Basis of Design

7th Street Grade Separation East (7SGSE) Project
Located in the City of Oakland, Alameda County

Client: Alameda County Transportation Commission (Alameda CTC)

November 20, 2018

Created by: HDR Engineering, Inc.

Revision History:

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<th>Revised By</th>
<th>Date</th>
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1. Introduction

The Alameda County Transportation Commission (Alameda CTC), in cooperation with the Port of Oakland (Port) and the City of Oakland (City), proposes to advance the 7th Street Grade Separation and Port Arterial Improvements Project (GoPort). The proposed package of landside transportation improvements are located within and near the Port of Oakland and provides critical improvements to the economy of the State and the San Francisco Bay Area region. The overall GoPort program of projects includes the 7th Street Grade Separation East (7SGSE) Project, the 7th Street Grade Separation West (7SGSW) Project, and the Oakland Freight Intelligent Transportation System (FITS) Project.

The 7SGSE Project (Project) proposes to realign and reconstruct the existing, substandard railroad underpass and multi-use path along 7th Street between west of Interstate 880 (I-880) to the east and Maritime Street. The Project will increase the vertical clearance for trucks and improve the shared pedestrian/bicycle pathway. Figure 1 below shows the vicinity map for this project.

Figure 1: Vicinity Map
1.1 7SGSE Project Description

The 7SGSE project consists of the following major project elements represented on Figures 3 and 4):

- Realignment of the 7th Street roadway, generally below existing grade, with an alignment north of the existing roadway and around the existing Kinder Morgan aircraft turbine fuel (ATF) tank, and will involve relocation of any apparatus associated with the roadway and realignment. The realigned portion of 7th Street will include two 12-foot wide travel lanes in each direction (4-foot inside and 8-foot outside shoulders).

- Railroad Bridge – installation of a new underpass structure in the realigned location north of the existing railroad bridge.

- Temporary realignment (shoofly) of the railroad tracks is required for construction of the new railroad bridge. For reconstruction of 7th Street, the Union Pacific Railroad (UPRR) railroad tracks will be temporarily realigned to allow the partial construction of the new 7SGSE underpass (railroad bridge structure) while maintaining operations of the UPRR rail corridor. Then the shoofly tracks will be shifted to the partially completed underpass structure, and the remainder of the structure and roadway beneath will be constructed. After completion of the new underpass structure construction, the railroad tracks will be constructed in their final alignment. Figure 4 below presents proposed construction during Phase 1 of the project.

- Multi-use path – reconstruction of the multi-use path. Along with the entire length of the realigned and widened roadway and shoulders, the existing bicycle and pedestrian path will be reconstructed and widened to create a 10-foot-wide paved multi-use pathway with 2-foot shoulders on each side (total paved width of 14 feet). The pathway would replace existing segments of the San Francisco Bay Trail on 7th Street.

- Bridge structure necessary to support relocation of the existing Kinder Morgan Fuel lines affected by the project

- Relocation of third-party utilities (by others) is required to clear the right of way for constructing the 7th Street realignment

- Potential access bridge across the relocated 7th street that may be required to provide an access to the reconstructed the building structure currently occupied by the Pacific Transload Systems cold storage (PTS) facility (approximately 65,000 sq. ft. building
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and paved and fenced yard) and USDA inspection station along with Port’s current tenant, Shippers Transport Express. Environmental studies assumed the worst case scenario of full relocation of this building facility, however the final location of the building and associated infrastructure are subject of negotiation with and approval by UPRR.

- Drainage work associated with the road realignment, including installation of a pump station at the vertical sag
- Clean water program elements associated with the road realignment
- Associated street lighting, signals and various roadway signs
- Installation of changeable message signs, east of the intersection of 7th Street and Maritime Street
- Installation of Radio Frequency Identifiers (RFIDs)

Upon completion of the reconfiguration of the 7SGSE undercrossing and roadway, the existing depressed portion of the 7th Street will be filled in to create a ground surface consistent with the surrounding area. The area under the existing bridge will be backfilled as required to preserve the structure. Existing bridge railings will be removed. The top three feet of the existing retaining walls will be removed as necessary to backfill and re-grade surface. Final determination of the site condition in the area of the existing road alignment will be done in coordination with UPRR.

The typical section of the roadway at the proposed railroad bridge location is shown in Figure 2 below.
Figure 3: Major Project Elements (Roadway / Bridge construction)
1.2 **Background – Existing Roadway Networks**

7th Street is a four-lane roadway with left-turn lanes at most intersections and traffic signals at the intersections of Maritime Street and the I-880 ramps. 7th Street is one of the three gateways to the Port. The other two gateways are W. Grand Avenue/Maritime Street and Adeline Street/Middle Harbor Road. 7th Street is the central gateway and provides access to the Port and includes a UPRR underpass between Bay Street and Maritime Street. Traffic signals on 7th Street are located at the intersections of the Interstate I-880 SB on-ramp and NB off-ramps, Maritime Street, and Middle Harbor Road. 7th Street also provides access to the current TraPac Terminal and Ben E. Nutter Terminal west of the intersection of 7th Street and Middle Harbor Road.

1.3 **Horizontal and Vertical Datum**

The Horizontal and Vertical Control Datum used for design and construction is as follows:

- Horizontal datum for this project, including all new surveys and mapping, Horizontal = North American Datum of 1983 (1986 adjustment – per Record of Survey No. 990), California Coordinate System Zone 3. All units are US survey feet (sft).
- Vertical datum is Port of Oakland established control based on their Record of Survey for monumentation control for the Port of Oakland July 1993.

1.4 **Document Production Standards**

Per the “Applicable Standards and Review” section of Alameda CTC’s Request for Proposals (RFP) for the 7SGSE Project released in March 2018 and in order to meet UPRR requirements for production of the railroad plans and to minimize potential conflicts, HDR proposes to use the following standards:

- Railroad related plans and documents will be prepared following UPRR standards.
- Roadway plans will be prepared following California Department of Transportation (Caltrans) standards and will be supplemental by local City of Oakland standard details for elements to be maintained by the City.
- CADD standard adopted for this project is MicroStation since this is the standard platform used by both UPRR and Caltrans.
- Various reports, calculations, and specifications will be prepared using Microsoft Word and Excel format.
- Project specifications will be based on Construction Specifications Institute (CSI) format and modified to include UPRR and City of Oakland standard specifications as needed.
- All documents will be converted to PDF format. Adobe Acrobat PDF or REVU Bluebeam software will be used for the production of PDF format documents and revision tracking.
- Conversion of the documents to AutoCAD format will be performed at the As-Built stage of the project.
2. DESIGN CODES, REGULATIONS, AND STANDARDS

2.1 Roadway and Civil Infrastructure

The design of civil infrastructure elements of the 7th Street Grade Separation East Project (7SGSE) will consist of geometric design, grading, utilities, pavement design, and signing and striping consistent with requirements for a 35 miles per hour Minor Arterial Street classification. Civil design shall conform to the standards established by the Sixth Edition of the Caltrans Highway Design Manual (HDM), 2011 and the Sixth Edition of the American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets (Green Book) and supplemented by the City of Oakland (City) standards.

<table>
<thead>
<tr>
<th>Street</th>
<th>Functional Classifications</th>
<th>Design Speed¹</th>
<th>Existing (Posted) Speed Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>7th Street</td>
<td>Minor Arterial Street</td>
<td>30 MPH to 40 MPH</td>
<td>35 MPH within the project area ²</td>
</tr>
<tr>
<td>Local Access</td>
<td>Local Street</td>
<td>25 MPH</td>
<td>20 MPH</td>
</tr>
</tbody>
</table>

¹Minimum design speeds conform to Index 101.1 and 101.2 of HDM per functional classifications of the facility listed above.
²Posted speed limit is subject to the municipal code requirements for a particular street segment.

Table 1: Street Functional Classifications and Design Speed

Additional details of the California Road System (CRS) Maps can be found at the link below (see Map 5L22):

Per the current City of Oakland municipal code information the following design speed established for portions of the 7th street in the vicinity of the project are:

10.20.030 - Prima facie speed limit of thirty (30) miles per hour.

<table>
<thead>
<tr>
<th>Street Name</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>7th Street</td>
<td>Bay Street</td>
<td>Grove Street</td>
</tr>
</tbody>
</table>

10.20.040 - Prima facie speed limit of thirty-five (35) miles per hour.

<table>
<thead>
<tr>
<th>Street Name</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>7th Street</td>
<td>Southern Pacific Underpass</td>
<td>Western terminus of 7th Street</td>
</tr>
</tbody>
</table>

Source: Oakland, California Municipal Code:
https://library.municode.com/CA/Oakland/codes/code_of_ordinances?nodeId=TIT10VETR
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According to information in the Green Book published by AASHTO, the design speed defined as the following: "Design speed is a selected speed used to determine the various geometric design features of the roadway." Federal Highway Administration’s (FHWA’s) Speed Concepts Informational Guide (2009) specifies "designers of highways use a designated design speed to establish design features; operators set speed limits deemed safe for the particular type of road, but drivers select their speed based on their perception of safety." The relationship between design speed posted speed, and operating speed concluded in the National Cooperative Highway Research Program (NCHRP) Report 504 that "while a relationship between operating speed and posted speed limit can be defined, a relationship of design speed to either operating speed or posted speed cannot be defined with the same level of confidence." It also concluded that when the posted speed exceeds the design speed, liability concerns may arise even though drivers can safely exceed the design speed. The Green Book does not address the posted speed limits and establishes them based on existing statutory limits.

Based on previously stated requirements and due to the geometric and site constraints for 7th street dictated by proximity to the existing Kinder Morgan Facility and limitations associated with ability to construct a shoofly for existing UPRR tracks, the proposed design and posted speed shall be 35 MPH and shall match requirements of the Municipal Code. It is recommended that a future speed survey be performed in the subject segment of 7th street to verify the 85th Percentile Speed that can be used as the basis for the City to revise the municipal ordinance to reduced statutory speed limit to 30 MPH.(1)

(1) 85th Percentile Speed — the 85th percentile speed is the speed at or below which 85 percent of the free-flowing vehicles travel. The 85th percentile speed has traditionally been considered in an engineering study to establish a speed limit. In most cases, the difference between the 85th percentile speed and the average speed provides a good approximation of the speed sample’s standard deviation.

2.1.1 Geometric Design

The geometric design shall conform to the standards provided in the Caltrans HDM. The following tables summarize the proposed geometric design criteria for this project:

<table>
<thead>
<tr>
<th>Required Criteria</th>
<th>Proposed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Radius of Horizontal Curve Radius: Table 202.2B (6% for urban street 35 MPH to 45 MPH)</td>
<td>(HDM Figure 202.2)² 410 feet (for 2% superelevation) and 513 feet (for -2% superelevation (Normal Crown))</td>
</tr>
<tr>
<td>Maximum Superelevation Rate (HDM 202.2): (6% for urban street 35 MPH to 45 MPH):</td>
<td>HDM Figure 202.2 Maximum Comfortable Speed on Horizontal Curves²</td>
</tr>
</tbody>
</table>

(2) According to the requirements in the Topic 202.2 of the HDM a maximum superelevation rate of \(e_{\text{max}} = 6\% \) is established for an urban facility with a design speed between 35 MPH and 45 MPH. Based on the information in
Table 202.2B for a speed of 35 MPH and design curve radius, the proposed superelevation rate is 5.2%. Because the tangent lengths between horizontal curves are insufficient to develop fully superelevated segments, the alignment will be in continuous transition without achieving full superelevation. This leads to undesirable drainage runoff patterns along the roadway and undesirable layout of drainage inlets. The superelevation design proposed for use on the project is based on a Maximum Comfortable Speed requirement as specified in the HDM, Figure 202.2. This criteria provided for both normal crown (NC) and remove adverse crown (RC) sections. Application of this design criteria adopted for 7th street is a normal crown section along entire length of the roadway segment. This criteria results in a comfortable and compliant roadway design and eliminates the issue of continuous superelavation transition of the roadway and undesirable drainage design.

Table 2A: Site Distance Requirements

<table>
<thead>
<tr>
<th>Required Criteria</th>
<th>Proposed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Distance Standard (HDM Table 201.1)</td>
<td>250 feet (Design Speed = 35 MPH)</td>
</tr>
<tr>
<td>Passing Site Distance (HDM Section 201.2)</td>
<td>N/A</td>
</tr>
<tr>
<td>Stopping Site Distance (HDM Section 201.3)</td>
<td>250 feet (Design Speed = 35 MPH)</td>
</tr>
<tr>
<td>Stopping Site Distance at Grade Crest (HDM Section 201.4)</td>
<td>Figure 201.4 (Design Speed = 35 MPH)</td>
</tr>
<tr>
<td>Stopping Site Distance at Grade Sag (HDM Section 201.5)</td>
<td>Figure 201.5 (Design Speed = 35 MPH)</td>
</tr>
<tr>
<td>Stopping Site Distance on Horizontal Curves (HDM Section 201.6)</td>
<td>Figure 201.6 (Design Speed = 35 MPH)</td>
</tr>
<tr>
<td>Corner Site Distance (HDM Section 405) (^3)</td>
<td>250 feet or equal stopping site distance in HDM Table 201.1</td>
</tr>
</tbody>
</table>

\(^3\) According to Section 405, Table 405.1 the corner site distance for 7th street should be as follows: (330 feet for 30 MPH speed and 385 feet for 35 MPH speed). Due to restrictive existing site conditions (existing retaining wall located east of the Bay Street intersection), and the separation barrier between the roadway and multi-use path, the proposed design is unable to meet requirements specified in Table 405.1 for the intersection of Bay Street and 7th street location. The design will meet minimum requirements for a site distance of 250 feet specified in the HDM Table 201.1.

Table 3: Roadway Profiles

<table>
<thead>
<tr>
<th>Required Criteria</th>
<th>Proposed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Stopping Sight Distance (HDM Table 201.1):</td>
<td>250 feet (Design Speed = 35 MPH)</td>
</tr>
<tr>
<td>Minimum Length of Crest Vertical Curve (VC):</td>
<td>Per HDM Figure 201.4</td>
</tr>
<tr>
<td>Minimum length of Sag Vertical Curve (VC):</td>
<td>Per HDM Figure 201.5</td>
</tr>
</tbody>
</table>
### Table 4: Roadway Cross Sections

<table>
<thead>
<tr>
<th>Required Criteria</th>
<th>Proposed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traveled Lane:</td>
<td>12 feet</td>
</tr>
<tr>
<td>Left- or Right-Turn Lane:</td>
<td>Conform to Surface Transportation Assistance Act (STAA) truck turning template for a truck tractor-semitrailer combination with a 48 foot semitrailer see HDM Figure 404.5A</td>
</tr>
<tr>
<td>Shoulder:</td>
<td>Outside: 8 feet</td>
</tr>
<tr>
<td></td>
<td>Inside: 4 feet</td>
</tr>
<tr>
<td>Sidewalk: (Utilities may be installed under the sidewalk – City of Oakland exception)</td>
<td>6 feet minimum (Commercial zone in City of Oakland)</td>
</tr>
<tr>
<td>Multi-use Path*:</td>
<td>14 feet (including 2 foot paved shoulders)</td>
</tr>
</tbody>
</table>

*Note: Multi-use pathway shall be physically separated from the traveled lane.

### Table 5: Cross Slopes

<table>
<thead>
<tr>
<th>Required Criteria</th>
<th>Proposed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Deck:</td>
<td>2%</td>
</tr>
<tr>
<td>Approach Roadway:</td>
<td>2% to 4% maximum</td>
</tr>
<tr>
<td>Sidewalk:</td>
<td>2% maximum</td>
</tr>
<tr>
<td>Multi-use Pathway:</td>
<td>2% maximum and varies</td>
</tr>
<tr>
<td>Side Slope:</td>
<td>2:1 maximum</td>
</tr>
</tbody>
</table>

### Table 6: Horizontal and Vertical Clearances

<table>
<thead>
<tr>
<th>Required Criteria</th>
<th>Proposed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Clearances to UPRR Tracks: (From Center of Track to Face of Bridge Abutment or Pier)</td>
<td>&gt;25 feet (Without Protection). Pier protection per AREMA Ch. 8, Part 2.1.5 for distances &lt;25’</td>
</tr>
</tbody>
</table>
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| Vertical Clearance over UPRR Tracks: (From Top of Rail to Bottom of Bridge Structure) | 23 feet-4 inches Min, per UPRR-BNSF Bridge Standards dated 1/05/16 |
| Vertical Clearance over Local Streets (UPRR Standards for New Construction): - Traveled Way | • 16 feet-6 inches for steel superstructure with 5 or more beams or 4 or more deck plate girders per track.  
• 17 feet-6 inches for concrete superstructure or steel through plate girders with bolted bottom flanges.  
• 20 feet-0 inches for steel through plate girders without bolted bottom flanges. |
| Vertical Clearance of Electric Wires above Thoroughfares Per California Public Utilities Commission (CPUC) General Order No. 95:  
115kV lines  
12kV lines | For 115kV: 30’ minimum  
For 12kV: 25’ minimum |

Table 7: Design Vehicle

<table>
<thead>
<tr>
<th>Required Criteria</th>
<th>Proposed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Vehicle Turning Template:</td>
<td>STAA – Standard Truck per HDM Figure 404.5</td>
</tr>
</tbody>
</table>

2.1.1.1 Driveway and Edge of Road Protection:

Driveways shall conform to Standard Details for Public Works Construction, City of Oakland Public Work Bureau of Engineering and Construction Engineering Design Division. The design of the edge of road protection will follow City curb design standard.

Figure 5 below is a graphic of the 7SGSE roadway alignment and application of various criteria listed above:
Figure 5: Roadway Alignment Criteria
2.1.2 Roadside Signs and Pavement Delineation

The California Manual on Uniform Traffic Control Devices (CA MUTCD) established uniform standards and specifications for traffic control devices in California and shall be used as a guideline for design of roadside signs and traffic striping and markings. The CA MUTCD supplemented by the pavement markers, traffic striping and pavement markings details shown in the Caltrans Standard Plans provide the guiding principles for signing and striping design.


2.1.3 Pavement Design

- The Traffic Index used for the pavement design of 7th Street was determined to be 16.0, based on projected traffic volumes in the year 2040.
- Several R-value tests were performed in the area, all exceeding a value of 40. The project site does not exhibit significantly different subsurface conditions, so an R-value of 40 is used throughout the project site to arrive at pavement structural section recommendations.
- The concrete section will be used as a pavement section for a depressed portion of the 7th street. Actual design details and limits of the concrete section will be determined based on geotechnical recommendations using soil conditions and water table in the area and will utilize the proposed CDSM section for stabilizing soil.
- The multi-use pathway constructed under the adjacent Oakland Army Base (OAB) project used a structural section of 2.5” AC over 7” of AB Class 2. For continuity, this project will use the same structural section.

2.2 San Francisco Bay Trail Connection

The 7SGSE Project will connect to the existing multi-use path that is currently in place but will reconstruct the multi-use path to a wider width in the new roadway configuration. The multi-use pathway is designed in conformance with the “San Francisco Bay Trail – Design Guidelines and Toolkit” (August 2016). The multi-use path has width criteria of a 10-foot width and 2-foot shoulders (total paved width = 14 feet).

2.3 Storm Drainage

2.3.1 Stormwater Requirements

The 7SGSE Project area falls under the jurisdiction of three agencies or owners; the Port, the City, and UPRR. Since the project improvements are primarily proposed street improvements, the drainage design will adhere to the standard in the City Storm Drainage Design Standards (SD Guide, 2014).
Roadway runoff will generally sheet flow to curb and gutters which will convey the flow to inlets placed at the edge of the gutters. The flow will then be conveyed in subsurface culverts until they discharge into an existing Port or City drainage system which will ultimately discharge into the San Francisco Bay.

The depressed section that is below available discharge elevations will require a pump station to provide adequate head to allow gravity flow of the collected runoff to discharge into existing drainage systems.

Ballasted track sections for the proposed rail extension are being designed to provide cross slope to areas where the runoff will be collected in either an underdrain system or into a proposed ditch at the base of the rail embankment. The proposed underdrain system and ditch will discharge to existing and proposed drainage systems near the new rail line.

The Port is included in the California State Water Resources Control Board (SWRCB) non-traditional Small Phase II MS4 permit. The Port has developed a Post-Construction Stormwater Design Manual dated August 2015, available on the Port’s website: http://www.portofoakland.com/files/PDF/environment/cleanwater_manual.pdf. The 7SGSE Project Stormwater design will meet the Port’s design manual requirements.

2.3.2 Design Criteria

Table 8 is a summary of the design criteria to be used in the drainage design. Details for the design criteria are given in the following sections.

Table 8: Drainage Design Criteria Table

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrence Interval</td>
<td>10-year</td>
</tr>
<tr>
<td>Estimating Runoff</td>
<td>Rational Method Q=CiA</td>
</tr>
<tr>
<td>Runoff Coefficient</td>
<td>C’=C + Cs + Ci</td>
</tr>
<tr>
<td>Time of Concentration</td>
<td>Minimum is 5 minutes</td>
</tr>
<tr>
<td>Rainfall Intensity</td>
<td>(Ij) = (0.33 + 0.091144 x MAP) x (0.249 + 0.1006 x Kj) x Tj^-0.56253</td>
</tr>
<tr>
<td></td>
<td>Where:</td>
</tr>
<tr>
<td></td>
<td>li = Rainfall intensity (in/hr) for return frequency, j, and storm duration I</td>
</tr>
<tr>
<td></td>
<td>MAP = Mean annual precipitation, 21 inches</td>
</tr>
<tr>
<td></td>
<td>Kj = Frequency factor, 1.339 for a 10-year storm event (Q10) (ACHHM Table 1)</td>
</tr>
</tbody>
</table>
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#### Storm Drain Hydraulics

- Hydraulic grade line = at least 1.25 ft below top of the curb (which is assumed 0.75 ft below top of grate or manhole located in the pavement areas)
- Minimum pipe size = 12 in
- Minimum perforated plastic pipe underdrain size = 4 inches
- Minimum velocity = 3 feet/second (normal depth outlet control)
- Minimum slope = 0.50% (for perforated plastic pipe underdrain, 0.20%)

*Source: SD Guide 2014*

### 2.3.3 Recurrence Interval

The roadway alignment is defined as high truck volume, a multi-lane roadway with posted speeds of 30 MPH or less. Per the SD Guide, “the design storm frequencies shall be 10-years for Secondary Facilities.” Secondary facilities are storm drainage facilities with a tributary area of fewer than 50 acres. The storm drainage systems being modified within the 7SGSE project area are considered as secondary facilities in the drainage design.

The design storm for pump stations will be a 50-year, 6-hour storm per FHWA guidelines.

### 2.3.4 Estimating Design Discharge

The hydrologic calculation will be based on the Modified Rational Method described in the SD Guide. This method is primarily applied to watershed areas less than 320 acres with a calculated time of concentration of less than one hour.

\[
\text{Rational Method, } Q = i (C' A)
\]

Where:

- \( Q \) = Rate of discharge from delineated tributary watershed (cfs)
- \( C' \) = Runoff coefficient modified by slope and rainfall intensity
- \( i \) = 10-year rainfall intensity (in/hr)
- \( A \) = Drainage area (acres)

### 2.3.5 Runoff Coefficient

The modified runoff coefficient \( C' \) specified in the SD Guide is made up of a basic runoff coefficient \( C \), a ground slope factor \( C_s \) and a rainfall intensity factor \( C_i \). The 7SGSE Project generally consists of pavement and some minor landscape areas; therefore, the basic runoff coefficient is greater than 0.80,
and the factors Cs and Ci are considered to be 0. Weighted runoff coefficients were used based on the impervious and pervious areas of the 7SGSE Project.

### 2.3.6 Rainfall Data and Intensities

From the SD Guide, the rainfall intensity for the appropriate time of concentration and storm recurrence interval is computed from the following equation. The minimum time of concentration for the 7SGSE Project will be five (5) minutes per the SD Guide.

\[
I_j = (0.33 + 0.091144 \times \text{MAP}) \times (0.249 + 0.1006 \times K_i) \times T_j^{-0.56253}
\]

- \(I_j\) (Intensity in/hr) = 3.48 in/hr
- Mean Annual Precipitation (MAP) = 21 in
- \(K_i\) (Frequency Factor) = 1.339 (10-year recurrence interval)
- \(T_j\) (Time of Concentration) = 5 min

### 2.3.7 Grate Interception and Gutter Spread

Grate interception and gutter spread calculations will be performed using Hydraflow Storm Sewers by Autodesk. A clogging factor of 50% will be manually adjusted in the Hydraflow. The acceptable spread width for the on-site drainage system will be less than \(\frac{1}{2}\) of the outside travel lane in compliance with the Caltrans HDM Table 831.3. The proposed project inlets will follow the City Standard Plans for inlets types “B”, “C” and “D.” Access structures such as manholes and inlets for underground storm drainage shall not be more than 400 feet apart.

### 2.3.8 Culvert Design

Hydraulic grade line for on-site drainage systems will be performed using Hydraflow Storm Sewers. The following summarizes the applicable design standards for the 7SGSE project based on the SD Guide requirements:

- Minimum pipe size in the City is 12 inches. Proposed culverts with a diameter smaller than 18 inches will be designated as high-density polyethylene (HDPE); and culverts with a diameter of 18 inches or greater will be designated as reinforced concrete pipe (RCP).
- Minimum pipe cover within the street Right of Way (ROW) shall be 3 feet.
- Freeboard for closed conduits from the design hydraulic grade line to the top of curb shall be 1.25 feet, and maximum energy grade lines shall be below the top of curb for closed conduits.
- Minimum velocity for the closed conduits shall be 3 ft/s (normal depth outlet control).
- Minimum slope of pipe shall be 0.50% and 0.20% for perforated plastic pipe underdrains.
- Viability of culvert materials to be revisited pending corrosion tests of in-situ soils.
- Culverts placed in areas containing hazardous materials will be HDPE and may be specified to have watertight joints unless the geotechnical engineer requires an alternative material.
2.3.9 Stormwater Treatment

Post-construction stormwater treatment may be required depending on the amount of added and/or replaced an impervious area of the proposed alternative. The 7SGSE will follow the guidance of Section F.5.g for post-construction stormwater management conditions of the Phase II MS4 Permit. The Port developed the Port of Oakland 2015 Post-Construction Stormwater Design Manual, 2015 to comply with the Phase I MS4 Permit and any proposed Best Management Practice (BMP) would adhere to the design manual requirements.

2.3.10 Hydrograph Modification

According to the Alameda County Clean Water Program Hydromodification susceptibility map, the 7SGSE Project is exempt from Hydromodification requirements. Hydromodification requirements do not apply to projects that drain directly to the Bay or are tidally influenced.

3.1 Sanitary Sewer

Similar to the drainage design, the sanitary sewer design will adhere to the standard of the Port and the City.

Table 9 is a summary of the design criteria to be used in the sanitary sewer design.

### Table 9: Sanitary Sewer Design Criteria Table

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Design Criteria</th>
</tr>
</thead>
</table>
| Manholes       | • New manholes will be placed entirely within a traffic lane to minimize traffic impacts during future maintenance  
• A manhole connection will be used when an 8-inch or larger lateral is connected to a min pipe. All other lateral connections will be with a blind connection.  
• New manholes or cleanouts will replace existing manholes or cleanouts that are impacted by the replacement of mainline pipes.  
• Maximum spacing between manholes will be 310 feet. |
| Pipes          | • New mainline pipes will be constructed of HDPE Standard Dimension Ration (SDR) 11 (or better) with smooth interior, light and plain colored pipe.  
• Minimum mainline pipe diameter will be an 8-inch inside diameter. |
### 7SGSE Basis of Design

| Laterals          | The project will replace all service laterals that are impacted by the 7SGSE project.  
|                   | Service laterals will be replaced up to within 2.5 feet of the roadway ROW.  
|                   | Two way clean outs will be placed at the end of all replaced service laterals  
|                   | Laterals will be connected to the mainline sewer pipe at 90° angles.  
|                   | Minimum lateral diameter will be 4” HDPE.  
| Minimum Design Velocities | Pipes will be designed to provide a minimum 2 feet per second velocity.  
|                     | The Manning’s roughness coefficient (n) for HDPE pipe will be 0.013.  
| Pipe Joints       | Pipe joints will be electro fusion welded.  
| Pump/Lift Stations| Pump stations will be designed to the standards of the Port.  

3.2 Railroad

3.2.1 Track

The temporary shoofly track and associated facilities by shall comply with UPRR design criteria and standards and is subject to their review and approval. The permanent track removed during construction will be replaced in its original location and condition after construction.

For additional information on technical specifications for construction of industrial tracks see the link specified below:

https://www.up.com/customers/ind-dev/operations/specs/track/index.htm

3.2.2 Structures

The railroad bridge and retaining walls supporting railroad loads shall comply with UPRR design criteria and standards, and is subject to review and approval by UPRR.

For additional information and guidelines see the link specified below:
https://www.up.com/real_estate/roadxing/industry/grade_separation/index.htm

For additional detail regarding design of railroad structures, see specific information in Section 3.3

3.2.3 Bridge Removal

If required, the removal of the existing railroad bridge and appurtenant structures shall comply with UPRR design criteria and standards, and is subject to review and approval by UPRR.

3.3 Structures

The following are general design criteria for the bridges and other roadway construction related structures such as structural roadway surface slab and retaining walls.

3.3.1 Design Codes


Underpasses shall comply with the guidelines in the AREMA Manual for Railway Engineering. UPRR Engineering Standards and UPRR/BNSF Guidelines for Railroad Grade Separation Projects shall also be followed.
3.3.2 Design Loads

3.3.2.1 Dead Load:
Dead loads shall include the actual self-weight of the structural members, tracks, ballast, fill, and other portions of supported elements. The assumed un-factored unit weight of concrete, including reinforcement, shall be 150 pounds per cubic foot. For the underpasses, the dead load shall include 30 inches of ballast with tie weight and 200 pounds per foot for track weight. For the vehicular overheads, the dead load shall include 35 psf for the future wearing surface.

3.3.2.2 Live Loading:
Overhead live loads shall include the HL-93 design vehicular live loading, pedestrian loading, and the California P15 permit truck in accordance with AASHTO LRFD Bridge Design Specifications and the California Amendments. Underpass live loads shall include the Cooper E-80 train loading with impact on each track.

3.3.2.3 Seismic Loading:
The overhead structures shall be designated as “Important” since closure would create a major economic impact. Site-specific ARS curves shall be developed to satisfy the Functional Level Earthquake and Safety Level Earthquake in accordance with Caltrans Memo to Designers (MTD) 20-1. The seismic performance criteria shall be satisfied by meeting the target ductility levels specified by Caltrans Seismic Design Criteria 1.7 and the damage levels specified by Caltrans MTD 20-1.

Seismic design of the 7th Street undercrossing shall follow the AREMA 2014 Seismic Design Criteria. Site-specific ground motions shall be calculated and structural performance shall adhere to prescribed limit states. These performance criteria are further outlined in the Draft 7th Street Grade Separation East (7SGSE) Seismic Design Criteria Technical Memorandum prepared by Moffatt & Nichol and dated May 31, 2017.

3.3.2.4 Buoyancy:
The effects of buoyancy shall be evaluated for proposed structures.

3.3.3 Materials

3.3.3.1 Concrete:
Reinforced and prestressed concrete components shall be of the following minimum strengths at 28 days after being poured unless otherwise specified. If design of a specific component requires higher strength, it shall be shown in the plans:
3.3.3.2 Reinforcing Steel:
Reinforcing steel shall be uncoated ASTM A706 Grade 60 reinforcing bars:

Minimum specified
yield: \( f_y = 60 \text{ ksi} \)

Elastic Modulus: \( E_s = 29,000 \text{ ksi} \)

3.3.3.3 Prestressing Steel:
Prestressing steel shall be a 0.6 inch diameter ASTM A4116 Grade 270 low relaxation strand:

Tensile Strength:
\( f_{pu} = 270 \text{ ksi} \)

Elastic Modulus:
\( E_s = 29,000 \text{ ksi} \)

Longitudinal prestressing tendons shall be placed in rigid galvanized metal ducts. Curvature and wobble coefficients shall be in accordance with the AASHTO LRFD Standard Bridge Design Specifications.

Long-term prestress losses from time-dependent effects may be estimated as 20 ksi in accordance with Article 5.9.5.3 of the California Amendments.

3.3.3.4 Waterproofing:
Waterproofing shall be provided atop the Railroad Underpass Structures and shall comply with the requirements of Chapter 8, Part 29 of AREMA. Spray-on waterproofing will require an integrated ballast mat protection per UPRR direction.
# Appendix A: Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>7SGSE</td>
<td>7th Street Grade Separation East</td>
</tr>
<tr>
<td>7SGSW</td>
<td>7th Street Grade Separation West</td>
</tr>
<tr>
<td>7SGSP</td>
<td>7th Street Grade Separation Project (both 7SGSE and 7SGSW)</td>
</tr>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>AB</td>
<td>Aggregate Base</td>
</tr>
<tr>
<td>AC</td>
<td>Asphalt Concrete</td>
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<tr>
<td>Alameda CTC</td>
<td>Alameda County Transportation Commission</td>
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<tr>
<td>AREMA</td>
<td>American Railway Engineering and Maintenance-of-Way Association</td>
</tr>
<tr>
<td>ARS</td>
<td>Acceleration Response Spectra</td>
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<tr>
<td>ATF</td>
<td>aircraft turbine fuel</td>
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<tr>
<td>BART</td>
<td>San Francisco Bay Area Rapid Transit</td>
</tr>
<tr>
<td>BMP</td>
<td>Best Management Practice</td>
</tr>
<tr>
<td>BNSF</td>
<td>BNSF Railway Company (formally known as Burlington Northern–Santa Fe</td>
</tr>
<tr>
<td>Caltrans</td>
<td>California Department of Transportation</td>
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<tr>
<td>CA MUTCD</td>
<td>California Manual on Uniform Traffic Control Devices</td>
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<tr>
<td>City</td>
<td>City of Oakland</td>
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<tr>
<td>CPUC</td>
<td>California Public Utilities Commission</td>
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<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>FITS</td>
<td>Freight Intelligent Transportation Systems</td>
</tr>
<tr>
<td>GoPort</td>
<td>GoPort is a project term that defines the collective 7SGSP sub-projects: 7SGSE, 7SGSW, PUR, and FITS</td>
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<tr>
<td>HDM</td>
<td>California Department of Transportation Highway Design Manual</td>
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<tr>
<td>HDPE</td>
<td>high density polyethylene</td>
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<tr>
<td>I-</td>
<td>Interstate</td>
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<tr>
<td>LRFD</td>
<td>Load and Resistance Factor Design</td>
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<tr>
<td>MTD</td>
<td>Caltrans Memo to Designers</td>
</tr>
<tr>
<td>NB</td>
<td>northbound</td>
</tr>
<tr>
<td>OAB</td>
<td>Oakland Army Base</td>
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<tr>
<td>Port</td>
<td>Port of Oakland</td>
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<tr>
<td>ROW</td>
<td>Right-Of-Way</td>
</tr>
<tr>
<td>SB</td>
<td>southbound</td>
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<tr>
<td>STAA</td>
<td>Surface Transportation Assistance Act</td>
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</table>
## 7SGSE Basis of Design

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>UPRR (or UP)</td>
<td>Union Pacific Railroad</td>
</tr>
<tr>
<td>VC</td>
<td>vertical curve</td>
</tr>
<tr>
<td>WB</td>
<td>westbound</td>
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</table>