Draft Hydrology and Hydraulic Report

Central Coast Layover Facility Project

City of San Luis Obispo, California

October 2021

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Acronyms

Agency	Rail Corridor Agency
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CWA	Clean Water Act
DDM	San Luis Obispo Creek Waterway Management Plan Volume III Drainage Design Manual
District	Railroad Historic District
ESA	Endangered Species Act
JD	jurisdictional delineation
LOSSAN	Los Angeles–San Diego–San Luis Obispo
MBTA	Migratory Bird Treaty Act
Project	Los Angeles–San Diego–San Luis Obispo Central Coast Layover Facility Project
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
S&I	service and inspection
SLO	San Luis Obispo
SWRCB	State Water Resources Control Board
U.S.	United States
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VCP	Vitrified Clay Pipe

1 Introduction

The LOSSAN Rail Corridor Agency is proposing the relocation and expansion of the existing Pacific Surfliner layover facility located at the northern end of the Los Angeles – San Diego – San Luis Obispo LOSSAN rail corridor in San Luis Obispo, California. The proposed Central Coast Layover Facility would increase overnight layover and storage capacity to support the service goals and objectives outlined for the Pacific Surfliner in both the 2018 California State Rail Plan and the LOSSAN Rail Corridor Agency's Fiscal Year 2019-20 and 2020-21 Business Plan.

1.1 Project Description

The proposed project will construct a maintenance facility identified as the LOSSAN Central Coast Layover Facility (CCLF) that will facilitate the maintenance of equipment at the northern terminus of the LOSSAN rail corridor. It will allow additional passenger trains to be maintained, serviced and stored in San Luis Obispo overnight with no impact to the operations of Union Pacific, allowing a second, more convenient, morning departure from San Luis Obispo, subject to Union Pacific approval of the proposed schedule. It will also provide for the opportunity to store and service additional train sets used for further expansion of the Service.

Funding is currently not available to construct the entire facility at once. Instead, a phased construction approach is intended, constructing an initial portion of the facility which includes the most immediately needed elements, and adding the remaining components as the need arises and additional funding becomes available. Phase 1 intends to meet or exceed the functionality of the existing layover facility and add layover capacity for at least one additional train. Later phases would include the remaining Master Plan components as dictated by operational needs and as allowed by available funding. Initially this would focus on all items identified as essential components of the ultimate facility, followed later by those features that would expand overall capacity of the facility, as well as enhance operations and efficiency, but which are not immediately mandatory. The drainage analysis in this report sizes the backbone storm system for the full build site improvements and provides necessary improvements to accommodate the Phase 1 layout.

The design of the new segment of Class I Bike Trail will feature a monument to the historic Southern Pacific Railroad Roundhouse, where the structure's remnant foundation remains visible. The project's improvements will avoid impacting the roundhouse footing and maintain the foundation as part of the Railroad Historic District.

1.2 Project Location

The project site is located on approximately 13 acres of relatively undeveloped land in the City of San Luis Obispo, California. The City of San Luis Obispo is located along the Central Coast region of California, approximately 190 miles north of Los Angeles (Figure 1-1. Regional Location). The existing Pacific Surfliner layover facility is located directly across from the San Luis Obispo Amtrak Station, located at 1011 Railroad Avenue. The proj ect site is located approximately 0.3-mile south of the San Luis Obispo Amtrak Station. The project site extends from south of the San Luis Obispo Railroad Museum's parking lot to east of Lawrence Drive. The project site is between the UP Main Tracks and existing commercial and residential development to the west. The focus of this drainage report is from the northern limit of the project site southward towards Francis Street and comprises 10.9 acres. Analysis of the project site area south of Francis Street will occur in future design phases and will not impact the design of the backbone storm system.

Figure 1-1. Regional Location

As shown on Figure 1-2, the project site is located entirely within the City of San Luis Obispo's Railroad Historic District (District). The District boundary covers approximately one-half square mile and extends along the railroad right-of-way (ROW) for about 1.7 miles in roughly a north-south axis. The District includes the original railroad yard, plus residential and commercial-zoned property on the west side of the railroad ROW (City of San Luis Obispo Community Development Department 1998).

Figure 1-2. Project Site

2 Methodology

2.1 Hydrology

The project site utilizes the Hydrology criteria established by the City of San Luis Obispo's Drainage Design Manual (DDM) titled "San Luis Obispo Creek, Waterway Management Plan, Volume III - Drainage Design Manual", dated February 2003. The manual indicates that for drainage areas less than 40 hectares (100 acres), the rational method criteria established in manual is acceptable for determining peak discharges. For this drainage report, copies of the hydrology calculations have been provided in Appendix B.

As depicted in the DDM, the Rational Method equation is as follows:

$$Q = C * I * Ca * A/Kc$$

Where:

Q =	Peak rate of runoff in (m^3/s) and cfs
C =	Runoff Coefficient, as depicted in Table 2-1 below
I =	Average intensity of rainfall for the time of concentration (Tc) for a selected design storm
Ca =	Antecedent Moisture Factor
A =	Drainage Area in hectares
Kc =	Unit conversion factor equal to 360, (1 in English units)

Runoff Coefficient ('C' value): To determine a runoff coefficient "C" at each subarea with varying land-uses. Table 2-1 below provides the C values are utilized for various landuse types:

Table 2-1. Project Runoff Coefficient Values

Landuse Description	C Value
Unimproved	0.45
Dirt Road / Ballasted Section	0.35
Impervious Asphalt and/or Concrete	0.87

Where the "C" value for the Unimproved and Impervious Landuses were obtained from the DDM Table 4-1 Runoff Coefficients. The "C" value for the Dirt Road / Ballasted Section was based upon the results indicated on AREMA Table 1-3-2 Urban Area Runoff Coefficient Values for Railroad Yards.

A composite weighted C value is to be calculated using the following equation:

$$Composite\ C\ value = \sum \frac{C1(Area\ C1)}{Total\ Area} + \frac{C2(Area\ C2)}{Total\ Area} + \dots$$

Antecedent Moisture Value ('Ca' value): As indicated in the DDM, the antecedent moisture value factor (Ca) is an attempt to account for changes in soil infiltration capacity and creek base flow rates that occur during very wet periods. Table 2-2 below provides the Ca value for the various frequency events.

Table 2-2. SLO – Antecedent Moisture (Ca) Factors

Recurrence Interval (years)	Antecedent Moisture Factor (Ca)
2 to 10	1.0
25	1.1
50	1.2
100	1.25

Time of Concentration: The time of concentration is defined in the DDM as the time required for runoff to flow from the most hydraulically remote part of the drainage area to the point under consideration. The DDM identifies three types of flows and provides a procedure for determining the travel time within each type of regime. The three types of flows are Overland Flow, Shallow Concentrated Flow and Channel or Pipe Flow. See the following descriptions below and how to calculate the time of concentration in each regime.

Overland Flow: Overland flow is considered shallow flow (flow less than 1 inch deep) over a planar surface. This flow is typically less than 300 feet in length prior to transitioning into Shallow Concentrated Flow. The DDM provides an Overland Flow Chart to be used in determining the time of concentration within this regime. Copies of this chart are attached in Appendix B for existing and proposed hydrology calculations.

Shallow Concentrated Flow: This regime occurs when overland flow converges, forming gullies and swales. It also occurs in man-made ditches and curb gutters. The equation for Shallow Concentrated Flow is as follows:

$$V = Ku * k * Sp^{0.5}$$

Where:

V =	Velocity (m/s)	k =	Interception Coefficient
Ku =	1.0 (3.28 in Imperial Units	Sp =	Slope (Percent)

Table 2-3 below provides the Interception Coefficient values obtained from the DDM.

Table 2-3. SLO – Interception Coefficient Values

Flow Regime	'k' value
Grassed Waterway	0.457
Unpaved	0.491
Paved Area; Small Upland Gullies	0.619

Once the Velocity is calculated for this flow regime, the travel time (Tt) can be calculated as follows:

$$Tt\ (minutes) = \frac{L}{60 * V}$$

Where:

Tt =	Travel Time (minutes)
L =	Length of Shallow Concentrated Flow
V =	Velocity (m/s)

Channel / Pipe Flow: The DDM utilizes the Manning's Equation for calculating channel flow. The manual allows for use of the initial bankfull Tc estimate to calculate the channel velocity.

Additional calculations should be provided as channel / pipe conditions change. The Manning's equation is as follows:

$$V = \frac{1R^{\frac{2}{3}} * S^{\frac{1}{2}}}{n}$$

Where:

V =	Velocity (m/s)
R =	Hydraulic Radius (m); r = A/Pw)
A =	Cross Sectional Flow Area (m^2)
S =	Slope of the grade line (Channel Slope m/m)
n =	Manning's roughness coefficient, for HDPE pipe use n = 0.013

The time of concentration equates the sum of various travel times in each flow regime within the drainage area. The minimum time of concentration shall be 10 minutes.

Intensity (I): Once the time of concentration has been calculated for a drainage reach, it is possible to calculate the intensity value by utilizing the Rainfall Intensity data provided in the DDM. The correct table is determined by identifying the Average Annual Precipitation based on Figure 2-1. For our project, the Average Annual Precipitation is P=593 mm, which coincides with using Table 4-6 of the DDM, see Table 2-4 below for the Rainfall Intensity data. The intensity values within each storm drain is calculated by interpolating between the data pairs for each duration.

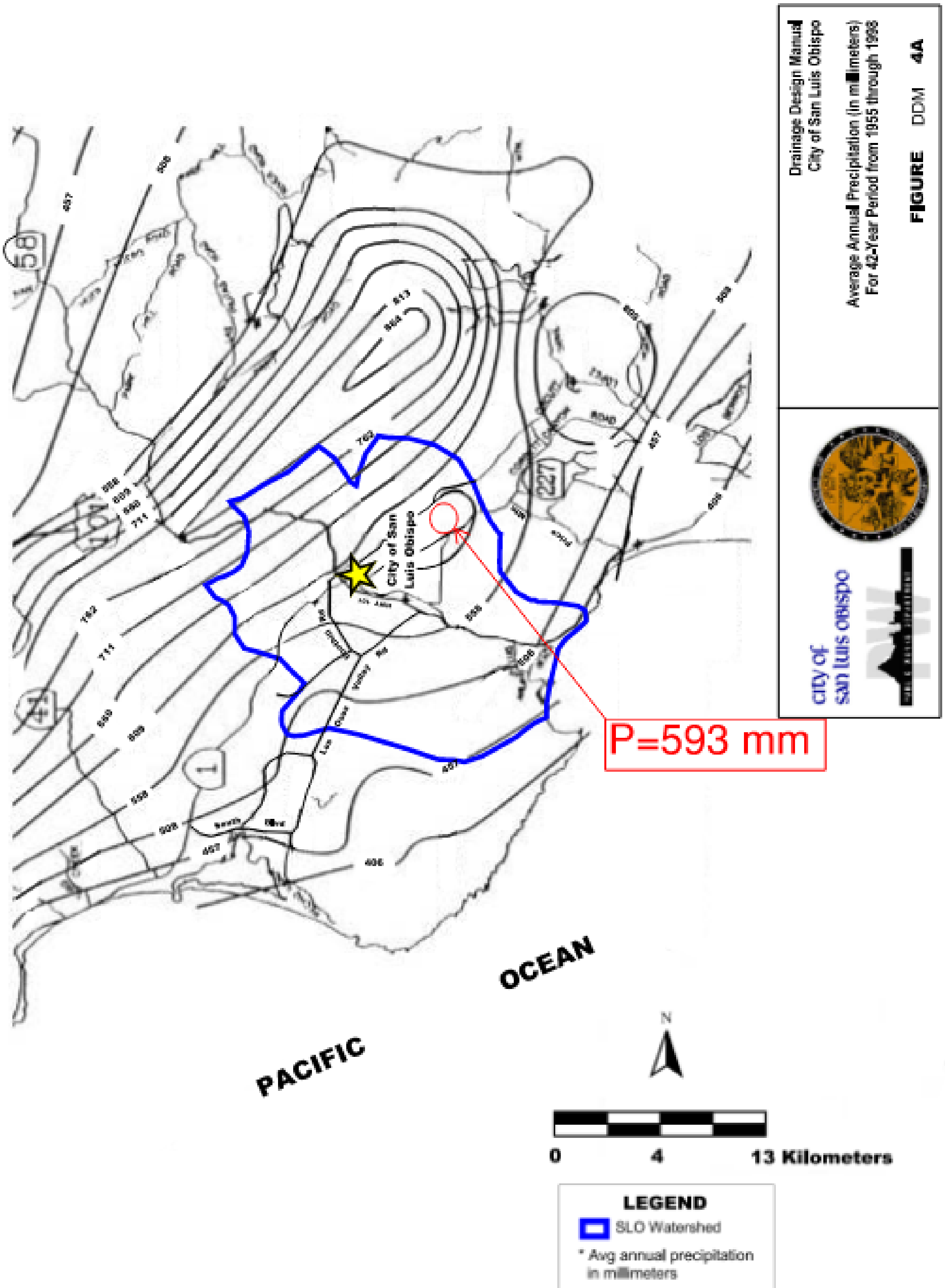
Table 2-4. SLO – Rainfall Intensity Data, Areas with 550mm to 700 mm Annual Rainfall

Recurrence Interval (Years)	Duration		
	10 min (mm/hr)	15 Min (mm/hr)	30 Min (mm/hr)
2	53	46	30
10	91	76	53
25	102	89	61
100	127	109	74

2.2 Hydraulics

For the preliminary design, the project will utilize normal depth calculations for sizing of the backbone storm drain, Line A, B, C and E. Copies of the Normal Depth Calculations are provided in Appendix C.

Figure 2-1. Average Annual Precipitation for 42 Year Period



3 Hydrology

3.1 Existing Hydrology

3.1.1 Site Description

The project study area is located within the 53,271-acre San Luis Obispo Creek watershed (83.2 square mile), which is located within the Estero Bay Hydrologic Unit (Hydrologic Unit 310). The Estero Bay Hydrologic Unit is divided into 19 subareas including the San Luis Obispo Creek (Hydrologic Unit 310.24), which is where the project study area is located (SLO Watershed Project 2020; Central Coast RWQCB 2019). Sheet flows within the project study area and surrounding vicinity generally drain to San Luis Obispo Creek. The natural bottom meandering San Luis Creek is largely confined due to urban development and agriculture before it outlets to the Pacific Ocean in Avila Beach, approximately 11 miles downstream of the project study area.

The project site is approximately 13 acres and is located within the City of San Luis Obispo, bounded by High Street to the north and McMillan Avenue to the south. The hydrologic analysis prepared for this report limits the extents to the portion of the project site north of Francis Avenue, approximately 10.9 acres. Future analysis for the area south of Francis Avenue is to be incorporated into this report during final design. The analyzed portion of the project site has three existing tracks located along the eastern portion of the right of way, 2 main tracks and one siding track. These tracks represent the eastern boundary of the project site and are not considered a part of this project. The western boundary is the railroad right of way and the adjacent commercial and residential developments. Between the railroad main tracks and the western boundary, the existing site is mostly vacant, however remnants of building footings/slabs and retaining walls remain from what was previously a rail maintenance facility constructed in the 1920's. Along the south western rail right of way, there are four existing utility buildings located south of Woodbridge Street which are in use today. These facilities are fenced off and are to be protected in place.

3.1.2 Floodplain

The DDM has identified that the middle one third portion of the SLO Creek watershed has been substantially built-out and that the City has created an Urban Reserve Boundary to encourage in-fill development and prevent urban sprawl. A review of DDM Figure 3-1 - Special Floodplain Management Zones (see Figure 3-1), indicates that the project is located within the Urban Reserve Boundary. The primary policy objective for this area is to minimize flood damage to existing and new buildings, and minimize additional obstructions to flood water passage. Two sets of standards and criteria have been established for these areas, one for "urban-in-fill development" within the existing urban area and one for "non-in-fill development" in large vacant parcel areas at the edges of the existing urban area. As the project is considered "urban in-fill development" within the existing urban area and is outside of the FEMA designated 100-year floodplain as depicted in DDM Figure 3-2 (see Figure 3-2), the Floodplain Management Zone criteria established in DDM Section 3.5 does not apply.

Figure 3-1. Special Floodplain Management Zones

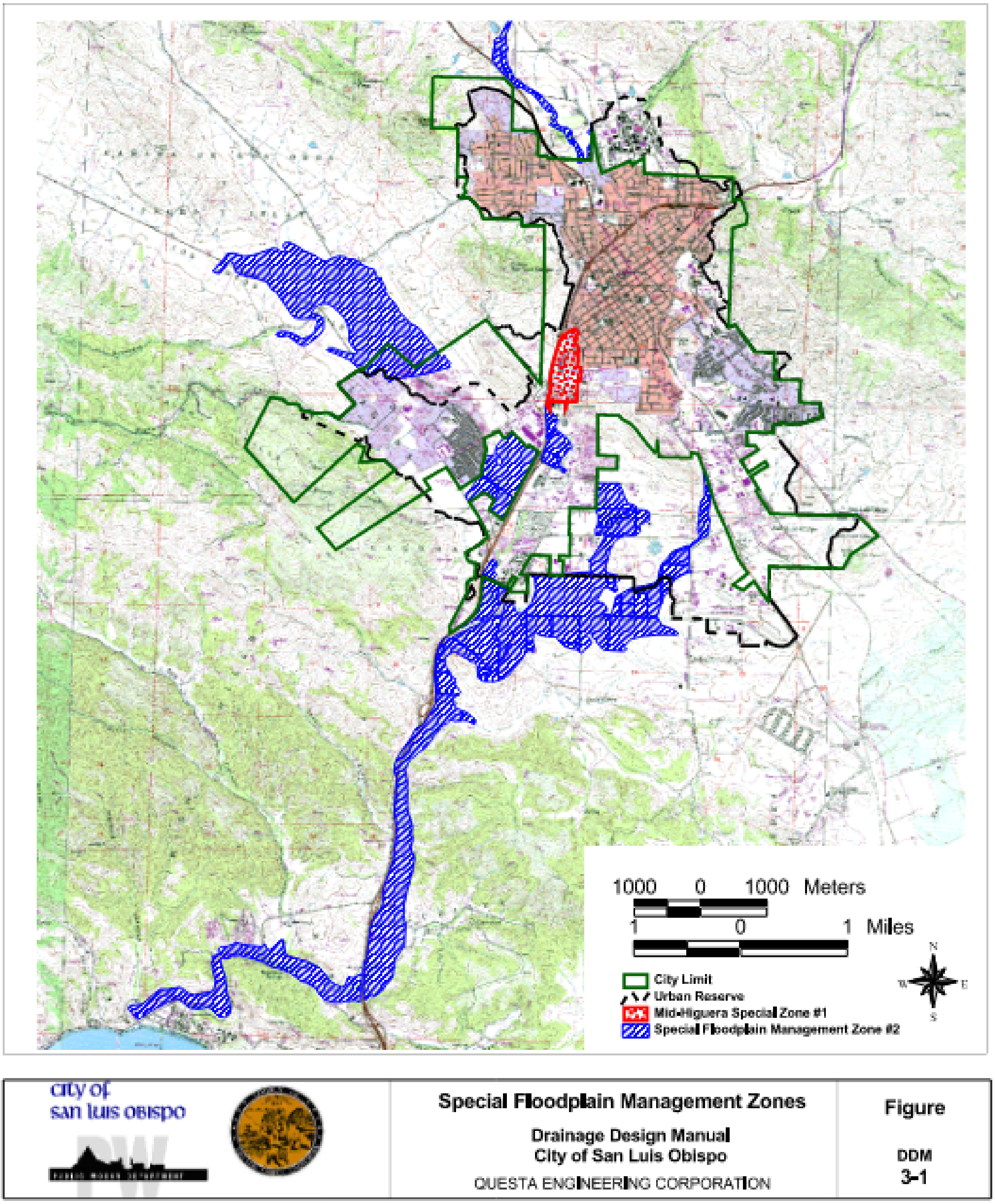
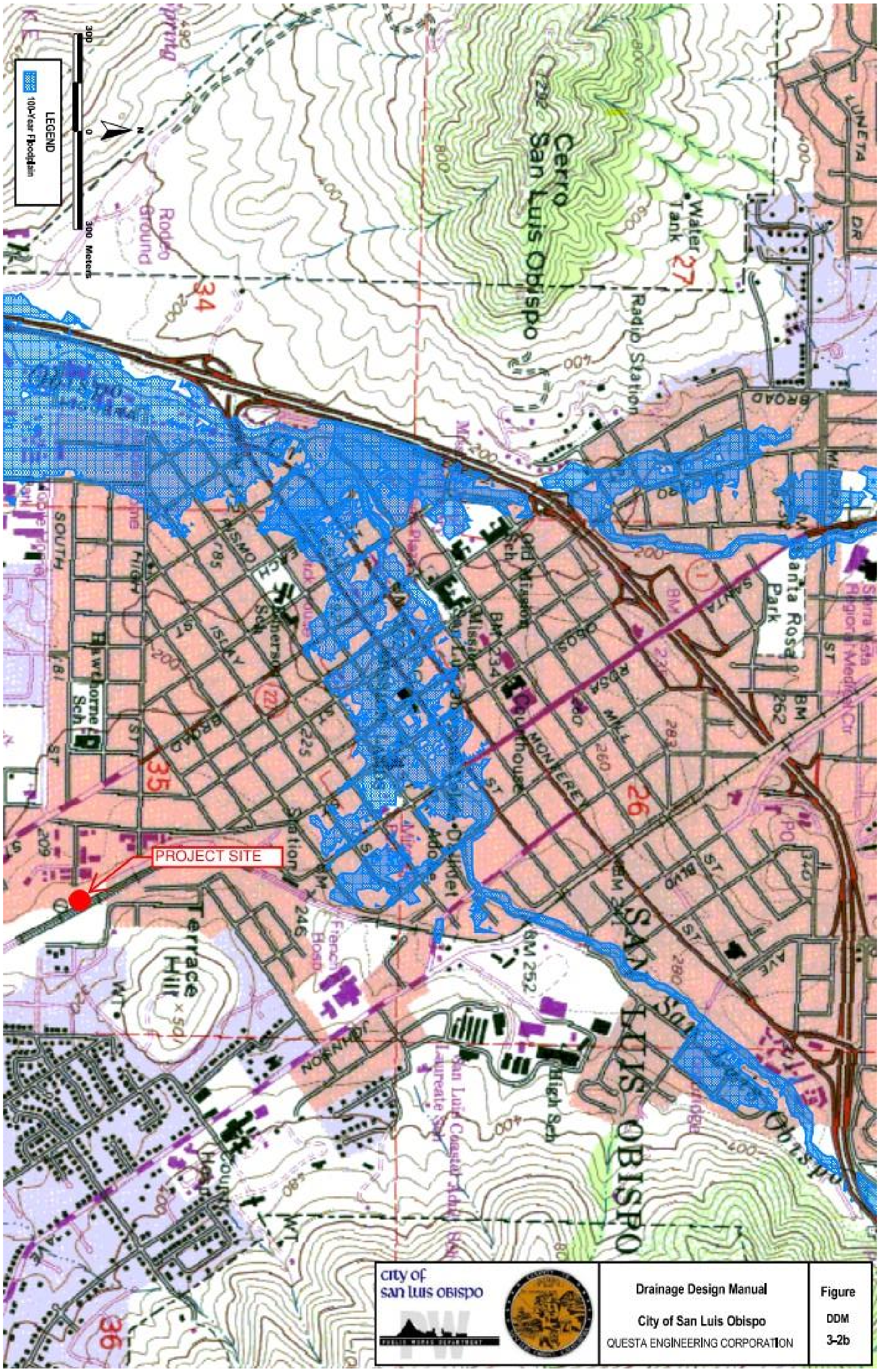


Figure 3-2. 100-Year Floodplain



3.1.3 Adjacent Land Uses

To the immediate east is an improved asphalt bike trail known as the “Railroad Safety Trail” that serves as a buffer between the rail right of way and the residential neighborhood located east of the bike trail. All runoff generated from the residential area and bike trail area is collected via drainage improvements and conveyed towards one of two existing storm drain systems, which traverse the project site.

The northernmost storm drain, identified as Existing Line 1, conveys runoff from east to west and discharges the runoff onto High Street via a curb outlet located midblock on the south side. A review of the City’s storm drain grid maps indicate the drain is city owned with the portion crossing the rail right of way being an 18” Vitrified Clay Pipe (VCP) and the western portion located under High Street being an 18” concrete pipe. Record drawings for the portion under High Street shows the storm drain was constructed in 1943. Record drawings were not available for the 18” VCP storm drain, however it can be assumed that this storm drain existed prior to construction of the concrete storm drain.

The southernmost storm drain crossing, identified as Existing Line 2, conveys the runoff from east to west and is directly connected to the existing storm drain at Alphonso Street based on field observations. A review of the City’s grid map indicates this is a private 24 inch diameter main with the portion under the rail right of way being cast iron. Invert elevations at the upstream and downstream ends were provided by city staff as part of a records request and were utilized in determining the location and elevation of the storm drain, however the invert elevations could not be verified by record drawings. Additional coordination efforts will include continued coordination with city staff to obtain all available record drawing for the portion of storm drain connecting to the storm drain on Alphonso Street. We are also planning to obtain supplemental field survey of the upstream and downstream catch basins to confirm the storm drain locations prior to completion of the preliminary design.

To the west of the project site is a light industrial/commercial area. This area is located downstream of the project site and does not contribute to the onsite drainage.

3.1.4 Soils

Five different soil series are mapped within the project site using the U.S. Department of Agriculture’s Natural Resources Conservation Service soil mapping website. Figure 3-3 provides the plan view image of the project site and the location of each soil series classification. Table 3-1. SLO – Antecedent Moisture (Ca) Factors provides a summary description for each soil series. The soils located within the project site are considered moderately to well drained with little to no clays, adobe or rockland. The project hydrology calculations will assume a soil group classification “C” for determination of the Run-off Coefficients.

Table 3-1. SLO – Antecedent Moisture (Ca) Factors

Series name	Series Description
Concepcion series	The Concepcion series consists of deep, well-drained soils. They are formed in weakly consolidated stratified alluvium or wind-deposited sandy material on soil terraces within 1 to 2 miles of the Pacific Ocean. Concepcion soils have slopes of 0 to 50 percent. The mean annual precipitation is about 17 inches, and the annual temperature is about 60 degrees Fahrenheit. The soil occurs in elevations between 40 and 200 feet.
Cropley series	The Cropley series consists of very deep, moderately and well-drained soils. They are formed in alluvium from mixed rock sources. Cropley soils have slopes of 0 to 15 percent. The mean annual precipitation is about 16 inches, and the mean annual temperature is 60 degrees Fahrenheit. The soil occurs in elevations between 10 and 2,100 feet.
Diablo series	The Diablo series is a member of the fine, smectitic, thermic family of Aridic Haploxererts and is a well-drained soil. They are formed in residuum, weather from shale, sandstone, and consolidated sediments with minor areas of tuffaceous material. Diablo soils have slopes of 5 to 50 percent. The mean annual precipitation is about 10 to 35 inches, and the mean annual temperature is 57 to 62 degrees Fahrenheit. The soil occurs in elevations between 25 and 3,000 feet.
Lodo series	The Lodo series consists shallow, somewhat excessively drained soils. They are formed in weathered material from hard shale and fine-grained sandstone. Lodo soils are on uplands and have slopes of 5 to 75 percent. The mean annual precipitation is about 20 inches, and the mean annual temperature is 62 degrees Fahrenheit. The soil occurs in elevations between 300 and 3,400 feet.
Los Osos series	The Los Osos series consists of moderately deep, well-drained soils. They are formed in weathered material from sandstone and shale. Los Osos soils are on uplands and have slopes of 5 to 75 percent. The mean annual precipitation is about 25 inches, and the mean annual temperature is 60 degrees Fahrenheit. The soil occurs in elevations between 100 and 3,500 feet.

Figure 3-3. United States Department of Agriculture Soils

3.1.5 Existing Topography and Drainage Areas

The site topography was generated via aerial imagery flown in September 2019. The topography shows the area between High Street and Roundhouse Street drains towards the western rail right of way, where runoff drains into the adjacent properties or runs along an adjacent retaining wall southward towards Roundhouse Street. The central portion of the site, between Roundhouse Street and the extension of Woodbridge Avenue generally drain from east to west, draining onto the adjacent properties. The southern portion of the project site primarily drains from southeast to northwest towards an existing parking lot located west of the rail right of way. It is assumed that the runoff south of Francis Avenue drains towards Francis Avenue or the existing culvert near McMillan Avenue, this is to be confirmed during final design.

The project site is divided into the following drainage areas as shown in the Existing Hydrology Exhibits provided in Appendix A and described below from north to south. Table 3-2. Existing Condition Runoff Flow provides the existing condition runoff flow rates for the 2-year, 10-year, 25-year and 100-year design storm.

Drainage Area 100 – This drainage area is located between High Street to the north and the adjacent offsite property identified as “Emily Yard” on the south and west. The drainage area is 0.9 Acres and is mostly barren with little vegetation. All runoff sheet flows from east to west where it is collected and conveyed into the ”Emily Yard” property. The flow continues along concrete gutter improvements constructed by the adjacent property towards riprap improvements at the end of the curb and gutter. The flow then combines with the adjacent property runoff and is conveyed westward along a concrete ribbon gutter towards a grate inlet where it enters the city storm drain system. The 100-year storm flow exiting the project site is 2.4 cubic feet per second (cfs).

Drainage Area 200 – This drainage area is bounded by Drainage Area 100 to the north and the project access from Roundhouse Street to the south. The drainage area is 1.8 Acres and is mostly barren with very little vegetation, where it is primarily located along the western rail right of way and near the project entrance at Roundhouse Street. The existing on-site runoff is collected along unimproved drainage swales located adjacent to the western rail right of way. The runoff is conveyed southward towards Roundhouse Street where the runoff is discharged onto the existing curb and gutter. The 100-year storm flow is 4.6 (cfs)

Drainage Area 300 – This drainage area is bounded by Drainage Area 200 and the project site access from Roundhouse Street to the north and the offsite retaining wall. This drainage area is primarily barren with sparse vegetation and contains the concrete remnants of a roundhouse structure from the early 1900’s. The runoff within the drainage area sheet flows east to west along unlined drainage swales and towards concrete lined ditches located west of the rail right of way and constructed by the adjacent properties. The runoff is conveyed into their catch basins and storm system. The drainage area is subdivided into the following drainage areas to define the flow entering each of the existing catch basin improvements located offsite. Drainage Area 300 is divided into Drainage Areas 300A, 300B and 300C and are described below.

Runoff from DA 300A is collected along the concrete ditch and conveyed northwards towards an inlet riser at the end of masonry retaining wall. The runoff discharges onto the adjacent parking lot and combines with the adjacent property runoff and sheet flows towards a grated inlet catch basin located within the driveway aisle. The drainage area is 0.6 Acres and generates 1.6 cfs.

Runoff from DA 300B is collected along the existing concrete ditch and conveyed southward towards a grated catch basin located within the adjacent property. The existing catch basin is connected to the grated catch basin within the driveway aisle (see DA 100) and drains towards the public storm drain system on Emily Street. The drainage area is 0.6 Acres and generates 1.6 cfs.

Runoff from DA 300C is collected along the existing concrete ditch and conveyed towards existing grated catch basins interspersed along the drainage ditch. The ditch and catch basin improvement are located within the adjacent private property. The existing catch basins are connected to the drainage system located within the driveway aisle and drain towards the public storm drain system on Emily Street. The drainage area is 1.1 Acres and generates 3.3 cfs.

Drainage Area 400 – This drainage area is bounded by the extension of South Street to the north and existing vegetated bioswale to the south. The drainage area is 2.2 Acres and consists of mostly bare soil with various building foundations along the western side. The runoff within the drainage area sheet flows east to west, towards a concrete lined drainage ditch located within the adjacent private property. The drainage ditch conveys the runoff southward towards the existing vegetated offsite swale that drains westerly towards the inlet riser near the intersection of Emily and Alphonso Streets. The 100-year storm flow is 6.8 cfs.

Drainage Area 500A – This drainage area is bounded by the extension of the vegetated bioswale to the north and the limits of the existing parking lot improvements to the south. The drainage area is 1.7 Acres and consists of mostly bare soil with a building foundation located in the northwest quadrant of the drainage area. The runoff within the drainage area sheet flows from east to west via unimproved swales which convey the flow towards a common low point along the western rail right of way. The adjacent private property, an improved parking lot, has constructed riprap improvements which convey the runoff directly onto the parking lot surface where the runoff sheet flows towards its western side and into the inlet improvement near the parking lot entrance. The total runoff generated from the Drainage Area is 5.0 cfs.

Drainage Area 500B – This drainage area is bounded by the southern limit of Drainage Area 500A to the north and the extension of the project entrance from Francis Street to the south. The drainage area is 2.1 Acres and consists primarily of barren soil with some vegetation and four fenced-off areas with building improvements. The runoff within the drainage area sheet flows towards an unlined and unimproved drainage swale located just east of the building improvements. The unimproved swale drains from south to north and discharging into the improved parking lot described in Drainage Area 500A. Similar to what is described in Drainage Area 500A, the adjacent parking lot has constructed riprap improvements to collect and convey the project site runoff onto the parking lot surface and conveyed along a concrete gutter improvement towards the existing inlet improvement located near the entrance. The 100-year storm flow is 5.2 cfs. See Appendix A for Existing Drainage Exhibit.

Table 3-2. Existing Condition Runoff Flow

Drainage Area	2 Year Storm (cfs)	10 Year Storm (cfs)	25 Year Storm (cfs)	100 year Storm (cfs)
100	0.8	1.4	1.7	2.4
200	1.6	2.6	3.3	4.6
300A	0.5	.9	1.1	1.6
300B	0.6	1.0	1.2	1.7
300C	1.1	1.9	2.3	3.3
400	2.3	3.9	4.8	6.8
500A	1.7	2.9	3.5	5.0
500B	1.8	2.9	3.7	5.2

3.2 Proposed Drainage

The proposed project site grading is set to have the northern and southern portions of the project site higher than the depressed “bowl” area in the middle which is consistent with the layout of rail maintenance yards to prevent accidental rolling away of rail vehicles. Exhibits for the proposed condition hydrology, provided in Appendix A, depict that proposed Drainage Areas DA200, DA300 and DA500 are located along the periphery of the project site and discharge the runoff into the adjacent properties and public roadways, consistent with the existing conditions hydrology. Drainage Areas DA100 and DA400 includes the portion of the project site whose runoff is collected within proposed storm drain improvements. The runoff is conveyed towards an underground storage system and discharged into Existing Line 2 at a point near the western rail right of way. The following is a description of the proposed drainage areas beginning at the north end and extending southward. Also included is Table 3-3 summarizing the runoff from each drainage area

Drainage Area 100 – The drainage area is located along the northwestern portion of the project site and is bounded by High Street to the north and the rail right of way boundary to the west. To the east, the drainage area is bounded by the ‘INSP’ Track. The drainage area includes a portion of the asphalt bike trail and maintenance roadway with some vegetation located in between both paved surfaces.

The drainage area is 1.6 Acres (0.64 hectares). All runoff sheet flows from north to south and is collected by storm drain improvement at or near the driveway extension from Roundhouse Street. The 100-year storm flow is 6.2 cfs (0.17 m^3/s). The proposed design eliminates all project site runoff draining onto the adjacent property.

Drainage Area 200 – The drainage area is located just south of Drainage Area 100 and includes the remaining portion of the asphalt bike trail adjacent to Roundhouse Street, the maintenance roadway west of DA100 and the biketrail and park area located south of Roundhouse Street. The drainage area is 0.32 Acres (0.13 hectares). The runoff is collected along the access road and bike trail curb improvements and conveyed towards the existing Roundhouse Street surface improvements. The 100-year storm flow is 1.1 cfs (0.03 m^3/s) and represents a 3.5 cfs reduction in runoff exiting the project site when compared to the existing condition.

Drainage Area 300 – The drainage area is bounded by the proposed asphalt bike trail improvements to the east and north and the adjacent developed properties to the west and south for the proposed condition. Runoff from DA 300 is collected along the existing concrete ditch improvements constructed by the adjacent private properties and discharged into the private storm system described in the existing condition analysis, see DA 300A and 300B. The drainage area is 0.3 Acres (0.11 hectares) and includes the landscaped embankments west of the bike trail. The 100-year storm flow is 0.8 cfs which is a significant reduction from the existing condition

Drainage Area 400 – This drainage area includes the portion of the proposed project site that is collected within the proposed storm drain and underdrain improvements for Phase I and the future track improvements. The drainage area includes the proposed maintenance road and asphalt bike trail improvements south of the high point described in DA300 and all future building sites. The Drainage Area storm drain is divided into three storm drain backbone systems, Lines A, B and C. The Line E storm drain collects all runoff from the various systems and conveys it to the underground storage system and Line F conveys the flow from the underground storage system to Existing Line 2, the 24" storm drain crossing the project site. The descriptions below provide information for each Drainage Area.

Drainage Area 400A – This drainage area is comprised of the area graded to drain into the catch basin at Sta 22+24.62~70.41' RT as well as the ballasted portion of the STR1 track from STA 18+90 to STA 22+32. All runoff from this drainage area is discharged into Line A storm drain and conveyed westward towards the underground storage system. The full-build alternative constructs the remaining storage tracks and the future access road in the area graded to drain towards the catch basin described above. The percent impervious for the full build condition is used in preparing the hydrology calculations. The drainage area is 0.90 Acres (0.65 hectares). The runoff entering the storm drain 4.0 cfs (0.16 m^3/s).

Drainage Area 400B – This drainage area includes the ballasted portion of the STR1 track from the underdrain high point at STA 24+62 northward to the point of connection to the Line A storm drain. It also includes the portion of the track inspection pit from STA 22+32 southwards to STA 26+17 and includes the access path east of the tracks. There are no future modification in this area. The drainage area is 0.51 Acres (0.21 hectares). The runoff entering the storm drain from the combined underdrain systems is 2.5 cfs (0.07 m^3/s).

Drainage Area 400C – This drainage area is located south of Drainage Area 400A and west of the existing freight tracks. This drainage area includes the area graded to drain into the catch basin located at STA 27+06.39~64.32' LT and the portion of the 'STR1' extending from STA 24+62 southwards to underdrain point of connection to the Line C storm drain. The full-build alternative constructs tracks and a future access road in the area graded to drain towards the catch basin described above. The percent impervious for the full build condition is used in preparing the hydrology calculations. The drainage area is 0.68 Acres (0.28 hectares). The 100-year storm flow is 2.2 cfs (0.06 m^3/s).

Drainage Area 400D – This drainage area begins at the southern end of the Phase I track improvements southward to Francis Avenue. The final configuration includes the southward extension of all tracks and maintenance roadways and construction of cleaning shelters and trash and recycling storage facilities. In Phase I, this area will remain mostly vacant with only a portion of the maintenance roadway constructed up to STA 28+48. This report utilizes the percent impervious calculation from the proposed full build condition in the hydrology calculations to appropriately size the curb inlet located at STA 26+18.85 ~ 134.81' RT and the Line C-4 storm drain. The runoff is ultimately discharged into Line C and conveyed towards the proposed underground storage system. The drainage area is 1.8 Acres (0.75 hectares) and the 100-year storm runoff is 5.2 cfs (0.14 m^3/s).

Drainage Area 400E – This drainage is west of DA 400B and DA 400C and includes the vacant area graded to drain towards the inlet located at STA 25+07.80 ~ 75.11' RT. The full build alternative includes construction of future building improvements and additional tracks within the vacant area. The percent impervious for the full build condition is used in preparing the hydrology calculations. The drainage area is 1.1 Acres (0.43 hectares). The runoff entering the storm drain from the combined underdrain systems is 5.2 cfs (0.15 m^3/s).

Drainage Area 400F – This drainage area is comprised of the asphalt bike trail from the high point at STA 21+17 southward towards the catch basin at STA 25+07.89. There are no modifications between Phase I and the final configuration. The drainage area entering the catch basin is 0.21 Acres (0.08 hectares) and the 100-year storm flow is 1.0 cfs (0.03 m^3/s).

Drainage Area 400G - This drainage area mostly comprises the asphalt bike trail from the high point at STA 17+60 northward towards the catch basin at STA 17+60.50. There are no assumed modifications between Phase I and the final configuration. The drainage area entering the catch basin is 0.30 Acres (0.12 hectares) and the 100-year storm flow is 1.2 cfs (0.03 m^3/s).

Drainage Area 400H – This drainage area is bounded to the north by the site boundary, to the east by the existing freight tracks and to the west by the 'INSP' track alignment. Runoff from the drainage area is graded to drain towards the catch basin at STA 18+85.56~70.41' LT or collected in the underdrains paralleling the 'INSP' and 'STR1' tracks and discharged into the Line B-1 storm drain. The percent impervious for the full build condition is used in preparing the hydrology calculations. The drainage area is 2.30 Acres (0.77 hectares). The runoff entering Line B-1 is 3.9 cfs (0.11 m^3/s).

Drainage Area 400I – This drainage area is located north drainage areas DA 400B and DA 400E and includes a portion of the 'STR1' and 'INSP' tracks between STA 18+98 and STA 22+32, as well as the area graded to drain towards the catch basin located at STA 20+77.62 ~ 44.17' RT. The runoff from this drainage area is conveyed into the Line B-2 storm drain. The percent impervious for the full build condition is used in preparing the hydrology calculations. The full build alternative includes construction of future building improvements and additional tracks within the vacant area. The drainage area is 0.80 Acres (0.32 hectares). The 100-year storm flow is 3.1 cfs (0.09 m^3/s).

Drainage Area 400J - This drainage is west of DA 400I and consists primarily of the maintenance roadway from the high point at STA 18+27 southwards to the proposed curb inlet at STA 22+28.82 ~ 113.50' RT. There are no future improvements in this area. The drainage area is 0.47 Acres (0.19 hectares). The runoff entering the storm drain from the combined underdrain systems is 2.6 cfs (0.07 m^3/s).

Drainage Area 500 – This drainage area includes that portion of the maintenance access roadway as well as that portion of the runoff from the existing warehouse facilities located along the southern portion of the project site that drain towards the existing adjacent parking lot. There are no future improvements proposed within this drainage area. The drainage area is 0.21 Acres (0.09 hectares). The runoff entering the storm drain from the combined underdrain systems is 0.8 cfs (0.02 m^3/s).

Table 3-3. Proposed Condition Runoff Flow

Drainage Area	2 Year Storm (cfs)	10 Year Storm (cfs)	25 Year Storm (cfs)	100 year Storm (cfs)
100	2.1	3.5	4.4	6.2
200	0.4	0.7	0.8	1.1
300	0.3	0.4	0.6	0.8
400A	1.3	2.8	2.8	4.0
400B	0.9	1.4	1.5	2.5
400C	0,7	1.2	1.4	2.2
400D	1.7	2.9	3.4	5.2
400E	1.8	3.0	3.4	5.2
400F	0.3	0.6	0.6	1.0
400G	0.4	0.7	0.8	1.2
400H	1.3	2.2	2.6	3.9
400I	1.0	1.8	2.0	3.1
400J	0.9	1.5	1.7	2.6
500	0.3	0.4	0.5	0.8

4 Proposed Drainage System

4.1 Ditches

The final configuration will not utilize trackside ditches. The Phase I design does provide for temporary concrete ditches to convey runoff within the vacant areas adjacent to each of the tracks. The ditches are graded to drain towards the catch basin improvements. The swales have a triangular cross-section with 3:1 side slopes and 24” in depth. They will convey a flowrate no greater than 2 cfs with a 0.5% gradient. A typical normal depth calculation is provided for this condition in Appendix C. Design and calculations for each ditch will be provided during final design.

4.2 Underdrains

The phase I design proposes underdrains located adjacent to the ‘INSP’ and ‘STR1’ track alignments. The underdrains will be sized per AREMA 4.22.5, where the minimum size of underdrain is 15” HDPE perforated pipe. The minimum slope gradient is 0.25%. Two normal depth calculations are provided in Appendix C, one calculation indicating the allowable runoff for a 12” and a second for the allowable runoff for a 15” underdrain. Design refinements, including the placement of cleanouts will be provided during final design

4.3 Pipe Network

The project storm drain backbone system is subdivided into three separate storm drains, Lines A B, and C. The flow is then combined and conveyed within Line E which is connected to the underground storage system. Line F then conveys the flow into Existing Line 2 near the rail right of way. Lines C-1, C-2, C-3 and C-4 are considered lateral lines connecting catch basins and other inlet structures to the backbone system and are to be analyzed during final design. Table 4-1 below provides the maximum Q within each backbone line and the proposed size. Normal depth calculations will be used for the preliminary design phase to size the backbone storm drain system.

Table 4-1. Proposed Runoff Flow by Storm Drain Line

Line	2 Year Storm (cfs)	10 Year Storm (cfs)	25 Year Storm (cfs)	100 year Storm (cfs)	Storm Drain Size (Inches)	Percent Full
Line A	5.3	9.6	11.3	16.2	24”	84%
Line B	3.8	6.4	7.7	11.4	24”	63%
Line C	3.9	6.5	7.6	11.6	24”	63%

Line E	11.3	19.8	22.9	34.1	36”	63%
Line F	-	-	-	-	Pending Final Design	

4.4 Underground Storage System

An underground storage system located under the western parking stalls is proposed for the preliminary design phase. Future calculations will be used for sizing of the basin and for Line F connecting to the existing 24” storm drain system.

5 Conclusions

The LOSSAN Rail Corridor Agency is proposing the relocation and expansion of the existing Pacific Surfliner layover facility in the City of San Luis Obispo. The full-build facility will include storage and servicing tracks, operations and maintenance buildings. The site will provide for a maintenance access roadway and a Class I Bike Trail for public use.

The project site grading is in a bowl type configuration. A storm drain backbone system is designed to collect most of the onsite runoff and conveying it towards an underground storage system located within the access roadway parking aisle. As a result, the existing points of discharge including the adjacent properties and Roundhouse Street will experience no net change or a reduction of surface flow when compared to the current conditions.

The proposed drainage system will be designed to accommodate the 100-year post-development runoff flows by conveying the pre-development runoff to ‘Existing Line 2’, a 24” storm drain crossing the project site. The proposed underground storage system will detain the difference between the pre- and post-development flows, eventually discharging the detained flow to the downstream systems.

Future analysis in the final design stage will be required to determine the existing capacity of Existing Line 2. The existing site runoff is uncontrolled surface flow, conveyed towards the storm drain by unlined swales and roadway curb and gutter improvements into the existing storm drain system at the existing inlets located adjacent to Alphonso Street or the inlet improvements within the existing parking lot. All the existing project runoff is conveyed into the Alphonso Street storm drain. Additional hydraulic analysis is required to confirm the available capacity within the storm drain between the proposed point of connection and the existing inlet located adjacent to Alphonso Street as well as size the proposed storm drain improvements. The capacity analysis will determine the size of the underground storage system needed to detain the difference between the pre-development and post-development runoff volume.

6 References

1. City of San Luis Obispo Department of Public Works and County of San Luis Obispo Flood Control District. 2003. *San Luis Obispo Creek Waterway Management Plan Vollume III Drainage Design Manual.*

2. HDR Engineering, May14, 2021. *Central Coast Layover Facility, Preliminary Geotechnical Design Report.*

3. HDR Engineering, January, 2021. *Central Coast Layover Facility, Draft Biological Resources Technical Report.*

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Appendix A. Existing and Proposed Hydrology Exhibits

LEGEND:

	RIGHT OF WAY
DA 500 0.31 AC	DRAINAGE AREA ACREAGE
—S—	EXISTING STORM DRAIN
	EXISTING SWALE
	DRAINAGE AREA 100
	DRAINAGE AREA 200
	DRAINAGE AREA 300A
	DRAINAGE AREA 300B
	DRAINAGE AREA 300C

40 0 40 80
SCALE IN FEET

HDR

UNION PACIFIC

DRAWN BY:	**UNION PACIFIC RAILROAD**
CHECKED BY:	LOCATION & DESCRIPTION: San Luis Obispo, California LOSSAN Central Coast Maintenance/Layover Facility (CCMF)
DATE: UNK 2021	
SHEET NUMBER of	SHEET TITLE: EXIST HYDROLOGY EXHIBIT SHEET 1 OF 2

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LEGEND:

	RIGHT OF WAY
DA 500 0.31 AC	DRAINAGE AREA ACREAGE
S	EXISTING STORM DRAIN
	DRAINAGE AREA 400
	DRAINAGE AREA 500A
	DRAINAGE AREA 500B

40 0 40 80
SCALE IN FEET

DRAWN BY:	UNION PACIFIC RAILROAD
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DATE: UNK 2021	
SHEET NUMBER of	SHEET TITLE: EXIST HYDROLOGY EXHIBIT SHEET 2 OF 2

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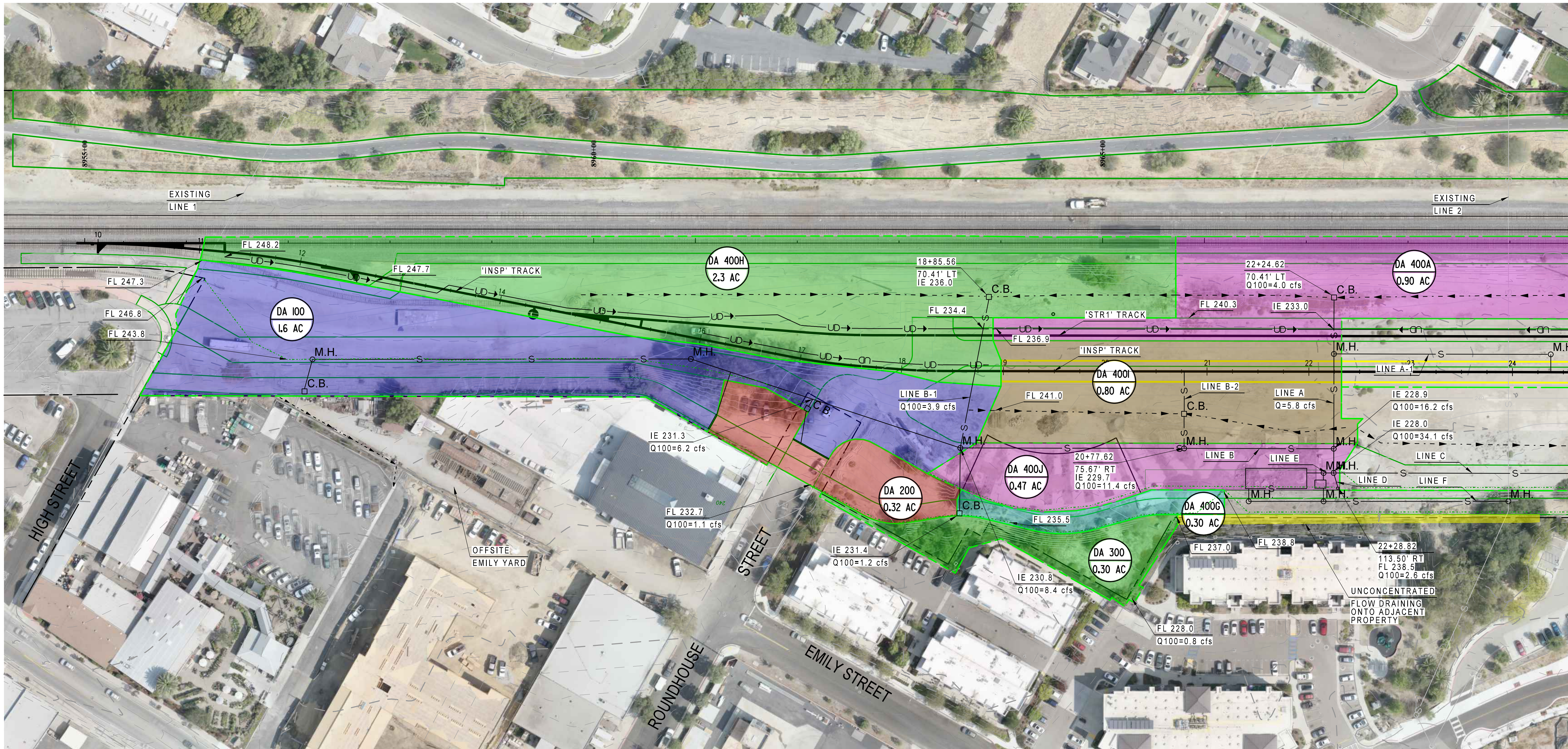

NOTES:

ALL STATIONING BASED ON 'INSP' TRACK ALIGNMENT

LEGEND:

RIGHT OF WAY	STORM DRAIN	DRAINAGE AREA 100	DRAINAGE AREA 400G
GRADED SWALE	DA 500 0.31 AC — DRAINAGE AREA ACREAGE	DRAINAGE AREA 200	DRAINAGE AREA 400H
UD — UNDERDRAIN		DRAINAGE AREA 300	DRAINAGE AREA 400I
S — STORM DRAIN		DRAINAGE AREA 400A	DRAINAGE AREA 400J
M.H. — MANHOLE	C.B. — CATCH BASIN		

40 0 40 80
SCALE IN FEET

HDR

UNION PACIFIC

DRAWN BY:	UNION PACIFIC RAILROAD
CHECKED BY:	LOCATION & DESCRIPTION: San Luis Obispo, California LOSSAN Central Coast Maintenance/Layover Facility (CCMF)
DATE: UNK 2021	
SHEET NUMBER of	SHEET TITLE: PROP HYDROLOGY EXHIBIT SHEET 1 OF 2

NOTES:

ALL STATIONING BASED ON 'INSP' TRACK ALIGNMENT

LEGEND:

RIGHT OF WAY	STORM DRAIN
GRADED SWALE	DRAINAGE AREA ACREAGE (DA 500 0.31 AC)
UNDERDRAIN	
STORM DRAIN	
MANHOLE (M.H.)	CATCH BASIN (C.B.)

	DRAINAGE AREA 400B
	DRAINAGE AREA 400C
	DRAINAGE AREA 400D
	DRAINAGE AREA 400E
	DRAINAGE AREA 400F
	DRAINAGE AREA 500

HDR

UNION PACIFIC

DRAWN BY:

CHECKED BY:

DATE: UNK 2021

SHEET NUMBER

of

UNION PACIFIC RAILROAD

LOCATION & DESCRIPTION:
San Luis Obispo, California
LOSSAN Central Coast
Maintenance/Layover Facility (CCMF)

SHEET TITLE: PROP HYDROLOGY EXHIBIT SHEET 2 OF 2

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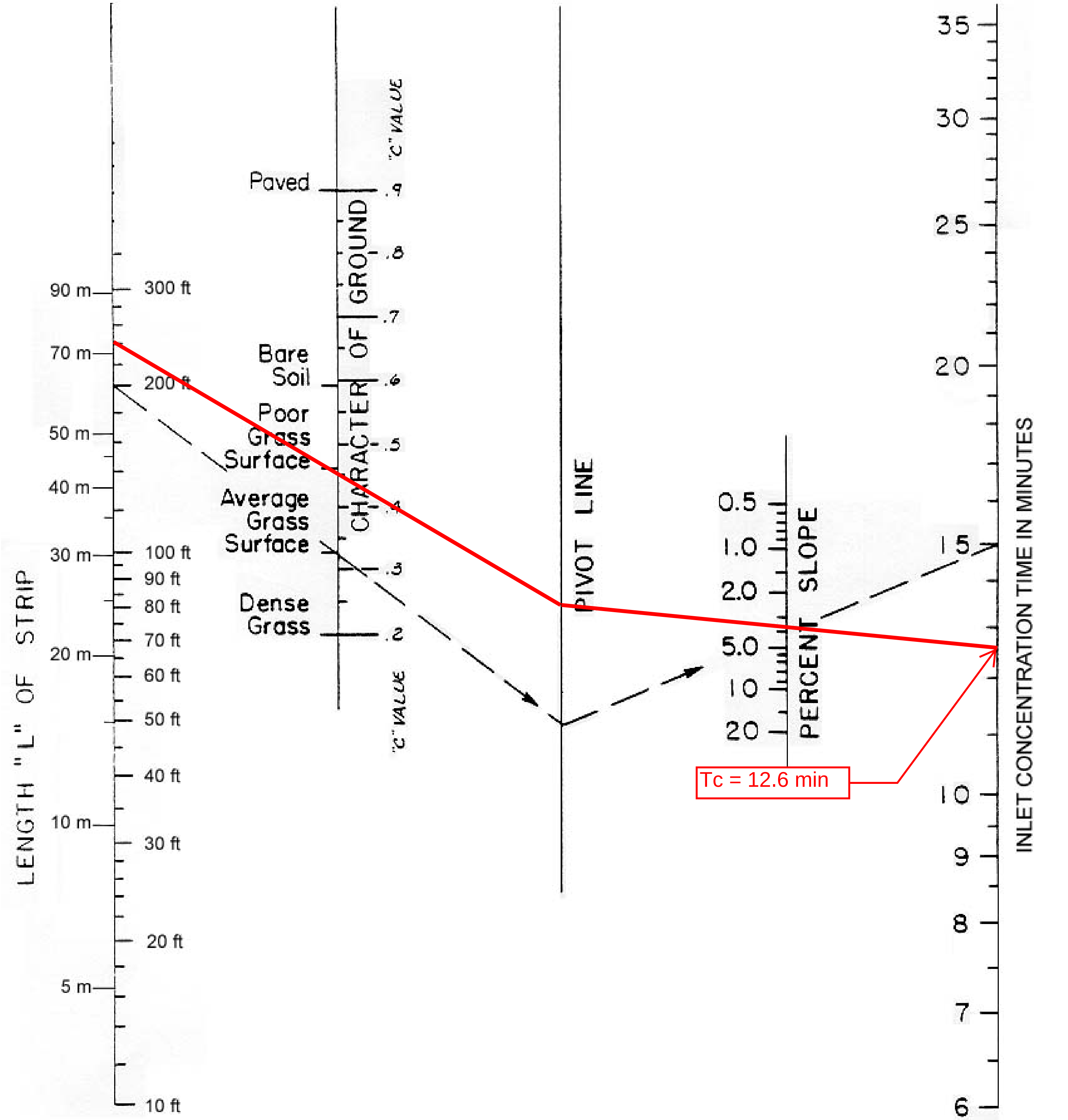
Appendix B. Hydrologic Calculations

EXISTING DRAINAGE AREA 100



EXISTING DRAINAGE AREA 100 - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
100	3,746	D	3.5%	Vacant	0.45	1685.7
		D	-			0
Total Area	3,746					1685.7
					C =	0.45

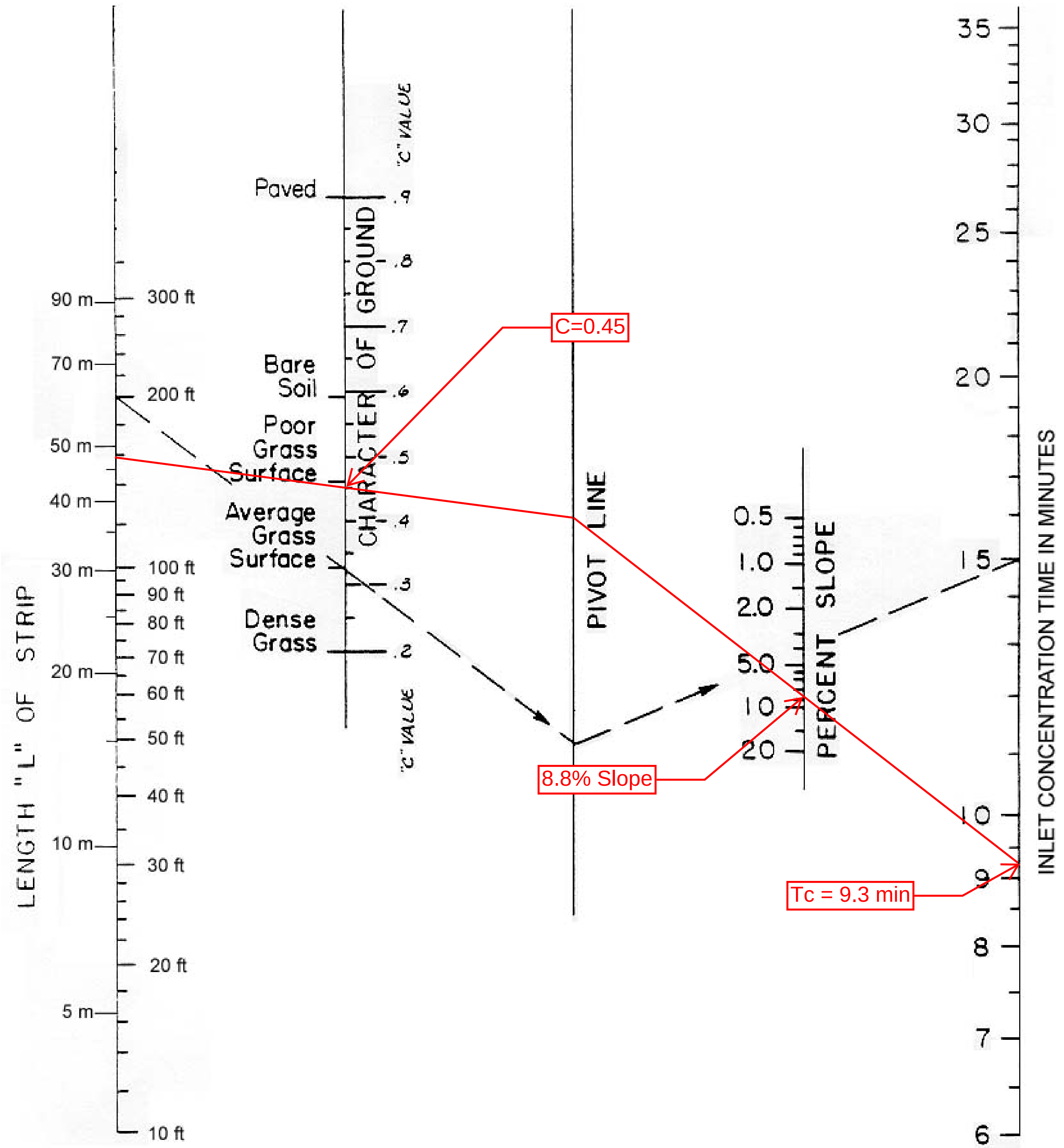
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Channel		
Length L (m)	75.7	-	-		
Upper Elevation (ft)	248.2	-	-		
Lower Elevation (ft)	239.5	-	-		
Watercourse Slope S	0.035	-	-		
Watercourse Slope in %	3.5	-	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	-	-		
Ku	-	-	-		
Equation to compute Velocity	-	Equation 3	-		
Velocity (m/s)	-	-	-		
Method to Compute Time	Figure 4-1	Equation 4	-		
Time (min)	12.6	-	-		
				Total Tc =	12.60

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.375	0.45	12.60	600	53	46	49.36	1	360	0.02	0.82
10-year	0.375	0.45	12.60	600	91	76	83.20	1	360	0.04	1.38
25-year	0.375	0.45	12.60	600	102	89	95.24	1.1	360	0.05	1.73
100-year	0.375	0.45	12.60	600	127	109	117.64	1.25	360	0.07	2.43

EXISTING DRAINAGE AREA 200



city of san luis obispo PUBLIC WORKS DEPARTMENT	**Overland Flow Time** **SLO Creek Phase II** **Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

EXISTING DRAINAGE AREA 200 - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
200-1	1,375	D	8.8	Vacant	0.45	618.8
200-2	5,872	D	-	Vacant	0.45	2,642.4
						0.0
Total Area	7,240				Total =	3261.15
					C =	0.45

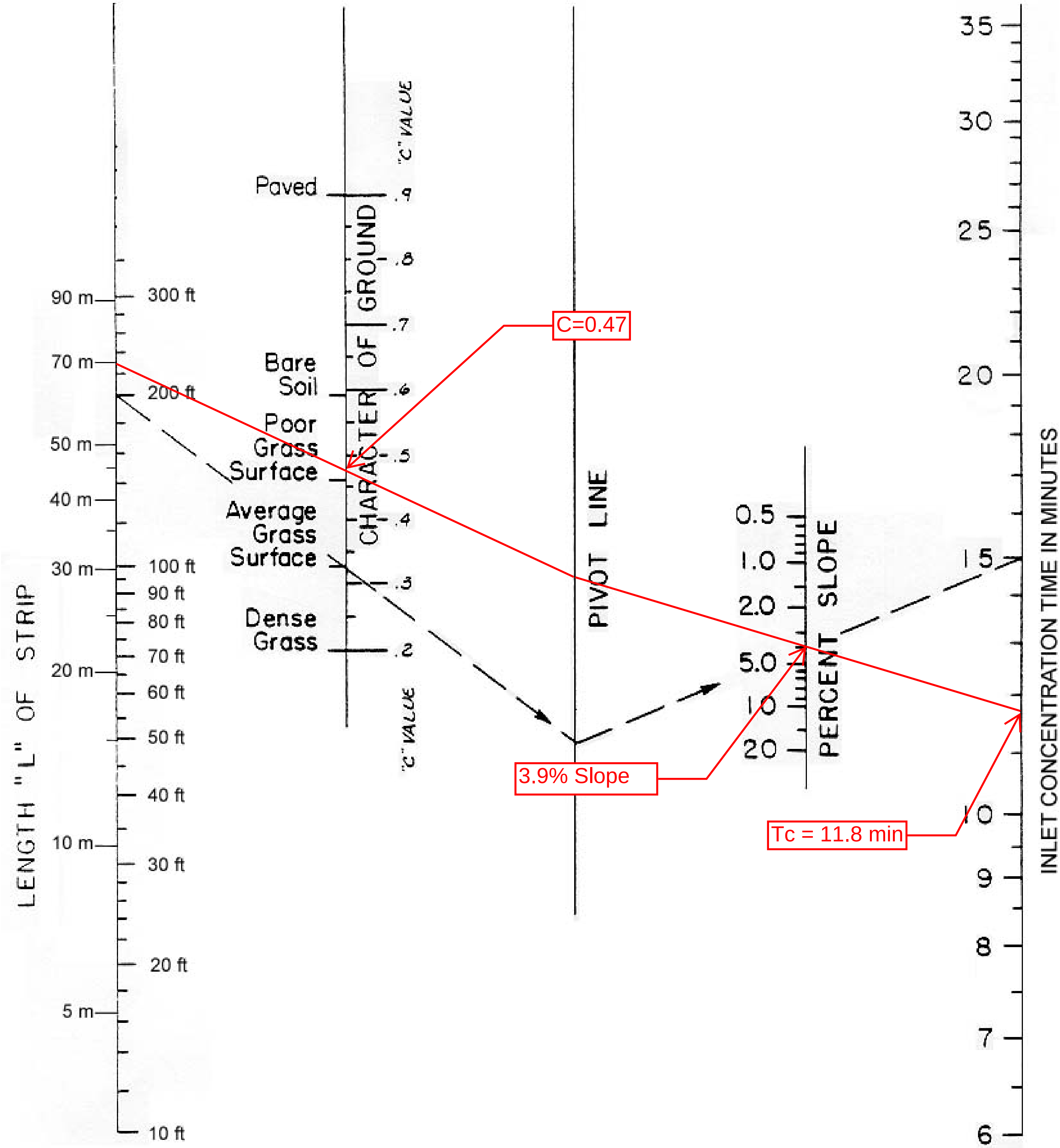
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Channel		
Length L (m)	48.3	108	-		
Upper Elevation (ft)	248.9	235	-		
Lower Elevation (ft)	235	231.7	-		
Watercourse Slope S	0.088	0.009	-		
Watercourse Slope in %	8.8	0.9	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	-		
Ku	-	1			
Equation to compute Velocity	-	Equation 3	-		
Velocity (m/s)	-	0.47	-		
Method to Compute Time	Figure 4-1	Equation 4	-		
Time (min)	9.3	3.80	-		
				Total Tc =	13.10

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.724	0.45	13.10	600	53	46	48.66	1	360	0.04	1.56
10-year	0.724	0.45	13.10	600	91	76	81.70	1	360	0.07	2.61
25-year	0.724	0.45	13.10	600	102	89	93.94	1.1	360	0.09	3.31
100-year	0.724	0.45	13.10	600	127	109	115.84	1.25	360	0.13	4.63

EXISTING DRAINAGE AREA 300A



city of san luis obispo

PUBLIC WORKS DEPARTMENT

Overland Flow Time

SLO Creek Phase II Drainage Manual

QUESTA ENGINEERING CORPORATION

Figure 4-1

EXISTING DRAINAGE AREA 300A - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
300A	2,143	D	3.9	Vacant	0.45	964.4
	124	D	-	Impervious	0.87	107.9
						0.0
Total Area	2,267				Total =	1072.23
					C =	0.47

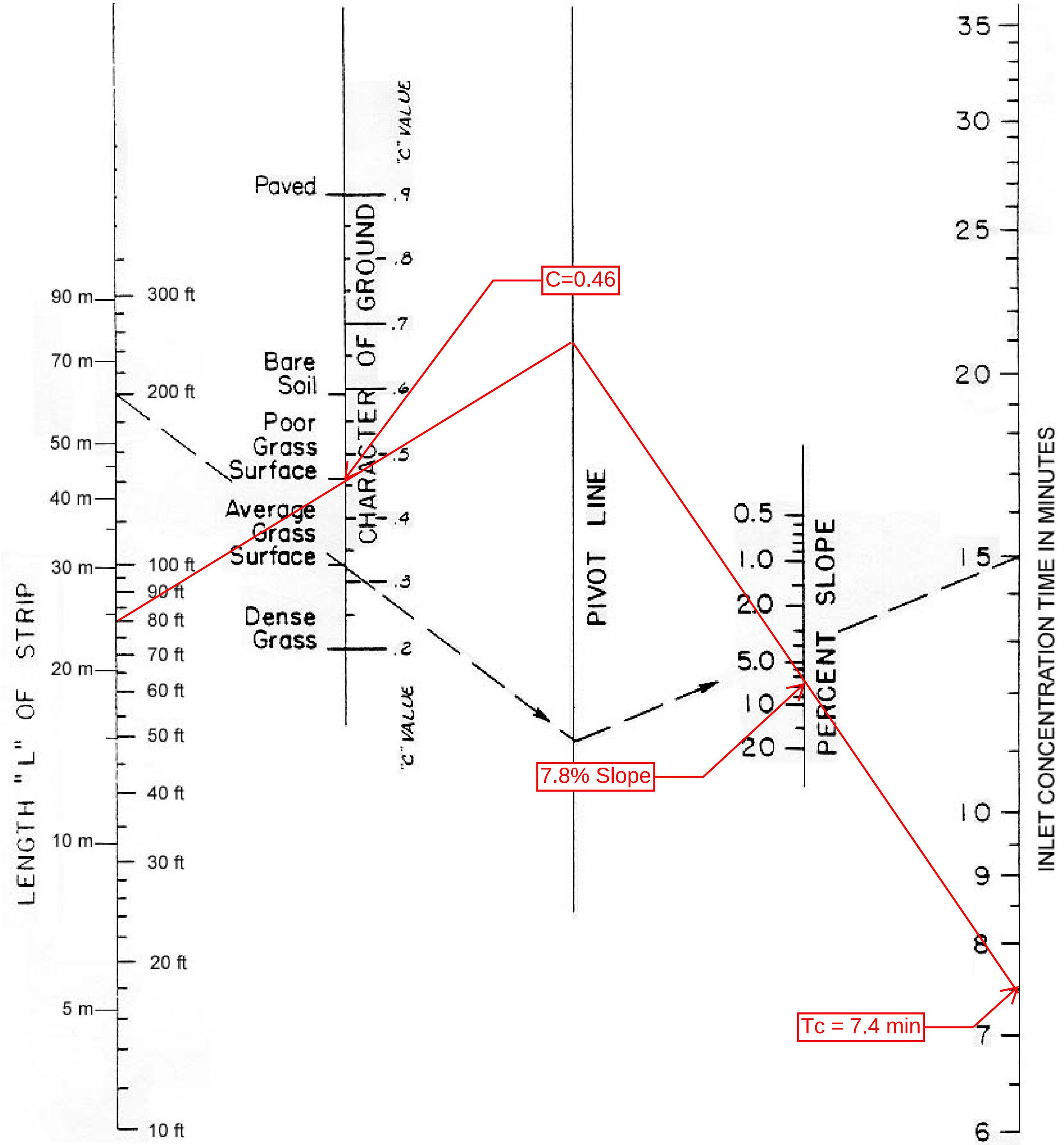
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Channel		
Length L (m)	69.8	39.9	-		
Upper Elevation (ft)	247.9	237.9	-		
Lower Elevation (ft)	239	229.5	-		
Watercourse Slope S	0.039	0.064	-		
Watercourse Slope in %	3.9	6.4	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	-		
Ku	-	1			
Equation to compute Velocity	-	Equation 3	-		
Velocity (m/s)	-	1.24	-		
Method to Compute Time	Figure 4-1	Equation 4	-		
Time (min)	11.8	0.53	-		
				Total Tc =	12.33

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.227	0.47	12.33	600	53	46	49.73	1	360	0.01	0.52
10-year	0.227	0.47	12.33	600	91	76	84.00	1	360	0.03	0.88
25-year	0.227	0.47	12.33	600	102	89	95.93	1.1	360	0.03	1.11
100-year	0.227	0.47	12.33	600	127	109	118.60	1.25	360	0.04	1.56

EXISTING DRAINAGE AREA 300B



city of san luis obispo PUBLIC WORKS DEPARTMENT	**Overland Flow Time** **SLO Creek Phase II Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

EXISTING DRAINAGE AREA 300B - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
300B-1	2,297	D	7.8	Vacant	0.45	1,033.7
300B-2	73	D	-	Impervious	0.87	63.5
						0.0
Total Area	2,370				Total =	1097.16
					C =	0.46

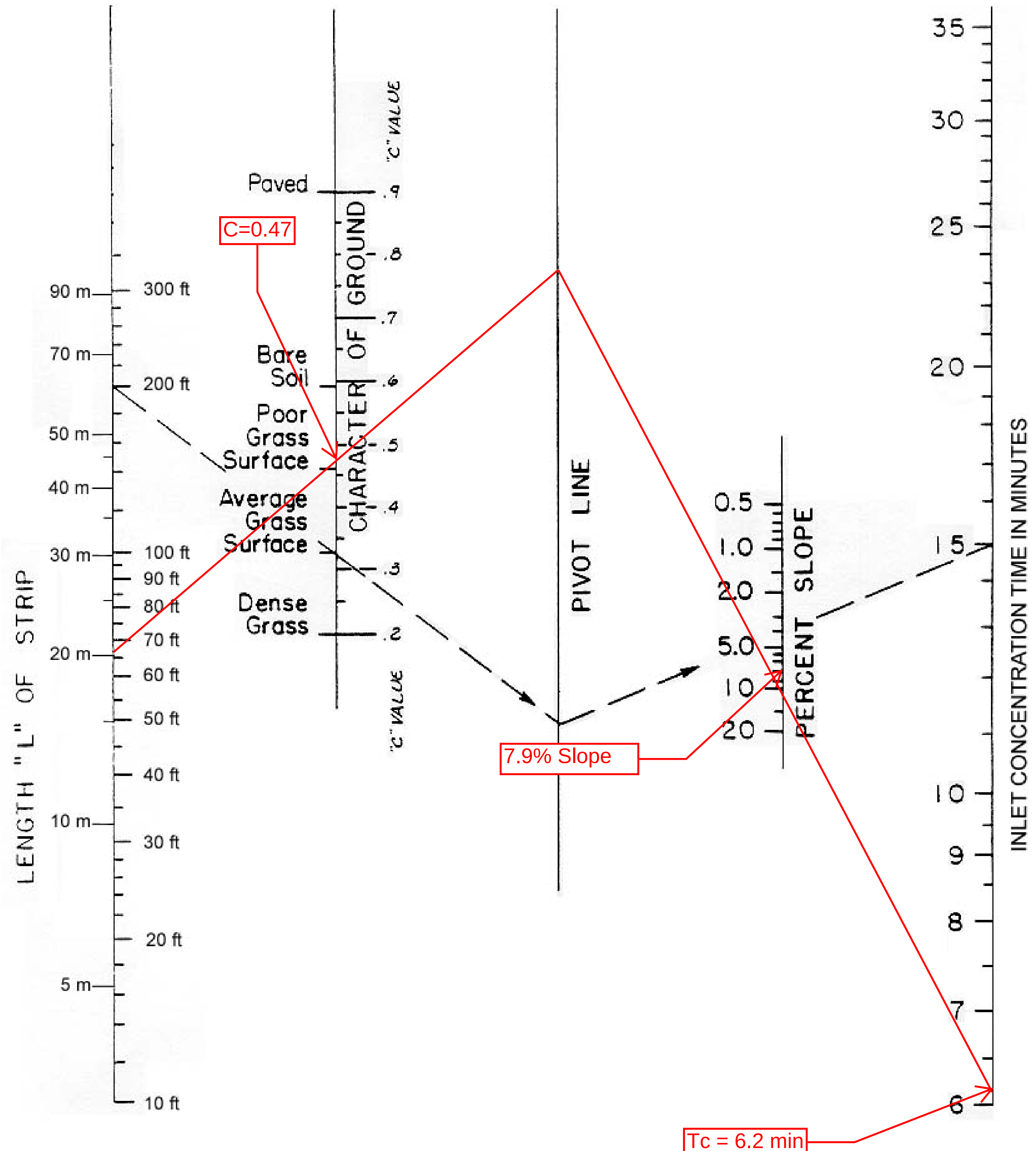
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Channel		
Length L (m)	24.5	75.6	-		
Upper Elevation (ft)	247.3	240.5	-		
Lower Elevation (ft)	241	225.5	-		
Watercourse Slope S	0.078	0.060	-		
Watercourse Slope in %	7.8	6.0	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	-		
Ku	-	1			
Equation to compute Velocity	-	Equation 3	-		
Velocity (m/s)	-	1.21	-		
Method to Compute Time	Figure 4-1	Equation 4	-		
Time (min)	7.4	1.04	-		
				Total Tc =	8.44

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.237	0.46	8.44	600	53	46	53.00	1	360	0.02	0.57
10-year	0.237	0.46	8.44	600	91	76	91.00	1	360	0.03	0.98
25-year	0.237	0.46	8.44	600	102	89	102	1.1	360	0.03	1.21
100-year	0.237	0.46	8.44	600	127	109	127.00	1.25	360	0.05	1.71

EXISTING DRAINAGE AREA 300C



city of san luis obispo PUBLIC WORKS DEPARTMENT	**Overland Flow Time** **SLO Creek Phase II Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

EXISTING DRAINAGE AREA 300C - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
	4,183	D	11.5	Vacant	0.45	1,882.4
	250	D	-	Impervious	0.87	217.5
						0.0
Total Area	4,433				Total =	2099.85
					C =	0.47

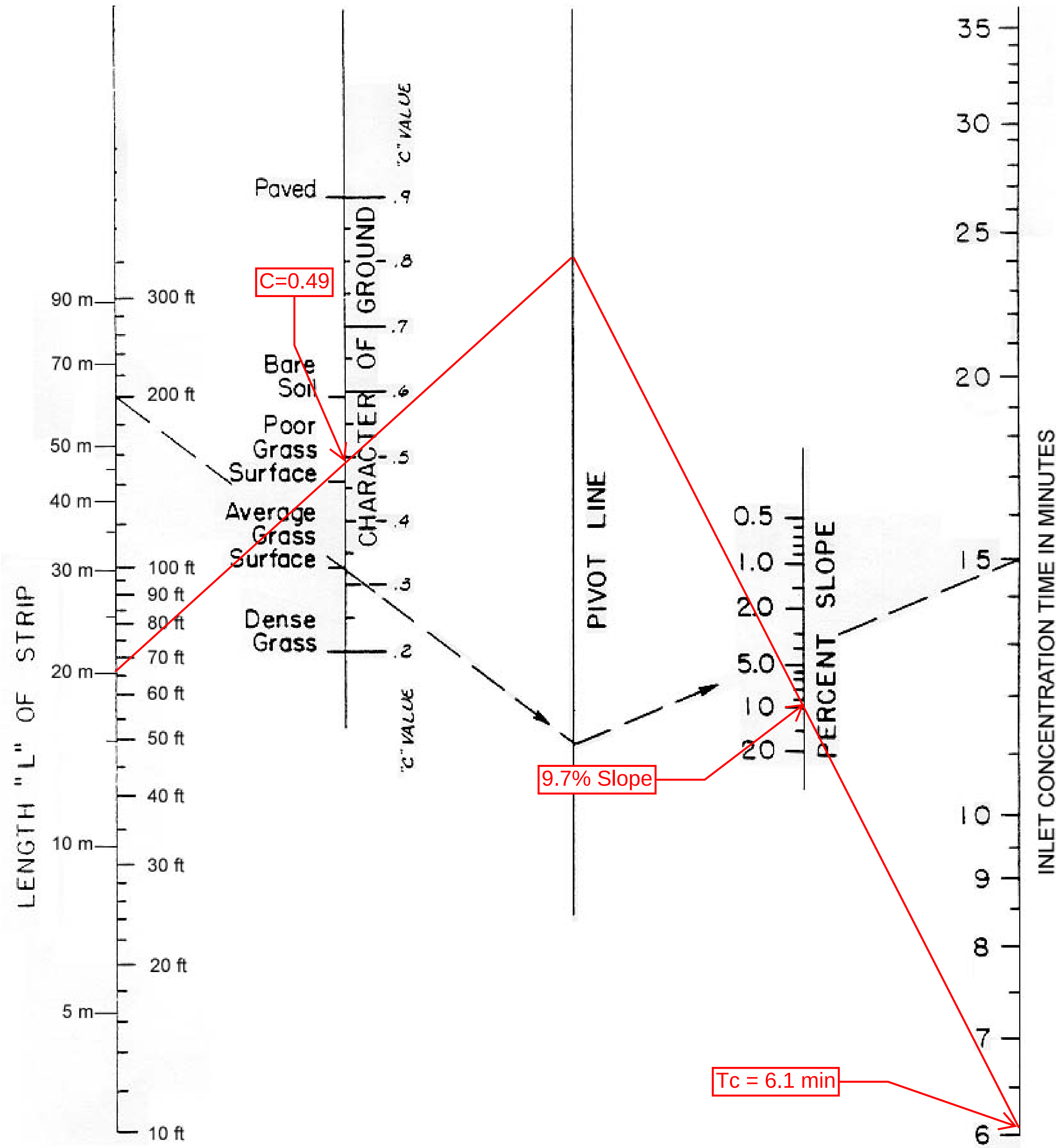
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Shallow Conc.		
Length L (m)	21	80	-		
Upper Elevation (ft)	247.9	240.7	-		
Lower Elevation (ft)	240	239	-		
Watercourse Slope S	0.115	0.006	-		
Watercourse Slope in %	11.5	0.6	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	-		
Ku	-	1	-		
Equation to compute Velocity	-	Equation 3	-		
Velocity (m/s)	-	0.40	-		
Method to Compute Time	Figure 4-1	Equation 4	-		
Time (min)	6.2	3.37	-		
				Total Tc =	9.57

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.443	0.47	9.57	600	53	46	53.00	1	360	0.03	1.09
10-year	0.443	0.47	9.57	600	91	76	91.00	1	360	0.05	1.87
25-year	0.443	0.47	9.57	600	102	89	102	1.1	360	0.07	2.31
100-year	0.443	0.47	9.57	600	127	109	127.00	1.25	360	0.09	3.27

EXISTING DRAINAGE AREA 400



city of san luis obispo PUBLIC WORKS DEPARTMENT	**Overland Flow Time** **SLO Creek Phase II Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

EXISTING DRAINAGE AREA 400 - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400	8,180	D	9.7	Vacant	0.45	3,681.0
	824	D	-	Impervious	0.87	716.9
						0.0
Total Area	9,004				Total =	4397.88
					C =	0.49

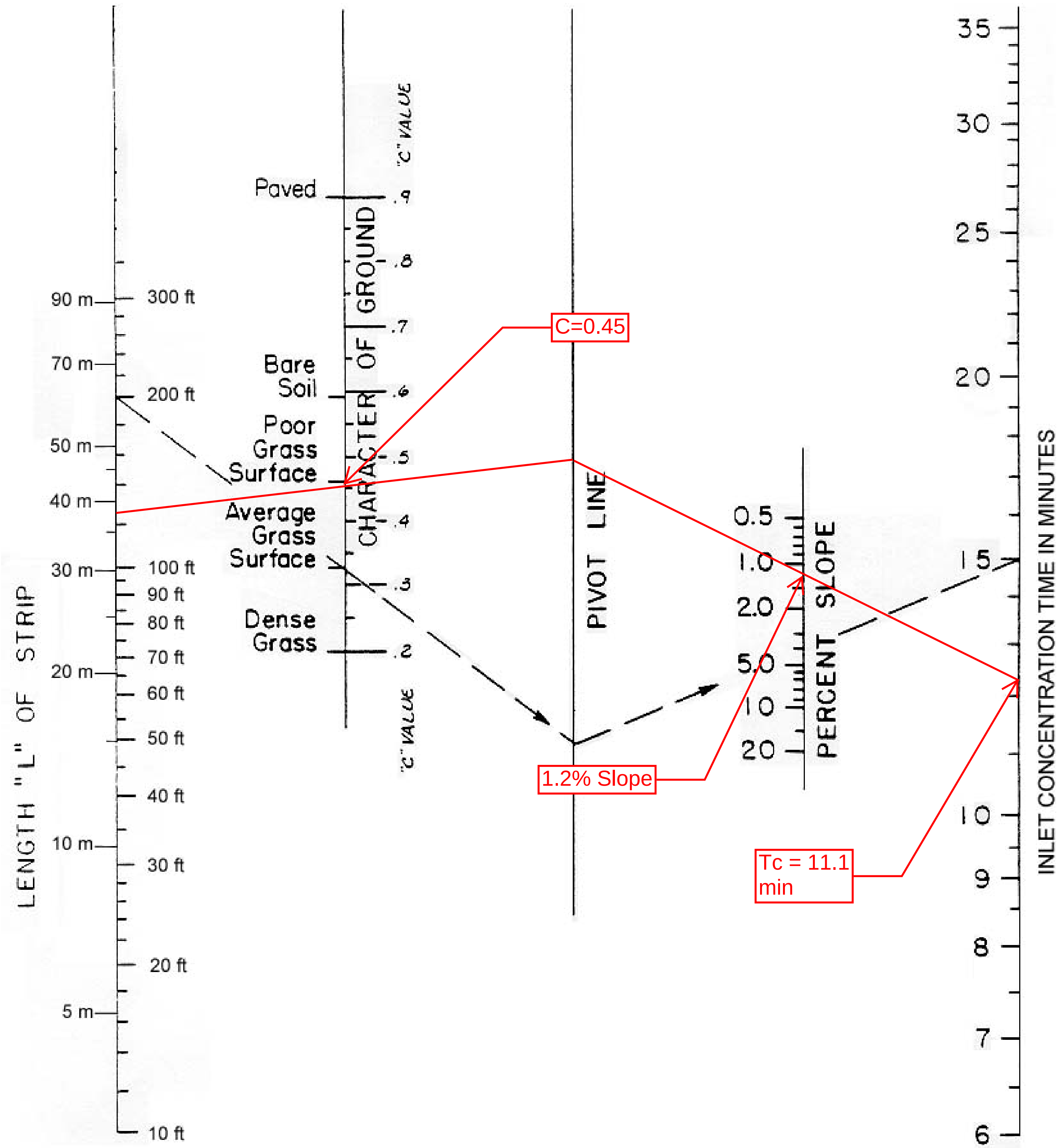
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Shallow Conc.		
Length L (m)	20.5	65	72.5		
Upper Elevation (ft)	246.8	240.5	236.5		
Lower Elevation (ft)	240.3	236.5	234		
Watercourse Slope S	0.097	0.019	0.011		
Watercourse Slope in %	9.7	1.9	1.1		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	0.491		
Ku	-	1	1		
Equation to compute Velocity	-	Equation 3	Equation 3		
Velocity (m/s)	-	0.67	0.50		
Method to Compute Time	Figure 4-1	Equation 4	Equation 4		
Time (min)	6.1	1.61	2.40		
				Total Tc =	10.11

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.900	0.49	10.11	600	53	46	52.84	1	360	0.06	2.28
10-year	0.900	0.49	10.11	600	91	76	90.67	1	360	0.11	3.91
25-year	0.900	0.49	10.11	600	102	89	101.71	1.1	360	0.14	4.83
100-year	0.900	0.49	10.11	600	127	109	126.60	1.25	360	0.19	6.83

EXISTING DRAINAGE AREA 500B



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Overland Flow Time

SLO Creek Phase II
Drainage Manual

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Figure

4-1

EXISTING DRAINAGE AREA 500B - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
500B	8,343	D	1.2	Vacant	0.45	3,754.4
		D	-			0.0
Total Area	8,343					3,754.4
					C =	0.45

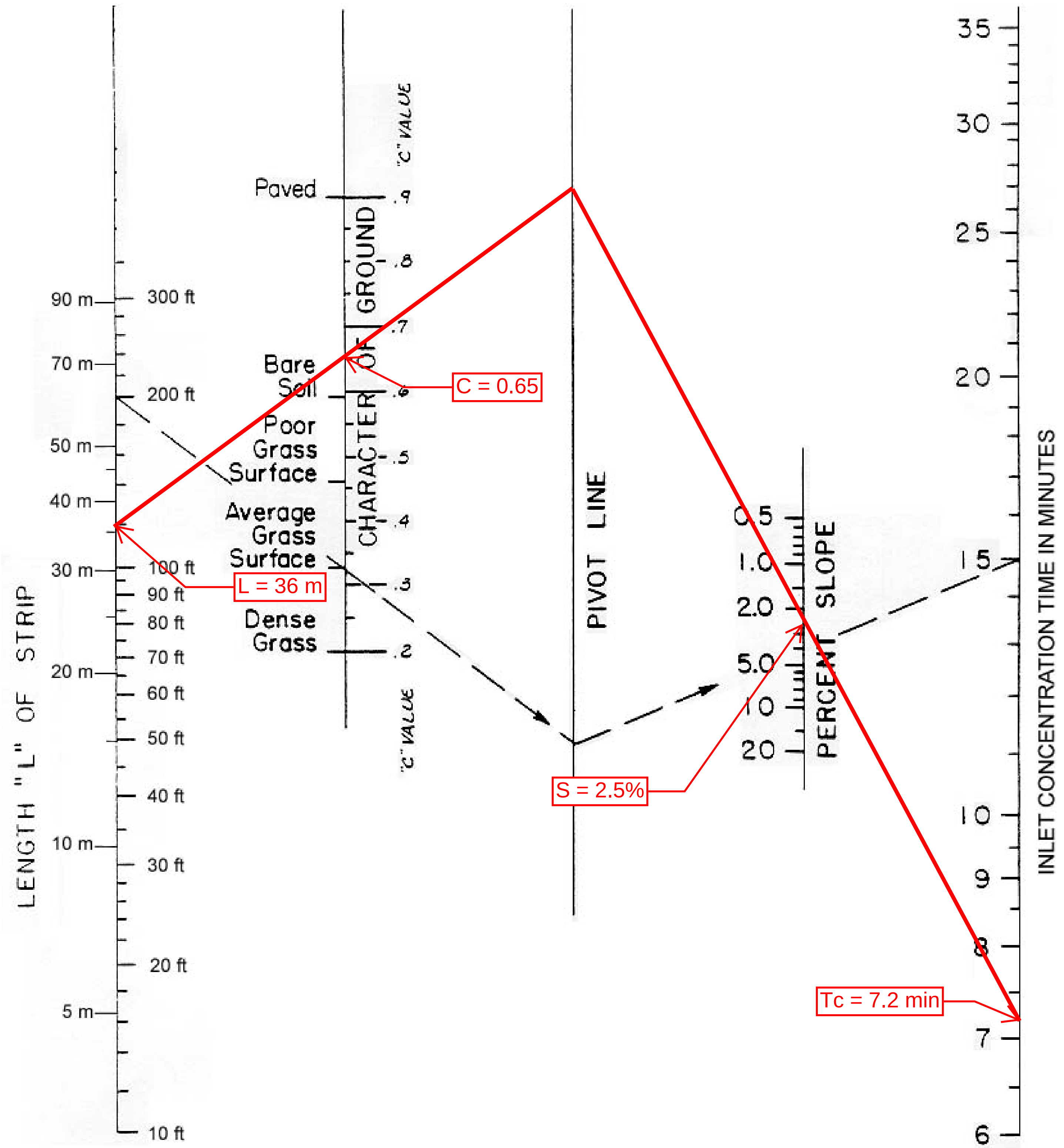
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Shallow Conc.		
Length L (m)	126	93.6	-		
Upper Elevation (ft)	247.1	242	-		
Lower Elevation (ft)	242	238	-		
Watercourse Slope S	0.012	0.013	-		
Watercourse Slope in %	1.2	1.3	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	0.491		
Ku	-	1	1		
Equation to compute Velocity	-	Equation 3	Equation 3		
Velocity (m/s)	-	0.56	-		
Method to Compute Time	Figure 4-1	Equation 4	Equation 4		
Time (min)	11.1	2.78	-		
				Total Tc =	13.88

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.834	0.45	13.88	600	53	46	47.56	1	360	0.05	1.75
10-year	0.834	0.45	13.88	600	91	76	79.35	1	360	0.08	2.92
25-year	0.834	0.45	13.88	600	102	89	91.90	1.1	360	0.11	3.72
100-year	0.834	0.45	13.88	600	127	109	113.02	1.25	360	0.15	5.20

PROPOSED DRAINAGE AREA 100



PROPOSED DRAINAGE AREA 100 - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
100	3196	D	2.5%	Impervious	0.87	2780.52
	754	D	2.5%	Dirt Road	0.35	263.9
	2,437	D	2.5%	Unimproved	0.45	1096.65
						0
Total Area	6,387				Total =	4141.07
					C =	0.65

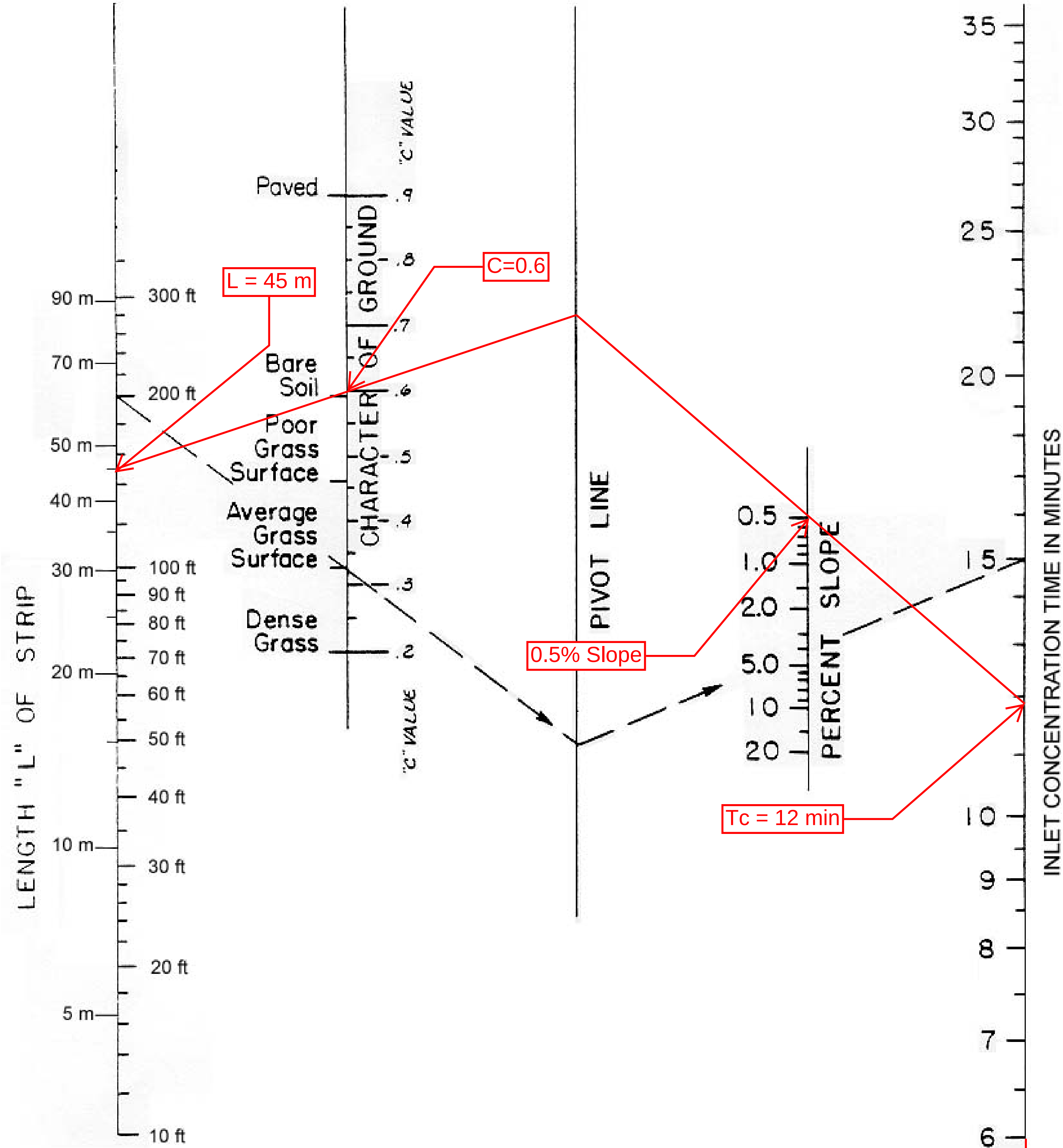
Time of Concentration Calculation

Segment	1	2				
Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (25 Year)
Length L (m)	36	157.6	46.53	46.53	46.53	46.53
Upper Elevation (ft)	246.8	243.8	231.52	231.52	231.52	231.52
Lower Elevation (ft)	243.8	237.8	230.76	230.76	230.76	230.76
Watercourse Slope S	0.025	0.012	0.005	0.005	0.005	0.005
Watercourse Slope in %	2.5	1.2	0.5	0.5	0.5	0.5
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.088	0.11	0.12	0.13
Interception Coefficient k	-	0.619	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 5	Equation 5	Equation 5	Equation 5
Velocity (m/s)	-	0.67	1.07	1.25	1.32	1.39
Method to Compute Time	Figure 4-1	Equation 4	Equation 6	Equation 6	Equation 6	Equation 6
Time (min)	7.2	3.94	0.72	0.62	0.59	0.56
		Total Tc =	11.86	11.76	11.73	11.70

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.64	0.65	11.86	600	53	46	50.39403	1	360	0.06	2.05
10-year	0.64	0.65	11.76	600	91	76	85.71525	1	360	0.10	3.48
25-year	0.64	0.65	11.73	600	102	89	97.51108	1.1	360	0.12	4.36
100-year	0.64	0.65	11.70	600	127	109	120.8944	1.25	360	0.17	6.14

PROPOSED DRAINAGE AREA 200



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Overland Flow Time

SLO Creek Phase II Drainage Manual

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Figure 4-1

PROPOSED DRAINAGE AREA 200 - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
200	448	D	0.5	Impervious	0.87	389.8
	829	D	15.2	Unimproved	0.45	373.1
	0	D	2.0%	Dirt Road	0.35	0.0
Total Area	1,277				Total =	762.8
					C =	0.60

Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Shallow Conc.		
Length L (m)	45	0.1	109		
Upper Elevation (ft)	233.4	0.1	243		
Lower Elevation (ft)	232.7	0.05	233.4		
Watercourse Slope S	0.005	0.152	0.027		
Watercourse Slope in %	0.5	15.2	2.7		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.619	0.619		
Ku	-	1	1		
Equation to compute Velocity	-	Equation 3	Equation 3		
Velocity (m/s)	-	2.42	1.01		
Method to Compute Time	Figure 4-1	Equation 4	Equation 4		
Time (min)	12	0.00			
				Total Tc =	12.00

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.13	0.60	12.00	600	53	46	50.19903	1	360	0.01	0.38
10-year	0.13	0.60	12.00	600	91	76	84.99793	1	360	0.02	0.64
25-year	0.13	0.60	12.00	600	102	89	96.79821	1.1	360	0.02	0.80
100-year	0.13	0.60	12.00	600	127	109	119.7975	1.25	360	0.03	1.12

PROPOSED DRAINAGE AREA 300 - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
300					0.45	0.0
	1,107	-	11.0	-	0.45	498.2
					0.1	0.0
Total Area	1,107				Total =	498.2
					C =	0.45

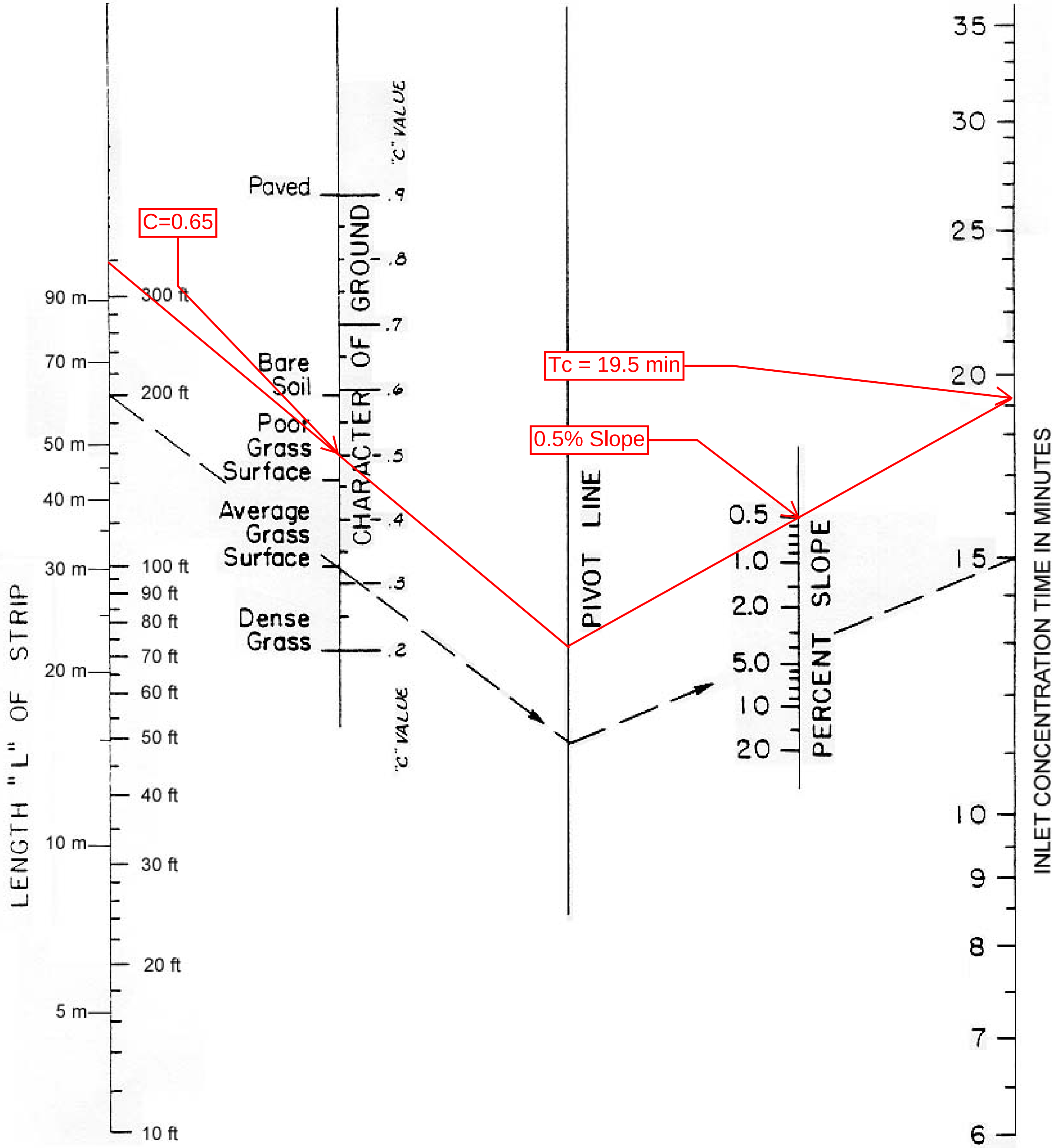
Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Channel		
Length L (m)		25	-		
Upper Elevation (ft)		237	-		
Lower Elevation (ft)		228	-		
Watercourse Slope S	#DIV/0!	0.110	-		
Watercourse Slope in %	#DIV/0!	11.0	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	-		
Ku	-	1			
Equation to compute Velocity	-	Equation 3	-		
Velocity (m/s)	-	1.63	-		
Method to Compute Time	Figure 4-1	Equation 4	-		
Time (min)	0	0.26	-		
				Total Tc =	0.26

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.11	0.45	0.26	600	53	46	53	1	360	0.01	0.26
10-year	0.11	0.45	0.26	600	91	76	91	1	360	0.01	0.44
25-year	0.11	0.45	0.26	600	102	89	102	1.1	360	0.02	0.55
100-year	0.11	0.45	0.26	600	127	109	127	1.25	360	0.02	0.78

PROPOSED DRAINAGE AREA 400A



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PUBLIC WORKS DEPARTMENT

Overland Flow Time

SLO Creek Phase II Drainage Manual

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Figure 4-1

PROPOSED DRAINAGE AREA 400A - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400A	799	D	0.5	Sparse Vegetation	0.45	359.6
	1,933	D	#DIV/0!	Dirt Road/Ballast	0.35	676.6
	908	-	#DIV/0!	Impervious	0.87	790.0
Total Area	3,640				Total =	1,826.1
					C =	0.50

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)			
Length L (m)	102	0	0			
Upper Elevation (ft)	240.9	0	0			
Lower Elevation (ft)	239.25	0	0			
Watercourse Slope S	0.005	#DIV/0!	#DIV/0!			
Watercourse Slope in %	0.5	#DIV/0!	#DIV/0!			
Watercourse n	-	-	0.013			
Approx. Channel top width (m)	-	-	-			
Approx Channel Depth (m)	-	-	-			
Hydraulic Radius (m)	-	-	0.053			
Interception Coefficient k	-	0.491	-			
Ku	-	1	1			
Equation to compute Velocity	-	Equation 3	Equation 3			
Velocity (m/s)	-	#DIV/0!	#DIV/0!			
Method to Compute Time	Figure 4-1	Equation 4	Equation 4			
Time (min)	19.5	0.00	0.00			
		Total Tc =	19.50			

Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.65	0.50	19.50	600	53	46	30	41.20	1	360	0.04	1.32
10-year	0.65	0.50	19.50	600	91	76	53	69.10	1.25	360	0.08	2.76
25-year	0.65	0.50	19.50	600	102	89	61	80.60	1.1	360	0.08	2.84
100-year	0.65	0.50	19.50	600	127	109	74	98.50	1.25	360	0.11	3.94

PROPOSED DRAINAGE AREA 400B - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400B	0	D	0.7	Sparse Vegetation	0.45	0.0
	481	D	0.7	Dirt Road/Ballast	0.35	168.4
	1612	-	0.7	Impervious	0.87	1,402.4
Total Area	2,093				Total =	1,570.8
					C =	0.75

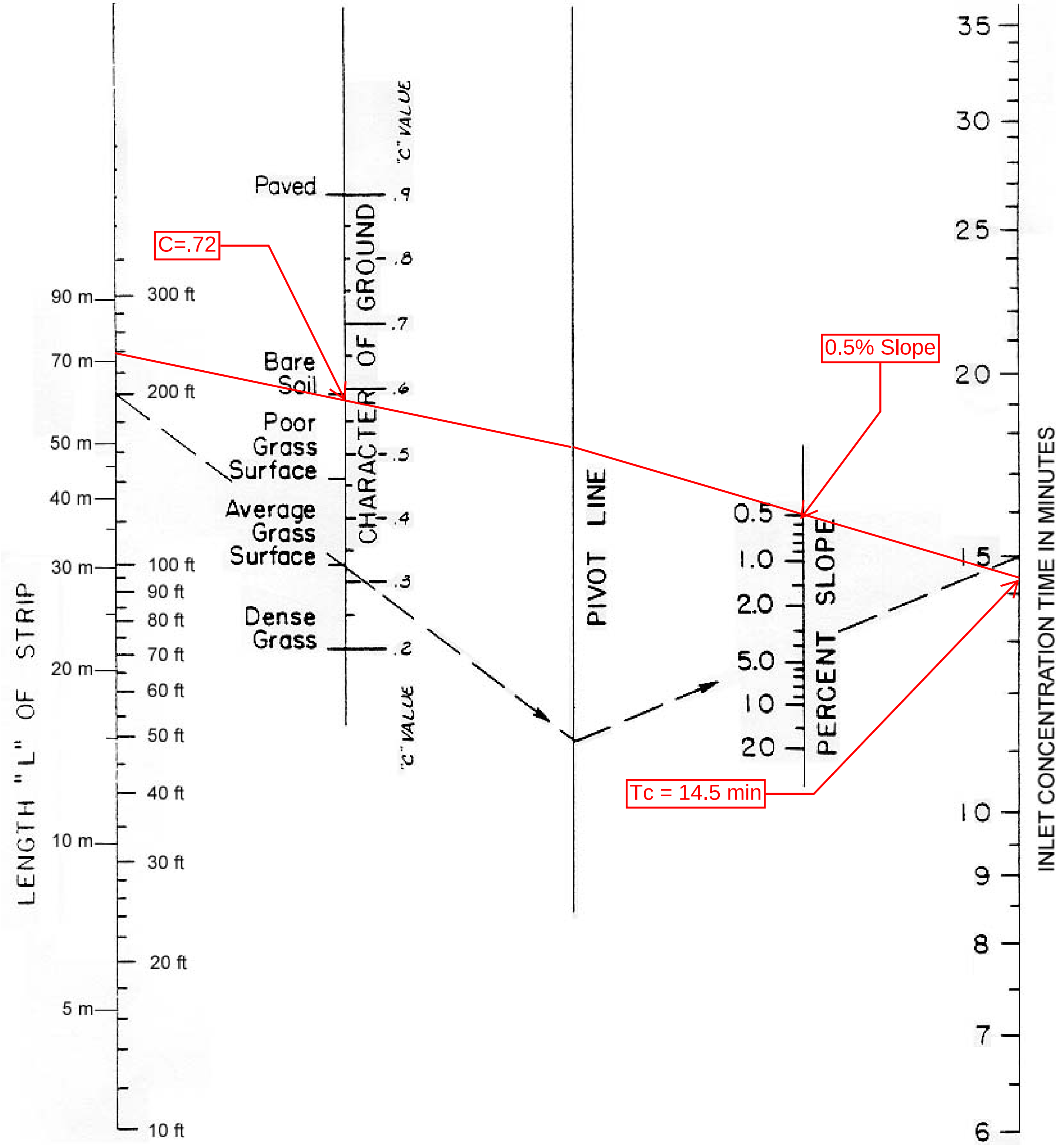
Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit		
Length L (m)	72	72	4.2		
Upper Elevation (ft)	240.9	240.9	230.3		
Lower Elevation (ft)	238.3	239.3	226.2		
Watercourse Slope S	0.011	0.007	0.298		
Watercourse Slope in %	1.1	0.7	29.8		
Watercourse n	-	-	0.013		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	0.0508		
Interception Coefficient k	-	0.491	0.491		
Ku	-	1	-		
Equation to compute Velocity	-	Equation 3	Equation 3		
Velocity (m/s)	-	0.40	5.76		
Method to Compute Time	Figure 4-1	Equation 4	Equation 4		
Time (min)		2.97	0.01		
				Total Tc =	2.98

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.21	0.75	2.98	600	53	46	30	53.00	1	360	0.02	0.82
10-year	0.21	0.75	2.98	600	91	76	53	91.00	1	360	0.04	1.40
25-year	0.21	0.75	2.98	600	102	89	61	89.00	1.1	360	0.04	1.51
100-year	0.21	0.75	2.98	600	127	109	74	127.00	1.25	360	0.07	2.45

PROPOSED DRAINAGE AREA 400C



city of san luis obispo PUBLIC WORKS DEPARTMENT	**Overland Flow Time** **SLO Creek Phase II Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

PROPOSED DRAINAGE AREA 400C - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400C	330	D	0.5	Unimproved	0.45	148.5
	1,248	D	3.0	Dirt Road/Ballast	0.35	436.8
	1177	-	3.8	Impervious	0.87	1,024.0
Total Area	2,755				Total =	1,609.3
					C =	0.58

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	71	0.01	38.1	38.1	38.1	38.1
Upper Elevation (ft)	240.89	1.001	235.7	235.7	235.7	235.7
Lower Elevation (ft)	239.7	1	231	231	231	231
Watercourse Slope S	0.005	0.030	0.038	0.038	0.038	0.038
Watercourse Slope in %	0.5	3.0	3.8	3.8	3.8	3.8
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.04	0.053	0.058	0.066
Interception Coefficient k	-	0.491	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	0.86	1.74	2.10	2.23	2.44
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	14.5	0.00	0.36	0.30	0.28	0.26
		Total Tc =	14.86	14.80	14.78	14.76

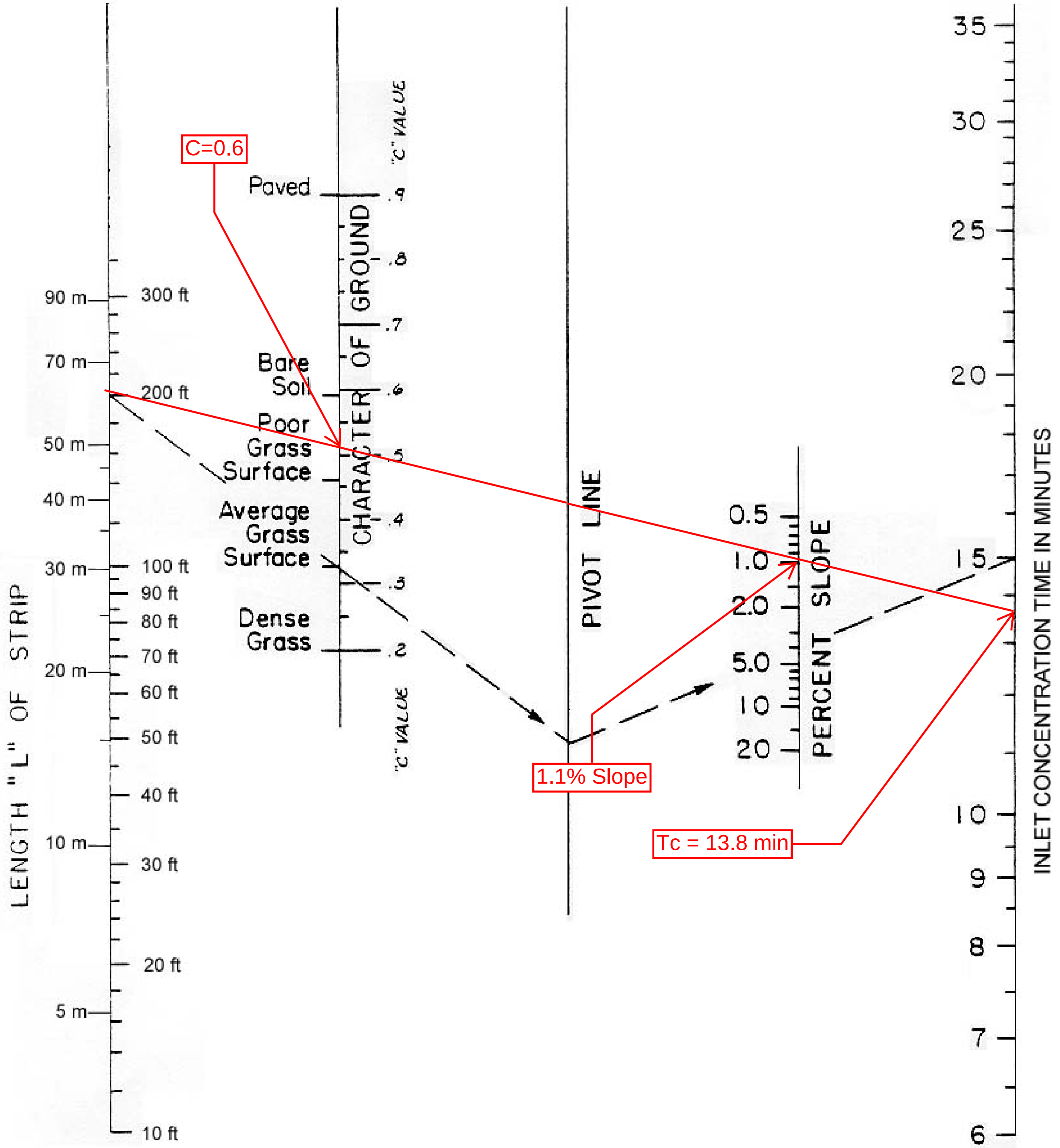
Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.28	0.58	14.50	600	53	46	30	46.70	1	360	0.02	0.74
10-year	0.28	0.58	14.50	600	91	76	53	77.50	1	360	0.03	1.22
25-year	0.28	0.58	14.50	600	102	89	61	90.30	1.1	360	0.04	1.57
100-year	0.28	0.58	14.50	600	127	109	74	110.80	1.25	360	0.06	2.19

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.28	0.58	14.86	600	53	46	30	46.19	1	360	0.02	0.73
10-year	0.28	0.58	14.80	600	91	76	53	76.59	1	360	0.03	1.21
25-year	0.28	0.58	14.78	600	102	89	61	89.56	1	360	0.04	1.41
100-year	0.28	0.58	14.76	600	127	109	74	109.86	1.25	360	0.06	2.17

PROPOSED DRAINAGE AREA 400D



city of san luis obispo	**Overland Flow Time** **SLO Creek Phase II Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

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PROPOSED DRAINAGE AREA 400D - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400D	3,571	D	1.1	Unimproved	0.45	1,607.0
	1,947	D	1.6	Dirt Road/Ballast	0.35	681.5
	2006	-	13.9	Impervious	0.87	1,745.2
Total Area	7,524				Total =	4,033.6
					C =	0.54

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	61	131	5.48	5.48	5.48	5.48
Upper Elevation (ft)	247.1	244.9	233.5	233.5	233.5	233.5
Lower Elevation (ft)	244.9	237.9	231	231	231	231
Watercourse Slope S	0.011	0.016	0.139	0.139	0.139	0.139
Watercourse Slope in %	1.1	1.6	13.9	13.9	13.9	13.9
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.04	0.051	0.055	0.066
Interception Coefficient k	-	0.491	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	0.63	3.35	3.94	4.15	4.68
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	13.8	3.48	0.03	0.02	0.02	0.02
		Total Tc =	17.31	17.31	17.31	17.30

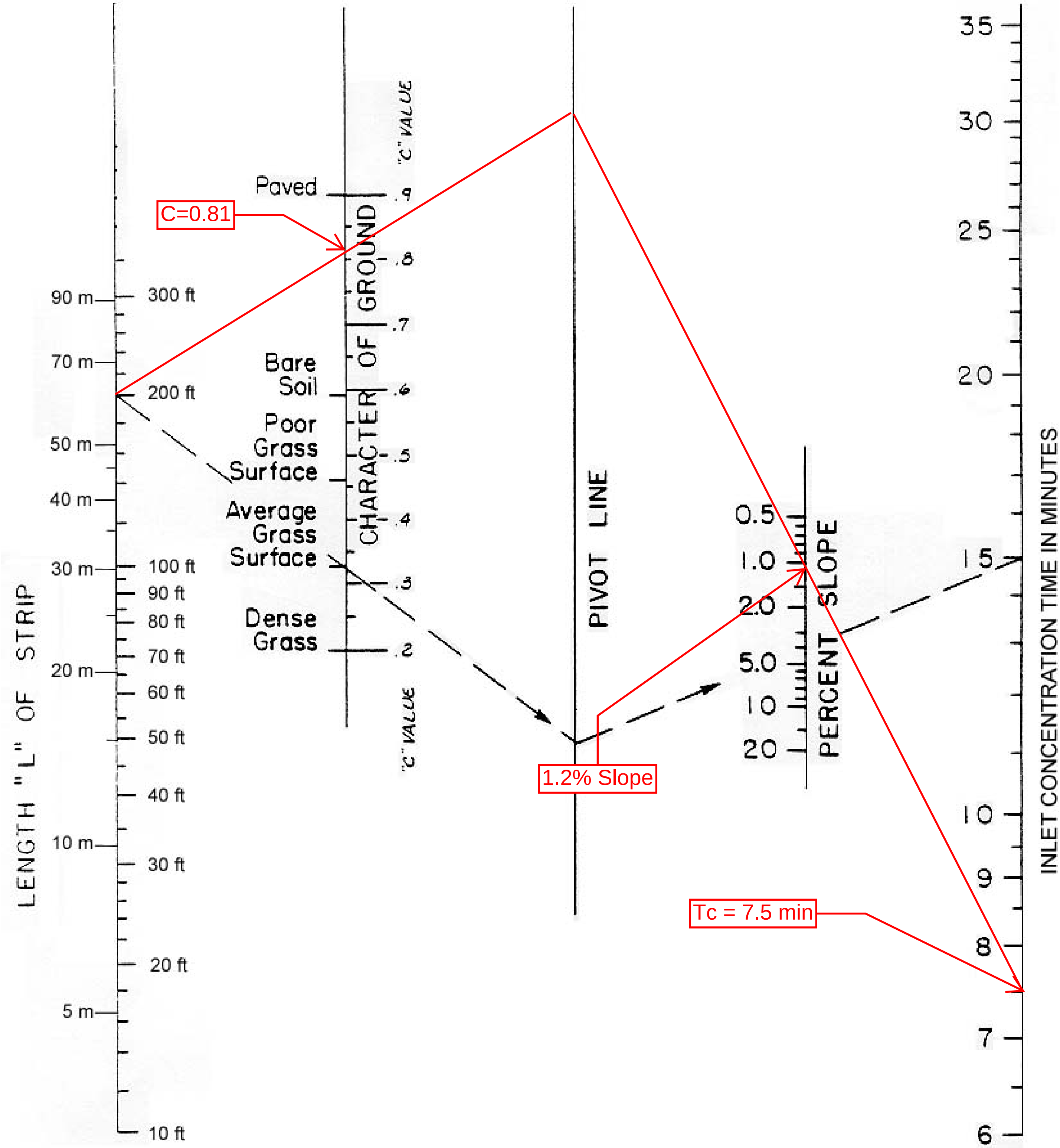
Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.75	0.54	17.28	600	53	46	30	43.56	1	360	0.05	1.72
10-year	0.75	0.54	17.28	600	91	76	53	72.50	1	360	0.08	2.87
25-year	0.75	0.54	17.28	600	102	89	61	84.74	1.1	360	0.10	3.69
100-year	0.75	0.54	17.28	600	127	109	74	103.67	1.25	360	0.15	5.13

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.75	0.54	17.31	600	53	46	30	43.53	1	360	0.05	1.72
10-year	0.75	0.54	17.31	600	91	76	53	72.46	1	360	0.08	2.87
25-year	0.75	0.54	17.31	600	102	89	61	84.69	1	360	0.09	3.35
100-year	0.75	0.54	17.30	600	127	109	74	103.62	1.25	360	0.15	5.12

PROPOSED DRAINAGE AREA 400E



city of san luis obispo PUBLIC WORKS DEPARTMENT		**Overland Flow Time** **SLO Creek Phase II Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

PROPOSED DRAINAGE AREA 400E - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400E	319	D	1.2	Unimproved	0.45	143.6
	223	D	0.5	Dirt Road/Ballast	0.35	78.1
	3757	-	5.9	Impervious	0.87	3,268.6
Total Area	4,299				Total =	3,490.2
					C =	0.81

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	78	55	5.18	5.18	5.18	5.18
Upper Elevation (ft)	239.5	237.7	230	230	230	230
Lower Elevation (ft)	236.5	236.8	229	229	229	229
Watercourse Slope S	0.012	0.005	0.059	0.059	0.059	0.059
Watercourse Slope in %	1.2	0.5	5.9	5.9	5.9	5.9
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.045	0.058	0.064	0.074
Interception Coefficient k	-	0.491	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	0.35	2.36	2.80	2.99	3.29
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	8.9	2.64	0.04	0.03	0.03	0.03
		Total Tc =	11.58	11.57	11.57	11.57

Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.43	0.81	11.54	600	53	46	30	50.84	1	360	0.05	1.74
10-year	0.43	0.81	11.54	600	91	76	53	86.37	1	360	0.08	2.96
25-year	0.43	0.81	11.54	600	102	89	61	97.99	1.1	360	0.10	3.69
100-year	0.43	0.81	11.54	600	127	109	74	121.44	1.25	360	0.15	5.20

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.43	0.81	11.58	600	53	46	30	50.79	1	360	0.05	1.74
10-year	0.43	0.81	11.57	600	91	76	53	86.28	1	360	0.08	2.95
25-year	0.43	0.81	11.57	600	102	89	61	97.91	1	360	0.09	3.35
100-year	0.43	0.81	11.57	600	127	109	74	121.35	1.25	360	0.15	5.19

PROPOSED DRAINAGE AREA 400F - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400F	279	D	#DIV/0!	Unimproved	0.45	125.6
	0	D	1.6	Dirt Road/Ballast	0.35	0.0
	581	-	0.6	Impervious	0.87	505.5
Total Area	860				Total =	631.0
					C =	0.73

Time of Concentration Calculation

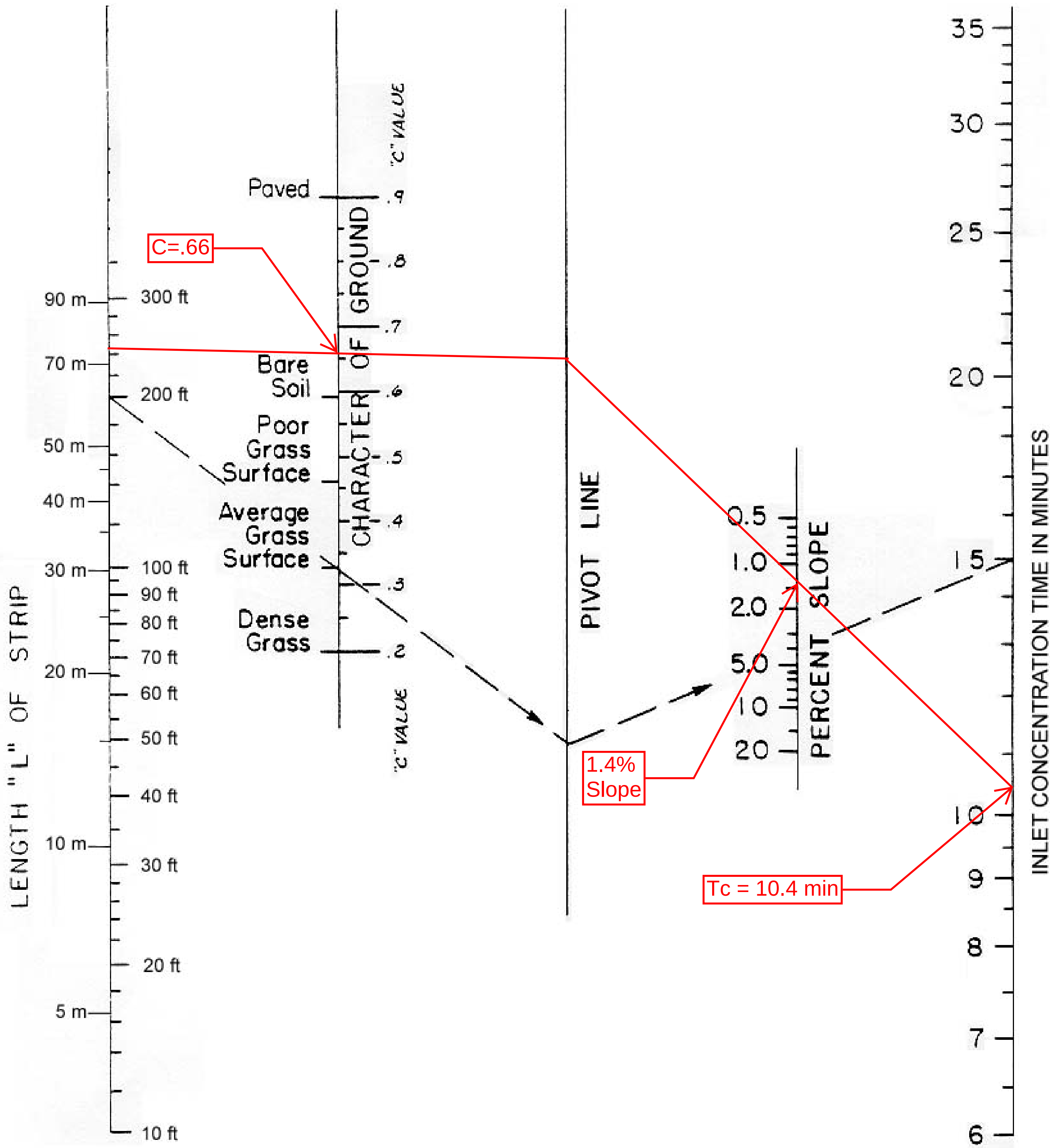
Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	0	119	10.75	10.75	10.75	10.75
Upper Elevation (ft)	0	238.6	228.4	228.4	228.4	228.4
Lower Elevation (ft)	0	232.3	228.2	228.2	228.2	228.2
Watercourse Slope S	#DIV/0!	0.016	0.006	0.006	0.006	0.006
Watercourse Slope in %	#DIV/0!	1.6	0.6	0.6	0.6	0.6
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.035	0.045	0.05	0.06
Interception Coefficient k	-	0.491	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	0.62	0.62	0.73	0.79	0.89
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	0	3.18	0.29	0.24	0.23	0.20
		Total Tc =	3.47	3.42	3.41	3.38

Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.09	0.73	3.18	600	53	46	30	53.00	1	360	0.01	0.33
10-year	0.09	0.73	3.18	600	91	76	53	91.00	1	360	0.02	0.56
25-year	0.09	0.73	3.18	600	102	89	61	102.00	1.1	360	0.02	0.69
100-year	0.09	0.73	3.18	600	127	109	74	127.00	1.25	360	0.03	0.98

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.09	0.73	3.47	600	53	46	30	53.00	1	360	0.01	0.33
10-year	0.09	0.73	3.42	600	91	76	53	91.00	1	360	0.02	0.56
25-year	0.09	0.73	3.41	600	102	89	61	102.00	1	360	0.02	0.63
100-year	0.09	0.73	3.38	600	127	109	74	127.00	1.25	360	0.03	0.98



city of san luis obispo PUBLIC WORKS DEPARTMENT	**Overland Flow Time** **SLO Creek Phase II Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

PROPOSED DRAINAGE AREA 400G - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400G	605	D	2.0	Unimproved	0.45	272.3
	0	D	1.0	Dirt Road/Ballast	0.35	0.0
	613	-	4.9	Impervious	0.87	533.3
Total Area	1,218				Total =	805.6
					C =	0.66

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	81	18.6	37	37	37	37
Upper Elevation (ft)	238.8	231.4	233.4	233.4	233.4	233.4
Lower Elevation (ft)	233.4	230.8	227.5	227.5	227.5	227.5
Watercourse Slope S	0.020	0.010	0.049	0.049	0.049	0.049
Watercourse Slope in %	2.0	1.0	4.9	4.9	4.9	4.9
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.012	0.025	0.027	0.033
Interception Coefficient k	-	0.491	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	0.49	0.89	1.45	1.53	1.74
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	10.4	0.64	0.69	0.43	0.40	0.35
		Total Tc =	11.73	11.46	11.44	11.39

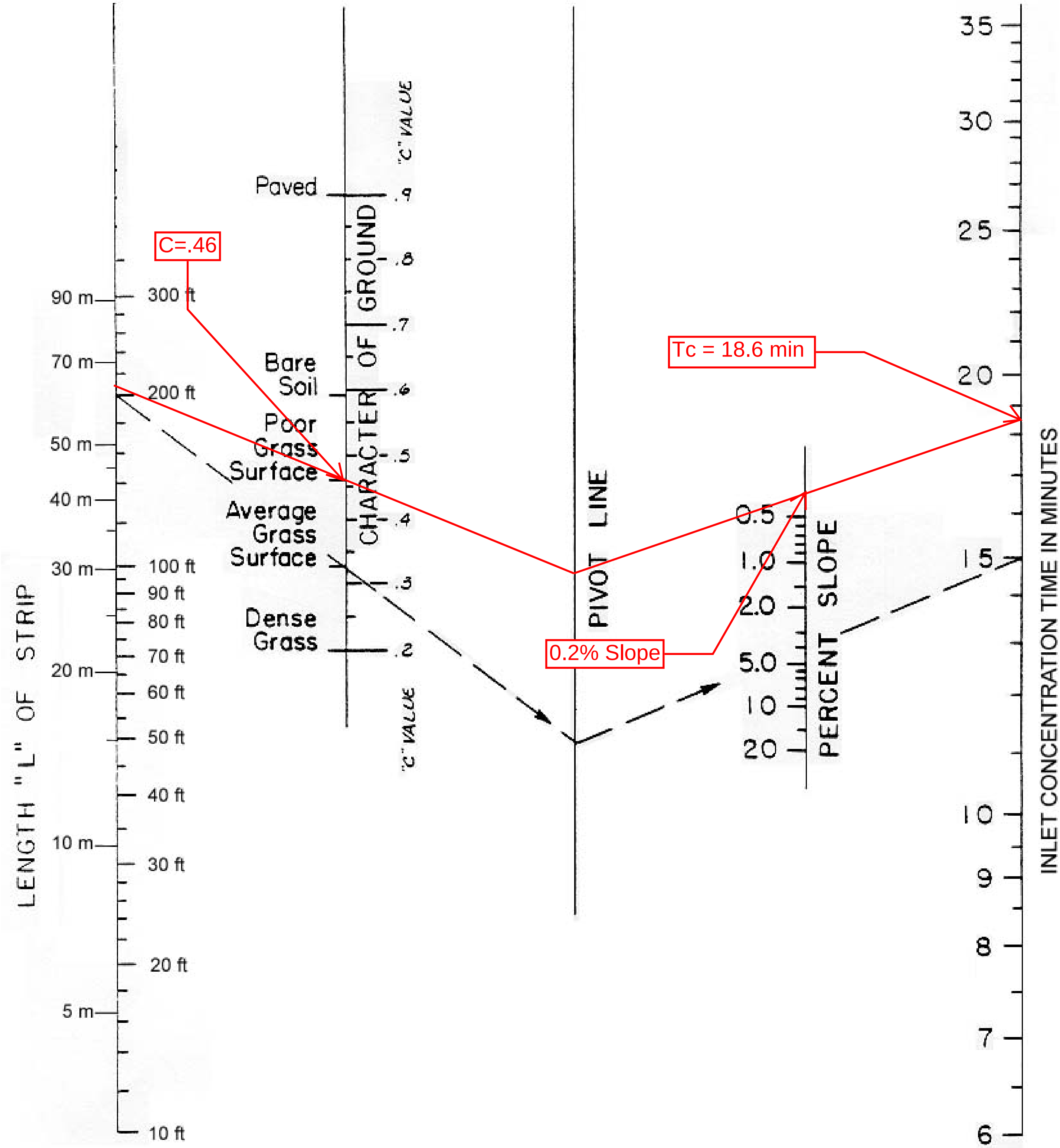
Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.12	0.66	11.04	600	53	46	30	51.55	1	360	0.01	0.41
10-year	0.12	0.66	11.04	600	91	76	53	87.89	1	360	0.02	0.69
25-year	0.12	0.66	11.04	600	102	89	61	99.30	1.1	360	0.02	0.86
100-year	0.12	0.66	11.04	600	127	109	74	123.27	1.25	360	0.03	1.22

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.12	0.66	11.73	600	53	46	30	50.58	1	360	0.01	0.40
10-year	0.12	0.66	11.46	600	91	76	53	86.61	1	360	0.02	0.68
25-year	0.12	0.66	11.44	600	102	89	61	98.25	1	360	0.02	0.78
100-year	0.12	0.66	11.39	600	127	109	74	122.00	1.25	360	0.03	1.20

PROPOSED DRAINAGE AREA 400H



City of San Luis Obispo Public Works Department		**Overland Flow Time** **SLO Creek Phase II** **Drainage Manual** QUESTA ENGINEERING CORPORATION	**Figure** 4-1

PROPOSED DRAINAGE AREA 400H - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400H	3,603	D	0.2	Unimproved	0.45	1,621.4
	3,123	D	2.0	Dirt Road/Ballast	0.35	1,093.1
	981	-	5.4	Impervious	0.87	853.5
Total Area	7,707				Total =	3,567.9
					C =	0.46

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	66.7	200	39	39	39	39
Upper Elevation (ft)	248.2	247.7	234.4	234.4	234.4	234.4
Lower Elevation (ft)	247.7	234.4	227.5	227.5	227.5	227.5
Watercourse Slope S	0.002	0.020	0.054	0.054	0.054	0.054
Watercourse Slope in %	0.2	2.0	5.4	5.4	5.4	5.4
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.012	0.025	0.027	0.033
Interception Coefficient k	-	0.491	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	0.70	0.94	1.53	1.61	1.84
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	18.6	4.77	0.69	0.43	0.40	0.35
		Total Tc =	24.06	23.79	23.77	23.72

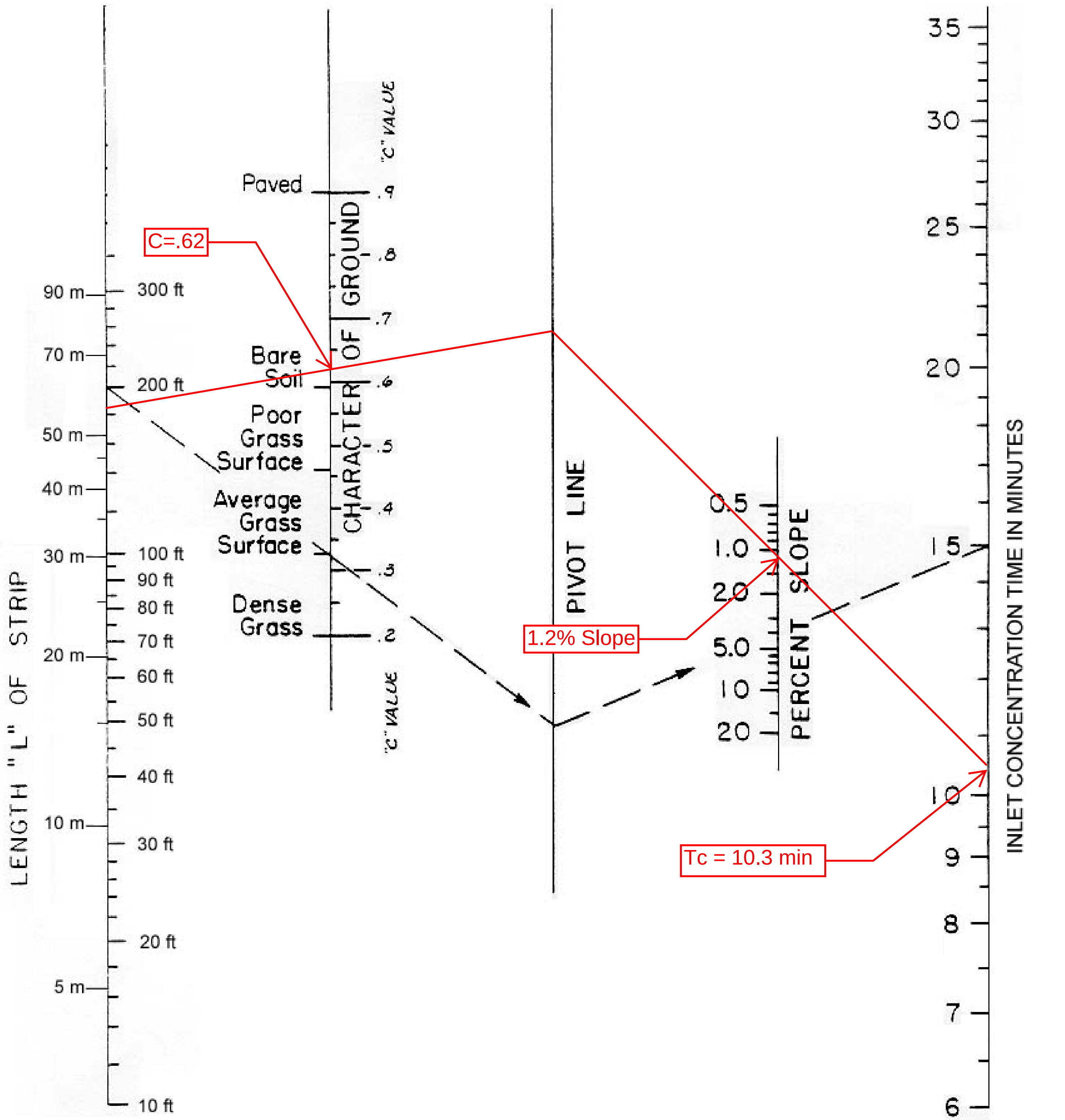
Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.77	0.46	23.37	600	53	46	30	37.07	1	360	0.04	1.30
10-year	0.77	0.46	23.37	600	91	76	53	63.17	1	360	0.06	2.21
25-year	0.77	0.46	23.37	600	102	89	61	73.38	1.1	360	0.08	2.82
100-year	0.77	0.46	23.37	600	127	109	74	89.47	1.25	360	0.11	3.91

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.77	0.46	24.06	600	53	46	30	36.33	1	360	0.04	1.27
10-year	0.77	0.46	23.79	600	91	76	53	62.52	1	360	0.06	2.19
25-year	0.77	0.46	23.77	600	102	89	61	72.62	1	360	0.07	2.54
100-year	0.77	0.46	23.72	600	127	109	74	88.65	1.25	360	0.11	3.88

PROPOSED DRAINAGE AREA 400I



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Overland Flow Time

SLO Creek Phase II
Drainage Manual

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Figure

4-1

PROPOSED DRAINAGE AREA 400I - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400I	1,532	D	1.2	Unimproved	0.45	689.4
	346	D	#DIV/0!	Dirt Road/Ballast	0.35	121.1
	1356	-	5.5	Impervious	0.87	1,179.7
Total Area	3,234				Total =	1,990.2
	3234				C =	0.62

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	61	0	10.5	10.5	10.5	10.5
Upper Elevation (ft)	241	0	228.4	228.4	228.4	228.4
Lower Elevation (ft)	238.5	0	226.5	226.5	226.5	226.5
Watercourse Slope S	0.012	#DIV/0!	0.055	0.055	0.055	0.055
Watercourse Slope in %	1.2	#DIV/0!	5.5	5.5	5.5	5.5
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.012	0.025	0.027	0.033
Interception Coefficient k	-		-	-	-	-
Ku	-		1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	#DIV/0!	0.95	1.54	1.63	1.86
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	10.3	0.00	0.18	0.11	0.11	0.09
		Total Tc =	10.48	10.41	10.41	10.39

Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.32	0.62	10.30	600	53	46	30	53.00	1	360	0.03	1.03
10-year	0.32	0.62	10.30	600	91	76	53	91.00	1	360	0.05	1.78
25-year	0.32	0.62	10.30	600	102	89	61	102.00	1.1	360	0.06	2.19
100-year	0.32	0.62	10.30	600	127	109	74	127.00	1.25	360	0.09	3.10

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.32	0.62	10.48	600	53	46	30	53.00	1	360	0.03	1.03
10-year	0.32	0.62	10.41	600	91	76	53	91.00	1	360	0.05	1.78
25-year	0.32	0.62	10.41	600	102	89	61	102.00	1	360	0.06	1.99
100-year	0.32	0.62	10.39	600	127	109	74	127.00	1.25	360	0.09	3.10

PROPOSED DRAINAGE AREA 400J

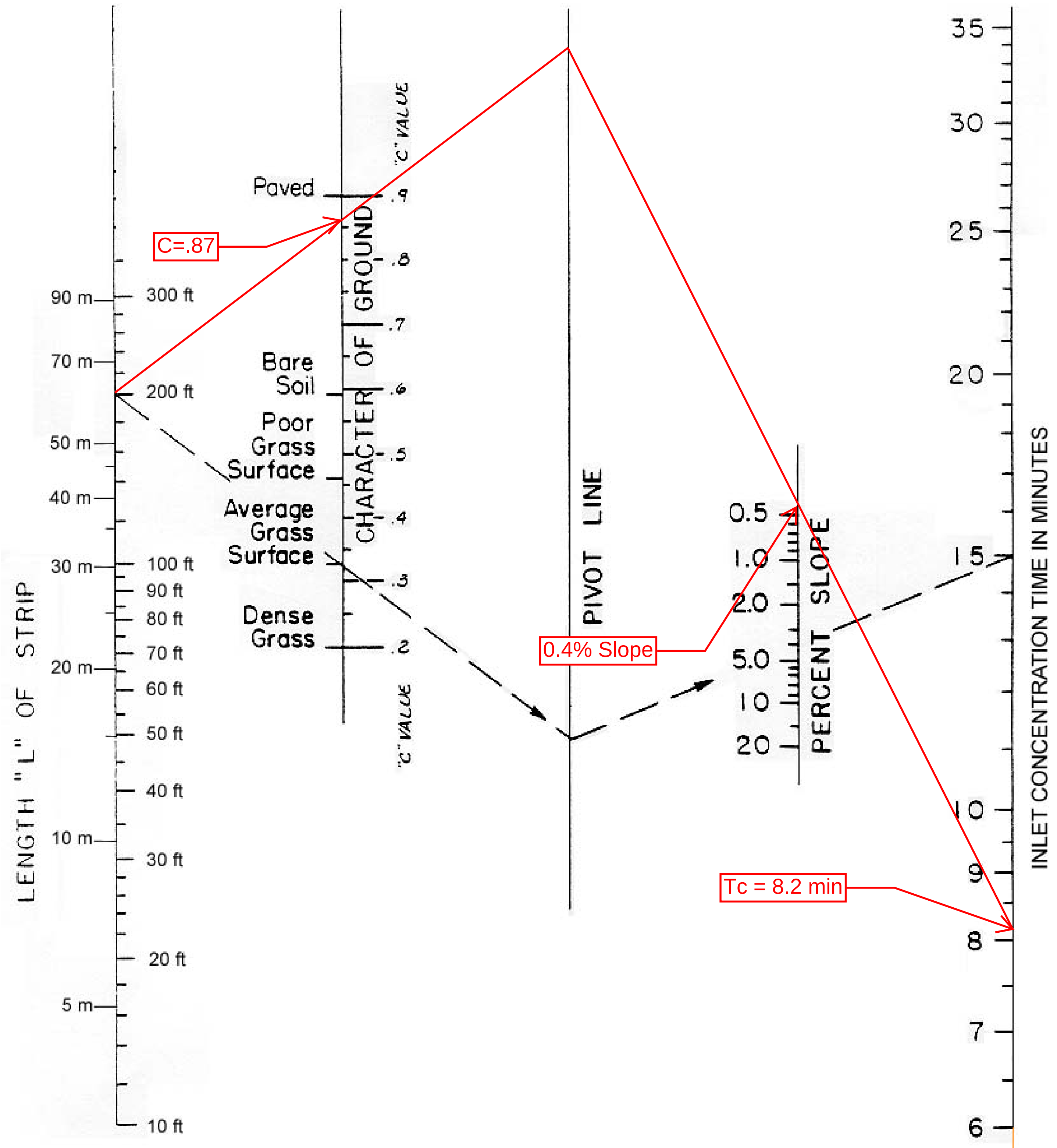

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Figure

4-1

PROPOSED DRAINAGE AREA 400J - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation

Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
400J	0	D	0.4	Unimproved	0.45	0.0
	0	D	0.1	Dirt Road/Ballast	0.65	0.0
	1901	-	50.0	Impervious	0.87	1,653.9
Total Area	1,901				Total =	1,653.9
	1901				C =	0.87

Time of Concentration Calculation

Type of Flow	Overland	Shallow Conc.	Closed Conduit (2 Year)	Closed Conduit (10 Year)	Closed Conduit (25 Year)	Closed Conduit (100 Year)
Length L (m)	66	66	5	5	5	5
Upper Elevation (ft)	239.6	238.8	234	234	234	234
Lower Elevation (ft)	238.8	238.5	225.8	225.8	225.8	225.8
Watercourse Slope S	0.004	0.001	0.500	0.500	0.500	0.500
Watercourse Slope in %	0.4	0.1	50.0	50.0	50.0	50.0
Watercourse n	-	-	0.013	0.013	0.013	0.013
Approx. Channel top width (m)	-	-	-	-	-	-
Approx Channel Depth (m)	-	-	-	-	-	-
Hydraulic Radius (m)	-	-	0.012	0.025	0.027	0.033
Interception Coefficient k	-	0.491	-	-	-	-
Ku	-	1	1	1	1	1
Equation to compute Velocity	-	Equation 3	Equation 3	Equation 3	Equation 3	Equation 3
Velocity (m/s)	-	0.18	2.85	4.65	4.89	5.60
Method to Compute Time	Figure 4-1	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
Time (min)	8.2	6.02	0.03	0.02	0.02	0.01
		Total Tc =	14.25	14.24	14.24	14.23

Runoff for calculation of Hydraulic Radius

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.19	0.87	14.22	600	53	46	30	53.00	1	360	0.02	0.86
10-year	0.19	0.87	14.22	600	91	76	53	91.00	1	360	0.04	1.48
25-year	0.19	0.87	14.22	600	102	89	61	102.00	1.1	360	0.05	1.82
100-year	0.19	0.87	14.22	600	127	109	74	127.00	1.25	360	0.07	2.58

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	30	I (time)	Ca	Kc	Q m^3/s	Q ft^3/s
2-year	0.19	0.87	14.25	600	53	46	30	53.00	1	360	0.02	0.86
10-year	0.19	0.87	14.24	600	91	76	53	91.00	1	360	0.04	1.48
25-year	0.19	0.87	14.24	600	102	89	61	102.00	1	360	0.05	1.65
100-year	0.19	0.87	14.23	600	127	109	74	127.00	1.25	360	0.07	2.58

PROPOSED DRAINAGE AREA 500

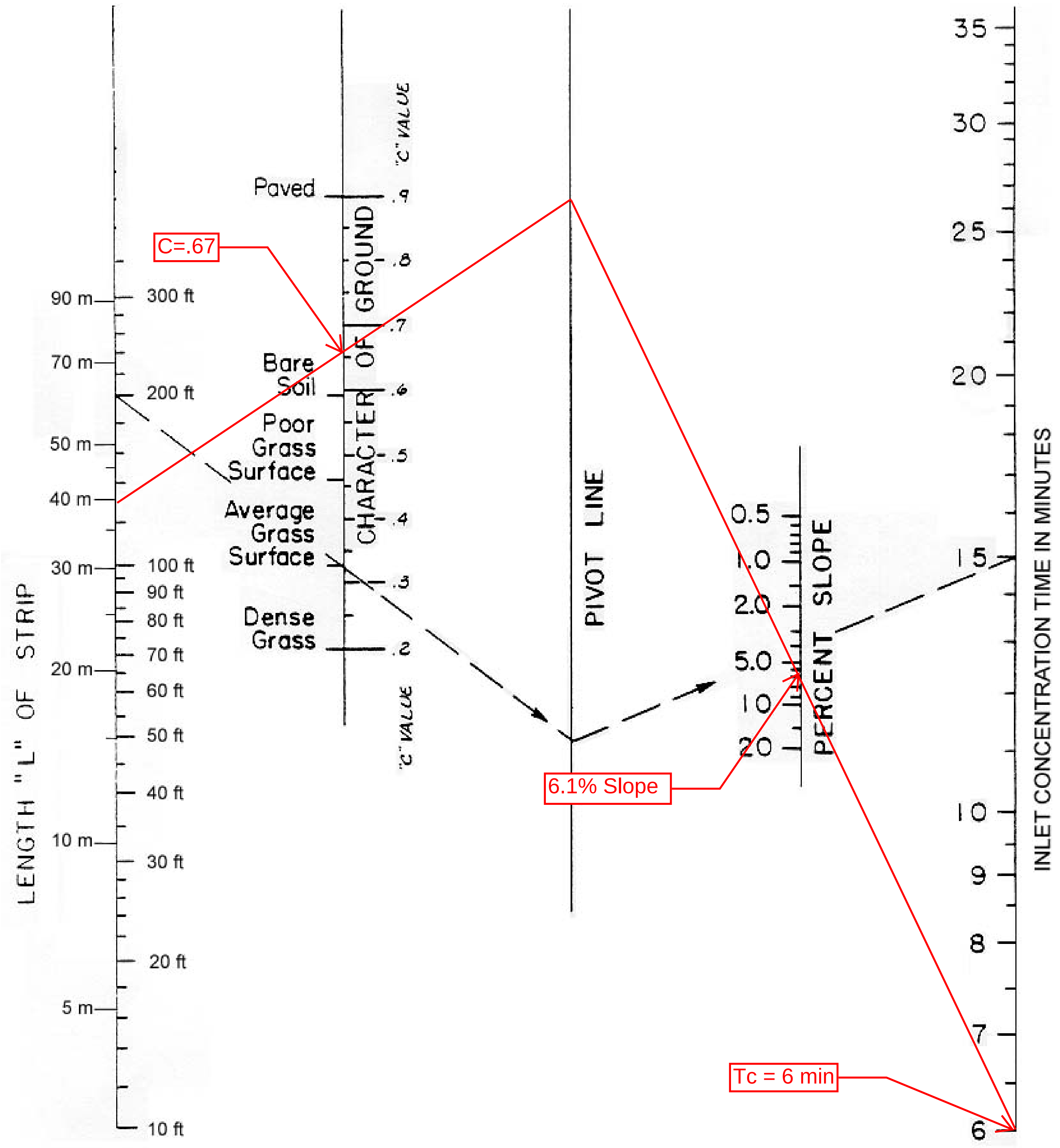

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Figure 4-1

PROPOSED DRAINAGE AREA 500 - HYDROLOGY CALCULATION

Composite Runoff Coefficient Computation						
Drainage Area	Area (m^2)	Soil Group	Slope (%)	Land Use	C	C * Area
500	614	D	0.0	Sparse Vegetation	0.45	276.3
	253	-	0.0	Asphalt	0.85	215.1
					0.1	0.0
Total Area	867				Total =	491.4
					C =	0.57

Time of Concentration Calculation

Segment	1	2	3		
Type of Flow	Overland	Shallow Conc.	Shallow Conc.		
Length L (m)	67.4	1	-		
Upper Elevation (ft)	238.8	0	-		
Lower Elevation (ft)	230.3	0	-		
Watercourse Slope S	0.038	0.000	-		
Watercourse Slope in %	3.8	0.0	-		
Watercourse n	-	-	-		
Approx. Channel top width (m)	-	-	-		
Approx Channel Depth (m)	-	-	-		
Hydraulic Radius (m)	-	-	-		
Interception Coefficient k	-	0.491	-		
Ku	-	1	-		
Equation to compute Velocity	-	Equation 3	-		
Velocity (m/s)	-	0.00	-		
Method to Compute Time	Figure 4-1	Equation 4	Equation 4		
Time (min)	6	0.00	-		
				Total Tc =	6.00

Rational Method Runoff Rate Computation

Recurrence Interval	Area (hectares)	C	Tc (min)	Annual Precip (mm)	Intensity (min) 10	15	I (time)	Ca	Kc	Q m^3/s	ft^3/s
2-year	0.09	0.57	6.00	600	53	46	53	1	360	0.01	0.26
10-year	0.09	0.57	6.00	600	91	76	91	1	360	0.01	0.44
25-year	0.09	0.57	6.00	600	102	89	102	1.1	360	0.02	0.54
100-year	0.09	0.57	6.00	600	127	109	127	1.25	360	0.02	0.77

Confluence Calculator

Runoff at Manhole STA 22+24 ~ 17.50'LT											
		LINE A	LINE B	QA	IA	TcA	QB	IB	Tc B	Qp	Tc (revised)
400 A to 400 B	2-Year	400A	400B	1.32	41.20	19.50	0.82	53.00	2.98	1.95	19.55
	10-Year			2.76	69.10	19.50	1.40	91.00	2.98	3.83	19.54
	25-Year			2.84	80.60	19.50	1.51	89.00	2.98	4.20	19.54
	100-Year			3.94	98.50	19.50	2.45	127.00	2.98	5.83	19.54
Runoff at Manhole STA 22+24 ~ 75.67'RT											
		LINE A	LINE B	QA	IA	TcA	QB	IB	Tc B	Qp	Tc (revised)
400 G to 400 H	2-Year	400G	400H	0.40	50.58	11.73	1.27	36.33	24.06	1.56	25.57
	10-Year			0.68	86.61	11.46	2.19	62.52	23.79	2.68	25.10
	25-Year			0.78	98.25	11.44	2.54	72.62	23.77	3.12	25.02
	100-Year			1.20	122.00	11.39	3.88	88.65	23.72	4.75	24.84
Runoff at Manhole STA 22+24 ~ 75.67'RT											
		LINE A	LINE B	QA	IA	TcA	QB	IB	Tc B	Qp	Tc (revised)
400 G&H &100	2-Year	Comb 400G&H	100.00	1.56	34.73	25.57	2.05	50.39	11.86	2.77	11.86
	10-Year			2.68	60.51	25.10	3.48	85.72	11.76	4.74	11.76
	25-Year			3.12	70.30	25.02	4.36	97.51	11.73	5.82	11.73
	100-Year			4.75	86.04	24.84	6.14	120.89	11.70	8.38	11.70
Runoff at Manhole STA 22+24 ~ 75.67'RT											
		LINE A	LINE B	QA	IA	TcA	QB	IB	Tc B	Qp	Tc (revised)
400 G&H to 400 I	2-Year	Comb 400G&H &100	400I	2.77	50.40	11.86	1.03	53.00	10.48	3.75	12.55
	10-Year			4.74	85.72	11.76	1.78	91.00	10.41	6.41	12.35
	25-Year			5.82	97.51	11.73	1.99	102.00	10.41	7.72	12.29
	100-Year			8.38	120.89	11.70	3.10	127.00	10.39	11.33	12.20
Comingle Runoff at Manhole STA 22+24 ~ 75.67' RT											
		LINE A-B	LINE G-H	QA	IA	TcA	QH	IH	Tc H	Qp	Tc (revised)
Comb. Above	2-Year	Comb 400 A&B	Comb 100, 400 G,H&I	1.95	41.20	19.55	3.75	53.00	12.55	5.27	12.55
	10-Year			3.83	69.10	19.54	6.41	83.94	12.35	9.56	12.35
	25-Year			4.20	80.60	19.54	7.72	96.03	12.29	11.25	12.29
	100-Year			5.83	98.50	19.54	11.33	119.06	12.20	16.15	12.20
Runoff at Manhole STA 26+70											
		Line A	Line B	QA	IA	Tc A	QB	IB	Tc B	Qp	Tc (revised)
400 C to 400 D	2-Year	400C	400D	0.73	46.19	14.86	1.72	43.53	17.31	2.41	17.49
	10-Year			1.21	76.59	14.80	2.87	72.46	17.31	4.01	17.46
	25-Year			1.41	89.56	14.78	3.35	84.69	17.31	4.69	17.45
	100-Year			2.17	109.86	14.76	5.12	103.62	17.30	7.17	17.43
Runoff at Manhole STA 26+18											
400 C&D to 400 E	2-Year	400C&D	400E	2.41	43.34	17.49	1.74	50.79	11.58	3.89	17.84
	10-Year			4.01	72.23	17.46	2.95	86.28	11.57	6.48	17.77
	25-Year			4.69	84.42	17.45	3.35	97.91	11.57	7.58	17.75
	100-Year			7.17	103.32	17.43	5.19	121.35	11.57	11.59	17.71
Runoff at Manhole STA 25+07											
400 C,D&E to 400 F	2-Year	400C,D&E	400F	3.89	42.97	17.84	0.33	53.00	3.47	4.16	17.84
	10-Year			6.48	71.75	17.77	0.56	91.00	3.42	6.93	17.77
	25-Year			7.58	83.86	17.75	0.63	102.00	3.41	8.10	17.75
	100-Year			11.59	102.67	17.71	0.98	127.00	3.38	12.38	17.71
Runoff at Manhole 22+24 with DA 400J											
400 C thru F to 400 J	2-Year	400C, D, E & F	400J	4.16	42.97	17.84	0.86	53.00	14.25	4.86	17.84
	10-Year			6.93	71.75	17.77	1.48	91.00	14.24	8.09	17.77
	25-Year			8.10	83.86	17.75	1.82	102.00	14.24	9.59	17.75
	100-Year			12.38	102.67	17.71	2.58	127.00	14.23	14.47	17.71
Runoff at Manhole 22+24 with Comingle A, B, G, H											
		Line B	Line A	QB	IB	Tc B	QA	IA	Tc A		
All 400	2-Year	400C, D, E, F & J	100, 400 A, B, G, H & I	4.86	42.97	17.84	5.27	53.00	12.55	11.26	12.55
	10-Year			8.09	71.75	17.77	9.56	91.00	12.35	19.82	12.35
	25-Year			9.59	83.86	17.75	11.25	102.00	12.29	22.91	12.29
	100-Year			14.47	102.67	17.71	16.15	127.00	12.20	34.05	12.20

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Appendix C. Normal Depth Calculations

Worksheet for LINE A (COMBINED) - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	24.0 in
Discharge	16.20 cfs

Results

Normal Depth	20.0 in
Flow Area	2.8 ft²
Wetted Perimeter	4.6 ft
Hydraulic Radius	7.3 in
Top Width	1.50 ft
Critical Depth	17.4 in
Percent Full	83.2 %
Critical Slope	0.007 ft/ft
Velocity	5.80 ft/s
Velocity Head	0.52 ft
Specific Energy	2.19 ft
Froude Number	0.749
Maximum Discharge	17.21 cfs
Discharge Full	16.00 cfs
Slope Full	0.005 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	63.1 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	20.0 in
Critical Depth	17.4 in
Channel Slope	0.005 ft/ft
Critical Slope	0.007 ft/ft

Worksheet for LINE B PIPE - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	24.0 in
Discharge	11.40 cfs

Results

Normal Depth	15.0 in
Flow Area	2.1 ft²
Wetted Perimeter	3.6 ft
Hydraulic Radius	6.8 in
Top Width	1.94 ft
Critical Depth	14.5 in
Percent Full	62.4 %
Critical Slope	0.005 ft/ft
Velocity	5.53 ft/s
Velocity Head	0.48 ft
Specific Energy	1.72 ft
Froude Number	0.945
Maximum Discharge	17.21 cfs
Discharge Full	16.00 cfs
Slope Full	0.003 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	45.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	15.0 in
Critical Depth	14.5 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Worksheet for LINE C PIPE - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	24.0 in
Discharge	11.60 cfs

Results

Normal Depth	15.2 in
Flow Area	2.1 ft²
Wetted Perimeter	3.7 ft
Hydraulic Radius	6.8 in
Top Width	1.93 ft
Critical Depth	14.7 in
Percent Full	63.1 %
Critical Slope	0.005 ft/ft
Velocity	5.55 ft/s
Velocity Head	0.48 ft
Specific Energy	1.74 ft
Froude Number	0.940
Maximum Discharge	17.21 cfs
Discharge Full	16.00 cfs
Slope Full	0.003 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	54.3 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	15.2 in
Critical Depth	14.7 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Worksheet for LINE E PIPE - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	36.0 in
Discharge	33.10 cfs

Results

Normal Depth	22.2 in
Flow Area	4.6 ft²
Wetted Perimeter	5.4 ft
Hydraulic Radius	10.1 in
Top Width	2.92 ft
Critical Depth	22.4 in
Percent Full	61.8 %
Critical Slope	0.005 ft/ft
Velocity	7.22 ft/s
Velocity Head	0.81 ft
Specific Energy	2.66 ft
Froude Number	1.016
Maximum Discharge	50.73 cfs
Discharge Full	47.16 cfs
Slope Full	0.002 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	61.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	22.2 in
Critical Depth	22.4 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Worksheet for Typical Triangular Ditch

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Left Side Slope	0.330 H:V
Right Side Slope	0.330 H:V
Discharge	2.00 cfs

Results	
Normal Depth	17.1 in
Flow Area	0.7 ft²
Wetted Perimeter	3.0 ft
Hydraulic Radius	2.7 in
Top Width	0.94 ft
Critical Depth	14.2 in
Critical Slope	0.014 ft/ft
Velocity	2.98 ft/s
Velocity Head	0.14 ft
Specific Energy	1.56 ft
Froude Number	0.621
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	17.1 in
Critical Depth	14.2 in
Channel Slope	0.005 ft/ft
Critical Slope	0.014 ft/ft

Worksheet for 12" Underdrain @ 0.25%

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.003 ft/ft
Diameter	12.0 in
Discharge	1.75 cfs

Results	
Normal Depth	9.7 in
Flow Area	0.7 ft^2
Wetted Perimeter	2.2 ft
Hydraulic Radius	3.7 in
Top Width	0.79 ft
Critical Depth	6.8 in
Percent Full	80.4 %
Critical Slope	0.007 ft/ft
Velocity	2.59 ft/s
Velocity Head	0.10 ft
Specific Energy	0.91 ft
Froude Number	0.494
Maximum Discharge	1.92 cfs
Discharge Full	1.78 cfs
Slope Full	0.002 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	41.2 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.7 in
Critical Depth	6.8 in
Channel Slope	0.003 ft/ft
Critical Slope	0.007 ft/ft

Worksheet for 15" Underdrain @ 0.25%

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.003 ft/ft
Diameter	15.0 in
Discharge	3.25 cfs

Results	
Normal Depth	12.4 in
Flow Area	1.1 ft²
Wetted Perimeter	2.8 ft
Hydraulic Radius	4.6 in
Top Width	0.95 ft
Critical Depth	8.7 in
Percent Full	82.5 %
Critical Slope	0.006 ft/ft
Velocity	3.00 ft/s
Velocity Head	0.14 ft
Specific Energy	1.17 ft
Froude Number	0.495
Maximum Discharge	3.47 cfs
Discharge Full	3.23 cfs
Slope Full	0.003 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	41.2 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	12.4 in
Critical Depth	8.7 in
Channel Slope	0.003 ft/ft
Critical Slope	0.006 ft/ft

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Appendix C. Normal Depth Calculations

Worksheet for LINE A (COMBINED) - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	24.0 in
Discharge	16.20 cfs

Results

Normal Depth	20.0 in
Flow Area	2.8 ft²
Wetted Perimeter	4.6 ft
Hydraulic Radius	7.3 in
Top Width	1.50 ft
Critical Depth	17.4 in
Percent Full	83.2 %
Critical Slope	0.007 ft/ft
Velocity	5.80 ft/s
Velocity Head	0.52 ft
Specific Energy	2.19 ft
Froude Number	0.749
Maximum Discharge	17.21 cfs
Discharge Full	16.00 cfs
Slope Full	0.005 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	63.1 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	20.0 in
Critical Depth	17.4 in
Channel Slope	0.005 ft/ft
Critical Slope	0.007 ft/ft

Worksheet for LINE B PIPE - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	24.0 in
Discharge	11.40 cfs

Results

Normal Depth	15.0 in
Flow Area	2.1 ft²
Wetted Perimeter	3.6 ft
Hydraulic Radius	6.8 in
Top Width	1.94 ft
Critical Depth	14.5 in
Percent Full	62.4 %
Critical Slope	0.005 ft/ft
Velocity	5.53 ft/s
Velocity Head	0.48 ft
Specific Energy	1.72 ft
Froude Number	0.945
Maximum Discharge	17.21 cfs
Discharge Full	16.00 cfs
Slope Full	0.003 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	45.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	15.0 in
Critical Depth	14.5 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Worksheet for LINE C PIPE - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	24.0 in
Discharge	11.60 cfs

Results

Normal Depth	15.2 in
Flow Area	2.1 ft²
Wetted Perimeter	3.7 ft
Hydraulic Radius	6.8 in
Top Width	1.93 ft
Critical Depth	14.7 in
Percent Full	63.1 %
Critical Slope	0.005 ft/ft
Velocity	5.55 ft/s
Velocity Head	0.48 ft
Specific Energy	1.74 ft
Froude Number	0.940
Maximum Discharge	17.21 cfs
Discharge Full	16.00 cfs
Slope Full	0.003 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	54.3 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	15.2 in
Critical Depth	14.7 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Worksheet for LINE E PIPE - 100 YEAR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Diameter	36.0 in
Discharge	33.10 cfs

Results

Normal Depth	22.2 in
Flow Area	4.6 ft²
Wetted Perimeter	5.4 ft
Hydraulic Radius	10.1 in
Top Width	2.92 ft
Critical Depth	22.4 in
Percent Full	61.8 %
Critical Slope	0.005 ft/ft
Velocity	7.22 ft/s
Velocity Head	0.81 ft
Specific Energy	2.66 ft
Froude Number	1.016
Maximum Discharge	50.73 cfs
Discharge Full	47.16 cfs
Slope Full	0.002 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	61.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	22.2 in
Critical Depth	22.4 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Worksheet for Typical Triangular Ditch

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Left Side Slope	0.330 H:V
Right Side Slope	0.330 H:V
Discharge	2.00 cfs

Results

Normal Depth	17.1 in
Flow Area	0.7 ft²
Wetted Perimeter	3.0 ft
Hydraulic Radius	2.7 in
Top Width	0.94 ft
Critical Depth	14.2 in
Critical Slope	0.014 ft/ft
Velocity	2.98 ft/s
Velocity Head	0.14 ft
Specific Energy	1.56 ft
Froude Number	0.621
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	17.1 in
Critical Depth	14.2 in
Channel Slope	0.005 ft/ft
Critical Slope	0.014 ft/ft

Worksheet for 12" Underdrain @ 0.25%

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.003 ft/ft
Diameter	12.0 in
Discharge	1.75 cfs

Results	
Normal Depth	9.7 in
Flow Area	0.7 ft²
Wetted Perimeter	2.2 ft
Hydraulic Radius	3.7 in
Top Width	0.79 ft
Critical Depth	6.8 in
Percent Full	80.4 %
Critical Slope	0.007 ft/ft
Velocity	2.59 ft/s
Velocity Head	0.10 ft
Specific Energy	0.91 ft
Froude Number	0.494
Maximum Discharge	1.92 cfs
Discharge Full	1.78 cfs
Slope Full	0.002 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	41.2 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.7 in
Critical Depth	6.8 in
Channel Slope	0.003 ft/ft
Critical Slope	0.007 ft/ft

Worksheet for 15" Underdrain @ 0.25%

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.003 ft/ft
Diameter	15.0 in
Discharge	3.25 cfs

Results

Normal Depth	12.4 in
Flow Area	1.1 ft²
Wetted Perimeter	2.8 ft
Hydraulic Radius	4.6 in
Top Width	0.95 ft
Critical Depth	8.7 in
Percent Full	82.5 %
Critical Slope	0.006 ft/ft
Velocity	3.00 ft/s
Velocity Head	0.14 ft
Specific Energy	1.17 ft
Froude Number	0.495
Maximum Discharge	3.47 cfs
Discharge Full	3.23 cfs
Slope Full	0.003 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	41.2 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	12.4 in
Critical Depth	8.7 in
Channel Slope	0.003 ft/ft
Critical Slope	0.006 ft/ft

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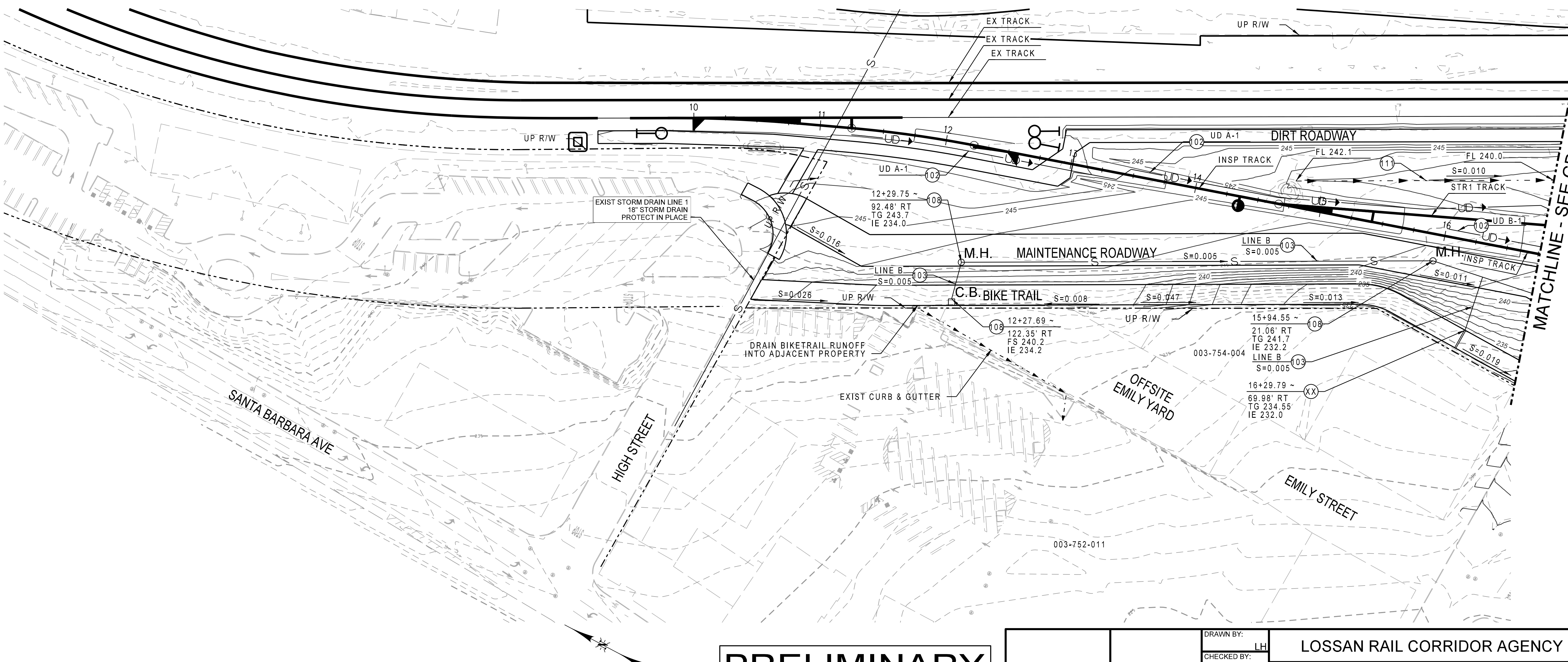
Appendix D. Proposed Design Plans

NOTES:

102 INSTALL 12" UNDERDRAIN
103 INSTALL 18" PVC STORM DRAIN
104 INSTALL 24" RCP STORM DRAIN (3000-D)
105 INSTALL 24" PVC STORM DRAIN
106 INSTALL CATCH BASIN, TYPE 'G-2' PER CALTRANS STD PLAN D72B
107 CONSTRUCT CATCH BASIN - SIDE OPENING, PER CITY OF SAN LUIS OBISPO ENGINEERING STANDARD 3350
108 CONSTRUCT STORM DRAIN MANHOLE PER CITY OF SAN LUIS OBISPO ENGINEERING STANDARD 3520
109 CONSTRUCT TRENCH DRAIN
110 CONSTRUCT UNDERGROUND DETENTION BASIN
111 CONSTRUCT TRIANGULAR CONCRETE DITCH

GENERAL NOTES

1. LOCATION OF EXISTING MAIN AT POINTS OF CONNECTION TO BE FIELD VERIFIED.
2. PROTECT IN PLACE EXISTING WAREHOUSE FACILITIES ADJACENT TO RIGHT OF WAY
3. ALL STATION AND OFFSETS BASED ON INSP TRACK ALIGNMENT



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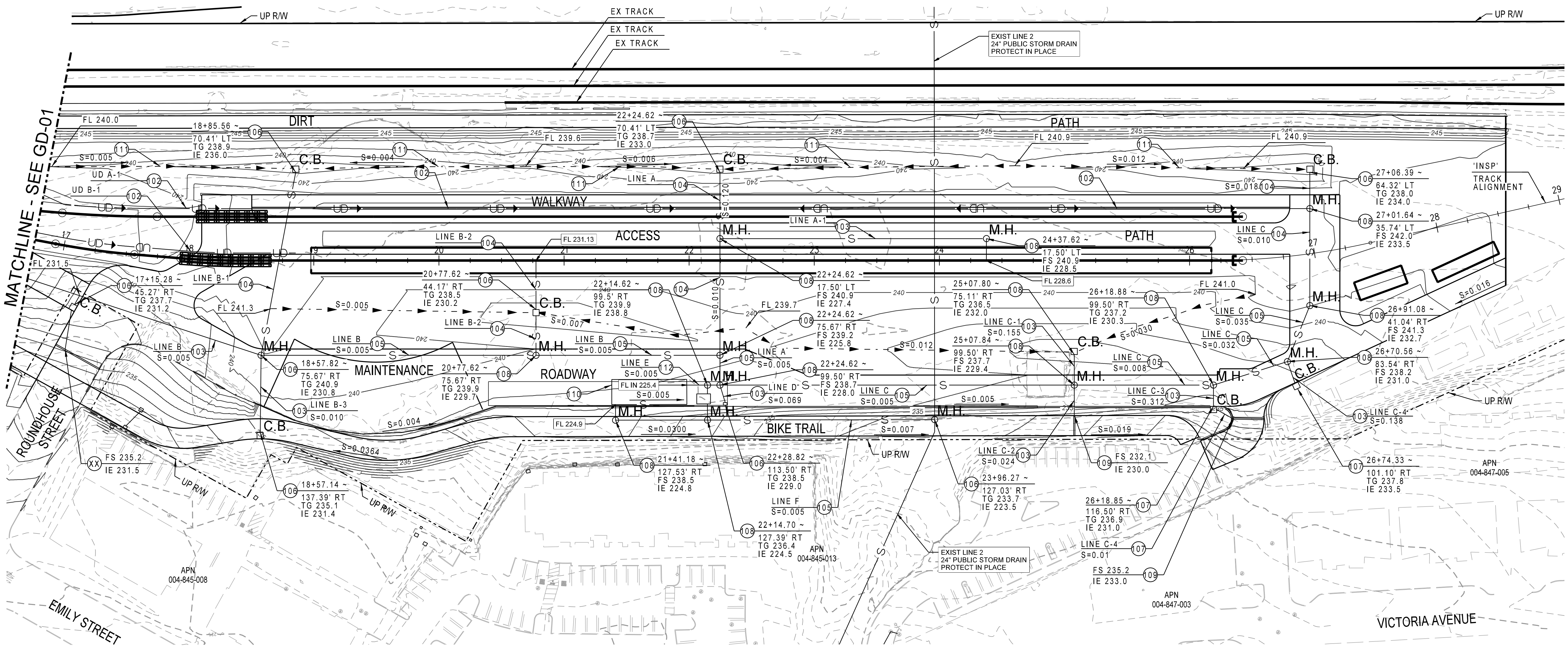
DATE: UNK 2021	
SHEET NUMBER GD-01 of GD-02	SHEET TITLE: GRADING & DRAINAGE PLAN SHEET 1 OF 2

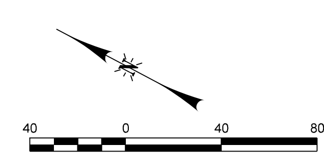
NOTES:

(102) INSTALL 12" UNDERDRAIN
(103) INSTALL 18" PVC STORM DRAIN
(104) INSTALL 24" RCP STORM DRAIN (3000-D)
(105) INSTALL 24" PVC STORM DRAIN
(106) INSTALL CATCH BASIN, TYPE 'G-2' PER CALTRANS STD PLAN D72B
(107) CONSTRUCT CATCH BASIN - SIDE OPENING, PER CITY OF SAN LUIS OBISPO ENGINEERING STANDARD 3350
(108) CONSTRUCT STORM DRAIN MANHOLE PER CITY OF SAN LUIS OBISPO ENGINEERING STANDARD 3520
(109) CONSTRUCT TRENCH DRAIN
(110) CONSTRUCT UNDERGROUND STORAGE SYSTEM
(111) CONSTRUCT TRIANGULAR CONCRETE DITCH
(112) INSTALL 36" PVC STORM DRAIN

GENERAL NOTES

1. LOCATION OF EXISTING MAIN AT POINTS OF CONNECTION TO BE FIELD VERIFIED.
2. PROTECT IN PLACE EXISTING WAREHOUSE FACILITIES ADJACENT TO RIGHT OF WAY
3. ALL STATION AND OFFSETS BASED ON INSP TRACK ALIGNMENT





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