternative for the tunnel bend section. The cut-and-cover alignment would involve a right-angle bend in an open trench heading north from Alameda and De Haro. The trench would extend about 80 feet north to the intersection of De Haro and Berry and then angle to the northeast for about 550 feet in Berry Street.

Eastward from sta. 35+50 in Berry Street, the tunnel may be a smaller diameter. This 7- to 12-foot tunnel will continue to the northeast following Berry Street and cross beneath 7th Street and the railroad. At its downstream end the tunnel will join a pre-constructed stub of the Channel Consolidated Transport/Storage Structure. The stub lies just east of the railroad alignment beneath the bend in Berry Street. Work to join the tunnel will be performed underground within the existing stub (receiving structure) of the Berry Street box. No shaft or excavation cut will be needed; access into the box will be through pre-formed panels with temporary street openings in Berry Street.

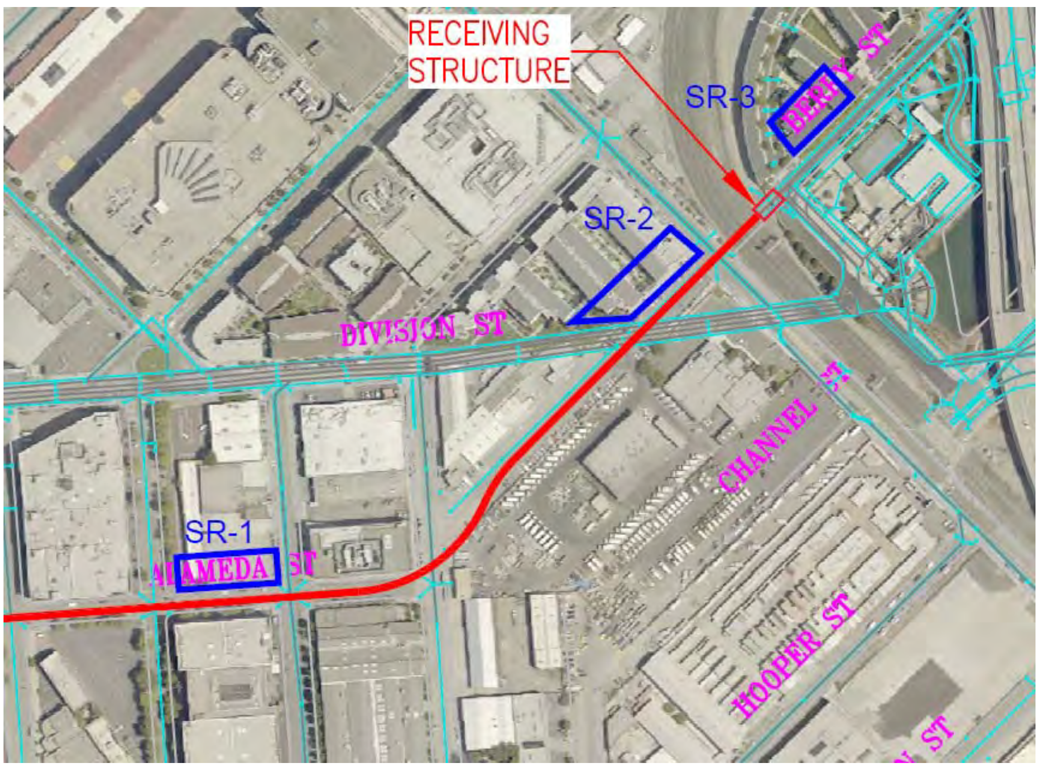
I.2 Conceptual Profile

Based on logs of geotechnical borings and rock outcrops adjacent to the alignment, the bedrock is expected to be Franciscan serpentinite. The tunnel alignment is expected to be in rock starting from east of the launch shaft to approximately the intersection of Alameda and Utah Street. For noise and vibration considerations sta. 15+00 is considered the downstream end of TBM tunneling in rock.

Eastward from approximately Utah Street, the tunnel is anticipated to be in alluvium and soil. Based on projected boring log information, the estimated depth of the tunnel crown in the alluvium and soil covered segment may vary from a maximum of approximately 25 feet to a minimum of 13 feet beneath street surfaces. However, this information is for conceptual modeling only. A confirmatory geotechnical investigation will need to be conducted with additional borings positioned on the tunnel alignment. See CER Appendix F for discussion of rock quality beneath the site. The project plan and profile and boring log locations are shown on figures attached to Appendix F.

As shown on Figure I-1a, the nearest sensitive receptors (residences SR-1 and SR-2) are located near the north side of the tunnel alignment at distances of approximately 30 to 90 feet. The residences nearest to planned surface construction locations are SR-3 approximately 80 feet from the Receiving Structure and SR-4 and SR-5 located approximately 700 feet and 1,100 feet from the Launch Shaft (Figure I-1b).

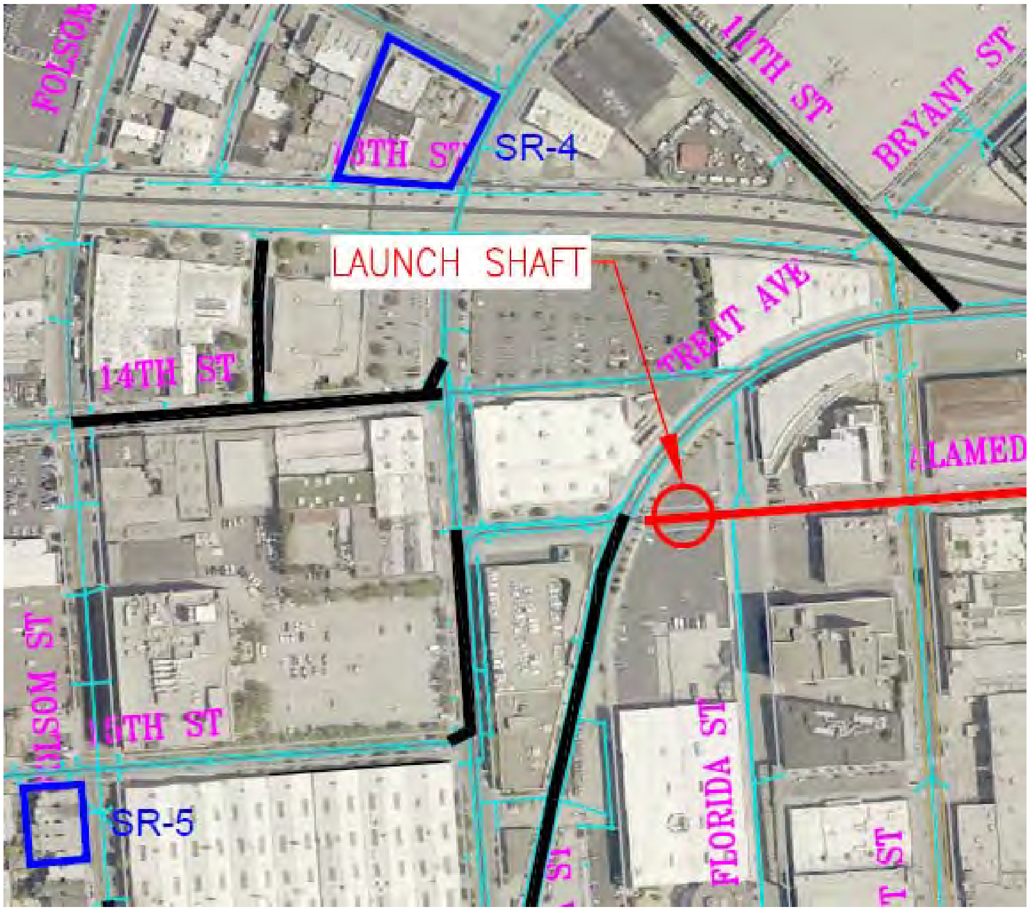
Figure I-1a Sensitive Receptors for TBM in soil (nearest residences)



Tunnel Alignment = red Base map: *Google Earth* 2017

SR-1 = Sensitive receptor (residential, blue)

Figure I-1b Sensitive Receptors for TBM in rock (nearest residences)



Tunnel Alignment and Launch Shaft = red

Base map: *Google Earth* 2017

SR-4 = Sensitive receptor (residential, blue)

I.3 Background - Vibration

Vibration is an oscillatory motion which can be described in terms of the displacement, velocity, or acceleration. Because the motion is oscillatory, there is no net movement of the element and therefore the average of the displacement is zero. The effects of movement, however, can be transmitted to other structures. The velocity is the instantaneous speed of the movement and acceleration is the rate of change of the speed.

The peak particle velocity (PPV) is commonly used in monitoring vibration effects on structures since it can be compared to established values that have an effect on the facilities. PPV is defined as the maximum instantaneous velocity of the element being oscillated. The effects of this displacement attenuate through the surrounding ground.

Although PPV is appropriate for evaluating the potential of structural damage, it is not commonly used for evaluating human response. It takes some time for the human body to respond to vibration signals and the body responds to an average vibration amplitude. Because the net average of a vibration signal is zero, the root mean square (rms) amplitude is used to describe the "smoothed" vibration amplitude. The root mean square value is calculated as the square root of the average of the squared amplitude of the signal. The average is typically calculated over a one-second period and is described in terms of vibration decibels (VdB).

Vibration velocity level in decibels is defined as:

$$L_v = 20 \times \log_{10} (v/v_{ref})$$

Where Lv: velocity in decibels
v: rms velocity amplitude, and
v_{ref}: reference velocity.

A reference is specified whenever a quantity is expressed in terms of decibels. The accepted reference for vibration velocity is 1×10^{-6} inches/second.

Tunnel construction activity can create varying degrees of ground vibration depending on the equipment and methods employed. The vibrations spread through the ground and diminish in amplitude with distance away from the tunnel. Buildings founded on the soil in the vicinity respond to these vibrations and the response can range from no perceptible effects to low rumbling sounds and perceptible vibrations to building damage.

Ground vibrations from tunneling construction activities do not often reach levels that can damage structures. However, they can achieve levels that are both felt (perceived) and heard in buildings very close to the site. Vibration sensitive equipment in the area can also be affected.

I.4 Vibration Criteria

Vibration criteria for continuous construction activity in terms of the comfort of residents (degree of perception) and effects on buildings based on information from the US Department of Transportation and Parsons' experience are summarized in Table 1.

People exhibit a wide variation of vibration tolerance, with a threshold of perception commonly cited as L_v in the range of 64 ~ 72 VdB (PPV in the range of 0.006 ~ 0.15 in/sec). Vibrations with L_v in the range of 100 and 108 VdB (PPV in the range of 0.5 ~ 1.0 in/sec) are very strongly noticeable and are considered annoying to people, but can be tolerable for short durations. With regard to the damage to structures, typically continuous construction vibrations with PPV of more than 0.20 in/sec will cause cosmetic damages. Levels more than 1.0 in/sec could cause structural damage. The vibration criteria developed in Table 1 are also shown on Figure I-2 with different colors for each level of PPV.

Table I-1 Vibration Criteria for Continuous Construction Activity
(sources: US DOT and Parsons)

Peak Particle Velocity, PPV (in/sec)	Approximate Lv (RMS velocity in VdB)[2]	Degree of Perception[1]	Effects on Buildings
0.001 ~ 0.006	48 ~ 64	Not felt	No effect
0.006 ~ 0.015	64 ~ 72	Threshold of perception	
0.015 ~ 0.02	72 ~ 74	Barely noticeable	
0.02 ~ 0.04	74 ~ 80	Just perceptible	
0.04 ~ 0.08	80 ~ 86	Noticeable	
0.08 ~ 0.10	86 ~ 88	Easily noticeable, acceptable if short term	Recommended upper level of the vibration for fragile structures
0.10 ~ 0.20	88 ~ 94	Level at which continuous vibrations begin to annoy people	Threshold of risk of architectural damage to plastered walls and ceilings
$\geq$ 0.20	$\geq$ 94	Disturbing, but tolerable if short term	Risk of architectural damage to normal dwelling houses with plastered walls and ceilings
$\geq$ 0.40	$\geq$ 100	Very strongly noticeable, but tolerable if short term	Would cause architectural damage and possibly minor structural damage
>1.0	> 108	Unpleasant to most people	Would cause architectural damage and possibly major structural damage

1. A degree of perception to vibrations may differ depending on the mode of transmission and frequency range of vibrations. Specific values may vary depending on social and cultural factors, psychological attitudes and expected degree of intrusion.
2. A crest factor of 4 (representing a PPV-rms difference of 12 VdB) has been used to calculate the approximate rms vibration limits from the PPV limits. These limits should be viewed as criteria that should be used during the assessment phase to identify problem locations that must be addressed as the design process is advanced.

I.5 Vibration Produced by TBM Tunneling Operations

The potential vibration impacts on the building structures near the planned Alameda Street and Berry Street tunnel alignment and potential sensitive receptors (private residences) have been estimated using TBM vibration attenuation data from a number of previous tunnel projects.

The vibration attenuation from the TBM will be influenced by various factors including distance between the source of vibration and the structure, structural conditions, soil and rock physical properties, groundwater, and depth of overburden. These vibrations can be described, analyzed, and reported in terms of a harmonic vibration parameters of peak particle velocity, peak acceleration, peak displacement, and frequency. Generally, monitoring results for evaluation of human perception and structural effects are reported in particle velocity (PV) and frequency.

In this assessment, the TBM ground vibration levels were estimated using historical data from tunnel projects in soil and rock. Vibration is commonly presented in a form of the following function relating PPV and distance:

$$PPV = K * D^{-r}$$

where

PPV: peak particle velocity (in/sec)

K: intercept value at D = 1 ft.

D: Distance between tunnel and the foundation of the structure (ft.)

r: attenuation rate

Table I-2 shows vibration attenuation functions for several tunnel projects. The TBM vibration attenuation functions (PPV vs. distance) for each set of historical data are plotted on Figure I-2.

Tunnel construction would be performed underground beneath city streets (Alameda Street and Berry Street). The western half of the alignment (west of about sta. 15+00 and Utah Street) will be in rock. The eastern half of the alignment (east of sta. 15+00) will be in alluvium and soil. Tunneling in alluvium and soil materials generates much lower particle velocities than in rock as indicated by the lowest curve on Figure I-2 (Dowding, 1996). For conservatism, the possible range of peak particle velocity (PPV) in soil, indicated by the vertical blue arrows and blue text on Figure I-2, is extended above the soil curve by about 2x. Maximum PPV for rock TBM tunneling for typical commercial/industrial buildings is indicated by green arrows and green text.

<u>Residential Receptors</u>. The vertical distance between the tunnel crown (i.e. the vibration source) and the ground surface (bottom of buildings) on properties adjacent to the alignment is in the range of 20 to 30 feet. The lateral distances from the tunnel to the nearest residential buildings on Alameda Street (SR-1 on Figure I-a) are approximately 30 to 40 feet based on field observations at the site on December 6, 2017. The residential buildings at location SR-2 on Berry Street are set back farther.   The east end of the 12-ft. diameter tunnel bore (sta. 35+00) is about 100 feet from the apartment complex (SR-2). The nearest approach of the last section of tunnel is about 50 feet from SR-2.

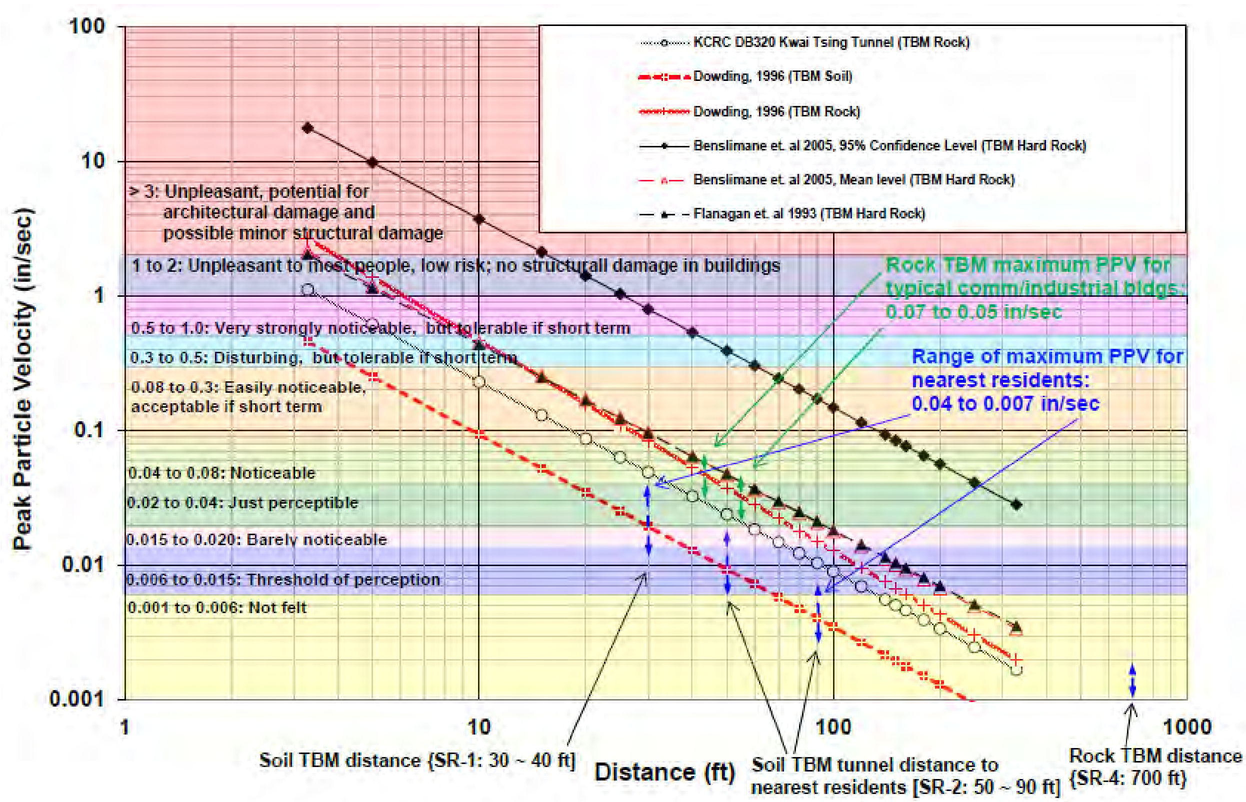
For the rock TBM portion of the tunnel, the distance to the nearest residences is approximately 700 to 1,100 feet. Thus, for rock tunneling, the estimated peak particle velocity (PPV) in the residential areas buildings is likely to be less than 0.002 in/sec as shown on Figure I-2.   It should be noted that even if the curve for “Benslimane et al (2005) 95% confidence level TBM hard rock” is projected to the distance range of 700 feet, vibrations from the rock TBM startup area (Launch Shaft) would be approximately 0.01 in/sec, just at the threshold of human perception. Therefore, even if the serpentinite bedrock is classified as hard rock, TBM vibrations are not likely to be an issue for offsite sensitive receptors.

Table I-2 Historical TBM Data used for Estimation of the PPV Attenuation Function

Type	Tunnel	Power Function	Reference	Note
TBM Rock	KCRC DB320 Kwai Tsing Tunnel	$PPV=28.188*D^{-1.4103}$	[13]	2
	-	$PPV = 67.537D^{-1.5637}$	[4]	2
TBM Soil	-	$PPV = 11.632D^{-1.4285}$		
TBM Hard Rock	Buffalo LRRT, Metro WWST, Chattachoochee (95% Confidence Level)	$PPV = 93.5D^{-1.4}$	[22]	1
	Buffalo LRRT, Metro WWST, Chattachoochee (Mean Level)	$PPV = 11.25D^{-1.4}$		
	Buffalo LRRT, Baltimore Metro Section C	$PPV = 51.321D^{-1.3788}$	[23]	2

1. The power functions were obtained directly from reference [22]
2. The power functions were derived from the original data plots from references [4], [13] and [23].

Figure I-2 TBM Vibration Attenuation



Commercial/Industrial Receptors. Studies of TBM-induced ground vibrations from historical data indicate that observed maximum peak particle velocities are generally low and well below accepted damage criteria for most structures. In general, at distances greater than 150 feet from the tunnel, vibrations due to TBM activity will not be felt. At the surface, buildings more than 120 feet from the tunnel, will not feel vibrations from tunneling activity (Flanagan, 1993).

In terms of human comfort and perception to commercial workers in the district, maximum vibrations from rock TBM activities are anticipated to be “noticeable” to “just perceptible” at typical locations along Alameda Street. Regarding effects on the structures/facilities, no effect or cosmetic damage is anticipated. On Figure I-2, the estimated maximum PPV for rock TBM tunneling is plotted for two locations along Alameda (sta. 6+00 and sta. 14+50). Sta. 14+50 is near Alameda and Utah Street. The tunnel will be at a depth of 26 ft. and offset about 33 ft. from buildings. Sta. 6+00 is near Alameda and York Street where the tunnel will be at a depth of 38 ft. and offset about 37 ft. At these locations the estimates for maximum PPV are less than 0.07 in/sec and 0.05 in/sec, respectively.

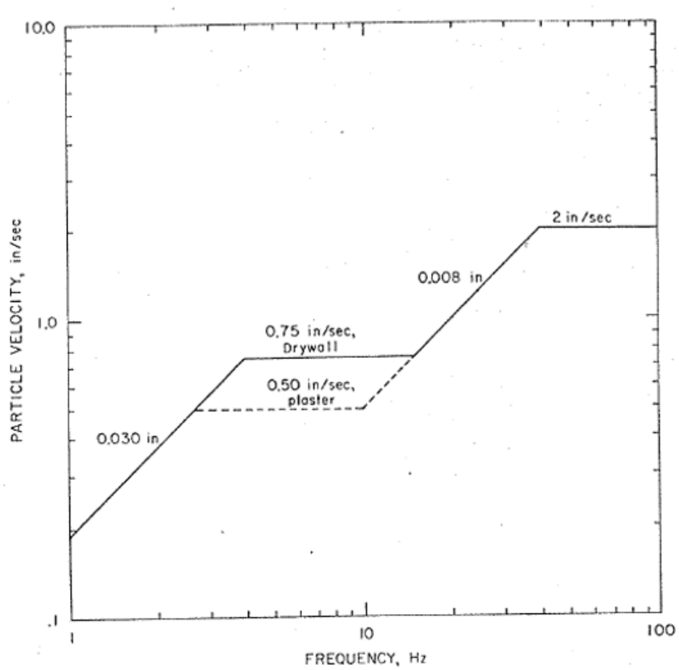
I.6 Conventional Tunnel Construction

For small tunneling projects, conventional tunneling by drilling and blasting is frequently the most economical method. However, for larger bores and tunnels that pass near sensitive receptors or involve long lengths in soil, the drill-and-blast method is less attractive. In the Folsom project blasting could possibly be used to deepen the launch shaft if hard rock is encountered. In the event that conventional tunneling is utilized in a portion of the tunnel, vibrations due to blasting will be a consideration and a blasting and vibration monitoring plan will need to be prepared.

The well-known criteria promulgated by the US Bureau of Mines (Nicholls, USBM, Bulletin 656, 1971 and Siskind et al, USBM, RI 8507, 1980), or other equivalent standards will be applied. The safe blasting vibration limits shown on the graph below were developed for residential structures. A peak particle velocity of 2 in/sec has become a generally accepted safe level of ground vibration for residential structures of new/sound construction. Substantial and industrial buildings can tolerate higher vibration limits. However, relatively older structures may need to be protected against lower ground motion velocity limits. Ground vibrations to historic buildings, sensitive structures, and structures in poor condition may need to be held below 0.50 in/sec or lower in which case other standards may apply.

Above 40 Hz, a constant peak particle velocity of 2.0 in/sec is the maximum safe value. Below 40 Hz, the maximum velocity decreases at a rate equivalent to a constant peak displacement of 0.008 in. At frequencies corresponding to 0.75 in/sec for drywall, and 0.50 in/sec for plaster, constant particle velocities are again appropriate. An ultimate maximum displacement of 0.030 inches is recommended, which would only be of concern where very low frequencies are encountered (<4 Hz).

Figure I-3 Safe Blasting Vibration Criteria



Safe Levels of Blasting Vibration for Houses (USBR, 1980)

Factors that can affect blast vibration, noise, and public perception include the following:

- Weather – Try to avoid isotherms, temperature inversions, wind shears, and unfavorable wind directions.
- Time – Avoid night blasts and other quiet times.
- Product – Example: electric initiation vs. primacord
- Stemming – Inert material packed in the blast hole above the charge.
- Delays – Increasing number of millisecond delays to spread the blast time.

The Contractor may need to engage a blasting specialist to prepare the blasting plan and assure its proper execution. Vibration monitoring with recording seismographs will need to be performed to document the level of vibrations being transmitted to structures at various distances from the blast source. Public notification will need to be carefully managed.

I.7 Construction Noise Levels

Maximum permissible noise levels for construction and excavation equipment and compliance monitoring distances will need to be established during pre-construction. Listed below in Table I-3 are typical values for the types of equipment that may be used in core drilling, excavation and shoring of excavation walls, cut-and-cover trenches, and supporting the underground tunneling work. These values are examples from previous projects. The Contractor will be responsible for proposing noise limits for approval and developing an acceptable noise reduction plan.

Table I-3 Maximum Permissible Construction Equipment Noise Limits

Equipment Category	Maximum Level Lmax (dBA) at 50 feet [1]
Auger drill rig	81
Backhoe	75
Boring jack power unit	80
Chain saw	81
Compactor (ground)	75
Compressor, air *	65
Compressor, other	75
Concrete mixer	71
Concrete pump	77
Concrete saw	81
Crane (mobile or stationary)	81
Dozer	81
Dump truck	81
Excavator	81
Flat bed truck	81
Front end loader	75
Generator (25 KVA or less)	70
Generator (more than 25 KVA)	80
Jackhammer	81
Paver	81
Pickup truck	55
Pneumatic Tools	81
Pumps	77
Rock drill	81
Vacuum excavator (vac-truck)	81
Welder	73

Notes:

[1] Equipment noise limits at a distance of 50 feet from construction equipment and associated components at all power ranges and operating modes.

* Portable air compressor rated at ≥75 cfm and operates at greater than 50 psi.

** Use Quiet Generators from MQ Power or equivalent to meet the noise limits.

Significant sound reductions can be achieved by the use of temporary portable sound barriers. These can take the form of sound absorbing blankets, temporary walls and deflectors, trailers, and tarps. Many forms of lightweight units are available as well as full enclosures for especially noisy units. Photographs of example barriers are shown as Figure I-4.

Figure I-4   Examples of Temporary Sound Barriers

I.8 Conclusions

TBM Operation. The tunnel construction operations for the sewer tunnel will create vibrations. However, it is anticipated that the vibrations due to TBM activity will have no adverse effect on the nearest residents or daily visitors and workers at commercial and industrial enterprises along the alignment. The vibration/noise caused by TBM operation will be generally less than the expected ambient background vibration/noise levels above the ground surface and will have no potential to cause structural damage.

At some locations along the alignment, vibration and noise may be perceptible. These effects are expected to be within the normal ambient noise levels experienced by commercial visitors and workers in light industrial enterprises in day-to-day operations. Existing ambient noise and vibration is also higher in areas adjacent to the busier street crossings and overhead freeway viaducts.

For the eastern half of the tunnel in soil and alluvium, given that the distance between the tunnel and nearest residential receptors is relatively close (30 to 50 feet) the estimated maximum peak particle velocity (PPV) from soil TBM operation is estimated to be in the range of 0.04 in/sec to 0.007 in/sec. These maximum PPV values are based on the soil tunneling curve (0.02 in/sec to 0.004 in/sec) of Dowding (1996) with conservative factor of safety 2x applied. The maximum TBM vibrations for the nearest sensitive receptors are anticipated to be in the range of “just perceptible”.

For the western portion of the tunnel which is in rock, the distance between the tunnel and nearest residential receptors is large (700 to 1,100 feet) and the estimated maximum peak particle velocity (PPV) is less than 0.002 in/sec in the “not felt” range. For commercial/industrial workers in the western portion of the alignment, maximum PPV due to TBM tunneling in rock will be less than 0.07 in/sec in the “noticeable” to “just perceptible” range.

Conventional Tunnel Excavation. If construction methods require the use of blasting for a portion of the work (e.g. deepening the Launch shaft), the Contractor will be responsible for developing a Blasting Plan to demonstrate how blasting effects will be kept within well-known safe limits (e.g. US Bureau of Mines criteria, or equivalent). Vibration monitoring may need to be performed at off-site residences to assure that PPV limits are not exceeded.

Surface Construction. Acceptable project noise levels for surface construction equipment will be maintained by the Contractor. Maximum Permissible noise limits (Lmax) for various pieces of construction equipment will need to be established along with project noise reduction practices. A variety of portable sound barriers are available for this purpose. Equipment types will be selected and operational practices will be developed in order to keep noise below Lmax limits. Monitoring with microphones and recording devices may need to be conducted periodically to demonstrate that acceptable noise level limits are being achieved. Such monitoring may be performed at surface construction locations such the Launch Shaft and the Receiving Structure at the downstream end of the tunnel. If the cut-and-cover option is selected, noise monitoring may also be performed at various locations along the shored excavation at intersection of Alameda and DeHaro Streets and along Berry Street to sta. 34+00.

I.9 References

[4] Dowding, H.C., “Construction Vibrations”, Prentice Hall, 1996.

[13] Kowloon Canton Railway Corporation KSL GSA 5100 Environmental Impact Assessment & Associated Services – Environmental Impact Assessment Report, 2005.

[20] U.S. Department of Transportation, Federal Transit Administration. “Transit Noise and Vibration Impact Assessment,” May 2006.

[22] Benslimane, A., Anderson, D.A., Munfakh, N., and Ziatanic, S., “Ground Borne Vibration on the East Side Access Project Manhattan Segment: Issues and Impacts”. Underground Space Use: Analysis of the Past and Lessons for the Future, 2005.

[23] Flanagan, F.R., “Ground Vibration from TBMs and Shields”, Tunnels & Tunneling, 1993.

Nicholls, H.R., Johnson, C.F., and Duvall, W.I., “Blasting Vibrations and Their Effects on Structures”. U.S. Bureau of Mines Bulletin 656, 1971.

Siskind, D.E., Stagg, M.S., Kopp, J.W., and Dowding, C.H., "Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting". U.S. Bureau of Mines Report of Investigations 8507, 1980.

APPENDIX J

DRAFT CER CHECKLIST

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CER CHECKLIST FOR ENVIRONMENTAL REVIEW (PROJECT DESCRIPTION REQUIREMENTS)

Project Name:	Folsom Area Stormwater Improvement Project
Project Number:	CWWSIPFCDB14
PM:	Saed Toloui
PE:	Chung Linh (Planning) Mohammad Kohgadai (Design)
EPM:	Lindsay Revelli

This checklist is designed to provide the design team assistance in determining the type of information that must be provided to Bureau of Environmental Management (BEM) for environmental review. These Description Requirements should be provided at the Draft CER stage. Each team, at the project's initial conception, should contact environmental staff for assistance in completing this form. The use of this form will be iterative as the project is developed, new environmental issues are identified, and additional detail is needed until CEQA certification and all permits are obtained.

Please note that although this form is titled "checklist", it is not a form that simply requires check marks. It is a set of required descriptions of the project components, to be supplied in text and graphics in sufficient detail, the adequacy of which will be determined by the Environmental Project Manager (EPMs). The checklist must be provided at the Draft CER stage, <u>but no later than six (6) months prior to completion of the first administrative draft of the EIR or MND</u>. In addition to filling out the checklist, the PM should provide a description of the project including all the project components covering construction, operation, and maintenance.

The checklist must be completed before a date can be set to present the CER to the Program Steering Committee. A project description outline is provided for your information only. Descriptions will vary depending on the project.

Project Objectives

1. Describe the purpose and need for the project. What will this particular project accomplish?

   The primary objective of the Folsom Area Stormwater Improvement Project is to address flooding for the Inner Mission neighborhood from 18th to 10th Streets under the current Sewer System Improvement Program (SSIP) level of service (LOS). The LOS includes the integration of "Green" and "Grey" infrastructure to minimize flooding and manage flows from a statistically derived storm lasting 3 hours, with a total of 1.3 inches of rainfall and a defined peak rainfall intensity (i.e., 5-year 3-hour storm, LOS storm). The design alternatives under consideration will manage stormwater via conveyance to meet the LOS storm within the Project study area.

2. List and describe specific project objectives (not Program objectives).

   The major scope of work includes:

   - Construction of 4,000 linear feet of 12' inside diameter tunnel (or 3,550 linear feet of 12' inside diameter tunnel and 450 linear feet open-cut box sewer), from approximately the intersection of Alameda Street and Treat Street connecting to the Channel Transport/Storage Box near the intersection of 7th Street and Berry Street.

   The project will also improve the upstream sewer system to divert flow towards the new infrastructure, which includes:

Location	Existing Size	Proposed Size	Linear Footage
Treat Street – 16th to Alameda	10.5'w x 9'h	10.5'w x 15'h	985'
Treat Street @ 16th	N/A	4'2"x9'0"	24'
15th Street – Mission to Minna	66"	72"	253'
15th Street – Minna to Capp	66"	78"	120'
15th Street – Capp to South Van Ness	66"	78"	295'

Location	Existing Size	Proposed Size	Linear Footage
15th Street – South Van Ness to Shotwell	66"-72"	78"	296'
Harrison Street – 19th to 18th[1]	3'0'x4'6" - 3'0"x5'0"	9'0"x6'0"	585’
Harrison Street – 18th to 17th	3'0"x5'0"	9'0"x6'0"/9'0"x7'0"	708’
Harrison Street – 17th to 16th	3'0"x5'0"	9'0"x8'0"	340'
18th Street – Shotwell to Folsom	60"	108"	288'
18th Street – Folsom to Treat	60"	90”/108"	320’
18th Street – Treat to Harrison	N/A	60"	377'
17th Street – Treat to Harrison	N/A	90"	217'
14th Street – Folsom to Harrison	75"	84"	620'
14th Street – Mission to South Van Ness	3’6”x5’3”	66”	581’
Folsom Street – 12th to 11th	N/A	48"	425'
11th Street – Folsom to Harrison	N/A	48"	630'
11th Street – Harrison to Division	N/A	75"	841'
17th Street – South Van Ness to Shotwell	N/A	102"	306'

[1] Harrison Street – 16th to 19th Streets may be replaced with a similarly sized box sewer on Treat Street. This is pending condition assessment of the existing Treat Street box sewer, to be performed by another project team.

Location	Existing Size	Proposed Size	Linear Footage
17th Street – Shotwell to Folsom	N/A	102"	312'
17th Street – Folsom to Treat	N/A	102"	453'
South Van Ness – 18th to 17th	12"-15"	42"	508'
South Van Ness @ 18th	N/A	36"	75'
Erie Street - South Van Ness to Folsom	12"/15"	12"/18"	395'
Trainor Street - 13th to 14th	12"	12"	303'
Folsom Street - 17th to 18th	15"	15"	294'
Folsom Street - 17th to 16th	12"	18"	154'
Shotwell Street - 19th to 18th	18"	18"	280'
19th Street - Folsom to Treat	12"	24"	298'
Mistral Street - Treat to Harrison	12"	12"	72'
Alabama Street - Mariposa to 17th	8"	12"/15"	430'
Harrison Street - 15th to Alameda	8"	12"	334'

Site Plan

Provide a site plan on a topographic map. Everything should be labeled as either new or existing. Information on the site plan should include the following, including square footage, length, diameter, etc.:

1. Structural footprints (general areas) – existing and created by the project.

- See attachment FASIP_Construction_Limits.pdf

2. Roadways and parking areas – existing & created by the project (both permanent and temporary).
   - Project is mostly within public ROW. No new roadways or parking areas will be created. See attachment FASIP_Construction_Limits.pdf
3. Utility lines, including construction utilities such as electrical or dewatering lines. *Water crossings should be clearly marked. Estimated pole locations should be marked.*
   - Public and private utility information to be provided during design. Dewatering lines will be within construction limits. See attachment FASIP_Construction_Limits.pdf
4. Locations of emergency generators, SCADA equipment.
   - Not applicable.
5. Fencing (permanent and construction).
   - Construction fencing, if needed, will be within construction limits. No new permanent fencing is proposed. See attachment FASIP_Construction_Limits.pdf.
6. Spoils areas.
   - Spoils will be maintained within construction limits. See attachment FASIP_Construction_Limits.pdf
7. All grading areas, such as cutting into a slope.
   - Project is not expected to change existing grading.
8. Laydown/staging areas.
   - Possible laydown staging areas in private property (requiring easement) is shown in attachment FASIP_Construction_Limits.pdf. Other staging will be in public right of way within construction limits.
9. Absolute limits on construction area (provide map, square feet/acreage of the project site). *Nothing can occur outside of this area – no parking cars for the workmen, no ground disturbance, nothing.*

Give yourself enough room to work. However, don't add areas you know you will not need, as it makes the environmental review much more difficult. For example, if you show that an area of trees is within the construction area, BEM will assume those trees will be taken down.

- See attachment FASIP_Construction_Limits.pdf. Preliminary estimate of 241 acres.

10. Estimated cut/fill information (cubic yards and acreages preferred, but LxWxD is OK). This is necessary for various topical analyses, such as truck haul estimates in the traffic section, land disturbance, etc.

- Preliminary truck trip and off-haul calculations provided in FASIP_Truck_Trips.pdf

11. Maximum depth of excavation.

- 35 feet

12. General information about elevation, and planned changes in topography. This includes spoils areas – provide a cross-section of the fill, or at least some type of quantified description.

- No changes in elevation and topography.

13. Specific information about the types of construction equipment to be used.

- Likely the following:
  - Saw-cutting machine
  - Excavator
  - Loader
  - Backhoe
  - Paver
  - Soil/concrete compactor
  - Roller
  - Dewatering pump
  - Traffic control truck
  - Sweeper
  - Grout mixer
  - Mortar spray
  - Pile driver
  - Various powered hand tools

14. Information on all structures affected by the project, including age of existing buildings if known.

- No existing aboveground structures will be affected.

15. Information on offsite spoils areas (and a list of potential landfills if possible). *CEQA addresses environmental impacts on offsite spoils areas*.
    - Offsite spoils area to be determined by Contractor.
16. Official address of site (or mailing address if no "official" address), *if known. Many PUC facilities do not have addresses*.
    - No address
17. Description of future and operations maintenance activities.
    - Access to sewer facilities through new manholes and/or access hatches for inspection and maintenance activities.
18. Information on parking/loading spaces (numbers of each, including handicapped spaces).
    - Metered parking affected: all parking spaces on block that is under construction may be affected.
    - Private lots parking affected: up to 100
19. Preliminary project schedule.
    - Design completion by November 2019, Bid/Advertise Award by May 2020, Construction end by June 2022
20. Construction durations by type of activity.
    - See CER text.
21. Blowoff locations, and information on where discharges will drain. Also, shutdown information when it concerns discharges.
    - Not Applicable
22. Landscaping plans.
    - Replace concrete/asphalt in kind

Land Use

CER CHECKLIST FOR ENVIRONMENTAL REVIEW (PROJECT DESCRIPTION REQUIREMENTS)

1. Aerials of the project area (including staging areas, spoils areas, etc.).
    - See attachment. FASIP_Construction_Limits.pdf
2. Information on encroachment issues – will anything (structures, trees) need to be removed from our ROW?
    - Existing fencing near 15th and Treat Streets may need to be removed.
3. Parcel maps of the area, showing adjacent properties.
    - See attachment FASIP_Construction_Limits.pdf
4. Copy of USGS 7.5-minute quad maps for the project area.

- See attachment CA_San_Francisco_North_20150311_TM_geo.pdf.

5. A list of all property owners within 300 feet of the property line of the site if a GRE, NegDec or EIR is expected. Two sets of address labels are required.
    - To be determined, and provided, if applicable.
6. San Francisco Master Plan designation and zoning of the project parcels. Sites outside City limits require local designation/zoning information.

- See attachment zoning_map(1).pdf.

7. Present and past use of the site, especially permitted uses, if available.
    - Majority of project is in public right-of-way. Portions of tunnel alignment will require easement negotiations with SPCA and CalTrans.
8. Information on growth-inducing issues.
    - There are no growth-inducing issues for this project to the best of our knowledge.
9. Information on any historic preservation requirements.
    - To be determined.

10. Information on watershed requirements, including applicable policies of the Watershed Management Plans, if applicable.
    - There are no existing watershed requirements to the best of our knowledge for the project area.
11. Information on all other permits other than CEQA, NEPA, & resource agencies for project approval (e.g., NPDES, SPMP, etc.) required for the project.
    - SF Excavation Permit
    - Underground Gas Classification (tunneling)

Water, Operations, and Maintenance

1. Dewatering information (estimated location of Baker tanks, location of discharge, estimated quantity if known, etc.)
    - To be located throughout project site to coincide with current construction activities.
2. Information on groundwater levels, if known.
    - Approximately 8-17 feet below underground.
3. Flood zone maps, if available.

- See attachment SF_SE.pdf.

4. Information on ordinary high water mark for waterways, if applicable.
    - Not applicable
5. Salt water intrusion information, if necessary.
    - Unknown
6. Information on operation water quality/quantity issues (such as any planned discharges, diversion rates, planned releases, etc.).
    - No known issues.

Hazardous Waste

1. UST information.
   - USTs currently unknown.
2. Information on chemicals and fuels storage during construction and operation.
   - No fuels other than gasoline/diesel during construction.
3. Site status on the State's "Cortese List" (list of sites with known hazardous contamination).
   - http://www.envirostor.dtsc.ca.gov/public/search?cmd=search&reporttype=CORTESE&site_type=CSITES,OPEN,FUDS,CLOSE&status=ACT,BKLG,COM,COLUR&reporttitle=HAZARDOUS+WASTE+AND+SUBSTANCES+SITE+LIST+(CORTESE) does not show any locations within project site.
4. Existing Phase I, Phase II, or geotechnical studies. Required if you already have them. However, it is not required for you to perform these studies.
   - Geotechnical investigation will be performed during design.

Noise

1. Information on pile driving, if needed.
   - Pile driving will likely be needed. Quantity and depth to be provided during design.
2. Spec. sheets on any noise-generating operational equipment (such as pumps, compressors, or generators – we also need to know the types of actuators being used on valves). *This is used with zoning information to determine if operational noise is within an acceptable range. If not, design changes may be required. This should be coordinated with the environmental team member. These spec. sheets do not need to be of the exact equipment that will be used (as that is probably not known). Spec. sheets of representative equipment can be used*.
   - There will not be any permanent noise-generating equipment.

Aesthetics

1. Spec. sheets on proposed lighting elements. *These spec. sheets do not need to be of the exact equipment that will be used (as that is probably not known). Spec. sheets of representative equipment*

can be used. While optional during preparation of this checklist, it will be eventually required for the environmental review.

- No proposed lighting.

2. Information on estimated size/height and detail of existing or proposed structures. *This includes vaults and proposed access to vaults*.

   - No aboveground structures.

3. Information on site lighting.

   - SFPUC/PG&E street lights

4. Planned color of structures, if known.

   - No aboveground structures.

Geology and Soils

1. Information on faults. This includes if the project is located on an Alquist-Priolo Earthquake Fault zone, if known (See http://www.consrv.ca.gov/CGS/rghm/ap/ for more information on these fault zones).

- Project limits partially in liquefaction zone. See attachment SAN_FRANCISCO_NORTH_EZRIM.pdf.

2. Information on expansive soil (as per Building code), if known.

   - Unknown

3. Geotechnical studies, if available (See hazardous waste above). *Required by the Planning Dept.*

   - Geotechnical investigation will be performed during design.

4. Information on geologic work near/adjacent to structures (estimates of vibration effects).

   - See CER appendix for Rock Quality Evaluation and Construction Settlement Impact Assessment.

Traffic

CER CHECKLIST FOR ENVIRONMENTAL REVIEW (PROJECT DESCRIPTION REQUIREMENTS)

1. Traffic information, such as proposed haul routes.
   - See CER graphics.
2. Lane closures in each direction and duration of closure
   - Lane closures will be determined during design with SFMTA Traffic Engineer. Preliminary discussion is provided in CER.
3. Estimated staffing levels of existing or proposed facility. *Used to determine parking/traffic issues*.
   - Facilities to be constructed do not require staffing.

Biological Description

If any trees greater than 4 inches in trunk diameter or taller than 20 feet will be removed, a plot plan is required showing the location, size, and common or botanic name(s) of each.

- None anticipated.

Air Quality

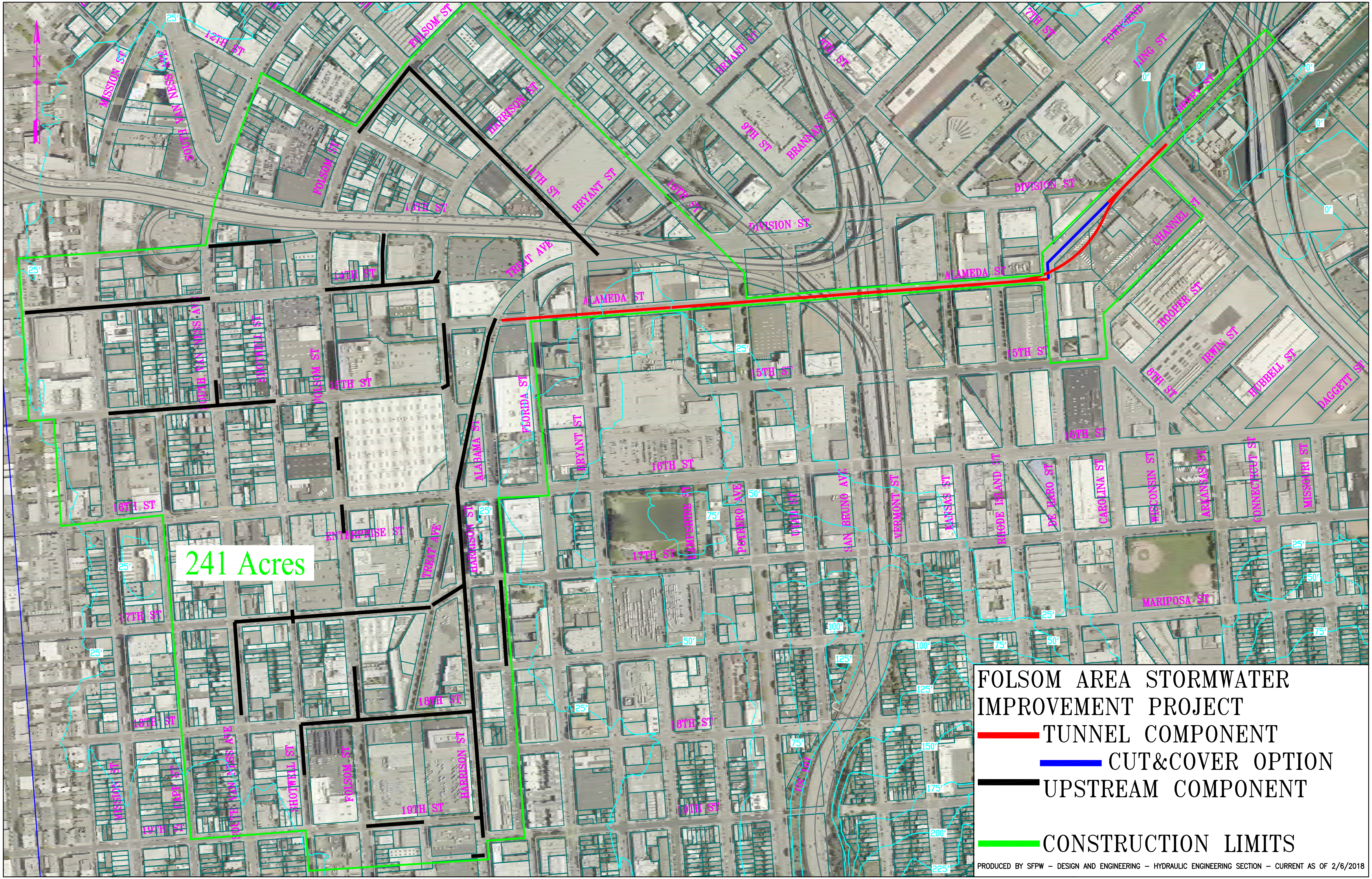
Information on any generators (including map and spec. sheets) for air requirements. Contact the EPM for the latest requirements and refer to Sample CEQA Air Quality Information (eDOCS DM #762889).

- No permanent generators.

Note on NEPA: *If your project has federal funding attached, requires certain federal permits (primarily an "Individual" Corps wetland permit), or is located on federal land, NEPA analysis might be required (NEPA is the federal equivalent of CEQA). NEPA will require that you analyze a range of alternatives in equal level of detail, and also have other informational requirements that will need to be addressed in the CER. Your EPM will have more information on NEPA compliance.*

Completed by:____________________________
Signature
Project Engineer (Planning)
Title
____
Date

Signed by:____________________________
Signature
Project Manager
Title
____
Date


FOLSOM AREA STORMWATER IMPROVEMENT PROJECT
TUNNEL COMPONENT
CUT&COVER OPTION
UPSTREAM COMPONENT
CONSTRUCTION LIMITS
PRODUCED BY SFPW – DESIGN AND ENGINEERING – HYDRAULIC ENGINEERING SECTION – CURRENT AS OF 2/6/2018
241 Acres
N
MISSION ST
SOUTH VAN NESS AVE
12TH ST
FOLSOM ST
HARRISON ST
11TH ST
BRYANT ST
10TH ST
9TH ST
BRANNAN ST
DIVISION ST
ALAMEDA ST
TREAT AVE
14TH ST
15TH ST
16TH ST
17TH ST
18TH ST
19TH ST
SHOTWELL ST
ENTERPRISE ST
ALABAMA ST
FLORIDA ST
CHANNEL ST
HOOPER ST
IRWIN ST
HUBBELL ST
DAGGETT ST
8TH ST
7TH ST
TOWNSEND
KING ST
POTRERO AVE
HAMPSHIRE ST
UTAH ST
SAN BRUNO AVE
VERMONT ST
KANSAS ST
RHODE ISLAND ST
DE HARO ST
CAROLINA ST
WISCONSIN ST
ARKANSAS ST
CONNECTICUT ST
MISSOURI ST
MARIPOSA ST
CAPP ST

TRUCK TRIPS CALCULATION
Folsom Area Stormwater Improvement Project

Prepared by: CL
Checked by: WL

Date: 04/04/18

PROJECT SCOPE

Proposed Pipe Sizes	Varies
Estimated Average Trench Width	Varies
Estimated Total Footage	12,500 cut-and-cover, 4000 tunnel
Estimated Project Working Days	910
Estimated Construction Start Date	2020

CALCULATION RESULT

Project Grand Total Truck Trips	**18968**
Maximum Number of Truck Trips Per Hour	**4**

EQUIPMENT TYPE	NO. OF UNITS	TYPICAL RATED HORSEPOWER	GRAND TOTAL NO. OF DAYS	TYPICAL NO. OF HOURS IN USE PER DAY PER LOCATION	GRAND TOTAL NO. OF HOURS IN USE
Sawcutting Machine	1	13	33	8	264
Excavator	1	157	787	4	3148
Loader/Backhoe	4	75	2361	4	9444
Paving Equipment (Grinder)	1	82	30	6	180
Other Material Handling Equipment (AC Supply Truck)	4	196	72	2.25	452
Paver	1	89	32	6	192
Roller	1	84	30	6	180
Other Material Handling Equipment (Concrete Mixer)	4	196	376	0.25	391
Off-Highway Trucks (Sewer Dump Truck)	6	381	716	2	5718
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	6	381	247	0.5	436
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	334	1	1199
Crane	1	600	172	8	1376

EQUIPMENT TYPE - TUNNELING EQUIPMENT	NO. OF UNITS	TYPICAL RATED HORSEPOWER	GRAND TOTAL NO. OF DAYS	TYPICAL NO. OF HOURS IN USE PER DAY PER LOCATION	GRAND TOTAL NO. OF HOURS IN USE
TBM	1	750	193	8	1543
TBM Cutterhead	1	500	193	2	463
Ventilation	1	250	193	14	2777
Compressor	1	300	193	8	1543
Shops	1	75	193	12	2314
Pumps	1	25	193	2	463
Misc	1	100	193	12	2314
Slurry Plant	1	200	193	8	1543
Slurry Pumps	1	125	193	8	1543
Lighting	1	30	193	12	2314
Locomotive	1	150	193	8	1543
Trucking Muck Removal	1	300	193	9	1697
Misc. Site Vehicles	1	800	193	1	154

Treat - 16th to Alameda (box sewer)

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	N/A	N/A
(E) Pipe Size, ft	N/A	10.5'wx9'h
(N) Pipe Size, in	N/A	N/A
(N) Pipe Size, ft	N/A	10.5'wx15'h

Pipe Length, LF	985
Trench Width, ft	15
"T" -Trench Width, ft	17
Estimated Working Days	195

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	517	CY	10	104
Existing Pipe/Soil Removal[2]	2298	CY	10	460
Hauling In				
Crushed Rock Bedding[3]	0	CY	10	0
Concrete	3119	CY	10	624
Piles	11880	LF	324	74
Rebar7	624000	LB	20000	64
Manholes	4	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**1328**

PAVING TRUCK TRIP CALCULATION

Curb-to Curb Paving Width, ft	40
Approx. Curb-to Curb Paving Length, ft	985
Paving Width, ft	0
Approx. Paving Length, ft	0

	AC	Concrete
Area, SF	39400	16745
Unit	TON	CY
Amount Needed[4]	493	413
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	84
Dump Truck for Grinding[5]	50
AC Supply Truck	84
TOTAL PAVING TRUCK TRIPS	**218**

TOTAL TRUCK TRIPS (Sewer + Paving)	**1546**

Notes:

[1] Trips have been doubled since 1 trip in and 1 trip out.
[2] Total Area of Existing Pipe and Soil = [Total Area of Crushed Rock Bedding + New Pipe Area - Existing Pipe Area]
[3] Total Area of Crushed Rock Bedding = ((0.42 ft + New O.D./2)*Trench Width) - (0.5*New Pipe Area)
[4] 1 ton of AC paves 80 SF of 2" thick AC.
[5] Dump truck capacity is 10 CY.
[6] For calculation purpose here, a 12 TON capacity truck is utilized. Depending on the construction company, some use 20 TON AC trucks.
7 Rebar approximated to 200 lb/CY of concrete

ABBREVIATIONS:

LF = Linear Feet
CY = Cubic Feet

Treat @ 16th Street

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	N/A	N/A
(E) Pipe Size, ft	N/A	0
(N) Pipe Size, in	N/A	N/A
(N) Pipe Size, ft	N/A	50"x108"

Pipe Length, LF	24
Trench Width, ft	8
"T" -Trench Width, ft	10
Estimated Working Days	60

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	7	CY	10	2
Existing Pipe/Soil Removal[2]	33	CY	10	8
Hauling In				
Crushed Rock Bedding[3]	0	CY	10	0
Concrete	43	CY	10	10
Piles	360	LF	324	4
Rebar7	9000	LB	20000	2
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**28**

PAVING TRUCK TRIP CALCULATION

Paving Width, ft	40
Approx. Paving Length, ft	24

	AC	Concrete
Area, SF	960	240
Unit	TON	CY
Amount Needed[4]	12	6
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	2
Dump Truck for Grinding[5]	2
AC Supply Truck	2
TOTAL PAVING TRUCK TRIPS	**6**

TOTAL TRUCK TRIPS (Sewer + Paving)	**34**

15th Street - Mission to Minna

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	66	79
(E) Pipe Size, ft	5.5	6.58333333
(N) Pipe Size, in	72	86
(N) Pipe Size, ft	6	7.16666667

Pipe Length, LF	253
Trench Width, ft	12
"T" -Trench Width, ft	14
Estimated Working Days	13

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	109	CY	10	22
Existing Pipe/Soil Removal[2]	320	CY	10	66
Hauling In				
Crushed Rock Bedding[3]	261	CY	10	54
Piping	253	LF	30	18
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**162**

PAVING TRUCK TRIP CALCULATION

Paving Width, ft	40
Approx. Paving Length, ft	253

	AC	Concrete
Area, SF	10120	3542
Unit	TON	CY
Amount Needed[4]	127	87
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	18
Dump Truck for Grinding[5]	14
AC Supply Truck	22
TOTAL PAVING TRUCK TRIPS	**54**

TOTAL TRUCK TRIPS (Sewer + Paving)	**216**

15th Street - Minna to Capp, Capp to South Van Ness, South Van Ness to Shotwell

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	66	79
(E) Pipe Size, ft	5.5	6.58333333
(N) Pipe Size, in	78	94
(N) Pipe Size, ft	6.5	7.83333333

Pipe Length, LF	711
Trench Width, ft	12
"T" -Trench Width, ft	14
Estimated Working Days	48

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	307	CY	10	62
Existing Pipe/Soil Removal[2]	1109	CY	10	222
Hauling In				
Crushed Rock Bedding[3]	736	CY	10	148
Piping	711	LF	30	48
Manholes	4	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**482**

PAVING TRUCK TRIP CALCULATION

Curb-to Curb Paving Width, ft	50
Approx. Curb-to Curb Paving Length, ft	400

	AC	Concrete
Area, SF	20000	9954
Unit	TON	CY
Amount Needed[4]	250	246
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	50
Dump Truck for Grinding[5]	26
AC Supply Truck	42
TOTAL PAVING TRUCK TRIPS	**118**

TOTAL TRUCK TRIPS (Sewer + Paving)	**600**

Harrison Street - 19th to 18th, 18th to 17th, 17th to 16th

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	N/A	0
(E) Pipe Size, ft	N/A	3'x5'
(N) Pipe Size, in	N/A	N/A
(N) Pipe Size, ft	N/A	9'x8'

Pipe Length, LF	1633
Trench Width, ft	13
"T" -Trench Width, ft	15
Estimated Working Days	290

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	756	CY	10	152
Existing Pipe/Soil Removal[2]	3447	CY	10	690
Hauling In				
Crushed Rock Bedding[3]	0	CY	10	0
Concrete	3629	CY	10	726
Piles	19680	LF	324	122
Rebar7	726000	LB	20000	74
Manholes	6	EA	4	4
			TOTAL SEWER TRUCK TRIPS	**1768**

PAVING TRUCK TRIP CALCULATION

Curb-to Curb Paving Width, ft	40
Approx. Curb-to Curb Paving Length, ft	1633

	AC	Concrete
Area, SF	65320	24495
Unit	TON	CY
Amount Needed[4]	817	605
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	122
Dump Truck for Grinding[5]	82
AC Supply Truck	138
TOTAL PAVING TRUCK TRIPS	**342**

TOTAL TRUCK TRIPS (Sewer + Paving)	**2110**

18th Street - Shotwell to Folsom, Folsom to Treat

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	60	72
(E) Pipe Size, ft	5	6
(N) Pipe Size, in	108	126
(N) Pipe Size, ft	9	10.5

Pipe Length, LF	608
Trench Width, ft	15
"T" -Trench Width, ft	17
Estimated Working Days	61

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	319	CY	10	64
Existing Pipe/Soil Removal[2]	2253	CY	10	452
Hauling In				
Crushed Rock Bedding[3]	940	CY	10	190
Piping	608	LF	10	122
Manholes	3	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**830**

PAVING TRUCK TRIP CALCULATION

Curb-to Curb Paving Width, ft	40
Approx. Curb-to Curb Paving Length, ft	600

	AC	Concrete
Area, SF	24000	10336
Unit	TON	CY
Amount Needed[4]	300	255
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	52
Dump Truck for Grinding[5]	30
AC Supply Truck	50
TOTAL PAVING TRUCK TRIPS	**132**

TOTAL TRUCK TRIPS (Sewer + Paving)	**962**

18th - Treat to Harrison

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	0	0
(E) Pipe Size, ft	0	0
(N) Pipe Size, in	60	72
(N) Pipe Size, ft	5	6

Pipe Length, LF	377
Trench Width, ft	10
"T" -Trench Width, ft	12
Estimated Working Days	19

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	140	CY	10	28
Existing Pipe/Soil Removal[2]	675	CY	10	136
Hauling In				
Crushed Rock Bedding[3]	280	CY	10	58
Piping	377	LF	40	20
Manholes	3	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**244**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	377

	AC	Concrete
Area, SF	15080	4524
Unit	TON	CY
Amount Needed[4]	189	112
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	24
Dump Truck for Grinding[5]	20
AC Supply Truck	32
TOTAL PAVING TRUCK TRIPS	**76**

TOTAL TRUCK TRIPS (Sewer + Paving)	**320**

17th - Treat to Harrison

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	0	0
(E) Pipe Size, ft	0	0
(N) Pipe Size, in	90	106
(N) Pipe Size, ft	7.5	8.83333333

Pipe Length, LF	217
Trench Width, ft	13
"T" -Trench Width, ft	15
Estimated Working Days	22

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	100	CY	10	22
Existing Pipe/Soil Removal[2]	752	CY	10	152
Hauling In				
Crushed Rock Bedding[3]	259	CY	10	52
Piping	217	LF	20	22
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**250**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	217

	AC	Concrete
Area, SF	8680	3255
Unit	TON	CY
Amount Needed[4]	109	80
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	18
Dump Truck for Grinding[5]	12
AC Supply Truck	20
TOTAL PAVING TRUCK TRIPS	**50**

TOTAL TRUCK TRIPS (Sewer + Paving)	**300**

14th - Folsom to Harrison

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	75	86
(E) Pipe Size, ft	6.25	7.16666667
(N) Pipe Size, in	84	100
(N) Pipe Size, ft	7	8.33333333

Pipe Length, LF	620
Trench Width, ft	13
"T" -Trench Width, ft	15
Estimated Working Days	42

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	287	CY	10	58
Existing Pipe/Soil Removal[2]	1069	CY	10	214
Hauling In				
Crushed Rock Bedding[3]	743	CY	10	150
Piping	620	LF	20	62
Manholes	3	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**486**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	620

	AC	Concrete
Area, SF	24800	9300
Unit	TON	CY
Amount Needed[4]	310	230
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	46
Dump Truck for Grinding[5]	32
AC Supply Truck	52
TOTAL PAVING TRUCK TRIPS	**130**

TOTAL TRUCK TRIPS (Sewer + Paving)	**616**

14th - Mission to South Van Ness

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	3'6"x5'3"	N/A
(E) Pipe Size, ft	N/A	N/A
(N) Pipe Size, in	66	79
(N) Pipe Size, ft	5.5	6.58333333

Pipe Length, LF	581
Trench Width, ft	11
"T" -Trench Width, ft	13
Estimated Working Days	30

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	233	CY	10	48
Existing Pipe/Soil Removal[2]	922	CY	10	186
Hauling In				
Crushed Rock Bedding[3]	512	CY	10	104
Piping	581	LF	40	30
Manholes	3	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**370**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	581

	AC	Concrete
Area, SF	23240	7553
Unit	TON	CY
Amount Needed[4]	291	186
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	38
Dump Truck for Grinding[5]	30
AC Supply Truck	50
TOTAL PAVING TRUCK TRIPS	**118**

TOTAL TRUCK TRIPS (Sewer + Paving)	**488**

Folsom - 12th to 11th, 11th - Folsom to Harrison

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	0	0
(E) Pipe Size, ft	0	0
(N) Pipe Size, in	48	58
(N) Pipe Size, ft	4	4.83333333

Pipe Length, LF	1055
Trench Width, ft	9
"T" -Trench Width, ft	11
Estimated Working Days	53

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	358	CY	10	72
Existing Pipe/Soil Removal[2]	1356	CY	10	272
Hauling In				
Crushed Rock Bedding[3]	639	CY	10	128
Piping	1055	LF	72	30
Manholes	5	EA	4	4
			TOTAL SEWER TRUCK TRIPS	**506**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	1055

	AC	Concrete
Area, SF	42200	11605
Unit	TON	CY
Amount Needed[4]	528	287
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	58
Dump Truck for Grinding[5]	54
AC Supply Truck	88
TOTAL PAVING TRUCK TRIPS	**200**

TOTAL TRUCK TRIPS (Sewer + Paving)	**706**

11th - Harrison to Division

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	0	0
(E) Pipe Size, ft	0	0
(N) Pipe Size, in	75	86
(N) Pipe Size, ft	6.25	7.16666667

Pipe Length, LF	841
Trench Width, ft	12
"T" -Trench Width, ft	14
Estimated Working Days	43

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	363	CY	10	74
Existing Pipe/Soil Removal[2]	2125	CY	10	426
Hauling In				
Crushed Rock Bedding[3]	868	CY	10	174
Piping	841	LF	30	58
Manholes	4	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**734**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	841

	AC	Concrete
Area, SF	33640	11774
Unit	TON	CY
Amount Needed[4]	421	291
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	60
Dump Truck for Grinding[5]	42
AC Supply Truck	72
TOTAL PAVING TRUCK TRIPS	**174**

TOTAL TRUCK TRIPS (Sewer + Paving)	**908**

17th - SVN to Shotwell, Shotwell to Folsom, Folsom to Treat

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	0	0
(E) Pipe Size, ft	0	0
(N) Pipe Size, in	102	120
(N) Pipe Size, ft	8.5	10

Pipe Length, LF	1071
Trench Width, ft	14
"T" -Trench Width, ft	16
Estimated Working Days	108

Sewer Hauling In and Out[1]				
Item	**Estimated Quantity**	**Unit**	**Units Per Truck Trip**	**Truck Trips**
Hauling Out				
Pavement	529	CY	10	106
Existing Pipe/Soil Removal[2]	4568	CY	10	914
Hauling In				
Crushed Rock Bedding[3]	1452	CY	10	292
Piping	1071	LF	10	216
Manholes	5	EA	4	4
			TOTAL SEWER TRUCK TRIPS	**1532**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	1071

	AC	Concrete
Area, SF	42840	17136
Unit	TON	CY
Amount Needed[4]	536	423
Truck Capacity	12	10

Paving Equipment[1]	
Item	**Truck Trips**
Concrete Mixer	86
Dump Truck for Grinding[5]	54
AC Supply Truck	90
TOTAL PAVING TRUCK TRIPS	**230**

TOTAL TRUCK TRIPS (Sewer + Paving)	**1762**

SVN - 18th to 17th

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	12	14.52
(E) Pipe Size, ft	1	1.21
(N) Pipe Size, in	42	51
(N) Pipe Size, ft	3.5	4.25

Pipe Length, LF	1071
Trench Width, ft	9
"T" -Trench Width, ft	11
Estimated Working Days	36

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	364	CY	10	74
Existing Pipe/Soil Removal[2]	1144	CY	10	230
Hauling In				
Crushed Rock Bedding[3]	627	CY	10	126
Piping	1071	LF	88	26
Manholes	5	EA	4	4
			TOTAL SEWER TRUCK TRIPS	**460**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	1071

	AC	Concrete
Area, SF	42840	11781
Unit	TON	CY
Amount Needed[4]	536	291
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	60
Dump Truck for Grinding[5]	54
AC Supply Truck	90
TOTAL PAVING TRUCK TRIPS	**204**

TOTAL TRUCK TRIPS (Sewer + Paving)	**664**

SVN - @ 18th

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	0	0
(E) Pipe Size, ft	0	0
(N) Pipe Size, in	36	44
(N) Pipe Size, ft	3	3.66666667

Pipe Length, LF	75
Trench Width, ft	8
"T" -Trench Width, ft	10
Estimated Working Days	3

Sewer Hauling In and Out[1]				
Item	**Estimated Quantity**	**Unit**	**Units Per Truck Trip**	**Truck Trips**
Hauling Out				
Pavement	23	CY	10	6
Existing Pipe/Soil Removal[2]	65	CY	10	14
Hauling In				
Crushed Rock Bedding[3]	35	CY	10	8
Piping	75	LF	120	2
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**32**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	75

	AC	Concrete
Area, SF	3000	750
Unit	TON	CY
Amount Needed[4]	38	19
Truck Capacity	12	10

Paving Equipment[1]	
Item	**Truck Trips**
Concrete Mixer	4
Dump Truck for Grinding[5]	4
AC Supply Truck	8
TOTAL PAVING TRUCK TRIPS	**16**

TOTAL TRUCK TRIPS (Sewer + Paving)	**48**

Erie - SVN to Folsom

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	12	14.52
(E) Pipe Size, ft	1	1.21
(N) Pipe Size, in	18	21.87
(N) Pipe Size, ft	1.5	1.8225

Pipe Length, LF	395
Trench Width, ft	6
"T" -Trench Width, ft	8
Estimated Working Days	12

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	98	CY	10	20
Existing Pipe/Soil Removal[2]	119	CY	10	24
Hauling In				
Crushed Rock Bedding[3]	98	CY	10	20
Piping	395	LF	216	4
Manholes	3	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**70**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	395

	AC	Concrete
Area, SF	15800	3160
Unit	TON	CY
Amount Needed[4]	198	78
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	16
Dump Truck for Grinding[5]	20
AC Supply Truck	34
TOTAL PAVING TRUCK TRIPS	**70**

TOTAL TRUCK TRIPS (Sewer + Paving)	**140**

Trainor - 13th to 14th, Mistral - Treat to Harrison

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	12	14.52
(E) Pipe Size, ft	1	1.21
(N) Pipe Size, in	12	14.52
(N) Pipe Size, ft	1	1.21

Pipe Length, LF	375
Trench Width, ft	6
"T" -Trench Width, ft	8
Estimated Working Days	10

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	93	CY	10	20
Existing Pipe/Soil Removal[2]	77	CY	10	16
Hauling In				
Crushed Rock Bedding[3]	77	CY	10	16
Piping	375	LF	324	4
Manholes	3	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**58**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	375

	AC	Concrete
Area, SF	15000	3000
Unit	TON	CY
Amount Needed[4]	188	74
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	16
Dump Truck for Grinding[5]	20
AC Supply Truck	32
TOTAL PAVING TRUCK TRIPS	**68**

TOTAL TRUCK TRIPS (Sewer + Paving)	**126**

Folsom - 17th to 18th

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	15	18.3
(E) Pipe Size, ft	1.25	1.525
(N) Pipe Size, in	15	18.3
(N) Pipe Size, ft	1.25	1.525

Pipe Length, LF	294
Trench Width, ft	6
"T" -Trench Width, ft	8
Estimated Working Days	8

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	73	CY	10	16
Existing Pipe/Soil Removal[2]	67	CY	10	14
Hauling In				
Crushed Rock Bedding[3]	67	CY	10	14
Piping	294	LF	324	2
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**48**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	294

	AC	Concrete
Area, SF	11760	2352
Unit	TON	CY
Amount Needed[4]	147	58
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	12
Dump Truck for Grinding[5]	16
AC Supply Truck	26
TOTAL PAVING TRUCK TRIPS	**54**

TOTAL TRUCK TRIPS (Sewer + Paving)	**102**

Folsom - 17th to 16th

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	12	14.52
(E) Pipe Size, ft	1	1.21
(N) Pipe Size, in	18	21.87
(N) Pipe Size, ft	1.5	1.8225

Pipe Length, LF	154
Trench Width, ft	6
"T" -Trench Width, ft	8
Estimated Working Days	5

Sewer Hauling In and Out[1]				
Item	**Estimated Quantity**	**Unit**	**Units Per Truck Trip**	**Truck Trips**
Hauling Out				
Pavement	38	CY	10	8
Existing Pipe/Soil Removal[2]	46	CY	10	10
Hauling In				
Crushed Rock Bedding[3]	38	CY	10	8
Piping	154	LF	216	2
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**30**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	154

	AC	Concrete
Area, SF	6160	1232
Unit	TON	CY
Amount Needed[4]	77	30
Truck Capacity	12	10

Paving Equipment[1]	
Item	**Truck Trips**
Concrete Mixer	8
Dump Truck for Grinding[5]	8
AC Supply Truck	14
TOTAL PAVING TRUCK TRIPS	**30**

TOTAL TRUCK TRIPS (Sewer + Paving)	**60**

Shotwell - 18th to 19th

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	18	21.87
(E) Pipe Size, ft	1.5	1.8225
(N) Pipe Size, in	18	21.87
(N) Pipe Size, ft	1.5	1.8225

Pipe Length, LF	280
Trench Width, ft	6
"T" -Trench Width, ft	8
Estimated Working Days	8

Sewer Hauling In and Out[1]				
Item	**Estimated Quantity**	**Unit**	**Units Per Truck Trip**	**Truck Trips**
Hauling Out				
Pavement	69	CY	10	14
Existing Pipe/Soil Removal[2]	69	CY	10	14
Hauling In				
Crushed Rock Bedding[3]	69	CY	10	14
Piping	280	LF	216	4
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**48**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	280

	AC	Concrete
Area, SF	11200	2240
Unit	TON	CY
Amount Needed[4]	140	55
Truck Capacity	12	10

Paving Equipment[1]	
Item	**Truck Trips**
Concrete Mixer	12
Dump Truck for Grinding[5]	14
AC Supply Truck	24
TOTAL PAVING TRUCK TRIPS	**50**

TOTAL TRUCK TRIPS (Sewer + Paving)	**98**

19th - Folsom to Treat

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	12	14.52
(E) Pipe Size, ft	1	1.21
(N) Pipe Size, in	24	28.85
(N) Pipe Size, ft	2	2.40416667

Pipe Length, LF	298
Trench Width, ft	7
"T" -Trench Width, ft	9
Estimated Working Days	9

Sewer Hauling In and Out[1]				
Item	**Estimated Quantity**	**Unit**	**Units Per Truck Trip**	**Truck Trips**
Hauling Out				
Pavement	83	CY	10	18
Existing Pipe/Soil Removal[2]	138	CY	10	28
Hauling In				
Crushed Rock Bedding[3]	100	CY	10	22
Piping	298	LF	184	4
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**74**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	298

	AC	Concrete
Area, SF	11920	2682
Unit	TON	CY
Amount Needed[4]	149	66
Truck Capacity	12	10

Paving Equipment[1]	
Item	**Truck Trips**
Concrete Mixer	14
Dump Truck for Grinding[5]	16
AC Supply Truck	26
TOTAL PAVING TRUCK TRIPS	**56**

TOTAL TRUCK TRIPS (Sewer + Paving)	**130**

Alabama - Mariposa to 17th, Harrison - 15th to Alameda

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	8	10.02
(E) Pipe Size, ft	0.66666667	0.835
(N) Pipe Size, in	15	18.3
(N) Pipe Size, ft	1.25	1.525

Pipe Length, LF	764
Trench Width, ft	6
"T" -Trench Width, ft	8
Estimated Working Days	20

Sewer Hauling In and Out[1]				
Item	**Estimated Quantity**	**Unit**	**Units Per Truck Trip**	**Truck Trips**
Hauling Out				
Pavement	189	CY	10	38
Existing Pipe/Soil Removal[2]	211	CY	10	44
Hauling In				
Crushed Rock Bedding[3]	175	CY	10	36
Piping	764	LF	324	6
Manholes	4	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**126**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	764

	AC	Concrete
Area, SF	30560	6112
Unit	TON	CY
Amount Needed[4]	382	151
Truck Capacity	12	10

Paving Equipment[1]	
Item	**Truck Trips**
Concrete Mixer	32
Dump Truck for Grinding[5]	38
AC Supply Truck	64
TOTAL PAVING TRUCK TRIPS	**134**

TOTAL TRUCK TRIPS (Sewer + Paving)	**260**

19th - Folsom to Treat

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	12	14.52
(E) Pipe Size, ft	1	1.21
(N) Pipe Size, in	24	28.85
(N) Pipe Size, ft	2	2.40416667

Pipe Length, LF	298
Trench Width, ft	7
"T" -Trench Width, ft	9
Estimated Working Days	9

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	83	CY	10	18
Existing Pipe/Soil Removal[2]	138	CY	10	28
Hauling In				
Crushed Rock Bedding[3]	100	CY	10	22
Piping	298	LF	184	4
Manholes	2	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**74**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	298

	AC	Concrete
Area, SF	11920	2682
Unit	TON	CY
Amount Needed[4]	149	66
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	14
Dump Truck for Grinding[5]	16
AC Supply Truck	26
TOTAL PAVING TRUCK TRIPS	**56**

TOTAL TRUCK TRIPS (Sewer + Paving)	**130**

Alabama - Mariposa to 17th, Harrison - 15th to Alameda

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	8	10.02
(E) Pipe Size, ft	0.66666667	0.835
(N) Pipe Size, in	15	18.3
(N) Pipe Size, ft	1.25	1.525

Pipe Length, LF	764
Trench Width, ft	6
"T" -Trench Width, ft	8
Estimated Working Days	20

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	189	CY	10	38
Existing Pipe/Soil Removal[2]	211	CY	10	44
Hauling In				
Crushed Rock Bedding[3]	175	CY	10	36
Piping	764	LF	324	6
Manholes	4	EA	4	2
			TOTAL SEWER TRUCK TRIPS	**126**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	40
Approx. Paving Length, ft	764

	AC	Concrete
Area, SF	30560	6112
Unit	TON	CY
Amount Needed[4]	382	151
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	32
Dump Truck for Grinding[5]	38
AC Supply Truck	64
TOTAL PAVING TRUCK TRIPS	**134**

TOTAL TRUCK TRIPS (Sewer + Paving)	**260**

Tunnel & Appurtenances

Fill in yellow boxes.

SEWER TRUCK TRIP CALCULATION

	Nominal Diameter	Outer Diameter
(E) Pipe Size, in	0	0
(E) Pipe Size, ft	0	0
(N) Pipe Size, in	144	180
(N) Pipe Size, ft	12	15

Pipe Length, LF	4000
Trench Width, ft	0
"T" -Trench Width, ft	0
Estimated Working Days	730

Sewer Hauling In and Out[1]

Item	Estimated Quantity	Unit	Units Per Truck Trip	Truck Trips
Hauling Out				
Pavement	0	CY	10	0
Existing Pipe/Soil Removal[2]	23562	CY	10	4714
Hauling In				
Crushed Rock Bedding[3]	0	CY	10	0
Piping	4000	LF	10	800
Concrete	4331	CY	10	868
Manholes	0	EA	4	0
			TOTAL SEWER TRUCK TRIPS	**6382**

PAVING TRUCK TRIP CALCULATION

1 block	
Paving Width, ft	0
Approx. Paving Length, ft	0

	AC	Concrete
Area, SF	0	0
Unit	TON	CY
Amount Needed[4]	0	0
Truck Capacity	12	10

Paving Equipment[1]

Item	Truck Trips
Concrete Mixer	0
Dump Truck for Grinding[5]	0
AC Supply Truck	0
TOTAL PAVING TRUCK TRIPS	**0**

TOTAL TRUCK TRIPS (Sewer + Paving)	**6382**

Treat - 16th to Alameda (box sewer)

Block Length, LF: 985
Total Work Days: 195
Work Hours: 8 AM - 5 PM

Equipment Type	Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	2	8	16
Excavator	1	157	100	4	400
Loader/Backhoe	1	75	195	4	780
Paving Equipment (Grinder)	1	82	2	6	12
Other Material Handling Equipment (AC Supply Truck)	2	196	2	2.25	9
Paver	1	89	2	6	12
Roller	1	84	2	6	12
Other Material Handling Equipment (Concrete Mixer)	4	196	90	0.25	90
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	39	2	312
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	0	381	11	0.5	0
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	16	1	64

Assumptions:
1. Each AC truck trip takes 45 minutes, including waiting time. Hours per unit per day can be more than 0.75--most likely a multiple of 0.75--if each unit needs to make more than one trip per day.
2. Each concrete mixer stays on site for 15 minutes (first 5 minute is free of charge, pouring speed 1 min/CY).
3. Crushed rock truck trip takes 30 minutes to off load.
4. Sewer delivery truck trip takes 1 hour to off-load.
5. Sewer/paving dump trucks stay on site for 1 hour. Hours per unit per day can be more than 1 if each unit needs to make more than one trip per day.
6. One AC supply truck makes 3 round trips max per day.

Treat @ 16th Street

Block Length, LF: 24
Total Work Days: 60
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	30	4	120
Loader/Backhoe	1	75	60	4	240
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	1	196	1	2.25	2.25
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	1	196	6	0.25	1.5
Off-Highway Trucks (Sewer and Paving Dump Truck)	1	381	3	2	6
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	0	381	8	0.5	0
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	2	381	5	1	10

15th Street - Mission to Minna

Block Length, LF: 253
Total Work Days: 13
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	2	8	16
Excavator	1	157	125	4	500
Loader/Backhoe	1	75	253	4	1012
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	2	2.25	9
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	5	0.25	2.5
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	7	2	56
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	6	0.5	12
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	2	381	5	1	10

15th Street - Minna to Capp, Capp to

Block Length, LF: 711
Total Work Days: 48
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	24	4	96
Loader/Backhoe	1	75	48	4	192
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	4	2.25	18
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	12	0.25	6
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	20	2	160
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	20	0.5	40
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	2	381	13	1	26

Harrison Street - 19th to 18th, 18th to

Block Length, LF: 1633
Total Work Days: 290
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	3	8	24
Excavator	1	157	150	4	600
Loader/Backhoe	1	75	290	4	1160
Paving Equipment (Grinder)	1	82	3	6	18
Other Material Handling Equipment (AC Supply Truck)	4	196	6	2.25	54
Paver	1	89	5	6	30
Roller	1	84	5	6	30
Other Material Handling Equipment (Concrete Mixer)	4	196	106	0.25	106
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	60	2	480
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	0	381	7	0.5	0
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	26	1	104

18th Street - Shotwell to Folsom,

Block Length, LF: 608

Total Work Days: 61

Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	30	4	120
Loader/Backhoe	1	75	61	4	244
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	3	196	3	2.25	20.25
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	12	0.25	6
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	36	2	288
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	24	0.5	48
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	40	1	160

18th - Treat to Harrison

Block Length, LF: 377

Total Work Days: 19

Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	10	4	40
Loader/Backhoe	1	75	19	4	76
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	3	2.25	13.5
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	7	0.25	3.5
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	12	2	96
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	3	381	10	0.5	15
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	2	381	5	1	10

17th - Treat to Harrison

Block Length, LF: 217
Total Work Days: 22
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	105	4	420
Loader/Backhoe	1	75	217	4	868
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	4	196	1	2.25	9
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	6	0.25	3
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	12	2	96
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	7	0.5	14
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	3	381	4	1	12

14th - Folsom to Harrison

Block Length, LF: 620
Total Work Days: 42
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	20	4	80
Loader/Backhoe	1	75	42	4	168
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	3	196	3	2.25	20.25
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	12	0.25	6
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	20	2	160
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	20	0.5	40
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	8	1	32

14th - Mission to South Van Ness

Block Length, LF: 581
Total Work Days: 30
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	15	4	60
Loader/Backhoe	1	75	30	4	120
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	3	196	3	2.25	20.25
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	5	0.25	5
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	17	2	136
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	13	0.5	26
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	4	1	16

Folsom - 12th to 11th, 11th - Folsom to

Block Length, LF: 1055
Total Work Days: 53
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	2	8	16
Excavator	1	157	25	4	100
Loader/Backhoe	1	75	53	4	212
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	4	196	4	2.25	36
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	7	0.25	7
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	25	2	200
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	16	0.5	32
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	5	1	20

11th - Harrison to Division

Block Length, LF: 841
Total Work Days: 43
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	2	8	16
Excavator	1	157	20	4	80
Loader/Backhoe	1	75	43	4	172
Paving Equipment (Grinder)	1	82	2	6	12
Other Material Handling Equipment (AC Supply Truck)	4	196	3	2.25	27
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	7	0.25	7
Off-Highway Trucks (Sewer and Paving Dump Truck)	6	381	23	2	276
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	6	381	16	0.5	48
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	8	1	32

17th - SVN to Shotwell, Shotwell to

Block Length, LF: 1071
Total Work Days: 108
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	2	8	16
Excavator	1	157	50	4	200
Loader/Backhoe	1	75	108	4	432
Paving Equipment (Grinder)	1	82	2	6	12
Other Material Handling Equipment (AC Supply Truck)	4	196	4	2.25	36
Paver	1	89	2	6	12
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	11	0.25	11
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	68	2	544
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	36	0.5	72
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	64	1	256

SVN - 18th to 17th

Block Length, LF: 1071
Total Work Days: 36
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	2	8	16
Excavator	1	157	18	4	72
Loader/Backhoe	1	75	36	4	144
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	4	196	4	2.25	36
Paver	1	89	2	6	12
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	7	0.25	7
Off-Highway Trucks (Sewer and Paving Dump Truck)	6	381	15	2	180
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	6	381	11	0.5	33
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	381	4	1	16

SVN - @ 18th

Block Length, LF: 75
Total Work Days: 3
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	3	4	12
Loader/Backhoe	1	75	75	4	300
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	1	196	2	2.25	4.5
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	1	196	2	0.25	0.5
Off-Highway Trucks (Sewer and Paving Dump Truck)	2	381	3	2	12
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	2	381	2	0.5	2
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	2	1	2

Erie - SVN to Folsom

Block Length, LF: 395

Total Work Days: 12

Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	6	4	24
Loader/Backhoe	1	75	12	4	48
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	3	2.25	13.5
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	2	0.25	2
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	4	2	32
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	3	0.5	6
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	2	381	2	1	4

Trainor - 13th to 14th, Mistral - Treat

Block Length, LF: 375
Total Work Days: 10
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	5	4	20
Loader/Backhoe	1	75	10	4	40
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	3	2.25	13.5
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	2	0.25	2
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	4	2	32
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	4	381	3	0.5	6
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	2	381	2	1	4

Folsom - 17th to 18th

Block Length, LF: 294

Total Work Days: 8

Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	4	4	16
Loader/Backhoe	1	75	8	4	32
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	3	2.25	13.5
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	2	0.25	2
Off-Highway Trucks (Sewer and Paving Dump Truck)	3	381	4	2	24
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	3	381	3	0.5	4.5
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	2	1	2

Folsom - 17th to 16th

Block Length, LF: 154
Total Work Days: 5
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	3	4	12
Loader/Backhoe	1	75	5	4	20
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	3	196	1	2.25	6.75
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	2	0.25	1
Off-Highway Trucks (Sewer and Paving Dump Truck)	2	381	4	2	16
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	2	381	3	0.5	3
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	2	1	2

Shotwell - 18th to 19th

Block Length, LF: 280

Total Work Days: 8

Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	4	4	16
Loader/Backhoe	1	75	8	4	32
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	2	2.25	9
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	3	0.25	1.5
Off-Highway Trucks (Sewer and Paving Dump Truck)	2	381	6	2	24
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	2	381	4	0.5	4
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	3	1	3

19th - Folsom to Treat

Block Length, LF: 298
Total Work Days: 9
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	5	4	20
Loader/Backhoe	1	75	9	4	36
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	3	2.25	13.5
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	4	0.25	2
Off-Highway Trucks (Sewer and Paving Dump Truck)	2	381	8	2	32
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	2	381	6	0.5	6
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	3	1	3

Alabama - Mariposa to 17th, Harrison -

Block Length, LF: 764
Total Work Days: 20
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	2	8	16
Excavator	1	157	10	4	40
Loader/Backhoe	1	75	20	4	80
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	6	2.25	27
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	4	0.25	4
Off-Highway Trucks (Sewer and Paving Dump Truck)	3	381	10	2	60
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	3	381	6	0.5	9
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	4	1	4

19th - Folsom to Treat

Block Length, LF: 298
Total Work Days: 9
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	5	4	20
Loader/Backhoe	1	75	9	4	36
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	2	196	3	2.25	13.5
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	4	0.25	2
Off-Highway Trucks (Sewer and Paving Dump Truck)	2	381	8	2	32
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	2	381	6	0.5	6
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	3	1	3

Alabama - Mariposa to 17th, Harrison -

Block Length, LF: 764
Total Work Days: 20
Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	1	8	8
Excavator	1	157	10	4	40
Loader/Backhoe	1	75	20	4	80
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	4	196	3	2.25	27
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	4	196	4	0.25	4
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	8	2	64
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	3	381	6	0.5	9
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	1	381	4	1	4

Tunnel & Appurtenances

Block Length, LF: 4000

Total Work Days: 730

Work Hours: 8 AM - 5 PM

Equipment Type	Total Number of Units	Horsepower	Total Number of Days	Hours per Unit per Day	Total Number of Hours
Sawcutting Machine	1	13	0	8	0
Excavator	1	157	10	4	40
Loader/Backhoe	1	75	730	4	2920
Paving Equipment (Grinder)	1	82	1	6	6
Other Material Handling Equipment (AC Supply Truck)	4	196	0	2.25	0
Paver	1	89	1	6	6
Roller	1	84	1	6	6
Other Material Handling Equipment (Concrete Mixer)	2	196	54	1	108
Off-Highway Trucks (Sewer and Paving Dump Truck)	4	381	300	2	2400
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	3	381	0	0.5	0
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	2	381	100	2	400

Crane	1	600	172	8	1376

Equipment	Number of Units	Total Days
Sawcutting Machine	1	33
Excavator	1	787
Loader/Backhoe	1	2361
Paving Equipment (Grinder)	1	30
Other Material Handling Equipment (AC Supply Truck)	4	72
Paver	1	32
Roller	1	30
Other Material Handling Equipment (Concrete Mixer)	4	376
Off-Highway Trucks (Sewer and Paving Dump Truck)	6	716
Off-Highway Trucks (Sewer Delivery Truck for Crushed Rock)	6	247
Off-Highway Trucks (Sewer Delivery Truck for Piping and Manholes)	4	334
Crane	1	172

Total Hours
264
3148
9444
180
452.25
192
180
390.5
5718
435.5
1199
1376

USGS science for a changing world
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map US Topo

SAN FRANCISCO NORTH QUADRANGLE
CALIFORNIA
7.5-MINUTE SERIES

Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 10S
10 000-foot ticks: California Coordinate System of 1983 (zone 3)

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery....NAIP, May 2012
Roads.... HERE, ©2013 - 2014
Names....GNIS, 2015
Hydrography....National Hydrography Dataset, 2012
Contours....National Elevation Dataset, 2012
Boundaries....Multiple sources; see metadata file 1972 - 2015
Public Land Survey System....BLM, 2011

MN
GN
13° 48′
245 MILS
0° 21′
6 MILS
UTM GRID AND 2015 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000-m Square ID
EG
Grid Zone Designation
10S

SCALE 1:24 000

KILOMETERS 1 0.5 0 1 2
METERS 1000 500 0 1000 2000
MILES 1 0.5 0 1
FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.18

CALIFORNIA
QUADRANGLE LOCATION

ADJOINING QUADRANGLES
1 San Rafael
2 San Quentin
3 Richmond
4 Point Bonita
5 Oakland West
6 San Francisco South OE W
7 San Francisco South
8 Hunters Point

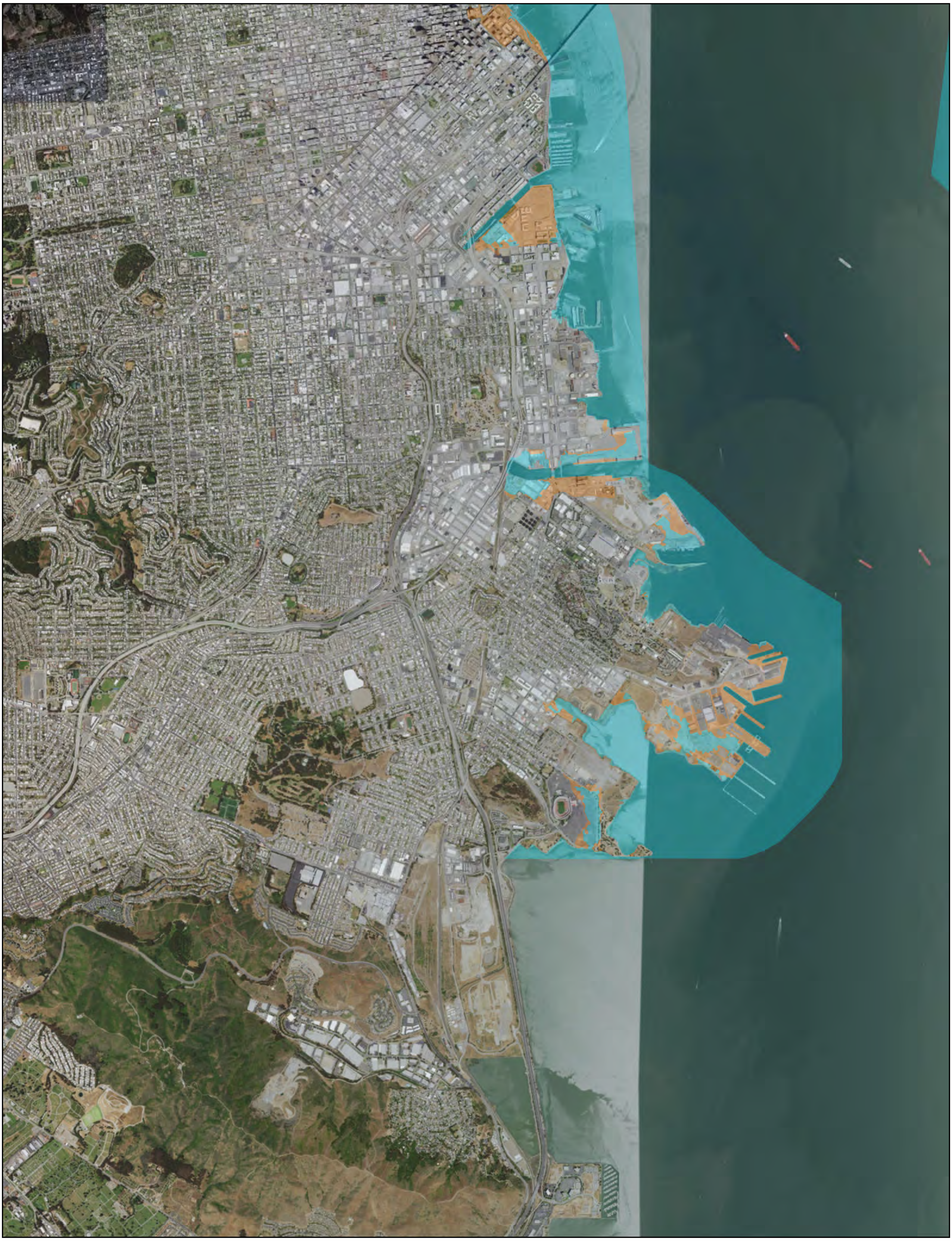
ROAD CLASSIFICATION

Expressway	Local Connector
Secondary Hwy	Local Road
Ramp	4WD
Interstate Route	US Route
State Route	

SAN FRANCISCO NORTH, CA
2015

NSN. 7643016357622
NGA REF NO. USGSX24K39619


SAN FRANCISCO
ZONING MAP
OCTOBER 2017
San Francisco Planning
ZONING USE DISTRICTS
Public
P Public
Residential, House Character Districts
RH-1(D) One Unit Per Lot, Detached
RH-1 One Unit Per Lot
RH-1(S) One Unit Per Lot, Minor Secondary Unit
RH-2 Two Units Per Lot
RH-3 Three Units Per Lot
Residential, Mixed (Houses & Apartments) Districts
RM-1 Low Density (1 Unit per 800 sf)
RM-2 Moderate Density (1 Unit per 600 sf)
RM-3 Medium Density (1 Unit per 400 sf)
RM-4 High Density (1 Unit per 200 sf)
Residential-Commercial Combined Districts
RC-3 Medium Density (1 Unit per 400 sf)
RC-4 High Density (1 Unit per 200 sf)
Residential Transit Oriented Districts
RTO Residential Transit Oriented
RTO-M Residential Transit Oriented, Mission
Downtown Residential Districts
RH-DTR Rincon Hill
SB-DTR South Beach
TB-DTR Transbay
Neighborhood Commercial Districts
NC-1 Cluster (1 Commercial Story)
NC-2 Small-Scale (2 Commercial Stories)
NC-3 Moderate-Scale (3+ Commercial Stories)
NC-S Shopping Center (2 Commercial Stories)
NCD Individual (Named, Controls Vary)
Neighborhood Commercial Transit Districts
NCT-1 Cluster
NCT-2 Small Scale
NCT-3 Moderate Scale
NCT Individual (Named, Controls Vary)
Chinatown Mixed Use Districts
CRNC Residential/Neighborhood Commercial
CVR Visitor Retail
CCB Community Business
Parkmerced Use Districts
PM-MU1 Mixed Use - Social Heart
PM-MU2 Mixed Use - Neighborhood Commons
PM-S School
PM-CF Community/Fitness
PM-OS Open Space
PM-R Residential
South of Market Mixed Use Districts
SPD South Park
RED Residential Enclave
RED-MX Residential Enclave Mixed Use
RSD Residential/Service
SLR Service/Light Industrial/Residential
SLI Service/Light Industrial
SALI Service/Arts/Light Industrial
SSO Service/Secondary Office
Eastern Neighborhoods Mixed Use Districts
MUG Mixed Use, General
WMUG Western SoMa, Mixed Use, General
MUO Mixed Use, Office
WMUO Western SoMa, Mixed Use, Office
MUR Mixed Use, Residential
UMU Urban Mixed Use
Commercial Districts
RCD Regional Commercial
C-2 Community Business
C-3-S Downtown Support
C-3-R Downtown Retail
C-3-G Downtown General
C-3-O Downtown Office
C-3-O(SD) Downtown Office (Specail Development)
Redevelopment Agency Districts
MB-OS Mission Bay, Open Space
MB-O Mission Bay, Office
MB-RA See Mission Bay Redevelopment Plans
HP-RA See Hunters Point Redevelopment Plans
Industrial Districts
M-1 Light Industrial
M-2 Heavy Industrial
Production, Distribution & Repair Districts
PDR-1-B Buffer
PDR-1-D Design
PDR-1-G General
PDR-2 Core
The Zoning Map of the City and County of San Francisco is established by Sections 105 and 106 of the Planning Code. A part of the San Francisco Municipal Code. Zoning use districts are established by Sections 201, 702, 802 and 902 of the Planning Code.
This map incorporates Board of Supervisors ordinances enacted through October 2017.
This map is not an element of the Official Zoning Map of San Francisco. The Official Zoning Map publication may be purchased wherever San Francisco Municipal Codes are sold.
Disclaimer: The City and County of San Francisco (CCSF) does not guarantee the accuracy, adequacy, completeness or usefulness of any information. CCSF provides this information on an "as is" basis without any warranty of any kind, including but not limited to warranties of merchantibility or fitness for a particular purpose, and assumes no responsibility for anyone's use of the information.
Please report all corrections to:
michael.webster@sfgov.org
PACIFIC OCEAN
SAN FRANCISCO BAY
PRESIDIO
GOLDEN GATE PARK
LAKE MERCED
McLAREN PARK
INDIA BASIN
SOUTH BASIN
CHINA BASIN
ISLAIS CREEK
San Francisco County
San Mateo County
N
0 0.25 0.5 1 Mile

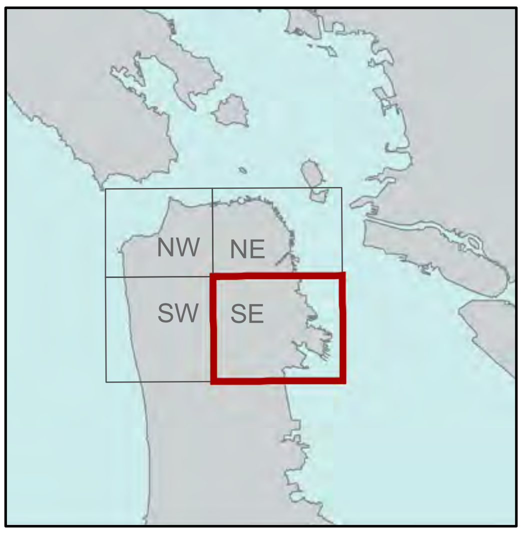


FLOOD HAZARD INFORMATION

Special Flood Hazard Areas

- 1% Annual Chance Flood Hazard
- .2% Annual Chance Flood Hazard

Source:
FEMA Preliminary Flood Insurance Rate Map
November 12, 2015



SAN FRANCISCO INTERIM FLOODPLAIN MAP

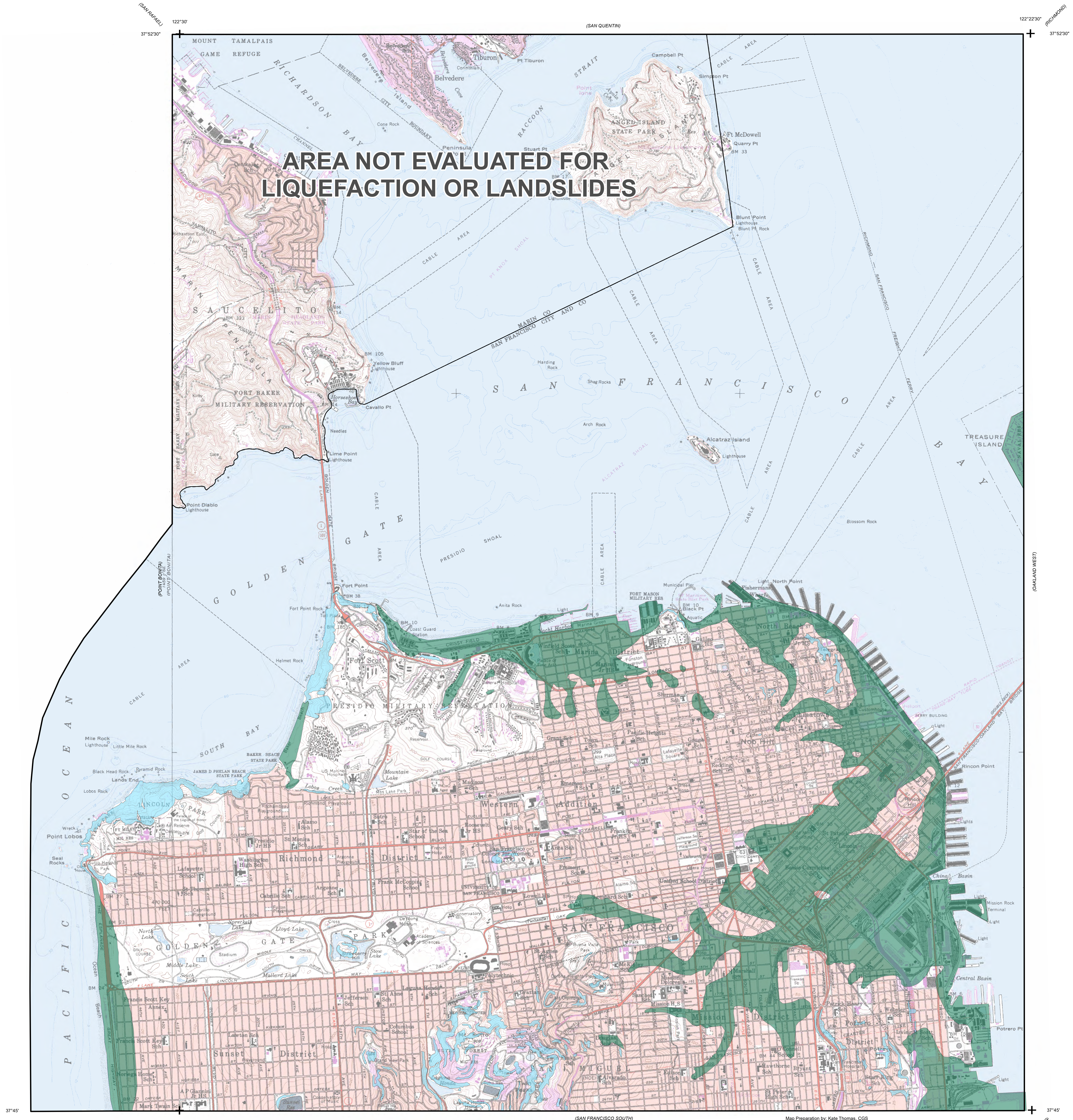
SE San Francisco

PRELIMINARY November 12, 2015

0 2,500 5,000 7,500 10,000 Feet

0 0.5 1 2 Miles

Map Projection:
Universal Transverse Mercator Zone 10N: North American Datum 1983.
Western Hemisphere; Vertical Datum: NAVD 88



Earthquake Zones of Required Investigation San Francisco North Quadrangle

California Geological Survey

This Map Shows Seismic Hazard Zones
Alquist-Priolo Earthquake Fault Zones Have Not Been Prepared
For The San Francisco North Quadrangle

This map shows the location of Seismic Hazard Zones, referred to here as Earthquake Zones of Required Investigation. The Geographic Information System (GIS) digital files of these regulatory zones released by the California Geological Survey (CGS) are the "Official Maps." GIS files are available at the GGS website http://maps.conservation.ca.gov/cgs/informationwarehouse/. These zones will assist cities and counties in fulfilling their responsibilities for protecting the public from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6) and the Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code Sections 2621-2630). For information regarding the general approach and recommended methods for preparing these zones, see CGS Special Publication 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California,* and Special Publication 42, *Earthquake Fault Zones, a Guide for Government Agencies, Property Owners/Developers, and Geoscience Practitioners for Assessing Fault Rupture Hazards in California,* Appendix C.

For information regarding the scope and recommended methods to be used in conducting required site investigations refer to CGS Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, and CGS Special Publication 42. For a general description of the Seismic Hazards Mapping and Alquist-Priolo Earthquake Fault Zoning acts, the zonation programs, and related information, please refer to the website at www.conservation.ca.gov/cgs/.

MAP EXPLANATION

SEISMIC HAZARD ZONES

Liquefaction Zones
Areas where historical occurrence of liquefaction, or local geological, geotechnical and ground water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslide Zones
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

ADDITIONAL INFORMATION

For additional information on the zones of required investigation presented on this map, the data and methodology used to prepare them, and additional references consulted, please refer to the following:

Seismic Hazard Zone Report for the City of County of San Francisco 7.5-minute Quadrangle,
San Francisco County, California. California Geological Survey, Seismic Hazard Zone Report 043.
http://gmw.conservation.ca.gov/SHP/EZRIM/Reports/SHZR/SHZR_043_City_And_County_of_San_Francisco.pdf

For more information on the Seismic Hazards Mapping Act please refer to:
http://www.conservation.ca.gov/cgs/shzp/Pages/SHMPpgminfo.aspx

Click the link below to learn how to take greater advantage of the GeoPDF format of this map after downloading.
http://gmw.conservation.ca.gov/SHP/EZRIM/Docs/TerragoUserGuide.pdf

SAN FRANCISCO NORTH QUADRANGLE

SEISMIC HAZARD ZONES

Delineated in compliance with Chapter 7.8,
Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

OFFICIAL MAP

Released: November 17, 2000

STATE GEOLOGIST

Study area defined by USGS quadrangle boundaries using NAD 27, represented by the visible map extent. Data are maintained and distributed in California Albers (meters), NAD 83 [EPSG:3310], as shown by tics and coordinates.
Shaded topographic relief derived from USGS 10 meter NED (2013).
Topographic base map from USGS 1956, photorevised 1968 and 1973.
Street data from US Census Bureau TIGER/Line, 2016.

Scale 1: 24000

Contour Interval 25 Feet

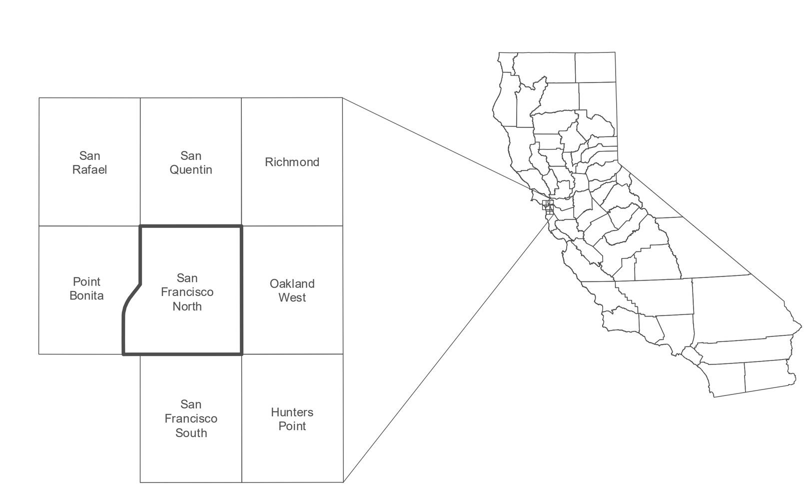
13½°
TRUE NORTH
MAGNETIC NORTH
Approximate Declination, 2016

N

California Geological Survey
Geologic Information and Publications
801 K Street, MS 14-34
Sacramento, CA 95814-3532
www.conservation.ca.gov/cgs

CALIFORNIA CONSERVATION

CGS CALIFORNIA GEOLOGICAL SURVEY



IMPORTANT

PLEASE NOTE THE FOLLOWING FOR ZONES SHOWN ON THIS MAP

1) This map may not show all faults that have the potential for surface fault rupture, either within the Earthquake Fault Zones or outside their boundaries. Additionally, this map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landside failure will not uniformly affect the entire area zoned.

2) Boundaries of Earthquake Fault Zones, if included on this map, are based on interpreted Holocene-active fault traces.

3) The identification and location of these faults are based on the best available data. However, the quality of data used is varied. Traces have been depicted as accurately as possible at a map scale of 1:24,000.

4) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toes of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

5) Landslide zones on this map were determined, in part, by adapting methods first developed by the U.S. Geological Survey (USGS). Landslide hazard maps prepared by the USGS typically use experimental approaches to assess earthquake-induced and other types of landslide hazards. Although aspects of these new methodologies may be incorporated in future CGS seismic hazard zone maps, USGS maps should not be used as substitutes for these Official SEISMIC HAZARD ZONES maps.

6) USGS base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.

7) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the California Public Resources Code.

8) Seismic Hazard Zones identified on this map may include developed land where delineated hazards have already been mitigated to city or county standards. Check with your local building/planning department for information regarding the location of such mitigated areas.

9) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

APPENDIX K

REAL ESTATE INQUIRY

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ARWS ASSOCIATED RIGHT OF WAY SERVICES, INC.

MEMORANDUM

DATE: March 13, 2018

TO: Saed Toloui, SFPUC Project Manager

FROM: Bill Tannenbaum/Bruz Meade – Associated Right of Way Services, Inc.

PROJECT: Folsom Area Storm Water Improvement Project

SUBJECT: Preliminary Right of Way Cost Estimate

SUMMARY

As requested, Associated Right of Way Services, Inc. ("AR/WS") has prepared this Preliminary Right of Way Cost Estimate ("Cost Estimate") for the San Francisco Public Utilities Commission ("SFPUC"). This Cost Estimate encompasses nine potential sites located in San Francisco as identified by the SFPUC on the attached **Exhibit 1**.

This Cost Estimate contains estimated acquisition costs for various land rights including temporary construction easements, permanent subsurface easements, and permanent access easements. This Cost Estimate also includes estimated Relocation Assistance (personal property only) for parcels where temporary and permanent surface access is being proposed.

This Cost Estimate identifies orders of magnitude for planning purposes. The categories estimated are potential costs to acquire properties and provide relocation assistance. All services to be provided in accordance with applicable public agency regulations.

METHODOLOGY

To develop our Cost Estimate, AR/WS researched recent sales data in the area of the subject properties and competing markets. Relocation Assistance costs have been estimated based on experience with similar relocation assignments. Potential loss of business goodwill was not estimated. Nor were possible fixtures and equipment acquisitions. Costs for professional services have not been included. This Cost Estimate is not an appraisal report. Results of an appraisal could vary significantly from the Cost Estimate conclusions.

Information regarding the subject properties was obtained from the SFPUC and other public resources. Site visits were conducted to gather information and observe current land uses. Each of the properties were discreetly viewed from the public right of way. None of the properties were inspected from the interior and no owners or tenants were contacted. During the inspections we observed several businesses that appeared to be operating on the subject properties.

The site located at Treat Avenue and Florida Street (3902-002) appears to be used as a fully contained dog run area associated with the adjacent SPCA facility. The owner of record for this parcel is SF Society for the Prevention of Cruelty to Animals. A 7,900 square feet temporary construction easement is being proposed for this site. Relocation Assistance costs for this site are included in the Cost Estimate.

The site located at Treat Avenue and Florida Street (3902-006) appears to be used as a surface parking lot. The owner of record for this parcel is the City and County of San Francisco, however signage indicated that California Parking operates a paid parking lot on this site. A check of California Parking's website indicated that the parking lot at 24 Florida Street offers monthly daytime permit parking and is currently sold out with a waiting list. The current published rate is $225 per month for weekday parking from 7 am to 5 pm. Public parking is available for $6.00 flat rate for up to 12 hours on nights and weekends. The parking lot is unattended and payment is made by telephone or mobile application. A proposed 7,900 square feet temporary construction easement appears to impact approximately 25 parking spaces as well as one of the entrances to the parking lot. A proposed 5,000 square feet permanent subsurface easement will prohibit structures which are currently allowed under the current 'zero lot line' zoning. Therefore, a 75% discount was applied to the estimated fee value when calculating the cost of the permanent subsurface easement. Additionally, a proposed 800 square feet permanent access easement containing a traffic-rated tunnel shaft cover will further diminish the estimated fee value by 15%. Relocation Assistance costs for this site are included in the Cost Estimate.

The site located at Bryant Street and Division Street appears to serve as a surface parking lot. The ownership of this site is assumed to be California Department of Transportation (Caltrans). This site appears to be excess right of way. The adjacent business (Byer California) appears to be utilizing this site for employee/visitor parking. The main entry for this site is a sliding gate off of Division Street which also serves as the entry to the Byer California loading dock area. It is unknown whether there is a current lease agreement in place. A proposed 16,000 square feet temporary construction easement appears to impact approximately 50 parking spaces. Relocation Assistance costs for this site are included in the Cost Estimate.

The site located at 1401 Bryant Street (3904-001) appears to serve as a surface parking lot. Marina and Allan Byer are the owners of record for this parcel, which appears to be utilized by Byer California, Inc. for employee/visitor parking. The proposed temporary construction easement proposed for this site appears to impact approximately 35 parking spaces. Relocation Assistance costs for this site are included in the Cost Estimate.

The site located at 1398 Bryant Street (3923-002) appears to serve as a surface parking lot for Hertz rental cars. The owner of record is Associated Limousine Operators. The proposed subsurface easement does not appear to impact the current surface usage of this site. The proposed easement will prohibit structures which are currently allowed under the current 'zero lot line' zoning. Therefore, a 75% discount was applied to the estimated fee value when calculating the cost of the permanent subsurface easement.

The site located at 1504 Bryant Street (3923-003) appears to serve as a surface parking lot for Beressi Fabrics Co. The owners of record are Salvator and Dagny Beressi. The proposed subsurface easement does not appear to impact the current surface usage of this site. The proposed easement will prohibit structures which are currently allowed under the current 'zero lot line' zoning. Therefore, a 75% discount was applied to the estimated fee value when calculating the cost of the permanent subsurface easement.

The site located at 145 Florida Street (3923-007) appears to serve as a surface parking lot for an adjacent office building. The owner of record is DP 1550 Bryant LLC. The proposed subsurface easement does not appear to impact the current surface usage of this site. The proposed easement will prohibit structures which are currently allowed under the current 'zero lot line' zoning. Therefore, a 75% discount was applied to the estimated fee value when calculating the cost of the permanent subsurface easement.

The site located at 575 Berry Street (3807-002; 3807-004 & 3807-008) appears to serve as a surface parking lot and equipment storage area for Recology. The owner of record is Macor, Inc. The proposed subsurface easement encumbers portions of three contiguous parcels and does not appear to impact the current surface usage of the site. The proposed easement will prohibit structures which are currently allowed under the current 'zero lot line' zoning. Therefore, a 75% discount was applied to the estimated fee value when calculating the cost of the permanent subsurface easement.

The site located at 7th Street and Berry Street appears to serve as rail road right of way. The owner of this site is not known but it is assumed to be under the control of Caltrain. It appears to occupy a portion of the Berry Street right of way and contains four separate rail tracks. The proposed subsurface easement does not appear to impact the current surface usage of this site. A 25% discount was applied to the estimated fee value when calculating the cost of the permanent subsurface easement.

Data used as a basis for this Cost Estimate included recent sales of vacant land, as well as improved properties that are slated for redevelopment. Various zoning classifications were analyzed and most weight was placed on sales with zoning similar to the subject properties, where residential development is not currently permitted.

The Cost Estimate summary for each parcel can be found on the attached Exhibit.

Assumptions and Limiting Conditions

These Assumptions and Limiting Conditions are included by reference and made a part of all research, emails, memorandums and reports related to this assignment.

General Assumptions

The following assumptions and limiting conditions have been relied upon and used in making this Cost Estimate:

1. The preliminary research presented here is not an appraisal and no attempt has been made to perform an appraisal of the identified properties. Actual appraised values could vary significantly. This Cost Estimate is not to be used in connection with any eminent domain, government code offer or other legal proceeding. AR/WS is not responsible for unauthorized use of this estimate.

2. No responsibility is assumed for legal or title considerations. Title to the properties is assumed to be clear and marketable. No recorded or unrecorded matters of exception to title were considered. Preliminary Title Reports were not provided and AR/WS relied on Assessor's records, and/or information supplied by the SFPUC.

3. The subject properties are assumed to be free and clear of any or all liens, encumbrances or private deed restrictions.

4. The information furnished by others is believed to be reliable. However, no warranty is given for its accuracy.

5. AR/WS relied upon the current zoning designations of each parcel as reported on the City and County of San Francisco website. It is assumed that there are no planned changes in the present zoning or regulations governing use, density, or shape or changes in use that would impact the estimated costs.

6. AR/WS assumes no responsibility for any property's subsoil or the structures that render it more or less valuable. It is assumed that there are no hazardous or toxic substances in the structure or soil comprising the subject ownerships. No responsibility is assumed for arranging for engineering studies or a survey, which may be required to discover these conditions. The estimated costs do not include costs which might be related to remediation or removal of hazardous waste, utility relocation costs, consulting or legal fees related to any property or condemnation.

7. For the purposes of this Cost Estimate, it is assumed that all estimated unencumbered fee simple values include mineral rights or subsurface rights.

8. Possession of this Cost Estimate, or a copy thereof, does not carry with it the right of publication. It may not be used for any purpose by any person other than the party to whom it is addressed without the written prior consent of AR/WS, and in any event, only with proper written qualification and only in its entirety. The delivery and/or possession of this document does not require AR/WS to attend or give testimony at any meeting, public hearing, pretrial conference, deposition, or court.

9. Neither all nor any part of the contents of this document *(especially any estimates, the identity of the estimator, or the firm with which the estimator is connected)* shall be disseminated to the public through advertising, public relations, news sales, or other media.

10. AR/WS relied on the location of the parcels depicted on exhibits provided by the SFPUC, the County Assessor's parcel map and other public information.

11. No administrative or soft costs associated with the acquisition of the property rights have been estimated.

12. This Cost Estimate does not include any allowances for potential loss of business goodwill claims. Claims for loss of business goodwill may be filed as a result of the proposed easements.

13. This Cost Estimate does not include any allowances for furniture, fixtures and equipment (FF&E).

14. It is assumed that improvements are in compliance with all applicable planning, zoning and use regulations and/or restrictions.

Special Assumptions and Limiting Conditions

1) This Cost Estimate should be updated periodically to reflect market changes, if any.

2) Buyers of industrial properties in the current market focus more on price per square foot of land rather than price per square foot of gross building area. Due to the lack of available vacant land within the San Francisco market, buyers are purchasing improved industrial sites and redeveloping with new uses.

3) For the purposes of this Cost Estimate, it is assumed that there are at least two leasehold interests impacted by the proposed temporary construction easement areas. It is beyond the scope of this Cost Estimate to confirm whether or not any impacted property is subject to a leasehold interest. All estimated acquisition costs are unallocated and are made under the assumption that leasehold interests, if any, will provide the necessary written consent to the proposed easements.

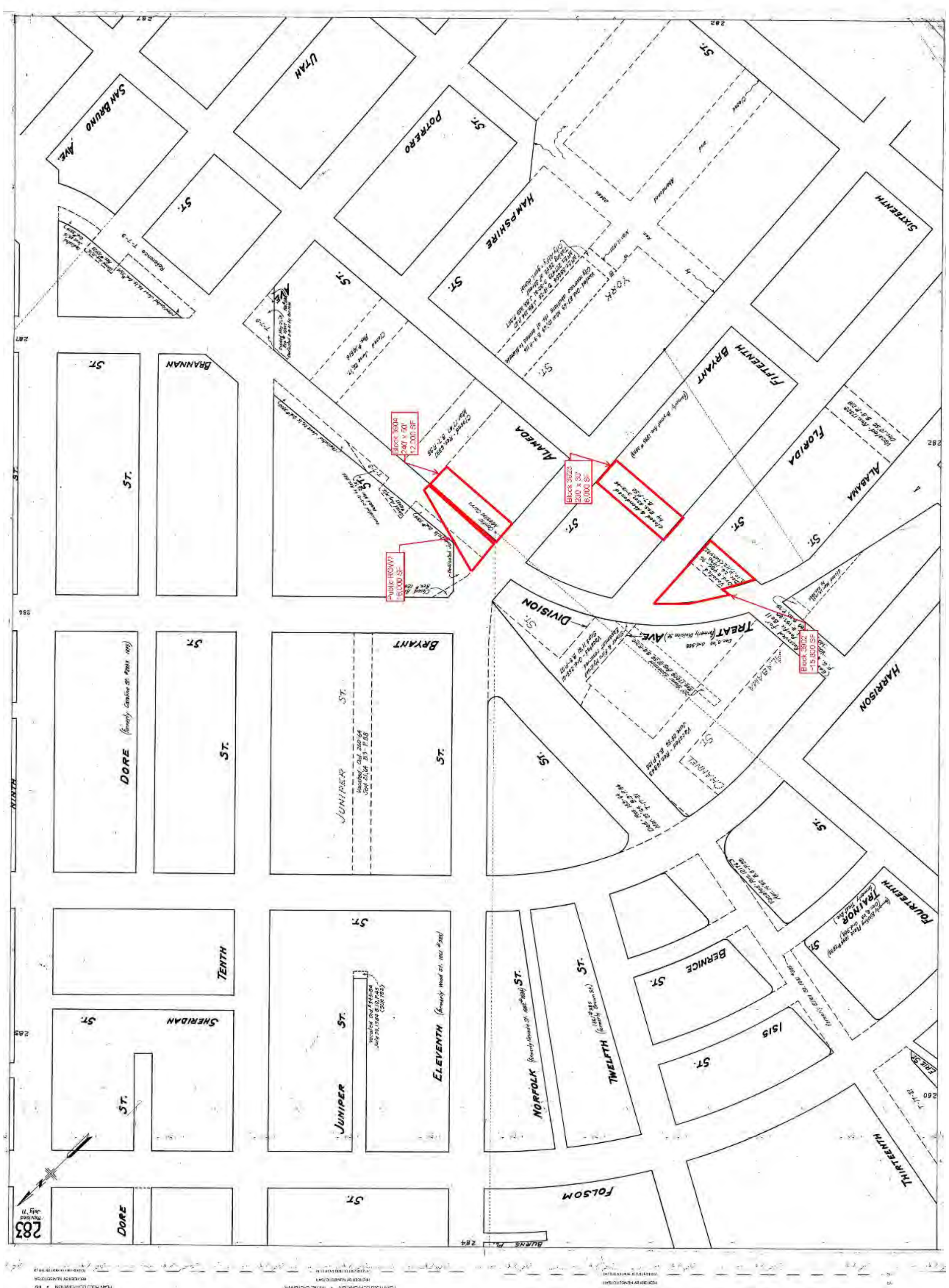
4) Temporary construction easements (TCE's) were calculated at 10% of the estimated unencumbered fee simple value per year and are based on a two-year duration.

5) The SFPUC provided basic specifications of the proposed storm water tunnel. Among these specifications are a minimum of twenty feet (20') of ground cover over the proposed fifteen feet (15') diameter tunnel. Additionally, the proposed tunnel will be directionally bored under the identified sites allowing existing surface uses to continue during construction. The only exception to this is the CCSF site (3902-006) on Florida Street where an approximate 800 square feet tunnel shaft will be constructed. These details were relied upon to estimate the economic impacts to the identified sites.

6) One of the proposed sites involves a subsurface easement running underneath existing railroad tracks. It should be noted that acquisitions impacting rail transportation systems are generally complex and may require approvals from multiple agencies. This may necessitate substantial lead time when preparing project schedules.

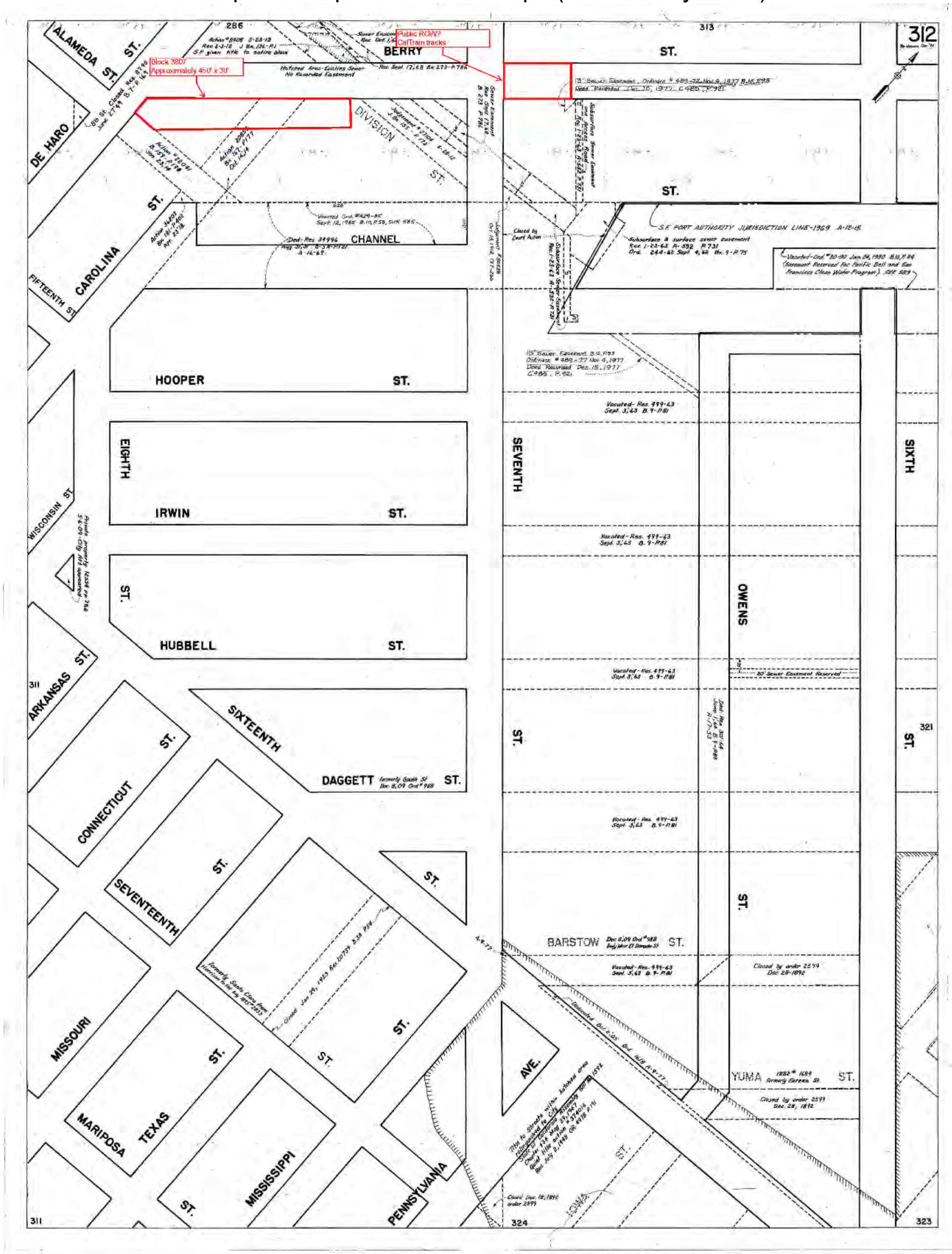
7) This Cost Estimate does not include the value of any improvements. The assumption is being made that all existing improvements that are removed or damaged during construction will be replaced with like kind materials. The proposed temporary construction easement areas will be returned to the same or similar condition as documented immediately prior to taking possession.

Proposed Impact Location Maps (provided by client)

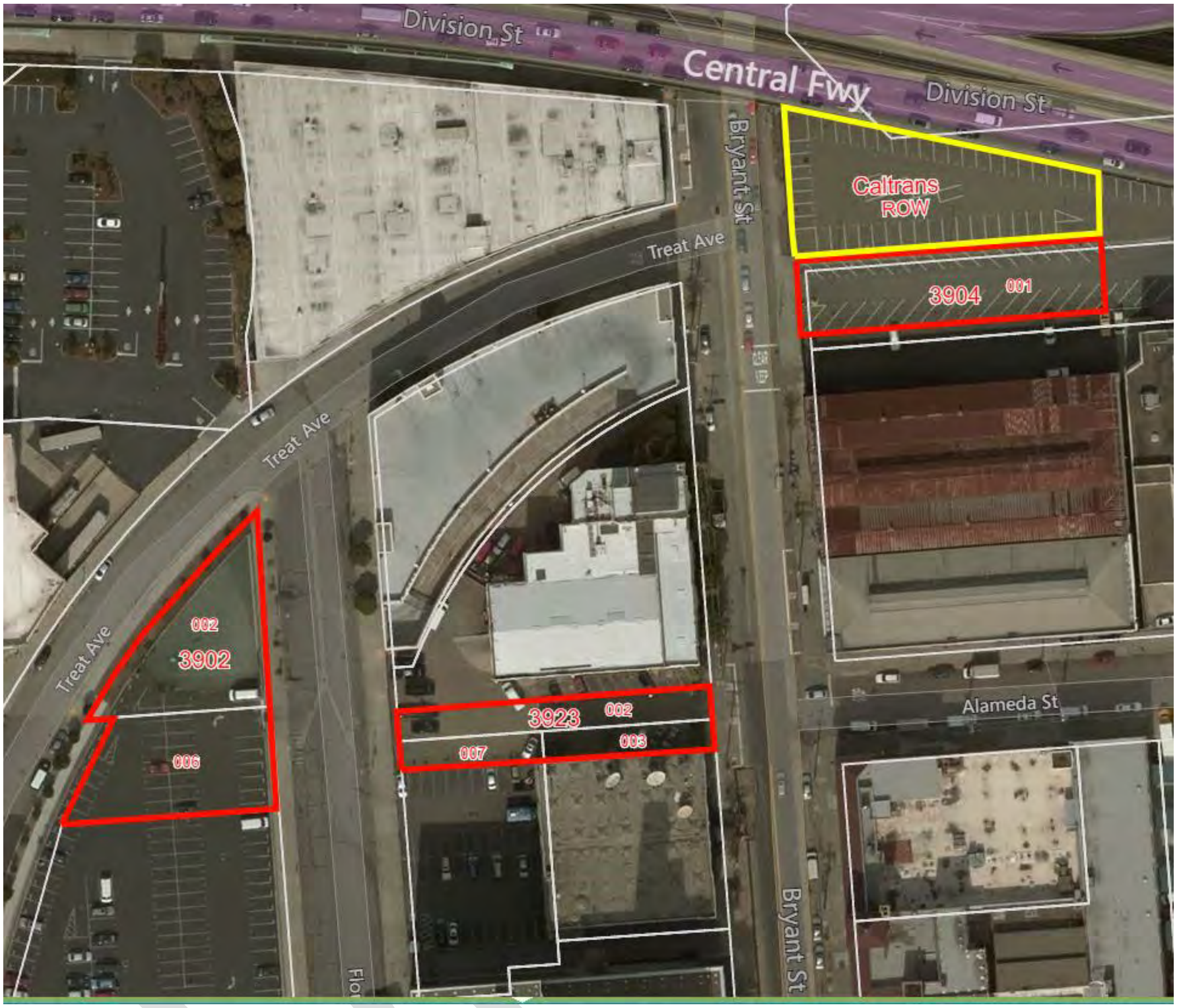


ASSOCIATED RIGHT OF WAY SERVICES, INC.

Proposed Impact Location Maps (Provided by client)



Aerial Map (Westerly portion of Project)



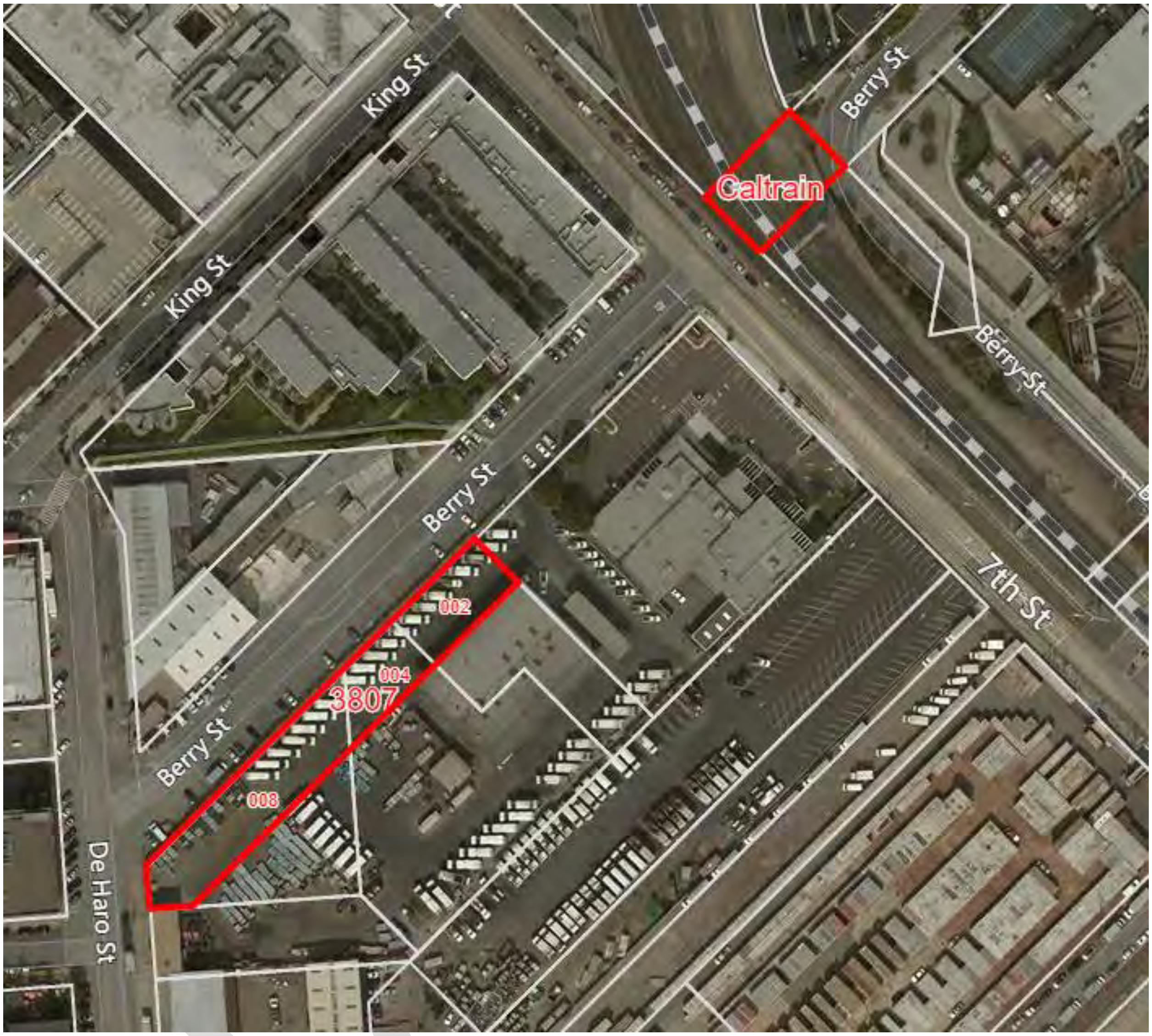
Map depicts:

Block 3902, Lot 002 (SPCA)
Block 3902, Lot 006 (CCSF)

Block 3923, Lot 002 (Associated Limousine Operators)
Block 3923, Lot 003 (Beressi)
Block 3923, Lot 007 (DP 1550 Bryant LLC)

Block 3904, Lot 001 (Byer)
Caltrans Right of Way

Aerial Map (Easterly portion of Project)



Map depicts: Block 3807, Lot 002 (Macor, Inc.)
Block 3807, Lot 004 (Macor, Inc.)
Block 3807, Lot 008 (Macor, Inc.)

Caltrain (ownership not confirmed)

Photos

Above: SPCA dog run (3902-002)
Below: CCSF parking lot (3902-006)

Photos

Above: Caltrans ROW [used as parking lot]
Below: Byer parking lot (3904-001)

Photos

Above: [Looking west from Bryant St.] - Hertz (3923-002) on right; Beressi (3923-003) on left
Below: [Looking east from Florida St.] – Hertz on left; DP 1550 Bryant LLC (3923-007) on right

Photos

Above: Recology yard (3807-002; -004; -008) – [Berry St. on right]
Below: Caltrain tracks [Berry St. ROW]

EXHIBIT 1

D R A F T

APN	OWNER	ESTIMATED LAND $/SF (LOW)	ESTIMATED LAND $/SF (HIGH)	AREA OF SUBSURFACE EASEMENT (SF)	ESTIMATED SUBSURFACE EASEMENT % OF FEE	ESTIMATED COST SUBSURFACE EASEMENT (LOW)	ESTIMATED COST SUBSURFACE EASEMENT (HIGH)	AREA OF ACCESS EASEMENT (SF)	ESTIMATED ACCESS EASEMENT % OF FEE	ESTIMATED COST ACCESS EASEMENT (LOW)	ESTIMATED COST ACCESS EASEMENT (HIGH)	AREA OF TCE (SF)	ESTIMATED TCE COST FOR 2 YEARS (LOW)	ESTIMATED TCE COST FOR 2 YEARS (HIGH)	ESTIMATED RELOCATION COST (LOW)	ESTIMATED RELOCATION COST (HIGH)	TOTAL ESTIMATED COST (LOW)	TOTAL ESTIMATED COST (HIGH)
3902-002	SF SPCA	$ 400.00	$ 700.00									7,900	$ 632,000	$ 1,106,000	$ 2,000	$ 5,000	$ 634,000	$ 1,111,000
3902-006	CCSF	$ 400.00	$ 700.00	5,000	75%	$ 1,500,000	$ 2,625,000	800	15%	$ 48,000	$ 84,000	7,900	$ 632,000	$ 1,106,000			$ 2,180,000	$ 3,815,000
ROW	CALTRANS	$ 400.00	$ 700.00									16,000	$ 1,280,000	$ 2,240,000	$ -	$ 2,000	$ 1,280,000	$ 2,242,000
3904-001	BYER, MARINA & ALLAN G.	$ 400.00	$ 700.00									12,000	$ 960,000	$ 1,680,000	$ -	$ 2,000	$ 960,000	$ 1,682,000
3923-003	BERESSI, SALVATOR & DAGNY L.	$ 400.00	$ 700.00	2,200	75%	$ 660,000	$ 1,155,000										$ 660,000	$ 1,155,000
3923-007	DP 1550 Bryant LLC	$ 400.00	$ 700.00	1,800	75%	$ 540,000	$ 945,000										$ 540,000	$ 945,000
3923-002	ASSOC. LIMOUSINE OPERATORS	$ 400.00	$ 700.00	2,000	75%	$ 600,000	$ 1,050,000										$ 600,000	$ 1,050,000
3807-002		$ 400.00	$ 700.00															
3807-004	MACOR, INC	$ 400.00	$ 700.00	13,500	75%	$ 4,050,000	$ 7,087,500										$ 4,050,000	$ 7,087,500
3807-008		$ 400.00	$ 700.00															
ROW	CALTRAIN/UNDETERMINED	$ 400.00	$ 700.00	8,500	25%	$ 850,000	$ 1,487,500										$ 850,000	$ 1,487,500
THIS TABLE WAS PREPARED FOR BUDGETING AND PLANNING PURPOSES ONLY AND IS NOT AN APPRAISAL NOR HAS ANY ATTEMPT BEEN MADE TO COMPLETE AN APPRAISAL																Total (Rounded)	$ 12,000,000	$ 21,000,000

D R A F T

APPENDIX L

PLANNING LEVEL CONSTRUCTION ESTIMATE

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Appendix L Cost Summary

Construction Cost	All Tunnel	Tunnel w/ Box
Tunnel Construction Cost (includes markup/profit)	$57,109,904.00	$59,051,338.00
Tunnel Base construction Cost (includes design/estimating contingency)	$74,242,875.20	$76,766,739.40
Tunnel Total Construction Cost (includes construction contingency)	**$81,667,162.72**	**$84,443,413.34**
Upstream Direct Construction Cost	$54,176,576.00	$54,176,576.00
Upstream Base Construction Cost (includes markup/profit, design/estimating contingencies)	$84,515,458.56	$84,515,458.56
Upstream Total Construction Cost (includes construction contingency)	**$92,967,004.42**	**$92,967,004.42**
Total Construction Cost (2018 Dollars)	**$174,600,000**	**$177,400,000**
Total Construction Cost * (2021 Dollars)	**$211,162,000**	**$214,548,000**

*Includes 1.26% for Environmental Mitigation/Compliance during construction and 3.3% for Security Upgrades per SSIP templates. Also includes escalation factor of 15.62%, escalated to midpoint of construction October 2021 at 4%/year.

Phase	Cost
Project Management	$10,711,000
Planning	$1,449,000
Environmental	$164,000
Right-of-Way	$340,000
Design	$9,228,000
Bid/Award	$1,073,000
Construction Management	$21,455,000
Construction	$214,548,000
Closeout	$1,073,000
Easement	$13,500,000
Total Project Cost (2021 Dollars)	**$273,600,000**

APPENDIX L: ALL TUNNEL AND TUNNEL AND BOX CONVEYANCE

L.1 General

The approach for the CER construction cost estimate was to update the AAR construction costs using the more refined project layout developed during conceptual engineering. The accuracy of the cost estimate is a considered to be a level IV estimate with -30% and +50% accuracy, but the cost analysis is intended for comparison purposes only to evaluate the relative costs of the All Tunnel versus the Tunnel and Box alternatives. This estimate has been prepared using the practices, skill, and care typical of similar projects and estimating standards at the conceptual engineering stage.

The Opinion of Probably Construction Costs (OPCC) provided in this report for the All Tunnel Alternative and the Tunnel and Box Alternative are shown in Table L-1 (with 30% design contingencies,10% construction contingencies and escalated to midpoint of construction October 2021). General conditions for public work projects are included and assumed to be part of the doing work in San Francisco of 15%. Real estate acquisition costs for tunneling under Recology are estimated to be $7,000000.   The estimated range of cost savings for an All Tunnel Alternative over the Tunnel and Box Alternative are on the order of $3 to 5.5 million.

Alignment attributes of the two alternatives are summarized in Table L-2. Detailed back up is provided in Table L-3 for the All Tunnel Alternative and Table L-4 for the Tunnel and Box Alternative. Estimated construction duration is about 30 months for both alternatives and are provided in Table L-5 and L-6. For the most part, the scheduled were assembled used a “just in time” management approach, although float is shown for various activities and at the end of the job. Some surface activities for the Tunnel and Box Alternative can be moved up front, but there is a potential for longer duration of surface disruption.

The main sources and references for costs include the following:

Engineering News Record, Historical Cost Indices as shown in Table L-7.

SFPUC [San Francisco Public Utilities Commission], 2013, Collection System Validation Report, Appendix B – SSMP Basis of cost memorandum, dated May 8, 2007, prepared by SSIP PMC, May 2012.

L.2 Methodology of Tunnel and Shaft Costs

The methodology for estimating the tunnel and shaft costs was to use:

SFPUC 2013, the recommended equations for storage tunnel in soil and rock for less than 30-ft diameter.

Shaft costs used were based on program recommendations at a cost of $5.96 million per shaft, not including the 10% construction contingency.

Two other parametric methods were used to check that the SFPUC guidelines were in the right ballpark as shown in Tables L-3 and L-4.

It should be noted that the SFPUC's Sunnydale Tunnel, which bid in April of 2010, the low bid for a unit cost of $ 9,345/FT. The project was through similar ground. Adjusting for inflation from April 2010 to October 2021increases the amount to $12,694/FT (about $88.15 per inch diameter/ft.). The range of unit costs provided in the tables are on the order of $12,900 (about $89.58 per inch-diameter/ft.).

L.3 Methodology of Cut-and-Cover Box Costs

The methodology for estimating the cut-and-cover costs was to use:

SFPUC 2013, Figure 1.1 for cover > 12 ft, SD1 (Northern Kentucky).

However, the cut and cover box costs were also checked by using a unit cost check for this work as shown in Table L-8. This yielded costs on the order of $2.5 million more than the costs from the cost curves. Thus, the range of capital costs of the Tunnel and Box Alternative over the All Tunnel Alternative are on the order of $3 to 5.5 million.

Table L-1: Summary of All Tunnel vs. Tunnel and Box Alternative

Alternative	Tunnel Lengths (ft)	Cut and Cover Box (ft)	Total Cost in 2018 Dollars (midpoint of construction plus 30% design contingencies and 10% construction contingencies)
All Tunnel	3,880		81,700,000
Tunnel and Box	3,203	561	84,500,000

Table L-2: Alignment Attributes for Tunnel and Tunnel and Box Alternatives

Summary	All Tunnel	Tunnel and Box	Check on Tunnel and Box
Tunnel Footage (Rock)	1200	1200	1200
Tunnel Footage (Soil)	2220	1288	1288
Tunnel Mixed Face	360	360	360
Cut-and-Cover Footage		561	561
Reception Shaft (air)		26	26
Transition Structure (air)		25	25
Tunnel under Division St (air)	100	100	100
Second Tunnel (Soil)		355	355
Total	3880	3915	3915
Base Construction Cost	$ 74,242,745	$ 76,766,739	$ 78,815,428
Total Construction Cost	$ 81,700,000	$ 84,500,000	$ 86,700,000
Check Delta All Tunnel vs. Tunnel/Box			$ 5,000,000

All tunnel				
Begin	End	Length	Type	Type
20	65	45	Soil	Soil
65	225	160	MF	MF
225	1425	1200	Rock	Rock
1425	1625	200	MF	MF
1625	3525	1900	Soil	Soil
3525	3625	100	Air	Division St
3625	3900	275	Soil	Soil
Total		3880		

Tunnel and Cut and Cover					Refs Drawings
Begin	End	Length	Type	Facility	Sheet
20	65	45	Soil	Tunnel	C-1
65	225	160	MF	Tunnel	C-1
225	1425	1200	Rock	Tunnel	C-2
1425	1625	200	MF	Tunnel	C-3
1625	2913	1288	Soil	Tunnel	C-3, C-4
2913	2939	26	Soil	Shaft	C-5
2939	3500	561	Soil	Open cut	C-5, C-6
3500	3525	25	Soil	Transition	C-6
3525	3625	100	Air	Division St	C-6, C-7
3625	3935	310	Soil	Tunnel	C-7
Total		3915			

Table L-3: Cost Curve Data for All Tunnel Alternative

Alt B1a Tunnel Portion

Bored Dia (ft)	Pipe Dia. (ft)	Qu (soil+mixed+air)	SP (Rock)	Qu (soil+mixed+air)	Qu (soil+mixed+air)	Total Length in soil + mixed face + air (ft)	Total Length in Rock (ft)	Ref 1 Cost in Soil ($)	Ref 2 Cost in Rock ($) Mixed	Ref 2 Cost in Rock ($) HardRock	Ref 2 Cost in Rock ($) Micro-T	CCI (normalized to 2018)	Akron to SF RSMeans adjustment	SF Public Sector Factor	Ref 1+Ref 2 Total Cost ($) Soil + Mixed	Ref 1+Ref 2 Total Cost ($) Soil+HR	Ref 1+Ref 2 Total Cost ($) Soil+MicT	Ref 2 Total Cost ($) Mixed	Ref 2 Total Cost ($) Micro-T	SF Total Cost ($)
15	12	267	1200	500	1913	2680	1200	21,082,317	17,948,231	7,240,070	2,322,485	12.94%	12.35%	15.00%	44,079,675	31,986,269	26,432,528	49,510,738	8,235,610	33,043,687

Alt B1a

Bored Dia (ft)	Pipe Dia. (ft)	Geology: Qu (soil+mixed+air)	Geology: SP (Rock)	Geology: Qu (soil+mixed+air)	Geology: Qu (soil+mixed+air)	Total Length in soil + mixed face + air (ft)	Total Length in Rock (ft)	Ref 1 Cost in Soil ($)	Ref 2 Cost in Rock ($) Mixed	Ref 2 Cost in Rock ($) HardRock	Ref 2 Cost in Rock ($) Micro-T	CCI (normalized to 2018)	Akron to SF RSMeans adjustment	SF Public Sector Factor	Ref 1+Ref 2 Total Cost ($) Soil + Mixed	Ref 1+Ref 2 Total Cost ($) Soil+HR	Ref 1+Ref 2 Total Cost ($) Soil+MicT	Ref 2 Total Cost ($) Mixed	Ref 2 Total Cost ($) Micro-T	Ref 3 Total Cost ($)			
15	12	267	1200	500	1913	2680	1200	21,082,317	17,948,231	7,240,070	2,322,485	12.94%	12.35%	15.00%	50,691,626	36,784,210	30,397,407	56,937,349	9,470,952	34,649,814	Soil		
15	12	267	1200	500	1913	2680	1200	21,082,317	17,948,231	7,240,070	2,322,485	12.94%	12.35%	15.00%	50,691,626	36,784,210	30,397,407	56,937,349	9,470,952	11,383,975	Rock		
Subtotal						Total Length in Rock (ft)									50,691,626			56,937,349		$ 46,033,789			
Drop Shafts (ea)		1	$ 3,689,357									12.94%	12.35%	15.00%						$ 5,383,354			
Odor Control (cfm)		40000	$ 29.00									12.94%	12.35%	15.00%						$ 1,692,623		price/ft	Price inch ID/ft
Total																				$ 53,109,766		$ 13,688	$ 49.59
Total with contingency			30%																	$ 69,042,696		$ 17,795	$ 64.47

Alt B1a Cut and Cover Portion NOT APPLICABLE

Bored Dia (ft)	Pipe Dia. (ft)	Qaf (fill)	Length (ft) Qu (soil)	SP (Rock)	Qu (soil)	Total Length in soil (ft)	Total Length in Rock (ft)	Ref 1 Cost in Soil ($)	Ref 2 Cost in Rock ($) Mixed	Ref 2 Cost in Rock ($) HardRock	Ref 2 Cost in Rock ($) Micro-T	CCI	Akron to SF RSMeans adjustment	SF Public Sector Factor	Ref 1+Ref 2 Total Cost ($) Soil + Mixed	Ref 1+Ref 2 Total Cost ($) Soil+HR	Ref 1+Ref 2 Total Cost ($) Soil+MicT	Ref 2 Total Cost ($) Mixed	Ref 2 Total Cost ($) Micro-T	SFPUC 2007 Tentative Recommendation (refs 3) Total Cost ($)	SFPUC 2007 SD1 (refs 3) Figure 1.1 Total Cost ($)	SFPUC 2007 Alocasan (refs 3) Figure 1.1 Total Cost ($)	Akron to SF RS Means + SF Public Sector Factor (refs 3)	CCI (normalized to 2018)	SFPUC 2007 Tentative Recommendation (refs 3) Total Cost ($)	SFPUC 2007 SD1 (refs 3) Total Cost ($)	SFPUC 2007 Alocasan (refs 3) Total Cost ($)
15	12					0		#NUM!	#NUM!	#NUM!	#NUM!	12.94%	12.35%	15.00%	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	0	-	-	1.292025	1.12936345	-	-	
																					Price per foot				#DIV/0!	#DIV/0!	#DIV/0!
																					Price per inch inside diameter/foot				#DIV/0!	#DIV/0!	#DIV/0!
																									may be okay	seems low	blows up

Pipe or Box Jack Portion 3-8' NOT APPLICABLE

Bored Dia (ft)	Pipe Dia. (ft)	Qaf (fill)	Length (ft) Qu (soil)	SP (Rock)	Qu (soil)	Total Length in	Total Length in
15	12					0	0
Quantity	Pipe Dia. (ft)					Total Length	
[illegible]	3	8				[illegible]	

	SFPUC 2007 Akron (refs 3) Figure 1.7 Soft Soil Tunneling Total Cost ($)	SFPUC 2007 Alocasan (refs 3) Figure 1.5 Pipe Jacking Total Cost ($)	Akron to SF RS Means + SF Public Sector Factor (refs 3)	CCI (normalized to 2018)	SFPUC 2007 Akron (refs 3) Figure 1.7 Soft Soil Tunneling	SFPUC 2007 Akron (refs 3) Figure 1.7 Total Cost ($)	[illegible]
#NUM!		-	1.292025	1.12936345	#NUM!		
Price per foot					#NUM!	#DIV/0!	[illegible]
Price per inch inside diameter/foot					#NUM!	#DIV/0!	[illegible]
					may be okay	may be okay	

	SFPUC 2007 Tentative Recommendation (refs 3) Section 1.7	SFPUC 2007 Alocasan (refs 3) Figure 1.5 Pipe Jacking
	$ 1,744,700	$ -
Price per foot	#DIV/0!	#DIV/0!
Price per inch inside diameter/foot	#DIV/0!	#DIV/0!
	seems low	seems low

TOTAL PIPE JACK and C&C -

			Combined CCI, Akron to SF, SF Public Sector	
Total Tunnel, Pipe Jack and C&C				46,033,789 without contingency
Drop Shafts (ea)	1	$ 3,689,357	1.459165811	$ 5,383,382.88
Odor Control (cfm)	40000	$ 29.00	1.459165811	$ 1,692,632.34
Junction Structure/Tie-In**				$ 4,000,000.00
Total				$ 57,109,804
Total with contingency		30%		$ 74,242,745

**Reference Sunnydale Tunnel, increased over B1a due to intertie with Division Box

References
1 Min, S. and J. Kaneshiro, 2012, Parametric Unit Cost Estimate of Soft Ground Bored Tunneling for Planning Studies, North American Tunneling Conference, Indianapolis.
2 Sepehrmanesh, M., J. Rostami, and E.A. Gharahbagh, 2012, Planning level cost estimation based on statistical analysis of historical data, North American Tunneling Conference, Indianapolis.
3 SSIP - PMC, May 2013, Collection System Validation Report, Appendix B: SSMP Basis of Cost Memorandum dated May 8, 2012/Updated March 12, 2012 of January 2007 AECOM memo.

Table L-4: Cost Curve Data for Tunnel and Box Alternative

Alt B1a Tunnel Portion

Bored Dia (ft)	Pipe Dia. (ft)	Qu (soil+mixed+air)	SP (Rock)	Qu (soil+mixed+air)	Qu (soil+mixed+air)	Total Length in soil (ft)	Total Length in Rock (ft)	Ref 1 Cost in Soil ($)	Ref 2 Cost in Rock ($) Mixed	Ref 2 Cost in Rock ($) HardRock	Ref 2 Cost in Rock ($) Micro-T	CCI (normalized to 2018)	Akron to SF RSMeans adjustment	SF Public Sector Factor	Ref 1+Ref 2 Total Cost ($) Soil + Mixed	Ref 1+Ref 2 Total Cost ($) Soil+HR	Ref 1+Ref 2 Total Cost ($) Soil+MicT	Ref 2 Total Cost ($) Mixed	Ref 2 Total Cost ($) Micro-T	SF Total Cost ($)
15	12	210	1570	500	1393	2103	1200	16,698,185	17,948,231	7,240,070	2,322,485	12.94%	12.35%	15.00%	39,126,397	27,034,991	21,481,250	43,801,389	7,039,158	28,547,668

Alt B1a

	Bored Dia (ft)	Pipe Dia. (ft)	Geology: Qu (soil)	Geology: SP (Rock)	Geology: Qu (soil)	Geology: Qaf (fill)	Total Length in soil (ft)	Total Length in Rock (ft)	Ref 1 Cost in Soil ($)	Ref 2 Cost in Rock ($) Mixed	Ref 2 Cost in Rock ($) HardRock	Ref 2 Cost in Rock ($) Micro-T	CCI (normalized to 2018)	Akron to SF RSMeans adjustment	SF Public Sector Factor	Ref 1+Ref 2 Total Cost ($) Soil + Mixed	Ref 1+Ref 2 Total Cost ($) Soil+HR	Ref 1+Ref 2 Total Cost ($) Soil+MicT	Ref 2 Total Cost ($) Mixed	Ref 2 Total Cost ($) Micro-T	Ref 3 Total Cost ($)		
	15	12	210	1200	500	1393	2103	1200	16,698,185	17,948,231	7,240,070	2,322,485	12.94%	12.35%	15.00%	44,997,656	31,090,240	24,703,437	50,371,597	8,095,032	27,064,755	Soil	
	15	12	210	1200	500	1393	2103	1200	16,698,185	17,948,231	7,240,070	2,322,485	12.94%	12.35%	15.00%	44,997,656	31,090,240	24,703,437	50,371,597	8,095,032	11,383,975	Rock	
Subtotal							Total Length in Rock (ft)									44,997,656			50,371,597		$ 38,448,730	$ 11,641	
Drop Shafts (ea)			2	$ 3,689,357									12.94%	12.35%	15.00%						$ 10,766,708		
Odor Control (cfm)			40000	$ 29.00									12.94%	12.35%	15.00%						$ 1,692,623	price/ft	Price inch ID/ft
Total																					$ 50,908,061	$ 15,413	$ 55.84
Total with contingency				30%																	$ 66,180,480	$ 20,036	$ 72.60

Alt B1a Cut and Cover Portion

Bored Dia (ft)	Pipe Dia. (ft)	Length (ft): Qaf (fill)	Length (ft): Qu (soil)	Length (ft): SP (Rock)	Length (ft): Qu (soil)	Total Length in soil (ft)	Total Length in Rock (ft)	Ref 1 Cost in Soil ($)	Ref 2 Cost in Rock ($) Mixed	Ref 2 Cost in Rock ($) HardRock	Ref 2 Cost in Rock ($) Micro-T	CCI (normalized to 2018)	Akron to SF RSMeans adjustment	SF Public Sector Factor	Ref 1+Ref 2 Total Cost ($) Soil + Mixed	Ref 1+Ref 2 Total Cost ($) Soil+HR	Ref 1+Ref 2 Total Cost ($) Soil+MicT	Ref 2 Total Cost ($) Mixed	Ref 2 Total Cost ($) Micro-T	SFPUC 2007 Tentative Recommendation (refs 3) Total Cost ($)	SFPUC 2007 SD1 (refs 3) Figure 1.1 Total Cost ($)	SFPUC 2007 Alocasan (refs 3) Figure 1.1 Total Cost ($)	Akron to SF RS Means + SF Public Sector Factor (refs 3)	CCI (normalized to 2018)	SFPUC 2007 Tentative Recommendation (refs 3) Total Cost ($)	SFPUC 2007 SD1 (refs 3) Total Cost ($)	SFPUC 2007 Alocasan (refs 3) Total Cost ($)
15	12					596		4,880,365	#NUM!	#NUM!	#NUM!	12.94%	12.35%	15.00%	#NUM!	#NUM!	#NUM!	11,748,125	1,304,022	2,839,437	2,738,365	5,605,860	1.292025	1.12936345	4,143,210	3,995,729	8,179,880
																					Price per foot				7,070	6,819	13,959
																					Price per inch inside diameter/foot				$ 75.62	$ 24.71	$ 50.58
																									may be okay	seems low	blows up

Pipe or Box Jack Portion 3 8'

	Bored Dia (ft)	Pipe Dia. (ft)	Length (ft): Qaf (fill)	Length (ft): Qu (soil)	Length (ft): SP (Rock)	Length (ft): Qu (soil)	Total Length in soil (ft)	Total Length in
	15	12					0	0
	Quantity	Pipe Dia. (ft)					Total Length	
[illegible]	1	12					0	

		SFPUC 2007 Akron (refs 3) Figure 1.7 Soft Soil Tunneling Total Cost ($)	SFPUC 2007 Alocasan (refs 3) Figure 1.5 Pipe Jacking Total Cost ($)	Akron to SF RS Means + SF Public Sector Factor (refs 3)	CCI (normalized to 2018)	SFPUC 2007 Akron (refs 3) Figure 1.7 Soft Soil Tunneling	SFPUC 2007 Akron (refs 3) Figure 1.7 Total Cost ($)	[illegible]
	#NUM!			1.292025	1.12936345	#NUM!		[illegible]
Price per foot						#NUM!	#DIV/0!	[illegible]
Price per inch inside diameter/foot						#NUM!	#DIV/0!	[illegible]
						may be okay	may be okay	

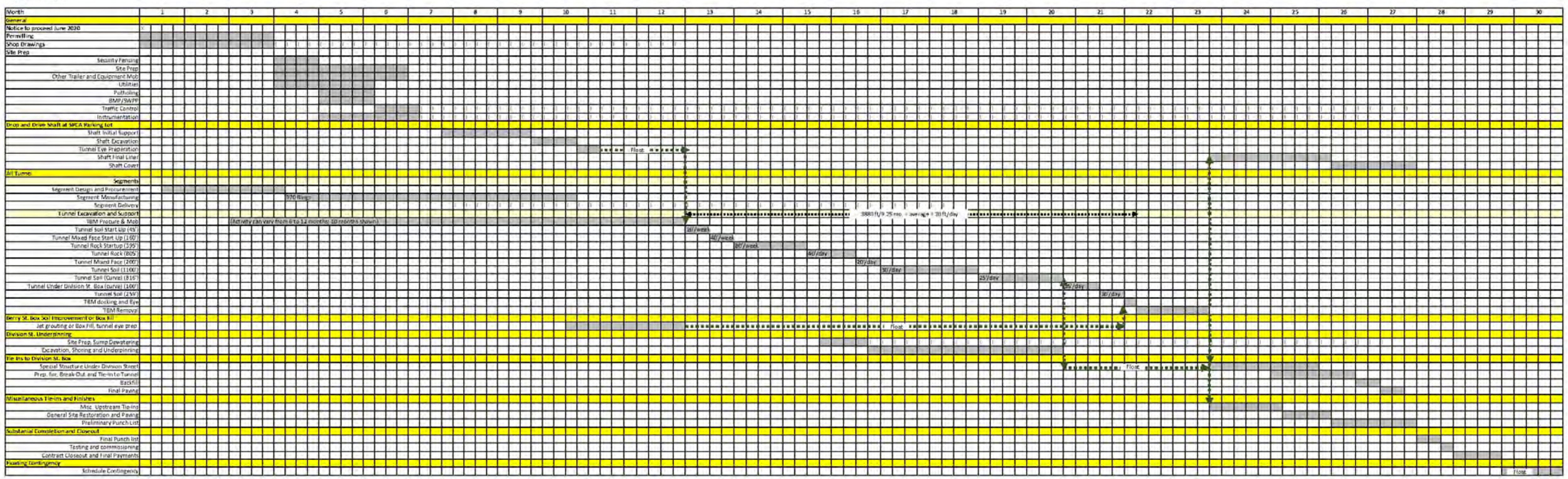
	SFPUC 2007 Tentative Recommendation (refs 3) section 1.7	SFPUC 2007 Alocasan (refs 3) Figure 1.5 Pipe Jacking
	$ 1,744,700	$ -
Price per foot	#DIV/0!	#DIV/0!
Price per inch inside diameter/foot	#DIV/0!	#DIV/0!
	seems low	seems low

						See Cut and Cover Check Tab
TOTAL PIPE JACK and C&C				$ 4,143,210	<Seems low	$ 5,719,124
Total Tunnel, Pipe Jack and C&C				42,591,940	without contingency	$ 44,167,854
			Combined CCI, Akron to SF, SF Public Sector			
Drop Shafts (ea)	2	$ 3,689,357	1.459165811	$ 10,766,765.77		$ 10,766,765.77
Odor Control (cfm)	40000	$ 29.00	1.459165811	$ 1,692,632.34		$ 1,692,632
Junction Structure/Tie-in**				$ 4,000,000.00		$ 4,000,000
Total				$ 59,051,338		$ 60,627,253
Total with contingency		30%		$ 76,766,739		$ 78,815,428

**Reference Sunnydale Tunnel, increased over B1a due to intertie with Division Box

Table L-5: Schedule for All Tunnel Alternative

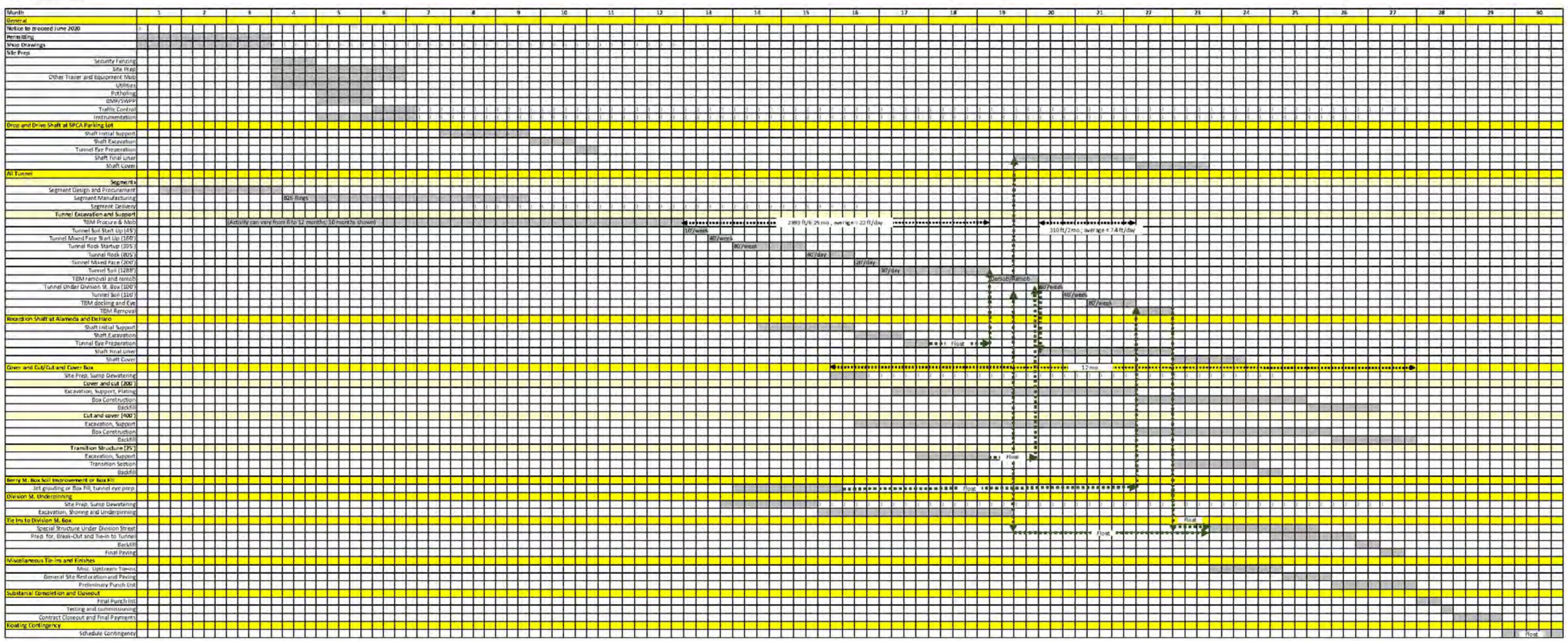
Folsom Street All Tunnel



Denotes a 1 day or single event
Continuous
Denotes Main Activity
Denotes Sub-activity under Main Activity
Predecessor ▶ Successor   Critical Path Across Main Activity
1 day = 10 hour shift
Work week 5 days per week
Assumes EPBM or Hybrid EPBM
RFP April 2018
Consultant NTP Sept 2018
Final Design = Dec 2019
Contractor Procurement May 2020
NTP to contractor = June 2020
Midpoint of construction = October 2021

Table L-6: Schedule for Tunnel and Box Alternative

Folsom Street Tunnel and Box

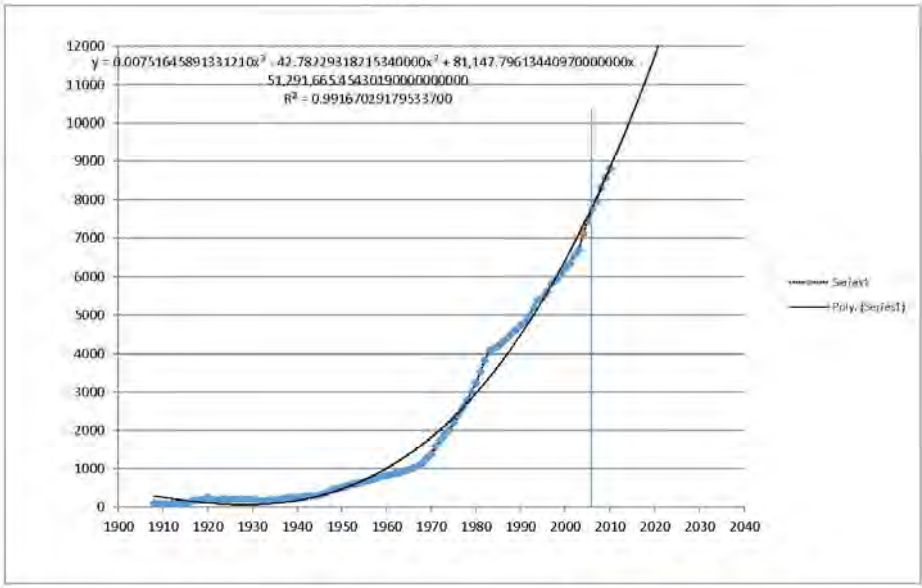


Denotes a 1 day or single event
Continuous
Denotes Main Activity
Denotes Subactivity under Main Activity
Predecessor ▪▪▪▪▪▪▪▪▪▪▶ Successor   Critical Path Across Main Activity
1 day = 10 hour shift
Work week 5 days per week
Assumes EPBM or Hybrid EPBM

NTP April 2018
Consultant NTP Sept 2018
Final Design = Dec 2019
Contractor Procurement May 2020
NTP to contractor = June 2020
Midpoint of construction = October 2021

Table L-7: ENR Construction Cost Index

ENR CPI



2017	10,806	2.84%
2018	11,110	2.81%
2019	11,420	2.79%
2020	11,735	2.76%
2021	12,055	2.73%
2022	12,381	2.71%
2023	12,713	2.68%

y 7,593

2005

1983	4066		
1984	4146		
1985	4195		
1986	4295		
1987	4406		
1988	4519		
1989	4615		
1990	4732		
1991	4835		
1992	4985	3.10%	
1993	5210	4.51%	
1994	5408	3.80%	
1995	5471	1.16%	
1996	5620	2.72%	
1997	5826	3.67%	
1998	5920	1.61%	
1999	6059	2.35%	
2000	6221	2.67%	
2001	6343	1.96%	
2002	6538	3.07%	
2003	6694	2.39%	
2004	7115	6.29%	3.27% 1999-2015
2005	7446	4.65%	
2006	7751	4.10%	
2007	7966	2.77%	
2008	8310	4.32%	
2009	8570	3.13%	
2010	8802	2.71%	
2011	9,093	3.31%	
2012	9,366	3.00%	
2013	9,643	2.96%	
2014	9,926	2.93%	
2015	10,214	2.90%	2.97% 2010-2015
2016	10,507	2.87%	

Memo indicates ENR CI =			9837.4		
Nomarlized to 2016 =			1.068095		
Ref 1	2010.5	8947.561262	12299.92	1.374667	
Ref 2	2013.5	9837.4	11110	**1.129363**	**USE FOR 201[illegible]**
				12.94%	
			11110	0.999990	For check
				-0.001%	
April 2010			9054.75	1.22698	
Jul-05			11110	22.70%	For Sunnydale comparison

Table L-8 Cut and Cover Box Unit Cost Estimate Check

Cut and Cover "Green Sheet" Check on Curves/2018 CA Costs

Item	Description	Quanitity	Unit	Unit Cost	Total	Shifts	Weeks	Months
1	Furnish and Install Shoring	46880	sf	$ 30.00	$ 1,406,400.00	30	6	
2	Rent and Remove Shoring	46880	sf/mo.	$ 5.00	$ 234,400.00	10	2	
3	Excavate	11100	CY	$ 30.00	$ 333,000.00	110	22	
4	Backfill	6000	CY	$ 30.00	$ 180,000.00	included		
5	Reinforce Concrete Box	1627	CY	$ 1,200.00	$ 1,952,400.00	60	12	
6	Repave	1	LS	$ 405,000.00	$ 405,000.00	5	1	
7	Dewater Nuisance	1	LS	$ 100,000.00	$ 100,000.00	included		
8	Traffic	1	LS	$ 260,000.00	$ 260,000.00	included		
9	Decking	3400	sf	$ 30.00	$ 102,000.00	included		
					$ 4,973,200.00	215	43	10
	San Francisco Factor	15.00%			$ 745,980.00			
	Subtotal				$ 5,719,180.00			
	Escalation to Midpoint of Construction	10.71%			$ 612,483.47			
	Subtotal				$ 6,331,663.47			
	30% Design Contingency	30%			$ 8,231,162.51			
	10% Construction Contingency	10%			$ 9,054,278.77			

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FOLSOM STORMWATER IMPROVEMENT PROJECT
UPSTREAM SEWER IMPROVEMENTS

SAN FRANCISCO, CA

CONTRACT NO. WW-XXX
PROJECT NO. XXXXX

PLANNING LEVEL CONSTRUCTION COST ESTIMATE
(AN OPINION OF PROBABLE CONSTRUCTION COST)
BASED ON
10% (CER) DOCUMENTS
(PILES SUPPORT FOR BOX SEWERS ONLY)

Owner:
WASTEWATER ENTERPRISE
SAN FRANCISCO PUBLIC UTILITIES COMMISSION (SFPUC)
CITY AND COUNTY OF SAN FRANCISCO

Prepared for
SFPW - Hydraulic Section
Contact: Chung Linh, PE, Civil Engineer
Email: Chung.Linh@sfdpw.org; Ph: 415-554-8298

Prepared by
SSIP PMC Team
TASK ORDER 84 M2
Task Order Manager: Bryce Wilson

Lead Cost Estimator: Martin Lee, PE, CPE
Certified Professional Estimator
Email: mlee@mleecorp.com; Ph: 415-693-0236

3/15/2018 Draft-R2

TO-84 M2 Folsom Upstream Sewer

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FOLSOM STORMWATER IMPROVEMENT PROJECT
UPSTREAM SEWER IMPROVEMENTS

PLANNING LEVEL CONSTRUCTION COST ESTIMATE (AN OPINION OF PROBABLE CONSTRUCTION COST) BASED ON 10% (CER) DOCUMENTS

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3/15/2018 Draft-R2

SSIP PROGRAM **DRAFT**
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)

1.0 BASIS OF ESTIMATE

3/15/2018 Draft-R2
By: MLee/FLee
PMC Team

1 Scope for this estimate is based on the following documents received from SFPW-Hydraulic Section on 5/15/2017:
a) Email from Chung Linh of SFPW dated 2/26/2018 with attached files
b) CER Upstream components spreadsheet from Chung Linh dated 20180221
c) Layout plans for the sewer replacements or new sewers, filename: 2817J 10_PCT.pdf, a total of 21 sheets

2 Specifically excluded from the cost estimates:
Cost escalation beyond the assumed construction midpoint of October 2021.
O&M cost
Relocation of SFPUC utilities
Relocation of private utilities, e.g. PG&E, AT&T etc

3 Cost estimates are based on the following assumed construction:

3.1 All work to be performed during regular work hours. No overtime has been included.

3.2 Labor rates are based on prevailing wages for San Francisco.

3.3 Assume pile-support for concrete box sewers only. No piles for other pipes.

3.4 Included allowances for disposal of contaminated soil at 60% of total excavated materials

3.5 Assume all sewers are gravity sewers - not pressurized

4 The estimate reflects probable construction costs obtainable in the project locality on the date of this estimate under competitive bidding for a lump sum contract with 4 to 6 responsible and responsive general bids and a minimum of 4 bidders for every major portion of the construction work (a fair market condition).

5 Terminology:
5.1 "Direct Construction Cost" is equivalent to subcontractor's bid to general contractor or the portion of work performed directly by the general contractor (self-performed work). This includes costs for materials, labor & equipment and subcontractor's markups.

5.2 Base Construction Cost is the estimated construction bid submitted by general contractor to Owner. A Markup factor of 56.0% is used to adjust Direct Construction Cost to Base Construction Cost. See Markup Section for calculation.

5.3 Total Construction Cost (Hardcost) is the estimated Base Construction Cost plus 10% contingency allowance for change orders during construction.

5.4 Soft Cost is the estimated expense incurred by Owner for design, engineering, construction management, project administration and other related costs required to deliver the project in addition to the amount pay to the Contractor. A Markup factor of 48.15% on the Hardcost is used for Softcost.

5.5 Total Capital Project Cost is the sum of Hard Cost and Soft Cost

6 Client acknowledges that our service is consistent with and limited to the standard of care applicable to such services, which is that we provide our services consistent with the professional skill and care ordinarily provided by consultants practicing in the same or similar locality under the same or similar circumstances. The estimate is intended to be a determination of fair market value for the project construction. Since we have no control over market conditions and other factors, which may affect the bid prices, we cannot and do not warrant or guarantee that bids or ultimate construction costs will not vary from the cost estimate. We make no other warranties, either expressed or implied, and are not responsible for the interpretation by others of the contents herein the cost estimate.

7 It should be noted that the cost estimate is a "snapshot in time" and that the reliability of this opinion of probable construction cost will inherently degrade over time.

8 Please note that the estimate has been prepared based on preliminary information and design assumptions which are subject to verifications and changes as the design progresses. An updated estimate should be prepared when more specific and detailed design information is available.

9 Abbreviations used in the estimate:
CY = cubic yard
EA = each
GSF = gross square foot
LB = pound
LF = linear foot
LOC = location
LS = lump sum
SF = square foot

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
2.0 BASE CONSTRUCTION COST MARKUP CALCULATION

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ITEM		WORK ITEM DESCRIPTION			
	A	**Direct Construction Cost**			100.00
1		Add Markups:			
2		Contractor General Conditions and Requirements	10.00%		10.00
3		Market Factor	0.00%	N/A	
4		Construction or Contract Phasing Factor	0.00%	N/A	
5		General Contractor Overhead and Profit	6.50%		7.00
6		Bonds and Insurance	2.50%		3.00
7		Design/Estimating Contingency	30.00%		36.00
8					
9	B	**Base Construction Cost (unescalated)**			**156.00**
10		Markup Factor: B/A-1 From Direct Cost to Base Construction Cost			**56.0%**

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
3.0 ESTIMATE SUMMARY

Date: **3/15/2018 Draft-R2**
By: MLee/FLee
PMC Team

	Project Name/Street	Street Length LF	Direct Construction Cost $	Base Construction Cost $	Total Construction Cost $	Total Capital Project Cost $ Unescalated	Total Capital Project Cost $ Escalated*
			ALL IN MAR 2018 DOLLARS (UNESCALATED)				
			A	B=A*(1+56%)	C=B*(1+10%)	D=C*(1+48.15%)	E=D(1+15.62%)
			From Attached				
	A) Tier 1						
1	17th Street – Folsom to Treat	453	2,117,660	$3,303,550	$3,633,905	$5,383,630	$6,224,553
2	17th Street – Shotwell to Folsom	312	1,491,550	$2,326,818	$2,559,500	$3,791,899	$4,384,194
3	17th Street – South Van Ness to Shotwell	306	1,463,365	$2,282,849	$2,511,134	$3,720,245	$4,301,347
4	17th Street – Treat to Harrison	217	825,155	$1,287,242	$1,415,966	$2,097,754	$2,425,423
5	18th Street – Folsom to Treat	320	1,473,690	$2,298,956	$2,528,852	$3,746,494	$4,331,696
6	18th Street – Shotwell to Folsom	288	1,327,615	$2,071,079	$2,278,187	$3,375,134	$3,902,330
7	18th Street – Treat to Harrison	377	1,153,720	$1,799,803	$1,979,783	$2,933,049	$3,391,191
8	Harrison Street – 17th to 16th	340	3,065,965	$4,782,905	$5,261,196	$7,794,462	$9,011,957
9	Harrison Street – 18th to 17th	708	5,994,688	$9,351,713	$10,286,884	$15,240,019	$17,620,510
10	Harrison Street – 19th to 18th	585	4,691,420	$7,318,615	$8,050,477	$11,926,782	$13,789,745
11	Treat Avenue – 16th to Alameda	985	11,652,284	$18,177,563	$19,995,319	$29,623,065	$34,250,188
12	Treat Avenue @ 16th	24	280,896	$438,198	$482,018	$714,110	$825,654
	Subtotal - A) Tie 1	4,915	$35,538,008	$55,439,291	$60,983,221	$90,346,643	$104,458,788
	B) Tier 2						
13	11th Street – Folsom to Harrison	630	1,448,705	$2,259,980	$2,485,978	$3,682,976	$4,258,257
14	11th Street – Harrison to Division	841	2,934,190	$4,577,336	$5,035,070	$7,459,456	$8,624,623
15	14th Street – Folsom to Harrison	620	2,041,290	$3,184,412	$3,502,853	$5,189,477	$6,000,073
16	14th Street – Mission to South Van Ness	581	4,093,955	$6,386,570	$7,025,227	$10,407,874	$12,033,584
17	15th Street – Capp to South Van Ness	295	858,205	$1,338,800	$1,472,680	$2,181,775	$2,522,568
18	15th Street – Minna to Capp	119	415,570	$648,289	$713,118	$1,056,484	$1,221,507
19	15th Street – Mission to Minna	253	855,955	$1,335,290	$1,468,819	$2,176,055	$2,515,955
20	15th Street – South Van Ness to Shotwell	296	971,770	$1,515,961	$1,667,557	$2,470,486	$2,856,376
21	19th Street - Folsom to Treat	298	320,303	$499,673	$549,640	$814,292	$941,484

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
3.0 ESTIMATE SUMMARY

Date: **3/15/2018 Draft-R2**
By: MLee/FLee
PMC Team

	Project Name/Street	Street Length LF	Direct Construction Cost $	Base Construction Cost $	Total Construction Cost $	Total Capital Project Cost $ Unescalated	Total Capital Project Cost $ Escalated*
			ALL IN MAR 2018 DOLLARS (UNESCALATED)				
			A	B=A*(1+56%)	C=B*(1+10%)	D=C*(1+48.15%)	E=D(1+15.62%)
			From Attached				
22	Alabama Street - Mariposa to 17th	430	510,670	$796,645	$876,310	$1,298,253	$1,501,040
23	Erie Street - South Van Ness to Folsom	395	419,260	$654,046	$719,451	$1,065,867	$1,232,355
24	Folsom Street – 12th to 11th	425	1,199,630	$1,871,423	$2,058,565	$3,049,764	$3,526,137
25	Folsom Street - 17th to 16th	154	140,408	$219,036	$240,940	$356,953	$412,709
26	Folsom Street - 17th to 18th*	294	282,769	$441,120	$485,232	$718,871	$831,159
27	Harrison Street - 15th to Alameda	334	286,308	$446,640	$491,304	$727,867	$841,560
28	Mistral Street - Treat to Harrison*	71	69,436	$108,320	$119,152	$176,524	$204,097
29	Shotwell Street - 19th to 18th*	280	348,850	$544,206	$598,627	$886,866	$1,025,394
30	South Van Ness – 18th to 17th	508	1,040,225	$1,622,751	$1,785,026	$2,644,516	$3,057,589
31	South Van Ness @ 18th	75	161,670	$252,205	$277,426	$411,007	$475,206
32	Trainor Street - 13th to 14th	303	239,399	$373,462	$410,808	$608,612	$703,677
	Subtotal - B) Tier 2	7,202	$18,638,568	$29,076,165	$31,983,783	$47,383,975	$54,785,350
1-32	**A)&B)-TOTAL TIERS 1 & 2 STORMWATER IMPROVEMENTS**	12,117	$54,176,576	$84,515,456	$92,967,004	$137,730,618	$159,244,138
	ROUNDED-OFF		**$54,180,000**	**$84,520,000**	**$92,970,000**	**$137,730,000**	**$159,240,000**

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
3.0 ESTIMATE SUMMARY

Date: **3/15/2018 Draft-R2**
By: MLee/FLee
PMC Team

Project Name/Street	Street Length LF	Direct Construction Cost $	Base Construction Cost $	Total Construction Cost $	Total Capital Project Cost $ Unescalated	Total Capital Project Cost $ Escalated*
		ALL IN MAR 2018 DOLLARS (UNESCALATED)				
		A From Attached	B=A*(1+56%)	C=B*(1+10%)	D=C*(1+48.15%)	E=D(1+15.62%)

Important Notes:

1) Specifically excluded from the cost estimates:
   - Cost escalation beyond the assumed construction midpoint of October 2021.
   - O&M cost
   - Relocation of SFPUC utilities & private utilities

2) The estimate has been prepared based on preliminary information and design assumptions which are subject to verifications and changes as the design progresses. An updated estimate should be prepared when more specific and detailed design information is available.

3) Please see attached Basis of Estimate and Estimate Details for assumptions, qualifications, inclusions and exclusions.

4) * Escalation to mid-point of construction Oct 2021 assuming 4% per year compounded.

Escalation Calc

Estimate Date	3/14/2018	
Midpoint	10/15/2021	
Months from Estimate Date to Midpoint	44	Months
	3.7	year
Escalation at 4% per year	4.00%	
Total escalation	15.62%	

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
3.0 ESTIMATE SUMMARY

Date: **3/15/2018 Draft-R2**
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PMC Team

	Project Name/Street	Base Construction Cost $	Unescalated Total Construction Cost $	Total Capital Project Cost $
		$/LF	$/LF	$/LF
	A) Tier 1			
1	17th Street – Folsom to Treat	7,293	8,022	11,884
2	17th Street – Shotwell to Folsom	7,458	8,204	12,154
3	17th Street – South Van Ness to Shotwell	7,460	8,206	12,158
4	17th Street – Treat to Harrison	5,932	6,525	9,667
5	18th Street – Folsom to Treat	7,184	7,903	11,708
6	18th Street – Shotwell to Folsom	7,191	7,910	11,719
7	18th Street – Treat to Harrison	4,774	5,251	7,780
8	Harrison Street – 17th to 16th	14,067	15,474	22,925
9	Harrison Street – 18th to 17th	13,209	14,529	21,525
10	Harrison Street – 19th to 18th	12,510	13,761	20,388
11	Treat Avenue – 16th to Alameda	18,454	20,300	30,074
12	Treat Avenue @ 16th	18,258	20,084	29,755
	Subtotal - A) Tie 1	11,280	12,408	18,382
	B) Tier 2			
13	11th Street – Folsom to Harrison	3,587	3,946	5,846
14	11th Street – Harrison to Division	5,443	5,987	8,870
15	14th Street – Folsom to Harrison	5,136	5,650	8,370
16	14th Street – Mission to South Van Ness	10,992	12,092	17,914
17	15th Street – Capp to South Van Ness	4,538	4,992	7,396
18	15th Street – Minna to Capp	5,448	5,993	8,878
19	15th Street – Mission to Minna	5,278	5,806	8,601
20	15th Street – South Van Ness to Shotwell	5,121	5,634	8,346
21	19th Street - Folsom to Treat	1,677	1,844	2,733
22	Alabama Street - Mariposa to 17th	1,853	2,038	3,019
23	Erie Street - South Van Ness to Folsom	1,656	1,821	2,698
24	Folsom Street – 12th to 11th	4,403	4,844	7,176
25	Folsom Street - 17th to 16th	1,422	1,565	2,318
26	Folsom Street - 17th to 18th*	1,500	1,650	2,445
27	Harrison Street - 15th to Alameda	1,337	1,471	2,179
28	Mistral Street - Treat to Harrison*	1,526	1,678	2,486
29	Shotwell Street - 19th to 18th*	1,944	2,138	3,167
30	South Van Ness – 18th to 17th	3,194	3,514	5,206
31	South Van Ness @ 18th	3,363	3,699	5,480
32	Trainor Street - 13th to 14th	1,233	1,356	2,009
	Subtotal - B) Tier 2	4,037	4,441	6,579
1-32	**A)&B)-TOTAL TIERS 1 & 2 STORMWATER IMPROVEMENTS**	6,975	7,672	11,367

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
3.0 ESTIMATE SUMMARY

Date: 3/15/2018 Draft-R2
By: MLee/FLee
PMC Team

	Unescalated		
Project Name/Street	**Base Construction Cost $**	**Total Construction Cost $**	**Total Capital Project Cost $**
	$/LF	$/LF	$/LF

Important Notes:

1) Specifically excluded from the cost estimates:

Cost escalation from March 2018 dollars. See 3.0 Estimate Summary for assumed escalation to construction midpoint of October 2021.

O&M cost

2) The estimate has been prepared based on preliminary information and design assumptions which are subject to verifications and changes as the design progresses. An updated estimate should be prepared when more specific and detailed design information is available.

3) Please see attached Basis of Estimate and Estimate Details for assumptions, qualifications, inclusions and exclusions.

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
5.0 ESTIMATE DETAILS - TIER 1

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
1		**A) Tier 1**				
2						
3	1	**17th Street – Folsom to Treat**				
4		Key Quantities:				
5		New				
6		Diameter	8.5	lf		
7		Length	453.0	lf		
8		Depth to invert	16.0	lf		
9		Work space, 1.5' each side, total add	3.0	ft		
10		Excavation				
11		Length	453.0	ft		
12		Width	11.5	ft		
13		Depth	17.0	ft		
14						
15						
16		Remove paving	6,116	SF	5.00	30,580
17		Temporary shoring	15,402	SF	45.00	693,090
18		Excavation	3,280	CY	30.00	98,400
19		Haul-off	3,280	CY	25.00	82,000
20		Premium for disposal of contaminated soil, say 30%	984	CY	150.00	147,600
21		Reinforced concrete pipe (RCP), coated	453	LF	1,420.00	643,260
22		Manhole	2	EA	20,000.00	40,000
23		Backfill, compacted	2,328	CY	55.00	128,040
24		Restore paving	6,116	SF	15.00	91,740
25		Allow for dewatering	1	LS	95,000.00	95,000
26		Allow for protecting utilities in place (no relocation)	1	LS	22,650.00	22,650
27		Allow for traffic control	1	LS	45,300	45,300
28						-
29		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
30		Pipe saddles/connection to piles		None		-
31						-
32						-
33		**Direct Cost Subtotal - Carried to DC Summary**	453	lf	4,675.00	**2,117,660**
34						
35						
36	**2**	**17th Street – Shotwell to Folsom**				
37		Key Quantities:				
38		New				
39		Diameter	8.5	lf		
40		Length	312	lf		
41		Depth to invert	16.0	lf		

SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
5.0 ESTIMATE DETAILS - TIER 1

Date: **3/15/2018 Draft-R2**
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PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM	WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
42	Work space, 1.5' each side, total add	3	ft		
43	Excavation				
44	Length	312	ft		
45	Width	11.5	ft		
46	Depth	17.0	ft		
47					
48					
49	Remove paving	4,212	SF	5.00	21,060
50	Temporary shoring	10,608	SF	45.00	477,360
51	Excavation	2,259	CY	30.00	67,770
52	Haul-off	2,259	CY	25.00	56,475
53	Premium for disposal of contaminated soil, say 30%	678	CY	150.00	101,700
54	Reinforced concrete pipe (RCP), coated	312	LF	1,420.00	443,040
55	Manhole	3	EA	20,000.00	60,000
56	Backfill, compacted	1,603	CY	55.00	88,165
57	Restore paving	4,212	SF	15.00	63,180
58	Allow for dewatering	1	LS	66,000.00	66,000
59	Allow for protecting utilities in place (no relocation)	1	LS	15,600.00	15,600
60	Allow for traffic control	1	LS	31,200	31,200
61					-
62	Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
63	Pipe saddles/connection to piles		None		-
64					-
65					-
66	**Direct Cost Subtotal - Carried to DC Summary**	312	lf	4,781.00	**1,491,550**
67					
68					
69	**3 17th Street – South Van Ness to Shotwell**				
70	Key Quantities:				
71	New				
72	Diameter	8.5	lf		
73	Length	306	lf		
74	Depth to invert	16.0	lf		
75	Work space, 1.5' each side, total add	3	ft		
76	Excavation				
77	Length	306	ft		
78	Width	11.5	ft		
79	Depth	17.0	ft		
80					
81					
82	Remove paving	4,131	SF	5.00	20,655

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ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
83		Temporary shoring	10,404	SF	45.00	468,180
84		Excavation	2,216	CY	30.00	66,480
85		Haul-off	2,216	CY	25.00	55,400
86		Premium for disposal of contaminated soil, say 30%	665	CY	150.00	99,750
87		Reinforced concrete pipe (RCP), coated	306	LF	1,420.00	434,520
88		Manhole	3	EA	20,000.00	60,000
89		Backfill, compacted	1,573	CY	55.00	86,515
90		Restore paving	4,131	SF	15.00	61,965
91		Allow for dewatering	1	LS	64,000.00	64,000
92		Allow for protecting utilities in place (no relocation)	1	LS	15,300.00	15,300
93		Allow for traffic control	1	LS	30,600	30,600
94						-
95		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
96		Pipe saddles/connection to piles		None		-
97						-
98						-
99		**Direct Cost Subtotal - Carried to DC Summary**	306	lf	4,782.00	**1,463,365**
100						
101						
102	**4**	**17th Street – Treat to Harrison**				
103		Key Quantities:				
104		New				
105		Diameter	7.5	lf		
106		Length	217	lf		
107		Depth to invert	14.0	lf		
108		Work space, 1.5' each side, total add	3	ft		
109		Excavation				
110		Length	217	ft		
111		Width	10.5	ft		
112		Depth	15.0	ft		
113						
114						
115		Remove paving	2,713	SF	5.00	13,565
116		Temporary shoring	6,510	SF	45.00	292,950
117		Excavation	1,266	CY	30.00	37,980
118		Haul-off	1,266	CY	25.00	31,650
119		Premium for disposal of contaminated soil, say 30%	380	CY	150.00	57,000
120		Reinforced concrete pipe (RCP), coated	217	LF	980.00	212,660
121		Manhole	1	EA	20,000.00	20,000
122		Backfill, compacted	911	CY	55.00	50,105
123		Restore paving	2,713	SF	15.00	40,695

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
5.0 ESTIMATE DETAILS - TIER 1

Date: **3/15/2018 Draft-R2**
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ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
124		Allow for dewatering	1	LS	36,000.00	36,000
125		Allow for protecting utilities in place (no relocation)	1	LS	10,850.00	10,850
126		Allow for traffic control	1	LS	21,700	21,700
127						-
128		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
129		Pipe saddles/connection to piles		None		-
130						-
131						-
132		**Direct Cost Subtotal - Carried to DC Summary**	217	lf	3,803.00	**825,155**
133						
134						
135	**5**	**18th Street – Folsom to Treat**				
136		Key Quantities:				
137		Replacement:				
138		Existing: 60"				
139		New:				
140		Diameter	9.0	lf		
141		Length	320	lf		
142		Depth to invert	13.0	lf		
143		Work space, 1.5' each side, total add	3	ft		
144		Excavation				
145		Length	320	ft		
146		Width	12.0	ft		
147		Depth	14.0	ft		
148						
149						
150		Remove paving	4,480	SF	5.00	22,400
151		Temporary shoring	8,960	SF	45.00	403,200
152		Excavation	1,991	CY	30.00	59,730
153		Haul-off	1,991	CY	25.00	49,775
154		Premium for disposal of contaminated soil, say 30%	597	CY	150.00	89,550
155		Remove existing sewer	320	LF	100.00	32,000
156						-
157		Reinforced concrete pipe (RCP), coated	320	LF	1,590.00	508,800
158		Connect to junction structure	1	EA	50,000.00	50,000
159		Backfill, compacted	1,237	CY	55.00	68,035
160		Restore paving	4,480	SF	15.00	67,200
161		Allow for dewatering	1	LS	75,000.00	75,000
162		Allow for protecting utilities in place (no relocation)	1	LS	16,000.00	16,000
163		Allow for traffic control	1	LS	32,000	32,000
164						-

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TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
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ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
165		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
166		Pipe saddles/connection to piles		None		-
167						-
168						-
169		**Direct Cost Subtotal - Carried to DC Summary**	320	lf	4,605.00	**1,473,690**
170						
171						
172	**6**	**18th Street – Shotwell to Folsom**				
173		Key Quantities:				
174		Replacement:				
175		Existing: 60"				
176		New:				
177		Diameter	9.0	lf		
178		Length	288	lf		
179		Depth to invert	14.0	lf		
180		Work space, 1.5' each side, total add	3.0	ft		
181		Excavation				
182		Length	288.0	ft		
183		Width	12.0	ft		
184		Depth	15.0	ft		
185						
186						
187		Remove paving	4,032	SF	5.00	20,160
188		Temporary shoring	8,640	SF	45.00	388,800
189		Excavation	1,920	CY	30.00	57,600
190		Haul-off	1,920	CY	25.00	48,000
191		Premium for disposal of contaminated soil, say 30%	576	CY	150.00	86,400
192		Remove existing sewer	288	LF	100.00	28,800
193						-
194		Reinforced concrete pipe (RCP), coated	288	LF	1,590.00	457,920
195		Manhole	-	None		-
196		Backfill, compacted	1,241	CY	55.00	68,255
197		Restore paving	4,032	SF	15.00	60,480
198		Allow for dewatering	1	LS	68,000.00	68,000
199		Allow for protecting utilities in place (no relocation)	1	LS	14,400.00	14,400
200		Allow for traffic control	1	LS	28,800	28,800
201						-
202		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
203		Pipe saddles/connection to piles		None		-
204						-

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
205						-
206		**Direct Cost Subtotal - Carried to DC Summary**	288	lf	4,610.00	**1,327,615**
207						
208						
209	**7**	**18th Street – Treat to Harrison**				
210		Key Quantities:				
211		New:				
212		Diameter	5.0	lf		
213		Length	377	lf		
214		Depth to invert	13.0	lf		
215		Work space, 1.5' each side, total add	3.0	ft		
216		Excavation				
217		Length	377.0	ft		
218		Width	8.0	ft		
219		Depth	14.0	ft		
220						
221						
222		Remove paving	3,770	SF	5.00	18,850
223		Temporary shoring	10,556	SF	45.00	475,020
224		Excavation	1,564	CY	30.00	46,920
225		Haul-off	1,564	CY	25.00	39,100
226		Premium for disposal of contaminated soil, say 30%	469	CY	150.00	70,350
227		Reinforced concrete pipe (RCP), coated	377	LF	590.00	222,430
228		Manhole	2	EA	15,000.00	30,000
229		Connect to junction structure	1	EA	40,000.00	40,000
230		Backfill, compacted	1,290	CY	55.00	70,950
231		Restore paving	3,770	SF	15.00	56,550
232		Allow for dewatering	1	LS	27,000.00	27,000
233		Allow for protecting utilities in place (no relocation)	1	LS	18,850.00	18,850
234		Allow for traffic control	1	LS	37,700	37,700
235						-
236		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
237		Pipe saddles/connection to piles		None		-
238						-
239						-
240		**Direct Cost Subtotal - Carried to DC Summary**	377	lf	3,060.00	**1,153,720**
241						
242						
243	**8**	**Harrison Street – 17th to 16th**				
244		Key Quantities:				
245		Replacement:				

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
5.0 ESTIMATE DETAILS - TIER 1

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM	WORK ITEM DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL $
246	Existing:	3'0"x5'0"				
247	New:	9'0"x8'0"				
248	Width		9.0	lf		
249	Depth		8.0	lf		
250	Length		340	lf		
251	Depth to invert		15.0	lf		
252	Work space, 1.5' each side, total add		3	ft		
253	Excavation					
254	Length		340	ft		
255	Width		12.0	ft		
256	Depth		16.0	ft		
257						
258						
259	Remove paving		4,760	SF	5.00	23,800
260	Temporary shoring		10,880	SF	45.00	489,600
261	Excavation		2,418	CY	30.00	72,540
262	Haul-off		2,418	CY	25.00	60,450
263	Premium for disposal of contaminated soil, say 30%		725	CY	150.00	108,750
264	Remove existing sewer		403	CY	200.00	80,600
265						-
266	Reinforced concrete box					-
267	Bottom slab, 2'0" thick		227	CY	500.00	113,500
268	Top slab, 1'6" thick		170	CY	1,100.00	187,000
269	Wall, 1'0" thick		113	CY	1,500.00	169,500
270	Water stops at wall and bottom slab		680	LF	15.00	10,200
271	Vitrified brick at bottom slab		2,380	SF	28.00	66,640
272						-
273	Connect to 12'-6"x9'-0" concrete box sewer		1	EA	50,000.00	50,000
274	Backfill, compacted		1,617	CY	55.00	88,935
275	Restore paving		4,760	SF	15.00	71,400
276	Allow for dewatering		1	LS	80,000.00	80,000
277	Allow for protecting utilities in place (no relocation)		1	LS	17,000.00	17,000
278	Allow for traffic control		1	LS	34,000	34,000
279						-
280	Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		138	EA	4,725.00	652,050
281	Pipe saddles/connection to piles		69	EA	10,000.00	690,000
282						-
283						-
284	**Direct Cost Subtotal - Carried to DC Summary**		340	lf	9,018.00	**3,065,965**
285						
286						
287	**9 Harrison Street – 18th to 17th**					

ITEM	WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
288	Key Quantities:				
289	Replacement:				
290	Existing:	3'0"x5'0"			
291	New:	9'0"x6'0"/9'0"x7'0"			
292	Width	9.0	lf		
293	Depth	6.5	lf		
294	Length	708	lf		
295	Depth to invert	13.0	lf		
296	Work space, 1.5' each side, total add	3	ft		
297	Excavation				
298	Length	708	ft		
299	Width	12.0	ft		
300	Depth	14.0	ft		
301					
302					
303	Remove paving	9,912	SF	5.00	49,560
304	Temporary shoring	19,824	SF	45.00	892,080
305	Excavation	4,405	CY	30.00	132,150
306	Haul-off	4,405	CY	25.00	110,125
307	Premium for disposal of contaminated soil, say 30%	1,322	CY	150.00	198,300
308					-
309	Remove existing sewer	839	CY	200.00	167,800
310					-
311	Reinforced concrete box				-
312	Bottom slab, 2'0" thick	472	CY	500.00	236,000
313	Top slab, 1'6" thick	354	CY	1,100.00	389,400
314	Wall, 1'0" thick	157	CY	1,500.00	235,500
315	Water stops at wall and bottom slab	1,416	LF	15.00	21,240
316	Vitrified brick at bottom slab	4,956	SF	28.00	138,768
317					-
318	Manhole	1	EA	20,000.00	20,000
319	Connect to concrete box sewer	1	EA	50,000.00	50,000
320	Backfill, compacted	2,737	CY	55.00	150,535
321	Restore paving	9,912	SF	15.00	148,680
322	Allow for dewatering	1	LS	167,000.00	167,000
323	Allow for protecting utilities in place (no relocation)	1	LS	35,400.00	35,400
324	Allow for traffic control	1	LS	70,800	70,800
325					-
326	Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.	286	EA	4,725.00	1,351,350
327	Pipe saddles/connection to piles	143	EA	10,000.00	1,430,000
328					-
329					-

SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
5.0 ESTIMATE DETAILS - TIER 1

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
330		**Direct Cost Subtotal - Carried to DC Summary**	708	lf	8,467.00	**5,994,688**
331						
332						
333	**10**	**Harrison Street – 19th to 18th**				
334		Key Quantities:				
335		Replacement:				
336		Existing:	3'0'x4'6"/3'0"x5'0"			
337		New:	9'0"x6'0"			
338		Width	9.0	lf		
339		Depth	6.0	lf		
340		Length	585	lf		
341		Depth to invert	10.0	lf		
342		Work space, 1.5' each side, total add	3	ft		
343		Excavation				
344		Length	585	ft		
345		Width	12.0	ft		
346		Depth	11.0	ft		
347						
348						
349		Remove paving	8,190	SF	5.00	40,950
350		Temporary shoring	12,870	SF	45.00	579,150
351		Excavation	2,860	CY	30.00	85,800
352		Haul-off	2,860	CY	25.00	71,500
353		Premium for disposal of contaminated soil, say 30%	858	CY	150.00	128,700
354		Remove existing sewer	693	CY	200.00	138,600
355						-
356		Reinforced concrete box				-
357		Bottom slab, 2'0" thick	390	CY	500.00	195,000
358		Top slab, 1'6" thick	293	CY	1,100.00	322,300
359		Wall, 1'0" thick	108	CY	1,500.00	162,000
360		Water stops at wall and bottom slab	1,170	LF	15.00	17,550
361		Vitrified brick at bottom slab	4,095	SF	28.00	114,660
362						-
363		Manhole	3	EA	20,000.00	60,000
364		Connect to concrete box sewer	1	EA	50,000.00	50,000
365		Backfill, compacted	1,482	CY	55.00	81,510
366		Restore paving	8,190	SF	15.00	122,850
367		Allow for dewatering	1	LS	138,000.00	138,000
368		Allow for protecting utilities in place (no relocation)	1	LS	29,250.00	29,250
369		Allow for traffic control	1	LS	58,500	58,500
370						-
371		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.	236	EA	4,725.00	1,115,100

SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
5.0 ESTIMATE DETAILS - TIER 1

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
372		Pipe saddles/connection to piles	118	EA	10,000.00	1,180,000
373						-
374						-
375		**Direct Cost Subtotal - Carried to DC Summary**	585	lf	8,020.00	**4,691,420**
376						
377						
378	**11**	**Treat Avenue – 16th to Alameda**				
379		Key Quantities:				
380		Replacement:				
381		Existing:	10.5'w x 9'h			
382		New:	10.5'w x 15'h			
383		Width	10.5	lf		
384		Depth	15.0	lf		
385		Length	985	lf		
386		Depth to invert	22.0	lf		
387		Work space, 1.5' each side, total add	3	ft		
388		Excavation				
389		Length	985	ft		
390		Width	13.5	ft		
391		Depth	23.0	ft		
392						
393						
394		Remove paving	15,268	SF	5.00	76,340
395		Temporary shoring	45,310	SF	49.50	2,242,845
396		Excavation	11,328	CY	30.00	339,840
397		Haul-off	11,328	CY	25.00	283,200
398		Premium for disposal of contaminated soil, say 30%	3,398	CY	150.00	509,700
399						-
400		Remove existing sewer	2,846	CY	200.00	569,200
401						-
402		Reinforced concrete box				-
403		Bottom slab, 2'0" thick	766	CY	500.00	383,000
404		Top slab, 1'6" thick	575	CY	1,100.00	632,500
405		Wall, 1'0" thick	839	CY	1,500.00	1,258,500
406		Water stops at wall and bottom slab	1,970	LF	15.00	29,550
407		Vitrified brick at bottom slab	8,373	SF	28.00	234,444
408		Connect to junction structure/box sewer	2	EA	50,000.00	100,000
409		Backfill, compacted	8,169	CY	55.00	449,295
410		Restore paving	15,268	SF	15.00	229,020
411		Allow for dewatering	1	LS	316,000.00	316,000
412		Allow for protecting utilities in place (no relocation)	1	LS	49,250.00	49,250
413		Allow for traffic control	1	LS	98,500	98,500

ITEM		WORK ITEM DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL $
414							-
415		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		396	EA	4,725.00	1,871,100
416		Pipe saddles/connection to piles		198	EA	10,000.00	1,980,000
417							-
418							-
419		**Direct Cost Subtotal - Carried to DC Summary**		985	lf	11,830.00	**11,652,284**
420							
421							
422	**12**	**Treat Avenue @ 16th**					
423		Key Quantities:					
424		New:	4'2"x9'0"				
425		Width		4.2	lf		
426		Depth		9.0	lf		
427		Length		24	lf		
428		Depth to invert		16.0	lf		
429		Work space, 1.5' each side, total add		3	ft		
430		Excavation					
431		Length		24	ft		
432		Width		7.2	ft		
433		Depth		17.0	ft		
434							
435							
436		Remove paving		221	SF	5.00	1,105
437		Temporary shoring		816	SF	49.50	40,392
438		Excavation		109	CY	30.00	3,270
439		Haul-off		109	CY	25.00	2,725
440		Premium for disposal of contaminated soil, say 30%		33	CY	150.00	4,950
441							-
442		Reinforced concrete box					-
443		Bottom slab, 2'0" thick		7	CY	500.00	3,500
444		Top slab, 1'6" thick		6	CY	1,100.00	6,600
445		Wall, 1'0" thick		10	CY	1,500.00	15,000
446		Water stops at wall and bottom slab		48	LF	15.00	720
447		Vitrified brick at bottom slab		53	SF	28.00	1,484
448		Manhole		1	EA	20,000.00	20,000
449		Connect to concrete box sewer		1	EA	50,000.00	50,000
450		Backfill, compacted		97	CY	55.00	5,335
451		Restore paving		221	SF	15.00	3,315
452		Allow for dewatering		1	LS	1,000.00	1,000
453		Allow for protecting utilities in place (no relocation)		1	LS	2,400.00	2,400
454		Allow for traffic control		1	LS	2,400	2,400
455							-

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
5.0 ESTIMATE DETAILS - TIER 1

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM	WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
456	Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.	12	EA	4,725.00	56,700
457	Pipe saddles/connection to piles	6	EA	10,000.00	60,000
458					-
459					-
460	**Direct Cost Subtotal - Carried to DC Summary**	24	lf	11,704.00	**280,896**
461					
462					

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
6.0 ESTIMATE DETAILS - TIER 2

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
1		**B) Tier 2**				
2						
3	13	**11th Street – Folsom to Harrison**				
4		Key Quantities:				
5		New				
6		Diameter	4.0	lf		
7		Length	630.0	lf		
8		Depth to invert	11.0	lf		
9		Work space, 1.5' each side, total add	3.0	ft		
10		Excavation				
11		Length	630.0	ft		
12		Width	7.0	ft		
13		Depth	12.0	ft		
14						
15						
16		Remove paving	5,670	SF	5.00	28,350
17		Temporary shoring	15,120	SF	36.00	544,320
18		Excavation	1,960	CY	30.00	58,800
19		Haul-off	1,960	CY	25.00	49,000
20		Premium for disposal of contaminated soil, say 30%	588	CY	150.00	88,200
21		Reinforced concrete pipe (RCP), coated	630	LF	460.00	289,800
22		Manhole	2	EA	15,000.00	30,000
23		Connect new to existing sewer	2	EA	30,000.00	60,000
24		Backfill, compacted	1,667	CY	55.00	91,685
25		Restore paving	5,670	SF	15.00	85,050
26		Allow for dewatering	1	LS	29,000.00	29,000
27		Allow for protecting utilities in place (no relocation)	1	LS	31,500.00	31,500
28		Allow for traffic control	1	LS	63,000	63,000
29						-
30		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
31		Pipe saddles/connection to piles		None		-
32						-
33						-
34		**Direct Cost Subtotal - Carried to DC Summary**	630	lf	2,300.00	**1,448,705**
35						
36						
37	14	**11th Street – Harrison to Division**				
38		Key Quantities:				
39		New				
40		Diameter	6.3	lf		
41		Length	841.0	lf		

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
42		Depth to invert	14.0	lf		
43		Work space, 1.5' each side, total add	3.0	ft		
44		Excavation				
45		Length	841.0	ft		
46		Width	9.3	ft		
47		Depth	15.0	ft		
48						
49						
50		Remove paving	9,461	SF	5.00	47,305
51		Temporary shoring	25,230	SF	45.00	1,135,350
52		Excavation	4,322	CY	30.00	129,660
53		Haul-off	4,322	CY	25.00	108,050
54		Premium for disposal of contaminated soil, say 30%	1,297	CY	150.00	194,550
55		Reinforced concrete pipe (RCP), coated	841	LF	880.00	740,080
56		Manhole	2	EA	15,000.00	30,000
57		Backfill, compacted	3,366	CY	55.00	185,130
58		Restore paving	9,461	SF	15.00	141,915
59		Allow for dewatering	1	LS	96,000.00	96,000
60		Allow for protecting utilities in place (no relocation)	1	LS	42,050.00	42,050
61		Allow for traffic control	1	LS	84,100	84,100
62						-
63		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
64		Pipe saddles/connection to piles		None		-
65						-
66						-
67		**Direct Cost Subtotal - Carried to DC Summary**	841	lf	3,489.00	**2,934,190**
68						
69						
70	15	**14th Street – Folsom to Harrison**				
71		Key Quantities:				
72		Replacement:				
73		Existing:	6.3	lf		
74		New				
75		Diameter	7.0	lf		
76		Length	620.0	lf		
77		Depth to invert	11.0	lf		
78		Work space, 1.5' each side, total add	3.0	ft		
79		Excavation				
80		Length	620.0	ft		
81		Width	10.0	ft		
82		Depth	12.0	ft		

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
83						
84						
85		Remove paving	7,440	SF	5.00	37,200
86		Temporary shoring	14,880	SF	45.00	669,600
87		Excavation	2,756	CY	30.00	82,680
88		Haul-off	2,756	CY	25.00	68,900
89		Premium for disposal of contaminated soil, say 30%	827	CY	150.00	124,050
90		Remove existing sewer	620	LF	85.00	52,700
91						-
92		Reinforced concrete pipe (RCP), coated	620	LF	880.00	545,600
93		Manhole	1	EA	15,000.00	15,000
94		Connect to existing concrete sewer	2	EA	25,000.00	50,000
95		Haul-off	1,872	CY	55.00	102,960
96		Restore paving	7,440	SF	15.00	111,600
97		Allow for dewatering	1	LS	88,000.00	88,000
98		Allow for protecting utilities in place (no relocation)	1	LS	31,000.00	31,000
99		Allow for traffic control	1	LS	62,000	62,000
100						-
101		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
102		Pipe saddles/connection to piles		None		-
103						-
104						-
105		**Direct Cost Subtotal - Carried to DC Summary**	620	lf	3,292.00	**2,041,290**
106						
107						
108	16	**14th Street – Mission to South Van Ness**				
109		Key Quantities:				
110		Replacement:				
111		Existing:	3'6"x5'3"			
112		New				
113		Diameter	5.5	lf		
114		Length	581.0	lf		
115		Depth to invert	11.0	lf		
116		Work space, 1.5' each side, total add	3.0	ft		
117		Excavation				
118		Length	581.0	ft		
119		Width	8.5	ft		
120		Depth	12.0	ft		
121						
122						
123		Remove paving	6,101	SF	5.00	30,505

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
124		Temporary shoring	13,944	SF	45.00	627,480
125		Excavation	2,195	CY	30.00	65,850
126		Haul-off	2,195	CY	25.00	54,875
127		Premium for disposal of contaminated soil, say 30%	659	CY	150.00	98,850
128		Remove existing sewer	775	CY	200.00	155,000
129						-
130		Reinforced concrete pipe (RCP), coated	581	LF	660.00	383,460
131		Manhole	2	EA	15,000.00	30,000
132		Connect to existing 6' dia sewer	2	EA	25,000.00	50,000
133		Backfill, compacted	1,684	CY	55.00	92,620
134		Restore paving	6,101	SF	15.00	91,515
135		Allow for dewatering	1	LS	51,000.00	51,000
136		Allow for protecting utilities in place (no relocation)	1	LS	29,050.00	29,050
137		Allow for traffic control	1	LS	58,100	58,100
138						-
139		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.	234	EA	4,725.00	1,105,650
140		Pipe saddles/connection to piles	117	EA	10,000.00	1,170,000
141						-
142						-
143		**Direct Cost Subtotal - Carried to DC Summary**	581	lf	7,046.00	**4,093,955**
144						
145						
146	17	**15th Street – Capp to South Van Ness**				
147		Key Quantities:				
148		Replacement:				
149		Existing:	5.5	lf		
150		New				
151		Diameter	6.5	lf		
152		Length	295.0	lf		
153		Depth to invert	11.0	lf		
154		Work space, 1.5' each side, total add	3.0	ft		
155		Excavation				
156		Length	295.0	ft		
157		Width	9.5	ft		
158		Depth	12.0	ft		
159						
160						
161		Remove paving	3,393	SF	5.00	16,965
162		Temporary shoring	7,080	SF	45.00	318,600
163		Excavation	1,246	CY	30.00	37,380
164		Haul-off	1,246	CY	25.00	31,150

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SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
6.0 ESTIMATE DETAILS - TIER 2

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
165		Premium for disposal of contaminated soil, say 30%	374	CY	150.00	56,100
166		Remove existing sewer	295	LF	80.00	23,600
167						-
168		Reinforced concrete pipe (RCP), coated	295	LF	660.00	194,700
169		Manhole		None		-
170		Backfill, compacted	883	CY	55.00	48,565
171		Restore paving	3,393	SF	15.00	50,895
172		Allow for dewatering	1	LS	36,000.00	36,000
173		Allow for protecting utilities in place (no relocation)	1	LS	14,750.00	14,750
174		Allow for traffic control	1	LS	29,500	29,500
175						-
176		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
177		Pipe saddles/connection to piles		None		-
178						-
179						-
180		**Direct Cost Subtotal - Carried to DC Summary**	295	lf	2,909.00	**858,205**
181						
182						
183	18	**15th Street – Minna to Capp**				
184		Key Quantities:				
185		Replacement:				
186		Existing:	5.5	lf		
187		New				
188		Diameter	6.5	lf		
189		Length	119.0	lf		
190		Depth to invert	13.0	lf		
191		Work space, 1.5' each side, total add	3.0	ft		
192		Excavation				
193		Length	119.0	ft		
194		Width	9.5	ft		
195		Depth	14.0	ft		
196						
197						
198		Remove paving	1,369	SF	5.00	6,845
199		Temporary shoring	3,332	SF	45.00	149,940
200		Excavation	586	CY	30.00	17,580
201		Haul-off	586	CY	25.00	14,650
202		Premium for disposal of contaminated soil, say 30%	176	CY	150.00	26,400
203		Remove existing sewer	119	LF	100.00	11,900
204						-

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
205		Reinforced concrete pipe (RCP), coated	119	LF	930.00	110,670
206		Manhole		None		-
207		Backfill, compacted	440	CY	55.00	24,200
208		Restore paving	1,369	SF	15.00	20,535
209		Allow for dewatering	1	LS	15,000.00	15,000
210		Allow for protecting utilities in place (no relocation)	1	LS	5,950.00	5,950
211		Allow for traffic control	1	LS	11,900	11,900
212						-
213		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
214		Pipe saddles/connection to piles		None		-
215						-
216						-
217		**Direct Cost Subtotal - Carried to DC Summary**	119	lf	3,492.00	**415,570**
218						
219						
220	19	**15th Street – Mission to Minna**				
221		Key Quantities:				
222		Replacement:				
223		Existing:	5.5	lf		
224		New				
225		Diameter	6.0	lf		
226		Length	253.0	lf		
227		Depth to invert	14.0	lf		
228		Work space, 1.5' each side, total add	3.0	ft		
229		Excavation				
230		Length	253.0	ft		
231		Width	9.0	ft		
232		Depth	15.0	ft		
233						
234						
235		Remove paving	2,783	SF	5.00	13,915
236		Temporary shoring	7,590	SF	45.00	341,550
237		Excavation	1,265	CY	30.00	37,950
238		Haul-off	1,265	CY	25.00	31,625
239		Premium for disposal of contaminated soil, say 30%	380	CY	150.00	57,000
240		Remove existing sewer	253	LF	80.00	20,240
241						-
242		Reinforced concrete pipe (RCP), coated	253	LF	660.00	166,980
243		Connect to existing sewer	1	EA	25,000.00	25,000
244		Backfill, compacted	1,000	CY	55.00	55,000
245		Restore paving	2,783	SF	15.00	41,745

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
246		Allow for dewatering	1	LS	27,000.00	27,000
247		Allow for protecting utilities in place (no relocation)	1	LS	12,650.00	12,650
248		Allow for traffic control	1	LS	25,300	25,300
249						-
250		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
251		Pipe saddles/connection to piles		None		-
252						-
253						-
254		**Direct Cost Subtotal - Carried to DC Summary**	253	lf	3,383.00	**855,955**
255						
256						
257	20	**15th Street – South Van Ness to Shotwell**				
258		Key Quantities:				
259		Replacement:				
260		Existing:	66"-72"			
261		New				
262		Diameter	6.5	lf		
263		Length	296.0	lf		
264		Depth to invert	11.0	lf		
265		Work space, 1.5' each side, total add	3.0	ft		
266		Excavation				
267		Length	296.0	ft		
268		Width	9.5	ft		
269		Depth	12.0	ft		
270						
271						
272		Remove paving	3,404	SF	5.00	17,020
273		Temporary shoring	7,104	SF	45.00	319,680
274		Excavation	1,250	CY	30.00	37,500
275		Haul-off	1,250	CY	25.00	31,250
276		Premium for disposal of contaminated soil, say 30%	375	CY	150.00	56,250
277		Remove existing sewer	296	LF	100.00	29,600
278						-
279		Reinforced concrete pipe (RCP), coated	296	LF	930.00	275,280
280		Connect to existing sewer	1	EA	25,000.00	25,000
281		Backfill, compacted	886	CY	55.00	48,730
282		Restore paving	3,404	SF	15.00	51,060
283		Allow for dewatering	1	LS	36,000.00	36,000
284		Allow for protecting utilities in place (no relocation)	1	LS	14,800.00	14,800
285		Allow for traffic control	1	LS	29,600	29,600
286						-

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SSIP PROGRAM | **Date:** **3/15/2018 Draft-R2**
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT | By: **MLee/FLee**
UPSTREAM SEWER IMPROVEMENTS | **PMC Team**
PLANNING LEVEL (AACE CLASS 4)
6.0 ESTIMATE DETAILS - TIER 2

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
287		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
288		Pipe saddles/connection to piles		None		-
289						-
290						-
291		**Direct Cost Subtotal - Carried to DC Summary**	296	lf	3,283.00	**971,770**
292						
293						
294	21	**19th Street - Folsom to Treat**				
295		Key Quantities:				
296		Replacement:				
297		Existing:	1.0	lf		
298		New				
299		Diameter	2.0	lf		
300		Length	298.0	lf		
301		Depth to invert	8.0	lf		
302		Work space, 1.5' each side, total add	3.0	ft		
303		Excavation				
304		Length	298.0	ft		
305		Width	5.0	ft		
306		Depth	9.0	ft		
307						
308						
309		Remove paving	2,086	SF	5.00	10,430
310		Temporary shoring	5,364	SF	27.00	144,828
311		Excavation	497	CY	30.00	14,910
312		Haul-off	497	CY	25.00	12,425
313		Premium for disposal of contaminated soil, say 30%	149	CY	150.00	22,350
314		Remove existing sewer	298	LF	10.00	2,980
315						-
316		VCP	298	LF	70.00	20,860
317		Manhole		None		-
318		Connect to existing sewer	2	EA	2,000.00	4,000
319		Backfill, compacted	462	CY	55.00	25,410
320		Restore paving	2,086	SF	15.00	31,290
321		Allow for dewatering	1	LS	4,000.00	4,000
322		Allow for protecting utilities in place (no relocation)	1	LS	8,940.00	8,940
323		Allow for traffic control	1	LS	17,880	17,880
324						-
325		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
326		Pipe saddles/connection to piles		None		-

SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
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Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
327						-
328						-
329		**Direct Cost Subtotal - Carried to DC Summary**	298	lf	1,075.00	**320,303**
330						
331						
332	22	**Alabama Street - Mariposa to 17th**				
333		Key Quantities:				
334		Replacement:				
335		Existing:	0.67	lf		
336		New				
337		Diameter	1.3	lf		
338		Length	430.0	lf		
339		Depth to invert	10.0	lf		
340		Work space, 1.5' each side, total add	3.0	ft		
341		Excavation				
342		Length	430.0	ft		
343		Width	4.3	ft		
344		Depth	11.0	ft		
345						
346						
347		Remove paving	2,688	SF	5.00	13,440
348		Temporary shoring	9,460	SF	27.00	255,420
349		Excavation	745	CY	30.00	22,350
350		Haul-off	745	CY	25.00	18,625
351		Premium for disposal of contaminated soil, say 30%	224	CY	150.00	33,600
352		Remove existing sewer	430	LF	8.00	3,440
353						-
354		VCP	430	LF	30.00	12,900
355		Manhole		None		-
356		Connect to existing sewer	2	EA	15,000.00	30,000
357		Backfill, compacted	725	CY	55.00	39,875
358		Restore paving	2,688	SF	15.00	40,320
359		Allow for dewatering	1	LS	2,000.00	2,000
360		Allow for protecting utilities in place (no relocation)	1	LS	12,900.00	12,900
361		Allow for traffic control	1	LS	25,800	25,800
362						-
363		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
364		Pipe saddles/connection to piles		None		-
365						-
366						-
367		**Direct Cost Subtotal - Carried to DC Summary**	430	lf	1,188.00	**510,670**

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
368						
369						
370	23	**Erie Street - South Van Ness to Folsom**				
371		Key Quantities:				
372		Replacement:				
373		Existing:	1.00 & 1.25	lf		
374		New				
375		Diameter	1.00 & 1.5	lf		
376		Length	395.0	lf		
377		Depth to invert	9.0	lf		
378		Work space, 1.5' each side, total add	3.0	ft		
379		Excavation				
380		Length	395.0	ft		
381		Width	4.5	ft		
382		Depth	10.0	ft		
383						
384						
385		Remove paving	2,568	SF	5.00	12,840
386		Temporary shoring	7,900	SF	27.00	213,300
387		Excavation	658	CY	30.00	19,740
388		Haul-off	658	CY	25.00	16,450
389		Premium for disposal of contaminated soil, say 30%	197	CY	150.00	29,550
390		Remove existing sewer	395	LF	10.00	3,950
391						-
392		VCP 12" dia	210	LF	20.00	4,200
393		VCP 18" dia	185	LF	40.00	7,400
394		Manhole		None		-
395		Backfill, compacted	632	CY	55.00	34,760
396		Restore paving	2,568	SF	15.00	38,520
397		Allow for dewatering	1	LS	3,000.00	3,000
398		Allow for protecting utilities in place (no relocation)	1	LS	11,850.00	11,850
399		Allow for traffic control	1	LS	23,700	23,700
400						-
401		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
402		Pipe saddles/connection to piles		None		-
403						-
404						-
405		**Direct Cost Subtotal - Carried to DC Summary**	395	lf	1,061.00	**419,260**
406						
407						
408	24	**Folsom Street – 12th to 11th**				

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
409		Key Quantities:				
410		Replacement:				
411		Existing:	3'0"x5'0"			
412		New				
413		Diameter	4.0	lf		
414		Length	425.0	lf		
415		Depth to invert	11.0	lf		
416		Work space, 1.5' each side, total add	3.0	ft		
417		Excavation				
418		Length	425.0	ft		
419		Width	7.0	ft		
420		Depth	12.0	ft		
421						
422						
423		Remove paving	3,825	SF	5.00	19,125
424		Temporary shoring	10,200	SF	45.00	459,000
425		Excavation	1,322	CY	30.00	39,660
426		Haul-off	1,322	CY	25.00	33,050
427		Premium for disposal of contaminated soil, say 30%	397	CY	150.00	59,550
428		Remove existing sewer	504	CY	200.00	100,800
429						-
430		Reinforced concrete pipe (RCP), coated	425	LF	460.00	195,500
431		Manhole	1	EA	20,000.00	20,000
432		Connect to existing sewer	2	EA	35,000.00	70,000
433		Backfill, compacted	1,124	CY	55.00	61,820
434		Restore paving	3,825	SF	15.00	57,375
435		Allow for dewatering	1	LS	20,000.00	20,000
436		Allow for protecting utilities in place (no relocation)	1	LS	21,250.00	21,250
437		Allow for traffic control	1	LS	42,500	42,500
438						-
439		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
440		Pipe saddles/connection to piles		None		-
441						-
442						-
443		**Direct Cost Subtotal - Carried to DC Summary**	425	lf	2,823.00	**1,199,630**
444						
445						
446	25	**Folsom Street - 17th to 16th**				
447		Key Quantities:				
448		Replacement:				
449		Existing:	1.00	lf		

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
450		New				
451		Diameter	1.5	lf		
452		Length	154.0	lf		
453		Depth to invert	7.0	lf		
454		Work space, 1.5' each side, total add	3.0	ft		
455		Excavation				
456		Length	154.0	ft		
457		Width	4.5	ft		
458		Depth	8.0	ft		
459						
460						
461		Remove paving	1,001	SF	5.00	5,005
462		Temporary shoring	2,464	SF	27.00	66,528
463		Excavation	205	CY	30.00	6,150
464		Haul-off	205	CY	25.00	5,125
465		Premium for disposal of contaminated soil, say 30%	62	CY	150.00	9,300
466		Remove existing sewer	154	LF	10.00	1,540
467						-
468		VCP	154	LF	40.00	6,160
469		Manhole		None		-
470		Backfill, compacted	195	CY	55.00	10,725
471		Restore paving	1,001	SF	15.00	15,015
472		Allow for dewatering	1	LS	1,000.00	1,000
473		Allow for protecting utilities in place (no relocation)	1	LS	4,620.00	4,620
474		Allow for traffic control	1	LS	9,240	9,240
475						-
476		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
477		Pipe saddles/connection to piles		None		-
478						-
479						-
480		**Direct Cost Subtotal - Carried to DC Summary**	154	lf	912.00	**140,408**
481						
482						
483	26	**Folsom Street - 17th to 18th***				
484		Key Quantities:				
485		Replacement:				
486		Existing:	1.25	lf		
487		New				
488		Diameter	1.3	lf		
489		Length	294.0	lf		
490		Depth to invert	8.0	lf		

SSIP PROGRAM
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Date: **3/15/2018 Draft-R2**
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PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
491		Work space, 1.5' each side, total add	3.0	ft		
492		Excavation				
493		Length	294.0	ft		
494		Width	4.3	ft		
495		Depth	9.0	ft		
496						
497						
498		Remove paving	1,838	SF	5.00	9,190
499		Temporary shoring	5,292	SF	27.00	142,884
500		Excavation	417	CY	30.00	12,510
501		Haul-off	417	CY	25.00	10,425
502		Premium for disposal of contaminated soil, say 30%	125	CY	150.00	18,750
503		Remove existing sewer	294	LF	10.00	2,940
504						-
505		VCP	294	LF	30.00	8,820
506		Manhole		None		-
507		Backfill, compacted	404	CY	55.00	22,220
508		Restore paving	1,838	SF	15.00	27,570
509		Allow for dewatering	1	LS	1,000.00	1,000
510		Allow for protecting utilities in place (no relocation)	1	LS	8,820.00	8,820
511		Allow for traffic control	1	LS	17,640	17,640
512						-
513		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
514		Pipe saddles/connection to piles		None		-
515						-
516						-
517		**Direct Cost Subtotal - Carried to DC Summary**	294	lf	962.00	**282,769**
518						
519						
520	27	**Harrison Street - 15th to Alameda**				
521		Key Quantities:				
522		Replacement:				
523		Existing:	0.67	lf		
524		New				
525		Diameter	1.0	lf		
526		Length	334.0	lf		
527		Depth to invert	7.0	lf		
528		Work space, 1.5' each side, total add	3.0	ft		
529		Excavation				
530		Length	334.0	ft		
531		Width	4.0	ft		

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
532		Depth	8.0	ft		
533						
534						
535		Remove paving	2,004	SF	5.00	10,020
536		Temporary shoring	5,344	SF	27.00	144,288
537		Excavation	396	CY	30.00	11,880
538		Haul-off	396	CY	25.00	9,900
539		Premium for disposal of contaminated soil, say 30%	119	CY	150.00	17,850
540		Remove existing sewer	334	LF	10.00	3,340
541						-
542		VCP	334	LF	20.00	6,680
543		Manhole		None		-
544		Backfill, compacted	386	CY	55.00	21,230
545		Restore paving	2,004	SF	15.00	30,060
546		Allow for dewatering	1	LS	1,000.00	1,000
547		Allow for protecting utilities in place (no relocation)	1	LS	10,020.00	10,020
548		Allow for traffic control	1	LS	20,040	20,040
549						-
550		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
551		Pipe saddles/connection to piles		None		-
552						-
553						-
554		**Direct Cost Subtotal - Carried to DC Summary**	334	lf	857.00	**286,308**
555						
556						
557	28	**Mistral Street - Treat to Harrison***				
558		Key Quantities:				
559		Replacement:				
560		Existing:	1.0	lf		
561		New				
562		Diameter	1.0	lf		
563		Length	71.0	lf		
564		Depth to invert	8.0	lf		
565		Work space, 1.5' each side, total add	3.0	ft		
566		Excavation				
567		Length	71.0	ft		
568		Width	4.0	ft		
569		Depth	9.0	ft		
570						
571						
572		Remove paving	426	SF	5.00	2,130

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UPSTREAM SEWER IMPROVEMENTS
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PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
573		Temporary shoring	1,278	SF	27.00	34,506
574		Excavation	95	CY	30.00	2,850
575		Haul-off	95	CY	25.00	2,375
576		Premium for disposal of contaminated soil, say 30%	29	CY	150.00	4,350
577		Remove existing sewer	71	LF	10.00	710
578						-
579		VCP	71	LF	20.00	1,420
580		Manhole		None		-
581		Connect to existing sewer	2	EA	1,500.00	3,000
582		Backfill, compacted	93	CY	55.00	5,115
583		Restore paving	426	SF	15.00	6,390
584		Allow for dewatering	1	LS	200.00	200
585		Allow for protecting utilities in place (no relocation)	1	LS	2,130.00	2,130
586		Allow for traffic control	1	LS	4,260	4,260
587						-
588		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
589		Pipe saddles/connection to piles		None		-
590						-
591						-
592		**Direct Cost Subtotal - Carried to DC Summary**	71	lf	978.00	**69,436**
593						
594						
595	29	**Shotwell Street - 19th to 18th***				
596		Key Quantities:				
597		Replacement:				
598		Existing:	1.50	lf		
599		New				
600		Diameter	1.5	lf		
601		Length	280.0	lf		
602		Depth to invert	11.0	lf		
603		Work space, 1.5' each side, total add	3.0	ft		
604		Excavation				
605		Length	280.0	ft		
606		Width	4.5	ft		
607		Depth	12.0	ft		
608						
609						
610		Remove paving	1,820	SF	5.00	9,100
611		Temporary shoring	6,720	SF	27.00	181,440
612		Excavation	560	CY	30.00	16,800
613		Haul-off	560	CY	25.00	14,000

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ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
614		Premium for disposal of contaminated soil, say 30%	168	CY	150.00	25,200
615		Remove existing sewer	280	LF	10.00	2,800
616						-
617		VCP	280	LF	40.00	11,200
618		Manhole		None		-
619		Connect to existing sewer	2	EA	2,000.00	4,000
620		Backfill, compacted	542	CY	55.00	29,810
621		Restore paving	1,820	SF	15.00	27,300
622		Allow for dewatering	1	LS	2,000.00	2,000
623		Allow for protecting utilities in place (no relocation)	1	LS	8,400.00	8,400
624		Allow for traffic control	1	LS	16,800	16,800
625						-
626		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
627		Pipe saddles/connection to piles		None		-
628						-
629						-
630		**Direct Cost Subtotal - Carried to DC Summary**	280	lf	1,246.00	**348,850**
631						
632						
633	30	**South Van Ness – 18th to 17th**				
634		Key Quantities:				
635		Replacement:				
636		Existing:	1.25	lf		
637		New				
638		Diameter	3.5	lf		
639		Length	508.0	lf		
640		Depth to invert	11.0	lf		
641		Work space, 1.5' each side, total add	3.0	ft		
642		Excavation				
643		Length	508.0	ft		
644		Width	6.5	ft		
645		Depth	12.0	ft		
646						
647						
648		Remove paving	4,318	SF	5.00	21,590
649		Temporary shoring	12,192	SF	45.00	548,640
650		Excavation	1,468	CY	30.00	44,040
651		Haul-off	1,468	CY	25.00	36,700
652		Premium for disposal of contaminated soil, say 30%	440	CY	150.00	66,000
653		Remove existing sewer	508	LF	10.00	5,080

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ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
654						-
655		VCP	508	LF	155.00	78,740
656		Manhole	1	EA	10,000.00	10,000
657		Connect to existing sewer	1	EA	20,000.00	20,000
658		Backfill, compacted	1,287	CY	55.00	70,785
659		Restore paving	4,318	SF	15.00	64,770
660		Allow for dewatering	1	LS	18,000.00	18,000
661		Allow for protecting utilities in place (no relocation)	1	LS	25,400.00	25,400
662		Allow for traffic control	1	LS	30,480	30,480
663						-
664		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
665		Pipe saddles/connection to piles		None		-
666						-
667						-
668		**Direct Cost Subtotal - Carried to DC Summary**	508	lf	2,048.00	**1,040,225**
669						
670						
671	31	**South Van Ness @ 18th**				
672		Key Quantities:				
673		New				
674		Diameter	3.0	lf		
675		Length	75.0	lf		
676		Depth to invert	15.0	lf		
677		Work space, 1.5' each side, total add	3.0	ft		
678		Excavation				
679		Length	75.0	ft		
680		Width	6.0	ft		
681		Depth	16.0	ft		
682						
683						
684		Remove paving	600	SF	5.00	3,000
685		Temporary shoring	2,400	SF	36.00	86,400
686		Excavation	267	CY	30.00	8,010
687		Haul-off	267	CY	25.00	6,675
688		Premium for disposal of contaminated soil, say 30%	80	CY	150.00	12,000
689		Remove sewer	75	LF	10.00	750
690						-
691		VCP	75	LF	120.00	9,000
692		Manhole		None		-
693		Backfill, compacted	247	CY	55.00	13,585
694		Restore paving	600	SF	15.00	9,000

ITEM		WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
695		Allow for dewatering	1	LS	2,000.00	2,000
696		Allow for protecting utilities in place (no relocation)	1	LS	3,750.00	3,750
697		Allow for traffic control	1	LS	7,500	7,500
698						-
699		Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
700		Pipe saddles/connection to piles		None		-
701						-
702						-
703		**Direct Cost Subtotal - Carried to DC Summary**	75	lf	2,156.00	**161,670**
704						
705						
706	32	**Trainor Street - 13th to 14th**				
707		Key Quantities:				
708		Replacement:				
709		Existing:	1.0	lf		
710		New				
711		Diameter	1.0	lf		
712		Length	303.0	lf		
713		Depth to invert	6.0	lf		
714		Work space, 1.5' each side, total add	3.0	ft		
715		Excavation				
716		Length	303.0	ft		
717		Width	4.0	ft		
718		Depth	7.0	ft		
719						
720						
721		Remove paving	1,818	SF	5.00	9,090
722		Temporary shoring	4,242	SF	27.00	114,534
723		Excavation	314	CY	30.00	9,420
724		Haul-off	314	CY	25.00	7,850
725		Premium for disposal of contaminated soil, say 30%	94	CY	150.00	14,100
726		Remove existing sewer	303	LF	10.00	3,030
727						-
728		VCP	303	LF	20.00	6,060
729		Connect to existing sewer	2	EA	1,500.00	3,000
730		Backfill, compacted	305	CY	55.00	16,775
731		Restore paving	1,818	SF	15.00	27,270
732		Allow for dewatering	1	LS	1,000.00	1,000
733		Allow for protecting utilities in place (no relocation)	1	LS	9,090.00	9,090
734		Allow for traffic control	1	LS	18,180	18,180
735						-

SSIP PROGRAM
TO 84 M2: FOLSOM STORMWATER IMPROVEMENT
UPSTREAM SEWER IMPROVEMENTS
PLANNING LEVEL (AACE CLASS 4)
6.0 ESTIMATE DETAILS - TIER 2

Date: **3/15/2018 Draft-R2**
By: **MLee/FLee**
PMC Team

ALL IN MAR 2018 DOLLARS (UNESCALATED)

ITEM	WORK ITEM DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL $
736	Piles, assume 12"x12" precast prestressed concrete pile at 5' o.c. 35 ft deep , 2 ea per loc.		None		-
737	Pipe saddles/connection to piles		None		-
738					-
739					-
740	**Direct Cost Subtotal - Carried to DC Summary**	303	lf	790.00	**239,399**
741					
742					