HYDROLOGY AND HYDRAULICS REPORT: OTAY MESA EAST PORT OF ENTRY

for

STATE ROUTE 11 AND THE OTAY MESA EAST PORT OF ENTRY

SAN DIEGO COUNTY, CALIFORNIA
DISTRICT 11–SD –ROUTE 11
PM 0.0/2.8 EA056310
DISTRICT 11–SD –ROUTE 905
PM R8.4/10.1

TIER II ENVIRONMENTAL IMPACT REPORT/ ENVIRONMENTAL IMPACT STATEMENT

November 2010

DEPARTMENT OF TRANSPORTATION UNITED STATES OF AMERICA

Caltrans

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Prepared by:

AECOM

Hydrology & Hydraulics Report

State Route 11 - Point of Entry (POE)

Caltrans District 11 Hydraulics Department

POE

AECOM

February 23, 2010

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February 23, 2010

AECOM

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Project Information

Informative Abstract

This report was prepared to analyze the hydrology and hydraulics of the proposed Point of Entry (POE) at the terminus of State Route 11 (SR-11) for the purpose of determining environmental footprint requirements and environmental impacts due to drainage infrastructure needs.

This report will analyze the existing offsite flows for the purpose of sizing and placing of cross culverts. Pre-developed and post-developed peak flows and runoff volumes will be analyzed for the purpose of sizing and placing detention/retention basins.

The POE design must comply with the several jurisdictional entity requirements. These requirements can be met during this preliminary design stage and/or the final design stage.

1. From the International Border (the Border), extending 60 feet north of the Border, the design must comply with The International Border Water Commission (IBWC) standards and requirements. This agency's *mission is to provide binational solutions to issues that arise during the application of United States - Mexico treaties regarding boundary demarcation, national ownership of waters, sanitation, water quality, and flood control in the border region.*[1] Correspondence specific to this project is located in Appendix F.
2. From 60 feet north of the Border to the County of San Diego (County) limits, the design must comply with the County standards and requirements.
3. The City of San Diego references the County of San Diego Hydrology Manual.
4. With respect to Flood Management in East Otay Mesa, all developments are subject to guidelines of the East Otay Mesa Specific Plan Comprehensive Flood Control Master Plan 1994. Essentially, developments within East Otay mesa are required to provide local or regional detention basins. Correspondence specific to this project is located in Appendix F.

All flow generated from the SR-11 and Commercial Vehicle Enforcement Facility (CVEF) will be treated, retained and/or detained prior to being release into drainage facilities under the POE.

[1] http://www.ibwc.state.gov/home.html

Due to the preliminary nature of this design, the ultimate design may be different. A section within this report titled, "Features Requiring Additional Discussion" covers the main assumptions and unique considerations taken within this design.

Project Description and Location

The POE will function as a new U.S. Customs and Border Protection Port of Entry that would be located in the unincorporated community of East Otay Mesa with the Otay Subregional Planning Area in the southernmost portion of San Diego County. The purpose is to improve the efficient movement of people, goods and services between the U.S. and Mexico by providing an additional crossing at U.S.-Mexico Border.

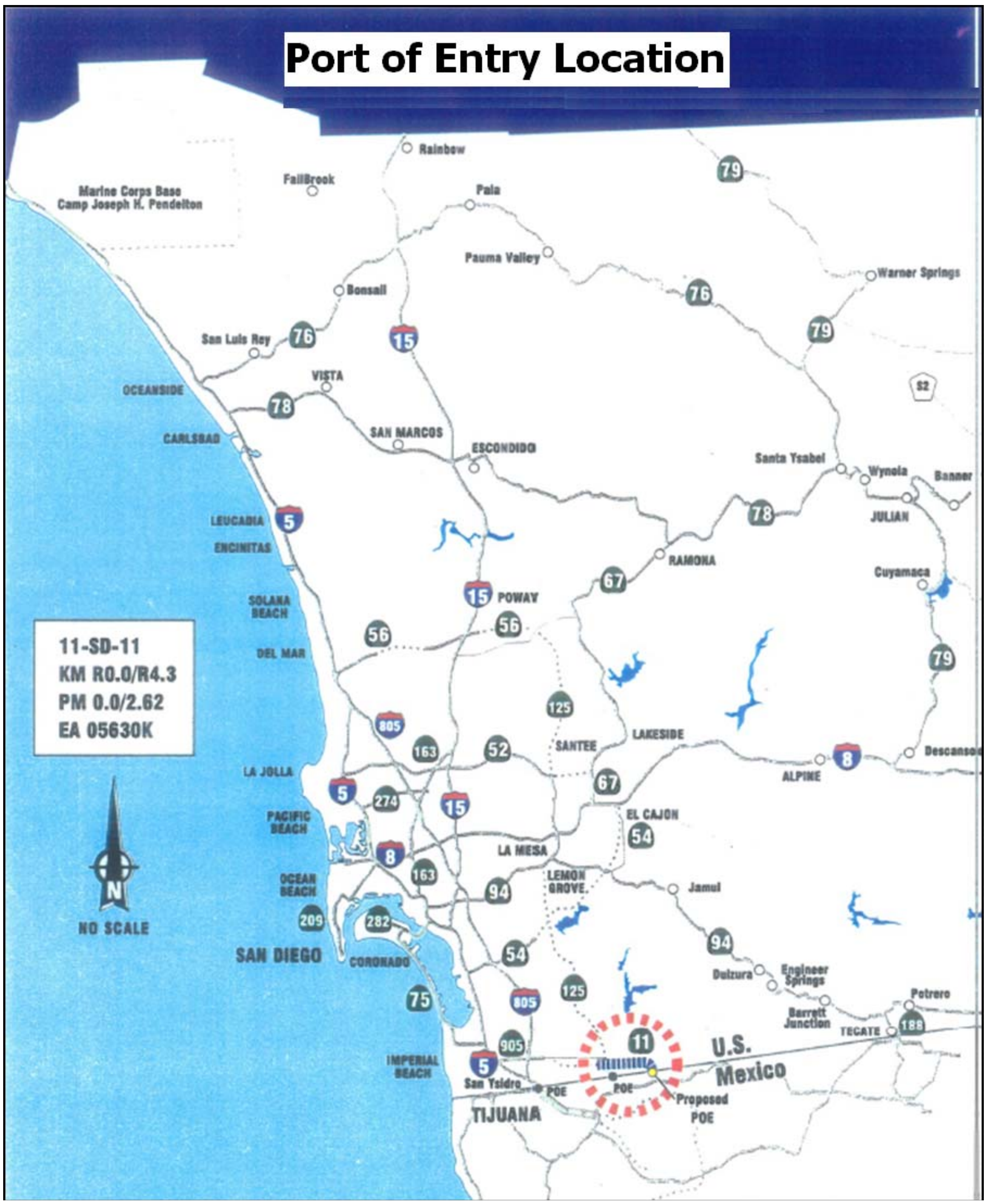
This POE will be located at the terminus of the SR-11 at the Border with Mexico. This location is 13-miles inland. See Project Location Map.

The Commercial Vehicle Enforcement Facility (CVEF), SR-11 and the SR-905 and SR-125 junction will be studied under separate reports.

The approximate center location of the project is at:

Latitude: 32°33'25"N, Longitude: 116°54'25"W

Project Location Map



Hydrology

Hydrologic Setting

Surrounding topography and soil conditions are described in a separate report entitled, Hydrogeologic Site Assessment/Storm Water Data Report. This report identifies the type of soil and the infiltration rates at the various basin locations. Topographical mapping generated from SANGIS (5' contour intervals) were utilized to define the large offsite watersheds. Where coverage was available, the use of two-foot topography contours further defined watersheds. Field investigations were conducted to further confirm the extent of each of these watersheds. Refer to the Offsite Culvert Exhibits in the Appendix C.

San Diego has on average 146 sunny days and 117 partly cloudy days a year. The average annual precipitation is less than 12 inches (300 mm), resulting in a borderline arid climate. Rainfall is strongly concentrated in the cooler half of the year, particularly the months December through March, although precipitation is lower than any other part of the U.S. west coast. The summer months are virtually rainless. Rainfall is highly variable from year to year and from month to month, and San Diego is subject to both droughts and floods. Thunderstorms and hurricanes are very rare.[2]

Most soils are thoroughly moistened during this period. Soil moisture however, is used up during rapid plant grown in spring, and unless irrigated, the soils are dry by June. On shallow droughty soils, there is not enough plant growth to control erosion, so some loss of soil can be expected with the first rains in November.

Existing Conditions

The POE footprint primarily consists of undeveloped natural terrain.

In addition to the 1st fence at the Border, a 2nd containment fence runs 125' north and parallel with the Border. There are a few earthen *vehicle* trails crisscrossing the POE footprint. The two primary trails run parallel to and are located on either side of the 2nd containment fence.

There are two primary watersheds being impacted by the POE footprint.

[2] http://en.wikipedia.org/wiki/Climate_of_San_Diego,_California

The flow from the western watershed discharges through an existing two-celled 3’ x 6’ reinforced concrete box culvert that runs under the 2nd containment fence. This flow is discharged into a broad and flat area between the two containment fences which discharges through a 3’ x 20’ secured opening in the Border fence. This flow then discharges into an existing 3’ x 20’ RCB under an existing road within Mexico. This road, Colina Del Sol, runs parallel to the Border for the length of the project.

The majority of the flow from the eastern watershed discharges into an existing three celled 3’ x 6’ reinforced concrete box culvert that runs under the 2nd containment fence. This containment fence terminates 1550’ east of this culvert. This flow is discharged into a broad flat area which discharges into an existing 3’ x 20’ secured opening in the Border fence then discharges across Colina Del Sol and down 12 Norte. The remainder of this watershed sheet flows to the Border fence and confluences at the same Border fence opening.

Refer to Appendix G for a photograph log of these existing drainage elements.

Based on aerial images from 1994 to 2001, these two watersheds had a confluence point approximately 600’ to 700’ south of the Border. This flow was carried via a natural channel through Mexico for 1.5 miles prior to entering the Tijuana River. Grading and development of the area south of the Border from 2001 to present has redirected this flow into concrete lined roadside channels (initially along 12 Norte in Mexico) and further into culverts flowing south towards the Tijuana River.

Refer to Appendix H for exhibits displaying this timeline.

Environmentally Sensitive Areas (ESA’s) are present outside of the proposed footprint and are delineated on the plans in Appendix A.

Two utility corridors cross the POE footprint. Approximately 36’ north of the 2nd containment fence lies a shallow 30’ high pressure gas utility corridor running approximately 165’ and parallel with the Border. The other utility corridor is almost 1300’ from the Border and contains a 24” Fuel Gas (CALPINE). This is to be relocated outside of the POE footprint.

Hydrologic Analysis

Watershed Delineation

These contributing drainage areas were determined by delineation using Microstation graphic tools.

The two primary existing watersheds of 295 and 350 acres are broken up into five (5) separate watersheds. The portions of these two watersheds that did not fall under the POE footprint are delineated separately as offsite watersheds that contribute to the flows that will be captured and conveyed within proposed cross culvert flowing under the POE. These watersheds were broken out since they will not be altered by the proposed POE.

The reminders of the watersheds were delineated separately as they will be altered by the proposed POE grading footprint.

All five watershed areas that have been delineated are within the 320 acre limit for the use of the Rational Method; therefore, the Rational Method is used to estimate peak runoff for drainage design purposes. This is a more conservative approach since by applying similar rainfall upon smaller overall areas will generate higher flows.

This area was also analyzed within the Preliminary Existing Condition Hydrology Calculations for State Route 11 Programmatic EIR/EIS, dated November 2007. Output data from HEC HMS runs were provided in this report and the final areas and flow rates are comparable and acceptable for this preliminary design.

Watershed Nomenclature

The watersheds that directly impact this project are labeled as ‘I’, ‘J’ ‘K’ and ‘L’, for continuity. Watersheds labeled A through G, H, X and Y were analyzed in the SR-11 Corridor Hydraulics and Hydrology Study by AECOM.

All watersheds flow towards the south unless otherwise indicated.

The approximate size of the watersheds and a brief description are summarized in the following table:

Table 1 - Offsite Watersheds

Name	Approximate Size	Description
H	162 acres	Medium, natural terrain, extending north up to 1023'
I	315 acres	Large, natural terrain, extending northeast up to 1600'
J	85 acres	Small, natural terrain, extending north up to 576'
K	41 acres	Small, natural terrain, extending east up to 510'
L	46 acres	Small natural terrain, extending east up to 620'

Calculations for each of these watersheds are provided the Appendix B and C.

Rainfall Intensity - Caltrans

Rainfall intensities derived from Caltrans methodology will be used for all on-site design of inlets and pipes and for cross culverts conveying off-site flows under the proposed POE. For Caltrans projects, it is required to use the Caltrans Intensity-Duration-Frequency Program, Version IDF 2000. IDF 2000 generated the following rainfall intensity equations:

$$i_2 = 0.49 \bullet D^{-0.500}$$
$$i_{10} = 0.92 \bullet D^{-0.500}$$
$$i_{25} = 1.15 \bullet D^{-0.500}$$
$$i_{50} = 1.33 \bullet D^{-0.500}$$
$$i_{100} = 1.50 \bullet D^{-0.500}$$

The following table summarizes the calculated Caltrans rainfall intensities using the default minimum Time of Concentration, T_C of 5 minutes (Note: D is in hours).

Table 2 - Caltrans Rainfall Intensity Chart

Storm Frequency (yr)	i – (inches/hour)
2	1.70
10	3.20
25	4.00
50	4.60
100	5.20

Rainfall Intensity – County of San Diego

San Diego County rainfall intensities were used for the majority of the calculations in this design, primarily in the pre-developed and post-development design for sizing of detention and retention basins. The County intensities calculated were higher and thus more conservative that those of Caltrans. The San Diego County Hydrology Manual was used to establish the following rainfall intensity equation:

$$i_{county} = 7.44 \bullet P_6 \bullet D^{-0.645}$$

The SD County Isopluvial Maps were utilized to obtain the 6-hour precipitation, P_6 at the following location at the center of the proposed POE:

Latitude: 32°33'25"N

Longitude: 116°54'25"W

The following table summarizes the County of San Diego precipitation, P_6.

Table 3 - SD County 6-Hour Precipitation

Storm Frequency (yr)	P_6 – (inches)
2	1.1
10	1.6
25	2.0
50	2.4
100	2.5

The following table summarizes the County of San Diego rainfall intensities using the rainfall intensity equation and a default minimum T_C of 5 minutes.

Table 4 - SD County Rainfall Intensity Chart

Storm Frequency (yr)	i – (inches/hour)
2	2.90
10	4.22
25	5.27
50	6.32
100	6.59

Time of Concentration

To determine the T_C for offsite and onsite watersheds travel times, California Highway Design Manual, 816.6 Time of Concentration (T_c) and Travel Time (T_t) was used.

Per the HDM, for all proposed paved areas, it is *recommended* that a minimum T_c of 5 minutes be used. For this preliminary design, all onsite drainage areas are assumed to have this minimum T_c. This is a conservative assumption and will generate higher intensities and flows. Where long onsite watershed lengths are found and additional conveyance mechanism were proposed, such as biofiltration swales, specific T_c analysis may be performed to define a more appropriate T_c.

Table 5 - Design Time of Concentration T_c

Watershed Location	Minimum T_c	Notes
Offsite	10 minutes	Overland flow
Onsite	5 minutes	Pavement flow

Runoff Coefficient

The runoff coefficient was determined using the HDM, Figure 819.2A. Generally, for paved surfaces of concrete or asphalt, a value of 0.90 was used. For existing natural terrain and proposed slope areas, C values ranged between 0.40 to 0.65 depending on slope and surface material. The HDM Topic 819.2(1) *Rational Methods* suggests increasing the runoff coefficient by the following factors:

Table 6 - Adjustments to Runoff Coefficient $C_{(f)}$

Storm Frequency (yr)	C(f)	Applies to:
2	1.00*C	~
10	1.00*C	Offsite Culvert Design
25	1.10*C	Onsite Design
50	1.20*C	~
100	1.25*C	Offsite Culvert Design

Units

Imperial Units were used.

Offsite Drainage

Offsite flow is to be quantified and convey under the proposed POE to the pre-project location. At this point, the offsite flows can confluence with treated and/or detained onsite flow from the POE site.

Culvert Analysis

Watershed flow rates were determined for each cross culvert location using Caltrans methodology described above.

For the design of offsite flows through culverts passing beneath the POE, the HDM, 821.3, "Selection of Design Flood", the following events were used:

Table 7 - Design Event for Offsite Culverts

Design Event	Notes
10-year	without headwaters (HW) rising above top of culvert
100-year	without HW causing objectionable backwater depths or outlet velocities or overtopping the POE Surface

Culvert sizing was determined using Bentley Culvert Master and/or WSPG.

Table 8 - Offsite Culvert Flows and Sizes

Location (Sta)	Culvert	100-year Flow (cfs)	Length (ft)	Shape and Size
Center	POE Center	251.6	724	Box – 2 cell 6' wide x 4' high
North East	POE I	313	1594	Box – 2 cell 6' wide x 4' high
East	POE L	49.5	1256	Circular - 36" RCP

Unless calculated within this report, the peak flows for these culverts were provided in the Preliminary Existing Condition Hydrology Calculations for State Route 11 Programmatic EIR/EIS, dated November 2007. Culvert calculations are provided in Appendix C.

Onsite Drainage

The POE onsite flow rates were generated using the same design storm and methodologies outlined in the Sixth Edition Caltrans Highway Design Manual (HDM), Table 831.3; *Desirable Roadway Drainage Guidelines.* For onsite roadway drainage, all drainage facilities are to be designed for the expected peak flows during a storm event of such magnitude that there is a 4% chance it may occur in any given year. This is also termed the '25-year storm.'

Design Storm:	**25-year**	**per HDM 831.3**

Design guidance is also provided from the Federal Highway Administration, Hydraulic Design Series (HDS) No. 2, HDS No. 5 and Hydraulic Engineer Circular (HEC) 22. Within these key technical resources, methods and procedures are given for the hydraulic design of storm drainage systems.

Drainage Area Layout

General paved areas and non-paved areas are delineated throughout the POE, based on the layout. The traffic lanes and buildings are impervious whereas all other areas are considered pervious.

Onsite Hydrology and Hydraulic Exhibits and Calculations are provided in Appendix D. Pavement drainage areas and slope (non-paved drainage areas were separated due to different runoff coefficient values. Pavement areas are designated with a *PV* whereas sloped areas are designated with a *SL*. The C-value for each is defined in the following table.

Table 9 - Onsite Runoff Coefficients (25-year Design Storm)

Type	Designation	C	$C_{(f)}$
Pavement	PV	0.90	0.99
Slope	SL	0.55	0.61

Drainage Area Nomenclature

Onsite drainage areas are labeled based on the following:

- the main watershed basin within the POE they drain within (I or J)

- the type of surface the watershed consists of (pavement (PV) or slope (SL).

For example, drainage area J.3.SL refers to the third (3rd) sloped (non-paved) area draining in watershed ‘J’.

Summary tables of the onsite flows for each watershed are provided in Appendix D.

Grated Inlet Design

Standard Caltrans inlet types G1 and G2 are graphically shown along the edges of pavement at key locations. A special Double G1 inlet with two grates will be shown at critical locations where additional capture is necessary. Double G1 inlets are used to capture flows from the detention basins. Where applicable, a concrete apron is used around these inlets as an elevation control device and for the ease of maintenance of the inlet.

Detailed onsite inlet calculations were not performed in this analysis. Inlets have been placed at key locations for collection of runoff and at critical locations such as at the downstream end of the basins. The layout shown is approximate and may change in the final design stage once the appropriate POE layout has been determined.

Onsite Culvert Design

The onsite culverts sizes can be assumed to be between the minimum 24” to 36” reinforced concrete pipes or alternative pipe material. The slopes of longitudinal runs of culverts generally follow the slope of the roadway. The minimum longitudinal slope will be 0.50%. This minimum constructible slope may be required in a few cases to reduce final structure depths. At this slope, self-cleaning velocities are in compliance with HDM requirements.

Detailed onsite culvert calculations were not performed in this analysis. Quantities are approximate and may change in the final design stage, once the appropriate alternative has been selected.

The primary purpose of this report was to determine the environmental footprint that will be required for drainage infrastructure.

Basin sizes that have been determined within this report are based on the assumption of this preliminary POE layout. The basins were sized based on primarily seven (7) different design criteria. These criteria being, retention volume, soil infiltration rates, water quality volume, silt accumulation volume, detention volume, freeboard and basin outlet structure. These basin sizes provided during this PA/ED phase assume that all jurisdictional criteria could be met, but that the final basin designs during the PS&E phase will be based on the feasibility and reasonability of meeting the different jurisdictional criteria.

Retention Volume

Pre-developed and post-developed watershed boundaries and times of concentration are presented in Appendix B. Their corresponding flow rates and times of concentration were determined using methodology described in the HDM, Section 816 (except for the use of the County of San Diego rainfall intensities). The post-developed watershed boundaries include post-project pavement and graded slope areas.

The volume of retention set aside within the basin was determined using the San Diego County Hydrology Manual Rational Hydrograph Procedure as described in Chapter 6-1. This procedure uses the rational method (Q=CiA) and develops pre-developed and post-developed hydrographs for the use in determining runoff volumes for use in sizing retention basins within watershed areas up to approximately 1 square mile in size.

The County's RATHYDRO computer program generates hydrograph ordinates using the formulas with this Manual. Peak flow rates, time of concentration, 6-hour rainfall depths, watershed area and runoff coefficients are used as the input for the RATHYDRO program.

Soil Infiltration Rates

Infiltration rates were provided in the Proposed State Route 11 Extension: Hydrogeologic Site Evaluation/Storm Water Data Report. The Percolation Rate Tests results for seven (7) locations from Alta Road to the Border ranged from 1.4 minutes per inch to 174.5 minutes per inch. At two locations there was no percolation observed during the testing.

For purposes of this analysis, it is assumed that the volume required for retention will percolate and be disposed of via infiltration or other subsurface engineering methods.

Basin constraints

Other than environmental constraints, there are no limitations on placement of retention basins since, according to the Hydrogeologic Site Evaluation/SWDR; *no ground water was encountered in all borings during the exploration program for this project.*

A basin outlet structure will be placed at an invert elevation which allows the retention area to remain in the basin. See Detention Volume section for more information on the outlet structure. Refer to calculations with Appendix E.

Water Quality Volume

Per the Caltrans Storm Water Quality Handbook: Project Planning and Design Guide (PPDG) May 2007 volume is to be set aside for the use of treatment of pavement runoff – this is the Water Quality Volume (WQV). With the use of Caltrans 'Basin Sizer' Program and the Maximized Volume Method stated in the PPDG, a volume was found for Water Quality purposes. When the WQV was less than that of required for retention of excess runoff, it was assumed treatment will occur within the retention basin and no additional volume was added to the basin. When the WQV was greater than that required for retention, the difference in volume was added to the basin. Refer to calculations in Appendix E.

Silt Accumulation Volume

Per the United States International Boundary and Water Commission (IBWC), Hydraulic and Hydrological Study reports are to include an analysis for silt accumulation within the basin. The basin design should include additional capacity for a 10-year volume of silt accumulation. See Appendix F for IBWC correspondence. Silt accumulation over a 10-year period was assumed to pass into the retention area and additional volume is to be added for this. The Universal Soil Loss Equation and methodology stated within the SDCHM, Chapter 5.2.3 were used to determine this volume. This accommodates silt from erosion of new cut slopes within the project limits. Refer to calculations in Appendix E.

Detention Volume

Where the post developed peak flow rates were increased from pre-developed conditions, detention basins were required to reduce flow rates. In a few cases, post-developed watershed flow rates were reduced and do not require detention basins.

For the purpose of peak attenuation (or peak shaving) additional volume is added above the retention, silt accumulation and WQV. With the use of a standardized engineered outlet structure, the detention basin volume will be added to reduce peak flows.

Basin Outlet Structure

In the Detention Basin Outlet calculations, a 2' reinforced concrete discharge pipe at 2% slope was placed from 2' to 3' from the basin floor allowing for retention below the invert. A rating table was provided analyzing outlet flows giving a range of headwater elevations.

With the defined outlet structure and using methodology described in HEC 22, Stage Storage Relationships were developed along with the Stage-Discharge Relationship (Performance Curve). A generalized routing procedure was performed to determine the additional volume needed for attenuation of peak flows. Refer to calculations in Appendix E.

Final Basin Size

The retention/detention facilities will be sized to reproduce pre-project peak flow rate, and to detain/retain excess runoff, infiltrate and or otherwise dispose (disposal of excess water should not go into Mexico).

Freeboard

A freeboard depth was added to the final calculated depth. All freeboard depths are in excess of one (1) foot in accordance with HEC 22 9.3.9 *Allowable High Water Elevation: The allowable high water (AHW) elevation in the station should be set such that the water* *surface elevation at the lowest inlet in the collection system provides 0.3 to 0.6 m (1 to 2 ft) of freeboard below the roadway grate.*[3]

Geometrics of the Basin

Rectangular / Trapezoidal shapes were chosen for all of the basins. HEC 22 – Equation 8-8 was used to determine basin volumes:

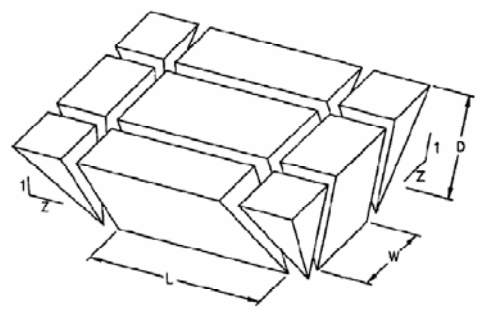


Figure 8-8. Trapezoidal Basin.

$$L = \frac{-ZD(r+1) + [(ZD)^2 (r+1)^2 - 5.33(ZD)^2 r + \frac{4rV}{D}]^{0.5}}{2r}$$

V = volume at a specific depth, m^3 (ft^3)
D = depth of ponding or basin, m (ft)
L = length of basin at base, m (ft)
W = width of basin at base, m (ft)
r = ratio of width to length of basin at the base
Z = side slope factor; ratio of horizontal to vertical components of side slope

[3] HEC 22, 2nd Edition Urban Drainage Design Manual

Features Requiring Further Discussion

POE Layout

It should be noted that the POE layout shown is preliminary and may change. No Project Report has been completed at this stage; therefore the hydrology and hydraulic characteristics will be assumed to change in the final design. For instance, the traffic lane configuration and building layout that is shown within this report was derived from assumed building and traffic lane needs from the distribution of the SR-11 lane configuration and the Mexico POE preliminary lane layout.

For the purpose of this analysis, it is assumed that the paved and the non-paved area quantity shown herein will be similar to the final design. These areas which are shown to be paved and unpaved were used to calculate basin sizes. If the pavement area is changed from what is shown within this report, re-evaluation of the onsite hydrology will be required.

The collection and routing of the onsite flows is schematic and it is assumed that onsite flows can be collected and discharged into either detention/retention basins or other storage devices to be determined.

Basin Design

A key element of this report was to determine the retention/detention basin sizes due to the proposed POE improvements. These graded basin sizes would assist in setting the right-of-way based on the unique footprint of these facilities. The preliminary locations of the basins are shown well within the POE outer limits. Any adjustments to the footprint of the basins in the ultimate design may not necessarily affect this defined POE limit.

IBWC requires that due to this projects proximity to the Border, (see Appendix F), the design assumes that the increase in volume from the new impervious surfaces will be retained (will not flow into Mexico).

To simplify the design at this preliminary stage, three flat-bottomed basins with 1:4 side-slopes are shown. The volume below the outlet structure elevation is always calculated to be greater than the retention requirement. The volume above the outlet device is used for peak-shaving/attenuation requirements and freeboard requirements.

Yet, infiltration rates have been found to be poor due to the soil type found in the area, (see: Proposed State Route 11 Extension: Hydrogeologic Site Assessment/Storm Water Data Report by the Department of Transportation Division of Engineering Services – Geotechnical Services, Office of Geotechnical Design –South 2)

Results of percolation tests revealed that the percolation rates at the project site are generally low, corresponding with the clayey (bentonite) and silty composition of the surficial soils and the dense, underlying sedimentary formation. In addition, percolation rates fluctuate from no percolation observed to the rate of 1.4 min/inch. However, the relatively fast percolation rate is attributed to the sandy nature of soils encountered only at this test location. This sandy granular soil is believed to be localized and not representative of a pervasive sedimentary stratum capable of absorbing and infiltrating runoff.[4]

To accommodate this lack of infiltration, the ultimate basin design may incorporate some or all of the following features to address the requirement for volume retention: concrete floors, subsurface retention vaults and/or pumps.

Culverts

POE-Center Culvert (H) is taking the flow from the CVEF analysis of Culvert H. This flow data is provided in the SR-11 Hydrology Report. Exhibits and calculations are added to this report.

Flow from the three offsite watersheds confluence just north of the Border at a location just west of the primary vehicular access point. Watersheds, H, I and L which are collected and delivered to this confluence location are not being modified by this project.

[4] Proposed State Route 11 Extension: Hydrogeologic Site Assessment/ SWDR, 09.09.09, page 4.

These culverts are capturing the historic flow rates and passing them under the POE. Velocity increase at the outfall of the culverts will be address by the use of Rip Rap (shown) or other energy dissipation devices. The RSP shown is preliminary in nature and the final design will determine the appropriate drainage device necessary to duplicate pre-developed flow patterns.

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References

1. “Highway Design Manual”, State of California Department of Transportation (Caltrans), Sixth Edition, July 2008.

2. “District 11 Hydraulics Section – Guidelines for Consultants Performing Hydraulic Design on Caltrans Projects”, Caltrans, October 2002.

3. “Civil Engineering Reference Manual”, Michael P. Lindeburg, Eighth Edition, 2002.

4. “Urban Drainage Design Manual”, Hydraulic Engineering Circular No.22, USDT Federal Highway Administration, November 1996.

5. “Caltrans Storm Water Quality Handbooks, Project Planning and Design Guide”, State of California Department of Transportation (Caltrans), May 2007

6. “Hydrology Manual”, County of San Diego Public Works Flood Control, January 2003

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Appendix A Port of Entry Exhibits and Drawings

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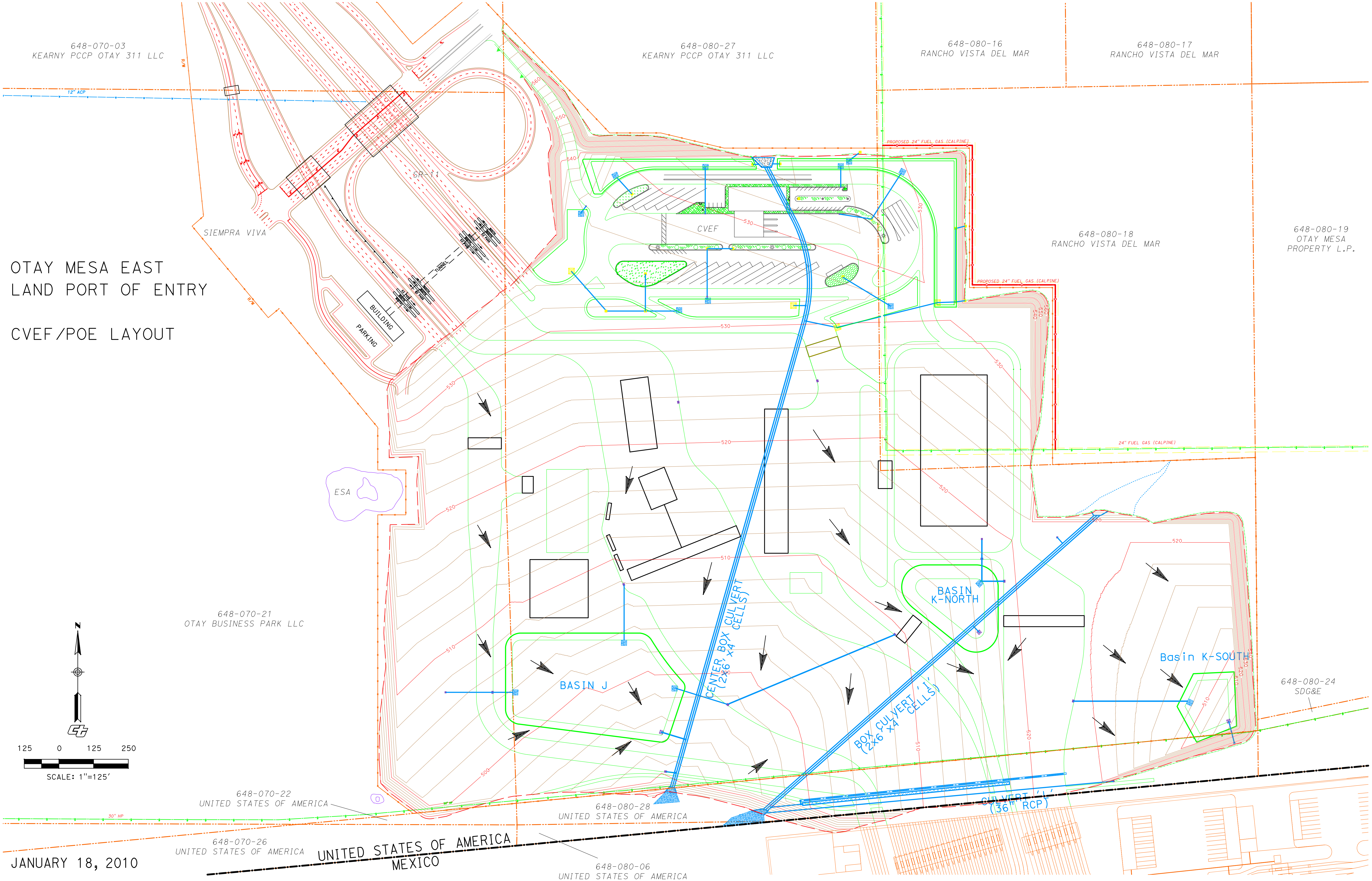
OTAY MESA EAST
LAND PORT OF ENTRY
CVEF/POE LAYOUT
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648-080-27
KEARNY PCCP OTAY 311 LLC
648-080-16
RANCHO VISTA DEL MAR
648-080-17
RANCHO VISTA DEL MAR
648-080-18
RANCHO VISTA DEL MAR
648-080-19
OTAY MESA
PROPERTY L.P.
SIEMPRA VIVA
SR-11
CVEF
BUILDING
PARKING
TUNNEL
PROPOSED 24" FUEL GAS (CALPINE)
24" FUEL GAS (CALPINE)
ESA
648-070-21
OTAY BUSINESS PARK LLC
BASIN J
BASIN
K-NORTH
Basin K-SOUTH
CENTER BOX CULVERT
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BOX CULVERT 'I'
(2x6 x4 CELLS)
CULVERT 'L'
(36" RCP)
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SDG&E
648-070-22
UNITED STATES OF AMERICA
648-080-28
UNITED STATES OF AMERICA
648-070-26
UNITED STATES OF AMERICA
648-080-06
UNITED STATES OF AMERICA
UNITED STATES OF AMERICA
MEXICO
125 0 125 250
SCALE: 1"=125'
JANUARY 18, 2010

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
KIRK BRADBURY
No. 71673
Exp. 12/31/09
CIVIL
STATE OF CALIFORNIA

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AECOM
7807 CONVOY COURT, SUITE 200
SAN DIEGO, CA 92111

NOTE:

FOR COMPLETE RIGHT OF WAY AND ACCURATE ACCESS DATA, SEE RIGHT OF WAY RECORD MAPS AT DISTRICT OFFICE.

THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

SCALE 1"=50'

DRAINAGE PLAN
D-POE

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY

CALCULATED-DESIGNED BY: MIKE BRUNING

CHECKED BY: GERARD DALZIEL

REVISED BY

DATE REVISED

LAST REVISION 11-13-09

DATE PLOTTED => 2/11/2010
TIME PLOTTED => 6:08:25 PM

2/11/2010 6:08:25 PM CarrilloG H:\Caltrans\2208300\Cad\planset\b056300iaPOE.dgn

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300iaPOE.dgn

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EA 06002

Appendix B Pre vs. Post-Development Calculations

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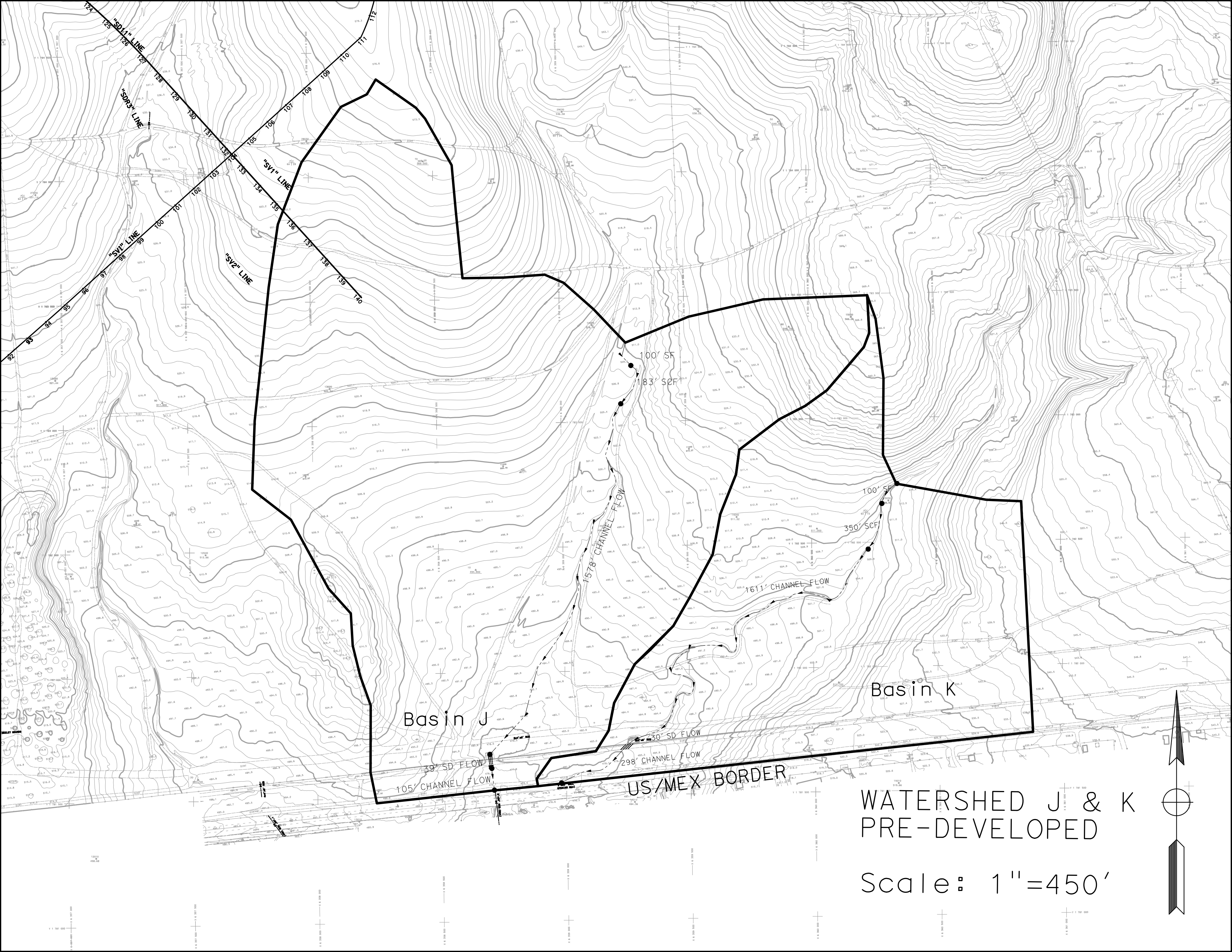

WATERSHED J & K
PRE-DEVELOPED
Scale: 1"=450'
Basin J
Basin K
US/MEX BORDER
"SD1" LINE
"SDR3" LINE
"SV1" LINE
"SV2" LINE
100' SF
183' SCF
1578' CHANNEL FLOW
39' SD FLOW
105' CHANNEL FLOW
100' SF
350' SCF
1611' CHANNEL FLOW
30' SD FLOW
298' CHANNEL FLOW

J Pre-Developed TcQ

PROJECT:	POE			DESCRIPTION:	POE Pre-Developed
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.09.10	WATERSHED:	J
CHK:	G.DALZIEL	DATE:		SYSTEM:	

BASIN AREA:

A =	3708854	ft^2	SOURCE:	MICROSTATION/USGS
	85.14	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.10	Flat/Average Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.06	Normal, some storage
TOTAL C =	0.36	

UNDEVELOPED AREA	100%	AT	0.36	0.360
PAVED SURFACE	0%	AT	0.90	0.000
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.36
C_{25} =	0.40
C_{50} =	0.43
C_{100} =	0.45

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	511.0	ft	Nothern watershed boundary
LOW POINT ELEVATION	509.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	5.42	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60 V}$

NOTES:

HIGH PT ELEVATION	509.0	ft	not concentrated yet
LOW POINT ELEVATION	505.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	183	ft	
SLOPE (S) = (H/L)	2.2%		
VELOCITY (SCF)	2.2	fps	<=V from Figure 816.6 grassed waterway
T_c (SH)=	1.39	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60 V}$

NOTES:

HIGH PT ELEVATION	505.0	ft	defined channel
LOW POINT ELEVATION	478.5	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	26.5	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	1578	ft	b = 44 ANG-DEG 14.036
SLOPE (S) = (H/L)	1.7%		d = 2 FLOWING FULL ASS'M
MANNING'S n	0.050		Natural Channel
HYDRAULIC RADIUS R	1.7	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.54	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)
T_c (CH)=	4.75	minutes	

J Pre-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	478.5	ft	Existing Box Culvert
LOW POINT ELEVATION	476.9	ft	
ELEVATION DIFF (H)	1.6	ft	
LENGTH (L)	39	ft	
SLOPE (S) = (H/L)	4.1%		
MANNING'S n	0.013		Conc
PIPE DIAMETER d	4.0	ft	Box
HYDRAULIC RADIUS R	1.0	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	23.2	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.03	minutes	

NOTES: (see right-hand column above)

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	476.9	ft	Broad/Flat area at border fence
LOW POINT ELEVATION	476.1	ft	
ELEVATION DIFF (H)	0.8	ft	
LENGTH (L)	105	ft	
SLOPE (S) = (H/L)	0.8%		
MANNING'S n	0.050		Natural Channel
HYDRAULIC RADIUS R	0.9	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.35	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)
T_C (CH)=	0.75	minutes	

NOTES:

CHANNEL DATA		TYPE =	TRAP'Z
Z=	20	ANG-RAD	0.050
b =	100	ANG-DEG	2.862
d =	1	FLOWING FULL ASS'M	

Tc (TOTAL) =	12.33	minutes
Minimum Tc =	10	minutes
USE Tc =	**12.33**	minutes

INTENSITY CHART: $I = 7.44\, P_6\, D^{-0.645}$

FLOW RESULTS:

COUNTY P_6

					cfs		inches
i_2 =	1.6	in/hr	X CA =	**Q_2 =**	49.6	2-year:	1.1
i_{10} =	2.4	in/hr	X CA =	**Q_{10} =**	72.2	10-year:	1.6
i_{25} =	2.9	in/hr	X CA =	**Q_{25} =**	99.3	25-year:	2.0
i_{50} =	3.5	in/hr	X CA =	**Q_{50} =**	129.9	50-year:	2.4
i_{100} =	3.7	in/hr	X CA =	**Q_{100} =**	**141.0**	100-year:	2.5

K Pre-Developed TcQ

PROJECT:	**POE**			**DESCRIPTION:**	**POE Pre-Developed**
JOB #:	**11A1190**			**STATION:**	**POE**
BY:	**M.BRUNING**	**DATE:**	**02.09.10**	**WATERSHED:**	**K**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

BASIN AREA:

A =	**1792299**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	41.15	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.10	Flat/Average Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.06	Normal, some storage
TOTAL C =	0.36	

UNDEVELOPED AREA	100%	AT	0.36	0.360
PAVED SURFACE	0%	AT	0.90	0.000
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.36
C_{25} =	0.40
C_{50} =	0.43
C_{100} =	0.45

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ **(in) = 1.80**

HIGH PT ELEVATION	510.0	ft	Northeast watershed boundary
LOW POINT ELEVATION	508.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	5.42	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	508.0	ft	not concentrated yet
LOW POINT ELEVATION	505.0	ft	
ELEVATION DIFF (H)	3.0	ft	
LENGTH (L)	350	ft	
SLOPE (S) = (H/L)	0.9%		
VELOCITY (SCF)	1.5	fps	<=V from Figure 816.6 grassed waterway
T_C (SH)=	3.89	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	505.0	ft
LOW POINT ELEVATION	480.6	ft
ELEVATION DIFF (H)	24.4	ft
LENGTH (L)	1611	ft
SLOPE (S) = (H/L)	1.5%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	1.5	ft
VELOCITY (CHANNEL)	4.88	fps
T_C (CH)=	5.50	minutes

defined channel

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	20	ANG-DEG	14.036
d =	2	FLOWING FULL ASS'M	

Natural Channel

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)

K Pre-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60V}$

			NOTES:
HIGH PT ELEVATION	480.6	ft	Existing Box Culvert
LOW POINT ELEVATION	479.8	ft	
ELEVATION DIFF (H)	0.8	ft	
LENGTH (L)	30	ft	
SLOPE (S) = (H/L)	2.7%		
MANNING'S n	0.013		Conc
PIPE DIAMETER d	4.0	ft	Box
HYDRAULIC RADIUS R	1.0	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	18.7	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.03	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60V}$

			NOTES:			
HIGH PT ELEVATION	479.8	ft	Broad/Flat area at border fence			
LOW POINT ELEVATION	477.9	ft	CHANNEL DATA		TYPE =	TRAP'Z
ELEVATION DIFF (H)	1.9	ft	Z=	20	ANG-RAD	0.050
LENGTH (L)	298	ft	b =	100	ANG-DEG	2.862
SLOPE (S) = (H/L)	0.6%		d =	1	FLOWING FULL ASS'M	
MANNING'S n	0.050		Natural Channel			
HYDRAULIC RADIUS R	0.9	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)			
VELOCITY (CHANNEL)	2.15	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)			
T_C (CH)=	2.31	minutes				

Tc (TOTAL) =	17.16	minutes
Minimum Tc =	10	minutes
USE Tc =	**17.16**	minutes

INTENSITY CHART: $I = 7.44 P_6 D^{-0.645}$ — **FLOW RESULTS:** — **COUNTY P_6**

					cfs		inches
i_2 =	1.3	in/hr	X CA =	**Q_2 =**	19.4	2-year:	1.1
i_{10} =	1.9	in/hr	X CA =	**Q_{10} =**	28.2	10-year:	1.6
i_{25} =	2.4	in/hr	X CA =	**Q_{25} =**	38.8	25-year:	2.0
i_{50} =	2.9	in/hr	X CA =	**Q_{50} =**	50.7	50-year:	2.4
i_{100} =	3.0	in/hr	X CA =	**Q_{100} =**	**55.1**	100-year:	2.5

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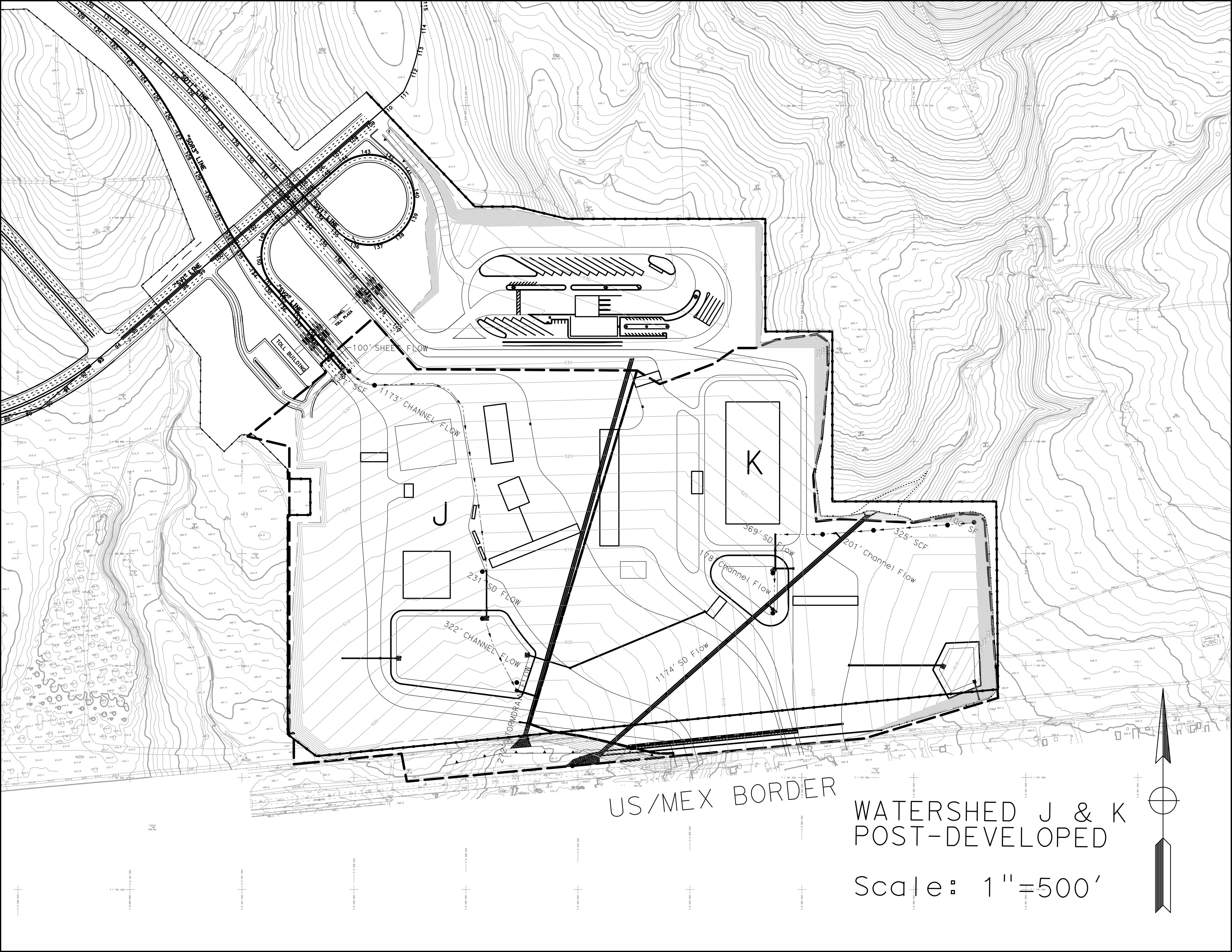

WATERSHED J & K
POST-DEVELOPED

Scale: 1"=500'

J Post-Developed TcQ

PROJECT:	POE			DESCRIPTION:	POE Post-Developed
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.09.10	WATERSHED:	J
CHK:	G.DALZIEL	DATE:		SYSTEM:	

BASIN AREA:

A =	3524400	ft^2	SOURCE:	MICROSTATION/USGS
	80.91	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.00
INFILTRATION (.04-.16)	0.00
VEGETATION (.04-.16)	0.00
STORAGE (.04-.12)	0.00
TOTAL C =	0.00

UNDEVELOPED AREA	0%	AT	0.00	0.000
PAVED SURFACE	48%	AT	0.90	0.429
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	52%	AT	0.55	0.288
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.72
C_{25} =	0.79
C_{50} =	0.86
C_{100} =	0.90

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	535.0	ft	Northwest corner of POE
LOW POINT ELEVATION	534.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.016		< = from Table 816.6A HMA
T_t (SFF)=	2.88	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60 V}$

NOTES:

HIGH PT ELEVATION	534.0	ft	down access road
LOW POINT ELEVATION	530.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	127	ft	
SLOPE (S) = (H/L)	3.1%		
VELOCITY (SCF)	5.0	fps	<=V from Figure 816.6 Gutter, not concentrated
T_C (SH)=	0.42	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60 V}$

NOTES:

HIGH PT ELEVATION	530.0	ft	channelizes in gutter of POE road
LOW POINT ELEVATION	508.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	22.0	ft	Z= 2, ANG-RAD 0.464
LENGTH (L)	1173	ft	b = 8, ANG-DEG 26.565
SLOPE (S) = (H/L)	1.9%		d = 0.5, FLOWING FULL ASS'M
MANNING'S n	0.016		HMA
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	7.37	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)
T_C (CH)=	2.65	minutes	

J Post-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	508.0	ft	Inlet to basin J
LOW POINT ELEVATION	506.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	231	ft	
SLOPE (S) = (H/L)	0.9%		
MANNING'S n	0.013		
PIPE DIAMETER d	2.0	ft	
HYDRAULIC RADIUS R	0.5	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	6.7	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.57	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:			
HIGH PT ELEVATION	506.0	ft	Basin bottom			
LOW POINT ELEVATION	494.0	ft	CHANNEL DATA		TYPE =	TRAP'Z
ELEVATION DIFF (H)	12.0	ft	Z=	4	ANG-RAD	0.245
LENGTH (L)	322	ft	b =	13	ANG-DEG	14.036
SLOPE (S) = (H/L)	3.7%		d =	1	FLOWING FULL ASS'M	
MANNING'S n	0.050		Basin bottom			
HYDRAULIC RADIUS R	0.8	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)			
VELOCITY (CHANNEL)	4.96	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$			
T_C (CH)=	1.08	minutes				

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	489.0	ft	5' drop to Basin outlet and Box Culvert
LOW POINT ELEVATION	480.0	ft	
ELEVATION DIFF (H)	9.0	ft	
LENGTH (L)	272	ft	
SLOPE (S) = (H/L)	3.3%		
MANNING'S n	0.013		
PIPE DIAMETER d	4.0	ft	
HYDRAULIC RADIUS R	1.0	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	20.8	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	0.22	minutes	

Tc (TOTAL) =	7.82	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

FLOW RESULTS:

COUNTY P_6

					cfs		inches
i_2 =	1.9	in/hr	X CA =	**Q_2 =**	107.5	2-year:	1.1
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	156.4	10-year:	1.6
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	215.0	25-year:	2.0
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	281.5	50-year:	2.4
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**305.5**	100-year:	2.5

K Post-Developed TcQ

PROJECT:	POE			DESCRIPTION:	POE Post-Developed
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.09.10	WATERSHED:	K
CHK:	G.DALZIEL	DATE:		SYSTEM:	

BASIN AREA:

A =	1424500	ft^2	SOURCE:	MICROSTATION/USGS
	32.70	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.00
INFILTRATION (.04-.16)	0.00
VEGETATION (.04-.16)	0.00
STORAGE (.04-.12)	0.00
TOTAL C =	0.00

UNDEVELOPED AREA	0%	AT	0.00	0.000
PAVED SURFACE	41%	AT	0.90	0.369
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	59%	AT	0.55	0.325
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.69
C_{25} =	0.76
C_{50} =	0.83
C_{100} =	0.87

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	535.0	ft	Northwest corner of POE
LOW POINT ELEVATION	534.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	across
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.016		< = from Table 816.6A HMA
T_t (SFF)=	2.88	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	534.0	ft	down access road
LOW POINT ELEVATION	530.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	325	ft	
SLOPE (S) = (H/L)	1.2%		
VELOCITY (SCF)	5.0	fps	<=V from Figure 816.6 Gutter, not concentrated
T_c (SH)=	1.08	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	530.0	ft	channelizes in gutter of POE road
LOW POINT ELEVATION	508.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	22.0	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	201	ft	b = 8 ANG-DEG 26.565
SLOPE (S) = (H/L)	10.9%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.016		HMA
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	17.81	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_c (CH)=	0.19	minutes	

K Post-Developed TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	508.0	ft	Inlet to basin K
LOW POINT ELEVATION	506.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	369	ft	
SLOPE (S) = (H/L)	0.5%		
MANNING'S n	0.013		
PIPE DIAMETER d	2.0	ft	
HYDRAULIC RADIUS R	0.5	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	5.3	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.16	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	506.0	ft	channelizes in gutter of POE road
LOW POINT ELEVATION	498.0	ft	CHANNEL DATA
ELEVATION DIFF (H)	8.0	ft	
LENGTH (L)	178	ft	
SLOPE (S) = (H/L)	4.5%		
MANNING'S n	0.050		Basin bottom
HYDRAULIC RADIUS R	0.8	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.44	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.54	minutes	

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	493.0	ft	5' drop to Basin outlet and Box Culvert
LOW POINT ELEVATION	480.0	ft	
ELEVATION DIFF (H)	13.0	ft	
LENGTH (L)	1174	ft	
SLOPE (S) = (H/L)	1.1%		
MANNING'S n	0.013		
PIPE DIAMETER d	4.0	ft	
HYDRAULIC RADIUS R	1.0	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	12.1	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.62	minutes	

Tc (TOTAL) =	7.47	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

FLOW RESULTS:

COUNTY P_6

					cfs		inches
i_2 =	1.9	in/hr	X CA =	**Q_2 =**	42.0	2-year:	1.1
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	61.1	10-year:	1.6
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	84.1	25-year:	2.0
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	110.0	50-year:	2.4
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**119.4**	100-year:	2.5

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Appendix C Offsite Culvert Calculations

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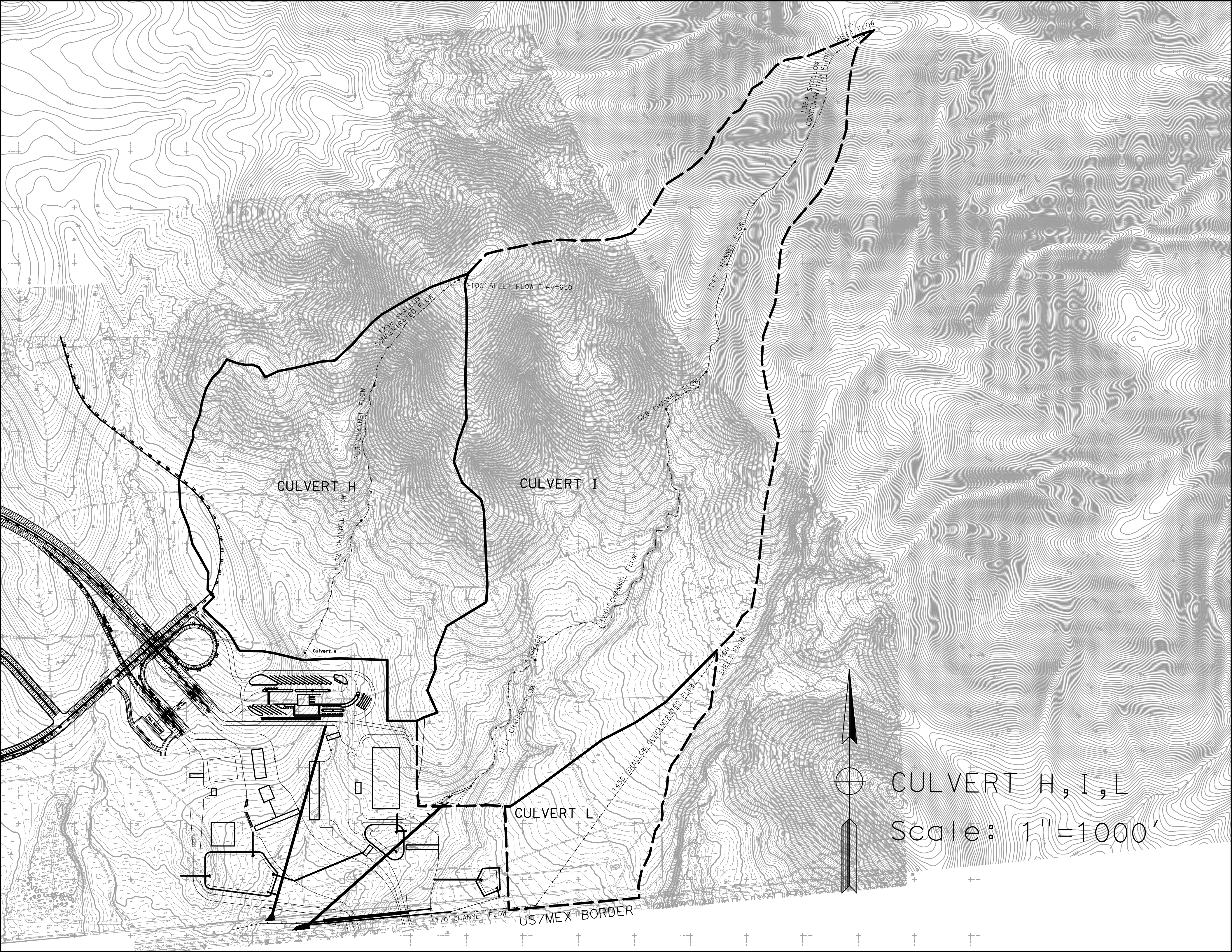

100' SHEET FLOW
1359' SHALLOW CONCENTRATED FLOW
100' SHEET FLOW Elev=630
1266' SHALLOW CONCENTRATED FLOW
1247' CHANNEL FLOW
528' CHANNEL FLOW
1283' CHANNEL FLOW
CULVERT H
CULVERT I
1332' CHANNEL FLOW
3230' CHANNEL FLOW
STORAGE
Culvert H
100' SHEET FLOW
162' CHANNEL FLOW
1456' SHALLOW CONCENTRATED FLOW
CULVERT L
770' CHANNEL FLOW
US/MEX BORDER
CULVERT H,I,L
Scale: 1"=1000'

H Culvert TcQ

PROJECT:	SR-11			DESCRIPTION:	SR-11 Culvert
JOB #:	11A1190			STATION:	CVEF
BY:	M.BRUNING	DATE:	01.12.10	WATERSHED:	H
CHK:	G.DALZIEL	DATE:		SYSTEM:	Culvert

BASIN AREA:

A =	7050716	ft^2	SOURCE: MICROSTATION/USGS
	161.86	acres	(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.22	Hilly Slopes ~ 15%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.49	

UNDEVELOPED AREA	100%	AT	0.49	0.490
PAVED SURFACE	0%	AT	0.90	0.000
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.49
C_{25} =	0.54
C_{50} =	0.59
C_{100} =	0.61

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	1023.9	ft	Northern watershed boundary
LOW POINT ELEVATION	1014.0	ft	
ELEVATION DIFF (H)	9.9	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	9.9%		
MANNING'S n	0.050		< = FROM TABLE 816.6A Fallow
T_t (SFF)=	2.86	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	1014.0	ft	
LOW POINT ELEVATION	672.0	ft	
ELEVATION DIFF (H)	342.0	ft	
LENGTH (L)	1266	ft	
SLOPE (S) = (H/L)	27.0%		
VELOCITY (SCF)	3.3	fps	<=V FROM FIG 816.6 Earthen/Grasses
T_C (SH)=	6.39	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	672.0	ft	channelizes
LOW POINT ELEVATION	581.1	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	90.9	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	1283	ft	b = 0.5 ANG-DEG 26.565
SLOPE (S) = (H/L)	7.1%		d = 1 FLOWING FULL ASS'M
MANNING'S n	0.080		grass/earthen
HYDRAULIC RADIUS R	0.5	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	3.13	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	6.82	minutes	

H Culvert TcQ

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	581.1	ft
LOW POINT ELEVATION	525.0	ft
ELEVATION DIFF (H)	56.1	ft
LENGTH (L)	1332	ft
SLOPE (S) = (H/L)	4.2%	
MANNING'S n	0.080	
HYDRAULIC RADIUS R	1.2	ft
VELOCITY (CHANNEL)	4.43	fps
T_C (CH)=	5.01	minutes

NOTES:

broader channel at confluence

CHANNEL DATA		TYPE =	TRAP'Z
Z=	3	ANG-RAD	0.322
b =	20	ANG-DEG	18.435
d =	1.5	FLOWING FULL ASS'M	

grass/earthen

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	21.09	minutes
Minimum Tc =	10	minutes
USE T_C =	**21.09**	minutes

INTENSITY CHART: **Caltrans IDF2000** **FLOW RESULTS**

					cfs
i_2 =	0.8	in/hr	X CA =	**Q_2 =**	65.8
i_{10} =	1.6	in/hr	X CA =	**Q_{10} =**	123.6
i_{25} =	1.9	in/hr	X CA =	**Q_{25} =**	169.9
i_{50} =	2.2	in/hr	X CA =	**Q_{50} =**	213.2
i_{100} =	2.5	in/hr	X CA =	**Q_{100} =**	**250.9**

~Use Caltrans 'i' for culvert sizing

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$ **FLOW RESULTS**

					cfs
i_2 =	1.1	in/hr	X CA =	**Q_2 =**	90.8
i_{10} =	1.7	in/hr	X CA =	**Q_{10} =**	132.1
i_{25} =	2.1	in/hr	X CA =	**Q_{25} =**	181.7
i_{50} =	2.5	in/hr	X CA =	**Q_{50} =**	237.8
i_{100} =	2.6	in/hr	X CA =	**Q_{100} =**	**258.1**

~Use County of SD 'i' for detention basin design

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

Culvert Calculator Report
POE H Center 10-yr

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	514.00 ft	Headwater Depth/Height	0.65
Computed Headwater Elevation	512.61 ft	Discharge	123.90 cfs
Inlet Control HW Elev.	512.36 ft	Tailwater Elevation	480.00 ft
Outlet Control HW Elev.	512.61 ft	Control Type	Entrance Control

Grades

Upstream Invert	510.00 ft	Downstream Invert	480.00 ft
Length	1,744.00 ft	Constructed Slope	1.7 %

Hydraulic Profile

Profile	S2	Depth, Downstream	0.89 ft
Slope Type	Steep	Normal Depth	0.89 ft
Flow Regime	Supercritical	Critical Depth	1.49 ft
Velocity Downstream	11.64 ft/s	Critical Slope	0.4 %

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	6.00 ft
Section Size	6 x 4 ft	Rise	4.00 ft
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev.	512.61 ft	Upstream Velocity Head	0.75 ft
Ke	0.50	Entrance Loss	0.37 ft

Inlet Control Properties

Inlet Control HW Elev.	512.36 ft	Flow Control	N/A
Inlet Type 45° bevels; 10 - 45° skewed headwall		Area Full	48.0 ft²
K	0.49800	HDS 5 Chart	11
M	0.66700	HDS 5 Scale	4
C	0.03270	Equation Form	2
Y	0.75000		

Culvert Calculator Report
POE H Center 100-yr

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	514.00 ft	Headwater Depth/Height	1.05
Computed Headwater Elevation	514.18 ft	Discharge	251.60 cfs
Inlet Control HW Elev.	513.79 ft	Tailwater Elevation	480.00 ft
Outlet Control HW Elev.	514.18 ft	Control Type	Entrance Control

Grades

Upstream Invert	510.00 ft	Downstream Invert	480.00 ft
Length	1,744.00 ft	Constructed Slope	1.7 %

Hydraulic Profile

Profile	S2	Depth, Downstream	1.43 ft
Slope Type	Steep	Normal Depth	1.43 ft
Flow Regime	Supercritical	Critical Depth	2.39 ft
Velocity Downstream	14.67 ft/s	Critical Slope	0.4 %

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	6.00 ft
Section Size	6 x 4 ft	Rise	4.00 ft
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev.	514.18 ft	Upstream Velocity Head	1.20 ft
Ke	0.50	Entrance Loss	0.60 ft

Inlet Control Properties

Inlet Control HW Elev.	513.79 ft	Flow Control	N/A
Inlet Type 45° bevels; 10 - 45° skewed headwall		Area Full	48.0 ft²
K	0.49800	HDS 5 Chart	11
M	0.66700	HDS 5 Scale	4
C	0.03270	Equation Form	2
Y	0.75000		

I Culvert TcQ

PROJECT:	POE			DESCRIPTION:	POE Pre-Developed
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.11.10	WATERSHED:	I
CHK:	G.DALZIEL	DATE:		SYSTEM:	Culvert

BASIN AREA:

A =	13962619	ft^2	SOURCE:	MICROSTATION/USGS
	320.54	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.26	Hilly Slopes ~ 13-20%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.06	fair to good vegetal cover
STORAGE (.04-.12)	0.04	significant storage at elevation 548.5
TOTAL C =	0.48	

UNDEVELOPED AREA	100%	AT	0.48	0.480
PAVED SURFACE	0%	AT	0.90	0.000
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.48
C_{25} =	0.53
C_{50} =	0.58
C_{100} =	0.60

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	1600.0	ft	Northern watershed boundary
LOW POINT ELEVATION	1598.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	5.42	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	1598.0	ft	not concentrated yet
LOW POINT ELEVATION	1130.0	ft	
ELEVATION DIFF (H)	468.0	ft	
LENGTH (L)	1359	ft	
SLOPE (S) = (H/L)	34.4%		
VELOCITY (SCF)	0.8	fps	<=V from Figure 816.6 short grass pasture
T_C (SH)=	30.20	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	1130.0	ft	broad channel
LOW POINT ELEVATION	700.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	430.0	ft	Z= 4 ANG-RAD 0.245
LENGTH (L)	2147	ft	b = 70 ANG-DEG 14.036
SLOPE (S) = (H/L)	20.0%		d = 1 FLOWING FULL ASS'M
MANNING'S n	0.080		Natural Channel
HYDRAULIC RADIUS R	0.9	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	8.03	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.46	minutes	

I Culvert TcQ

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	700.0	ft	
LOW POINT ELEVATION	656.0	ft	
ELEVATION DIFF (H)	44.0	ft	
LENGTH (L)	528	ft	
SLOPE (S) = (H/L)	8.3%		
MANNING'S n	0.050		
HYDRAULIC RADIUS R	1.8	ft	
VELOCITY (CHANNEL)	12.67	fps	
T_C (CH)=	0.69	minutes	

defined channel to confluence

CHANNEL DATA		TYPE =	TRAP'Z
Z=	3	ANG-RAD	0.322
b =	50	ANG-DEG	18.435
d =	2	FLOWING FULL ASS'M	

Natural Channel
R=(bdsinA+d^2cosA)/(bsinA+2d)
From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	656.0	ft
LOW POINT ELEVATION	548.5	ft
ELEVATION DIFF (H)	107.5	ft
LENGTH (L)	3230	ft
SLOPE (S) = (H/L)	3.3%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	2.5	ft
VELOCITY (CHANNEL)	9.98	fps
T_C (CH)=	5.39	minutes

defined channel to storage

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	30	ANG-DEG	26.565
d =	3	FLOWING FULL ASS'M	

Natural Channel
R=(bdsinA+d^2cosA)/(bsinA+2d)
From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	548.5	ft
LOW POINT ELEVATION	510.0	ft
ELEVATION DIFF (H)	38.5	ft
LENGTH (L)	1621	ft
SLOPE (S) = (H/L)	2.4%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	2.3	ft
VELOCITY (CHANNEL)	8.08	fps
T_C (CH)=	3.34	minutes

defined channel to location of future culvert I

CHANNEL DATA		TYPE =	TRAP'Z
Z=	2	ANG-RAD	0.464
b =	20	ANG-DEG	26.565
d =	3	FLOWING FULL ASS'M	

Natural Channel
R=(bdsinA+d^2cosA)/(bsinA+2d)
From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

Tc (TOTAL) =	49.51	minutes
Minimum Tc =	10	minutes
USE Tc =	**49.51**	minutes

INTENSITY CHART: Caltrans IDF2000 **FLOW RESULTS:**

					cfs
i_2 =	0.5	in/hr	X CA =	**Q_2 =**	83.3
i_{10} =	1.0	in/hr	X CA =	**Q_{10} =**	156.5
i_{25} =	1.3	in/hr	X CA =	**Q_{25} =**	215.2
i_{50} =	1.5	in/hr	X CA =	**Q_{50} =**	269.9
i_{100} =	1.7	in/hr	X CA =	**Q_{100} =**	**317.7**

~Use Caltrans 'i' for culvert sizing

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$ **FLOW RESULTS**

					cfs
i_2 =	0.7	in/hr	X CA =	**Q_2 =**	101.6
i_{10} =	1.0	in/hr	X CA =	**Q_{10} =**	147.8
i_{25} =	1.2	in/hr	X CA =	**Q_{25} =**	203.2
i_{50} =	1.4	in/hr	X CA =	**Q_{50} =**	266.1
i_{100} =	1.5	in/hr	X CA =	**Q_{100} =**	**288.7**

~Use County of SD 'i' for detention basin design

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

Culvert Calculator Report
POE I 10-yr

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	512.00 ft	Headwater Depth/Height	0.76
Computed Headwater Elevation	511.05 ft	Discharge	156.50 cfs
Inlet Control HW Elev.	510.76 ft	Tailwater Elevation	481.03 ft
Outlet Control HW Elev.	511.05 ft	Control Type	Entrance Control

Grades

Upstream Invert	508.00 ft	Downstream Invert	480.00 ft
Length	1,594.00 ft	Constructed Slope	1.8 %

Hydraulic Profile

Profile	S2	Depth, Downstream	1.03 ft
Slope Type	Steep	Normal Depth	1.03 ft
Flow Regime	Supercritical	Critical Depth	1.74 ft
Velocity Downstream	12.68 ft/s	Critical Slope	0.4 %

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	6.00 ft
Section Size	6 x 4 ft	Rise	4.00 ft
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev.	511.05 ft	Upstream Velocity Head	0.87 ft
Ke	0.50	Entrance Loss	0.44 ft

Inlet Control Properties

Inlet Control HW Elev.	510.76 ft	Flow Control	Unsubmerged
Inlet Type	45° bevels; 10 - 45° skewed headwall	Area Full	48.0 ft²
K	0.49800	HDS 5 Chart	11
M	0.66700	HDS 5 Scale	4
C	0.03270	Equation Form	2
Y	0.75000		

Culvert Calculator Report
POE I 100-yr

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	518.00	ft	Headwater Depth/Height	1.22	
Computed Headwater Elevation	512.89	ft	Discharge	317.70	cfs
Inlet Control HW Elev.	512.43	ft	Tailwater Elevation	481.67	ft
Outlet Control HW Elev.	512.89	ft	Control Type	Entrance Control	

Grades

Upstream Invert	508.00	ft	Downstream Invert	480.00	ft
Length	1,594.00	ft	Constructed Slope	1.8	%

Hydraulic Profile

Profile	S2		Depth, Downstream	1.67	ft
Slope Type	Steep		Normal Depth	1.67	ft
Flow Regime	Supercritical		Critical Depth	2.79	ft
Velocity Downstream	15.87	ft/s	Critical Slope	0.4	%

Section

Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	6 x 4 ft		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties

Outlet Control HW Elev.	512.89	ft	Upstream Velocity Head	1.40	ft
Ke	0.50		Entrance Loss	0.70	ft

Inlet Control Properties

Inlet Control HW Elev.	512.43	ft	Flow Control	Unsubmerged	
Inlet Type 45° bevels; 10 - 45° skewed headwall			Area Full	48.0	ft^2
K	0.49800		HDS 5 Chart	11	
M	0.66700		HDS 5 Scale	4	
C	0.03270		Equation Form	2	
Y	0.75000				

L Culvert TcQ

PROJECT:	**POE**			DESCRIPTION:	**POE Pre-Developed**
JOB #:	**11A1190**			STATION:	**POE**
BY:	**M.BRUNING**	DATE:	**02.11.10**	WATERSHED:	**L**
CHK:	**G.DALZIEL**	DATE:		SYSTEM:	**Culvert**

BASIN AREA:

A =	**2003187**	**ft^2**	**SOURCE:**	**MICROSTATION/USGS**
	45.99	**acres**		**(SCALE = 1:1)**

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.10	Flat/Average Slopes ~ 5%
INFILTRATION (.04-.16)	0.12	Negligible infiltration capacity - See Geotechnical Report
VEGETATION (.04-.16)	0.08	Fair natural cover
STORAGE (.04-.12)	0.07	Normal
TOTAL C =	0.37	

UNDEVELOPED AREA	100%	AT	0.37	0.370
PAVED SURFACE	0%	AT	0.90	0.000
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	0%	AT	0.55	0.000
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.37
C_{25} =	0.41
C_{50} =	0.44
C_{100} =	0.46

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} S^{2/5}}$

NOTES: $P_{2,24}$ **(in) = 1.80**

HIGH PT ELEVATION	620.0	ft	Northern watershed boundary
LOW POINT ELEVATION	618.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	100	ft	
SLOPE (S) = (H/L)	2.0%		
MANNING'S n	0.050		< = From Table 816.6A Fallow
T_t (SFF)=	5.42	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60V}$

NOTES:

HIGH PT ELEVATION	618.0	ft	not concentrated yet
LOW POINT ELEVATION	540.0	ft	
ELEVATION DIFF (H)	78.0	ft	
LENGTH (L)	1456	ft	
SLOPE (S) = (H/L)	5.4%		
VELOCITY (SCF)	0.8	fps	<=V from Figure 816.5 short grass pasture
T_C (SH)=	32.36	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60V}$

NOTES:

HIGH PT ELEVATION	540.0	ft	broad channel
LOW POINT ELEVATION	523.0	ft	
ELEVATION DIFF (H)	17.0	ft	
LENGTH (L)	770	ft	
SLOPE (S) = (H/L)	2.2%		
MANNING'S n	0.080		Natural Channel
HYDRAULIC RADIUS R	0.9	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	2.63	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	4.88	minutes	

CHANNEL DATA — TYPE = TRAP'Z

Z=	4	ANG-RAD	0.245
b =	50	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

L Culvert TcQ

Tc (TOTAL) =	42.66	minutes
Minimum Tc =	10	minutes
USE Tc =	**42.66**	minutes

INTENSITY CHART: Caltrans IDF2000

FLOW RESULTS:

					cfs	
i_2 =	0.6	in/hr	X CA =	**Q_2 =**	9.9	
i_{10} =	1.1	in/hr	X CA =	**Q_{10} =**	18.6	
i_{25} =	1.4	in/hr	X CA =	**Q_{25} =**	25.6	
i_{50} =	1.6	in/hr	X CA =	**Q_{50} =**	32.2	
i_{100} =	1.8	in/hr	X CA =	**Q_{100} =**	**37.9**	~Use Caltrans 'i' for culvert sizing

INTENSITY CHART: $I = 7.44\ P_6\ D^{-0.645}$

FLOW RESULTS

					cfs	
i_2 =	0.7	in/hr	X CA =	**Q_2 =**	12.4	
i_{10} =	1.1	in/hr	X CA =	**Q_{10} =**	18.0	
i_{25} =	1.3	in/hr	X CA =	**Q_{25} =**	24.7	
i_{50} =	1.6	in/hr	X CA =	**Q_{50} =**	32.4	
i_{100} =	1.7	in/hr	X CA =	**Q_{100} =**	**35.1**	~Use County of SD 'i' for detention basin design

COUNTY P_6

	inches
2-year:	1.1
10-year:	1.6
25-year:	2.0
50-year:	2.4
100-year:	2.5

Culvert Calculator Report
POE L 10-yr

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	519.00 ft	Headwater Depth/Height	0.73
Computed Headwater Elevation	518.18 ft	Discharge	18.60 cfs
Inlet Control HW Elev.	517.94 ft	Tailwater Elevation	480.82 ft
Outlet Control HW Elev.	518.18 ft	Control Type	Entrance Control

Grades			
Upstream Invert	516.00 ft	Downstream Invert	480.00 ft
Length	1,256.00 ft	Constructed Slope	2.9 %

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.82 ft
Slope Type	Steep	Normal Depth	0.82 ft
Flow Regime	Supercritical	Critical Depth	1.38 ft
Velocity Downstream	11.80 ft/s	Critical Slope	0.4 %

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	518.18 ft	Upstream Velocity Head	0.53 ft
Ke	0.50	Entrance Loss	0.27 ft

Inlet Control Properties			
Inlet Control HW Elev.	517.94 ft	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Calculator Report
POE L 100-yr

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	520.00	ft	Headwater Depth/Height	1.11	
Computed Headwater Elevation	519.33	ft	Discharge	37.90	cfs
Inlet Control HW Elev.	519.13	ft	Tailwater Elevation	481.20	ft
Outlet Control HW Elev.	519.33	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	516.00	ft	Downstream Invert	480.00	ft
Length	1,256.00	ft	Constructed Slope	2.9	%

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.20	ft
Slope Type	Steep		Normal Depth	1.20	ft
Flow Regime	Supercritical		Critical Depth	2.00	ft
Velocity Downstream	14.40	ft/s	Critical Slope	0.5	%

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	519.33	ft	Upstream Velocity Head	0.89	ft
Ke	0.50		Entrance Loss	0.44	ft

Inlet Control Properties					
Inlet Control HW Elev.	519.13	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

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Appendix D Onsite Hydrology and Hydraulics Calculations

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
11	SD	11	23.3/26.6		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

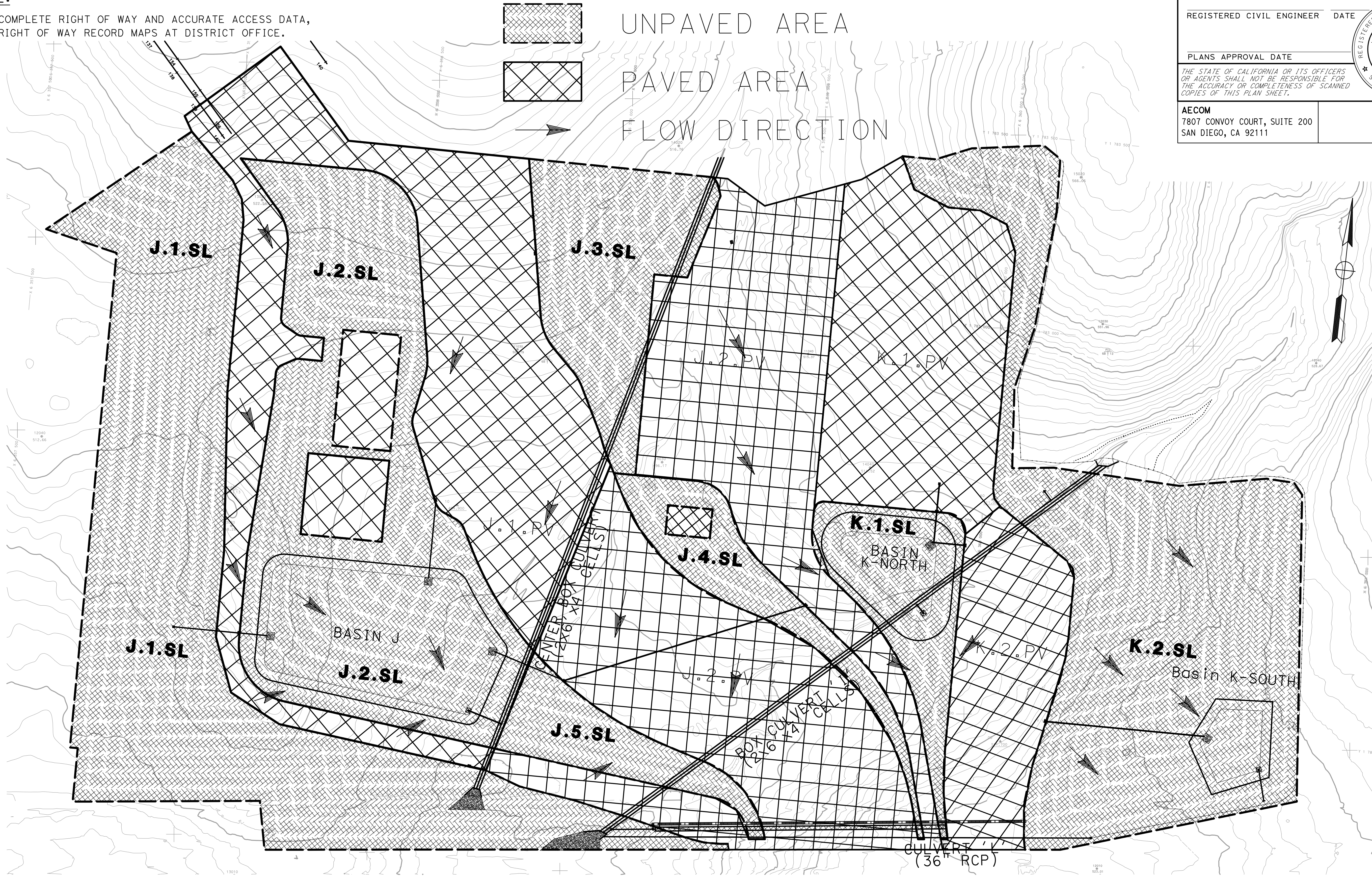
REGISTERED PROFESSIONAL ENGINEER KIRK BRADBURY No. 71673 Exp. 12/31/09 CIVIL STATE OF CALIFORNIA

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

AECOM
7807 CONVOY COURT, SUITE 200
SAN DIEGO, CA 92111

NOTE:

FOR COMPLETE RIGHT OF WAY AND ACCURATE ACCESS DATA, SEE RIGHT OF WAY RECORD MAPS AT DISTRICT OFFICE.



THIS PLAN ACCURATE FOR DRAINAGE WORK ONLY.

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DRAINAGE AREA PLAN

SCALE 1"=50'

DA-POE

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: KIRK BRADBURY
CALCULATED-DESIGNED BY: MIKE BRUNING
CHECKED BY: GERARD DALZIEL
REVISED BY
DATE REVISED

LAST REVISION 11-13-09
DATE PLOTTED => 2/11/2010
TIME PLOTTED => 6:10:04 PM

2/8/2010 6d0s03 PM CarrilloG H:\Caltrans\2208300\Cad\planset\b056300iaPOE_DA.dgn
BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => CarrilloG
DGN FILE => ...\b056300iaPOE_DA.dgn

CU XXXXX

EA 06002

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J Onsite D.A. Table

PROJECT:	POE	**DESCRIPTION:**	Onsite Drainage Areas (D.A.)
JOB #:	11A1190	**STATION:**	POE
BY:	M.BRUNING	**DATE:**	02.09.10
CHK:	G.DALZIEL	**DATE:**	
WATERSHED:	J	**SYSTEM:**	

PAVED

Name	C_{25}	Area SF	Area Acres	Tc min	Caltrans i_{25} in/hr	Caltrans Q_{25} cfs	County i_{100} in/hr	County Q_{100} cfs	Drains to: Bioswale	Drains to: Inlet	Drains to: Destination	@ Station	Offset
J.1.PV	0.99	755900	17.4	5	4.0	68.44	6.6	113.16	~	J.1	J	POE	~
J.2.PV	0.99	925800	21.3	5	4.0	83.82	6.6	138.59	~	J.2	J	POE	~

Σ 1681700 *PAVED*

SLOPE

Name	C_{25}	Area SF	Area Acres	Tc min	Caltrans i_{25} in/hr	Caltrans Q_{25} cfs	County i_{100} in/hr	County Q_{100} cfs	Drains to: Bioswale	Drains to: Inlet	Drains to: Destination	@ Station	Offset
J.1.SL	0.61	829900	19.1	10	2.8	32.74	4.2	48.95	~	J.1	J	POE	~
J.2.SL	0.61	593600	13.6	10	2.8	23.42	4.2	35.01	~	J.2	J	POE	~
J.3.SL	0.61	220800	5.1	10	2.8	8.71	4.2	13.02	~	J.3	J	POE	~
J.4.SL	0.61	105400	2.4	10	2.8	4.16	4.2	6.22	~	J.4	J	POE	~
J.5.SL	0.61	93000	2.1	10	2.8	3.67	4.2	5.49	~	J.5	J	POE	~

Σ 1842700 *SLOPE*

Total :	3524400	80.91
	SF	*ac*

C_{25}:	0.79
C_{100}:	0.90

K Onsite D.A. Table

PROJECT:	POE	**DESCRIPTION:**	Onsite Drainage Areas (D.A.)
JOB #:	11A1190	**STATION:**	POE
BY:	M.BRUNING	**DATE:**	02.09.10
CHK:	G.DALZIEL	**DATE:**	
		WATERSHED:	K
		SYSTEM:	

PAVED

Name	C_{25}	Area SF	Area Acres	Tc min	Caltrans i_{25} in/hr	Caltrans Q_{25} cfs	County i_{100} in/hr	County Q_{100} cfs	Drains to: Bioswale	Drains to: Inlet	Drains to: Destination	@ Station	Offset
K.1.PV	0.99	372100	8.5	5	4.0	33.69	6.6	55.70	~	K.1	K	POE	~
K.2.PV	0.99	211600	4.9	5	4.0	19.16	6.6	31.68	~	K.2	K	POE	~

Σ 583700 *PAVED*

SLOPE

Name	C_{25}	Area SF	Area Acres	Tc min	Caltrans i_{25} in/hr	Caltrans Q_{25} cfs	County i_{100} in/hr	County Q_{100} cfs	Drains to: Bioswale	Drains to: Inlet	Drains to: Destination	@ Station	Offset
K.1.SL	0.61	144600	3.3	10	2.8	5.70	4.2	8.53	~	K.1	K	POE	~
K.2.SL	0.61	696200	16.0	10	2.8	27.46	4.2	41.07	~	K.2	K	POE	~

Σ 840800 *SLOPE*

Total :	1424500 *SF*	32.70 *ac*

C_{25}:	0.76
C_{100}:	0.87

Appendix E Detention/Retention Basin Calculations

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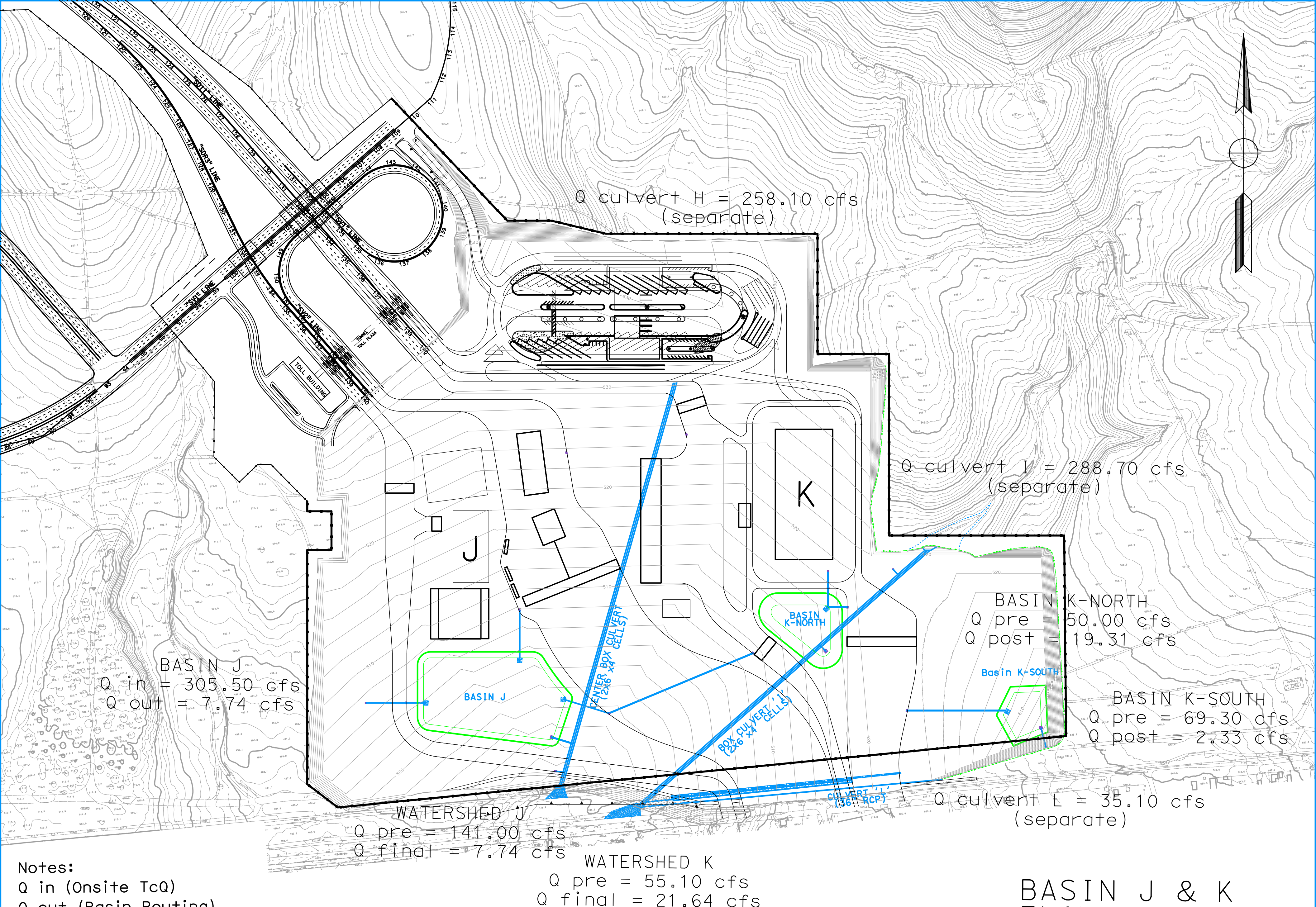


Notes:

Q in (Onsite TcQ)

Q out (Basin Routing)

Q culvert (Culvert TcQ)

Q bypass (Onsite D.A. Table)

Q pre (Pre-Developed TcQ)

Q final = Q culvert + Q out + Q bypass

BASIN J & K FLOW SUMMARY

Scale: 1"=500'

Basin J Retention

PROJECT:	**POE**			**DESCRIPTION:**	**POE Basin**
JOB #:	**11A1190**			**STATION:**	**POE**
BY:	**M.BRUNING**	**DATE:**	**02.09.10**	**WATERSHED:**	**J**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:

* The difference between pre-developed and post-developed values gives the approximate volume to detain.
Stage-Storage calculations will determine accurate volume

RETENTION BASIN VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}= 141.0 cfs
Tc= 12.3 min
$P_{100,6}$= 2.5 in

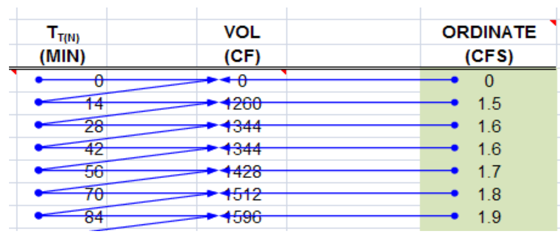
C= 0.45
A= 85.14 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
12	4104	5.7
24	4248	5.9
36	4464	6.2
48	4536	6.3
60	4752	6.6
72	4896	6.8
84	5256	7.3
96	5400	7.5
108	5760	8
120	6048	8.4
132	6552	9.1
144	6840	9.5
156	7560	10.5
168	8064	11.2
180	9216	12.8
192	10008	13.9
204	12240	17
216	13896	19.3
228	20448	28.4
240	30600	42.5
252	101520	141
264	16416	22.8
276	10944	15.2
288	8568	11.9
300	7200	10
312	6264	8.7
324	5616	7.8
336	5040	7
348	4680	6.5
360	4320	6
372	0	0

SUM= 345456 ft^3
7.93 acre-feet

Check: $V = C*A*P_6$
V= 7.98 acre-feet
OK

Example of Steps:



$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
14	1260	1.5
28	1344	1.6
42	1344	1.6
56	1428	1.7
70	1512	1.8
84	1596	1.9

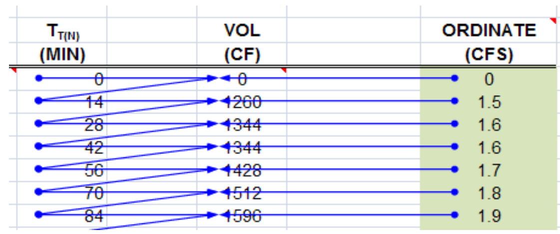
Basin J Retention

Post-Developed volume calculations

Q_{100}=	305.5	cfs			
Tc=	10.0	min	C=	0.90	
$P_{100,6}$=	2.5	in	A=	80.91	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	6540	10.9
20	6660	11.1
30	6900	11.5
40	7080	11.8
50	7380	12.3
60	7500	12.5
70	7920	13.2
80	8100	13.5
90	8520	14.2
100	8760	14.6
110	9300	15.5
120	9600	16
130	10320	17.2
140	10740	17.9
150	11640	19.4
160	12180	20.3
170	13500	22.5
180	14340	23.9
190	16440	27.4
200	17820	29.7
210	21780	36.3
220	24840	41.4
230	36420	60.7
240	52080	86.8
250	183300	305.5
260	29220	48.7
270	19560	32.6
280	15300	25.5
290	12840	21.4
300	11160	18.6
310	9960	16.6
320	9060	15.1
330	8280	13.8
340	7680	12.8
350	7200	12
360	6780	11.3
370	0	0

Example of Steps:



SUM= 656700 ft^3
15.08 acre-feet

Check: V = $C*A*P_6$
V= 15.11 acre-feet
OK

	15.08				
	- **7.93**				
Retention volume =	**7.15**	**acre-feet**	**=**	**311244 ft^3**	**Basin Required**

Basin J Retention

WATER QUALITY VOLUME (WQV) CALCULATION

Per the Caltrans Storm Water Quality Handbook: Project Planning and Design Guide (PPDG) (May 2007)
Provide additional capacity for Water Quality

Output from Basin Sizer

Water Quality Volumes

Maximized Volume Method (in/area)*

Basin Drainage Time (hrs)	Runoff Coefficient 0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
12	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.4
24	0.16	0.21	0.27	0.31	0.37	0.42	0.46	0.52
48	0.2	0.26	0.32	0.38	0.44	0.51	0.57	0.58
72	0.22	0.29	0.37	0.43	0.51	0.58	0.66	0.73

C_{100}= 0.90
A= 80.91 acres

WQ_{72}: 0.73 in/area

Water Quality Volume (WQV) = **214401** **ft^3**

WQV to be added to retention volume = **0** **ft^3** **WQV is within Retention**

If the WQV is less than retention requirement, do not add volume since WQ is addressed in Retention

SILT ACCUMULATION ANALYSIS (Long Term)

Per the United States International Boundary and Water Commission (IBWC)
Provide additional capacity for a 10-year volume of silt accumulation

Onsite Highway *Sloped* runoff area, A:	1842700	ft^2
A:	42.30	acres
	10.00	years
where: R=	30.00	
K=	0.24	
Ls=	18.00	
C=	0.012	
P=	1.00	
As	1.56	tons/yr.Ac

Universal Soil Loss Equation (SDCHM 5.2.3)

$A_s = RKLsCP$

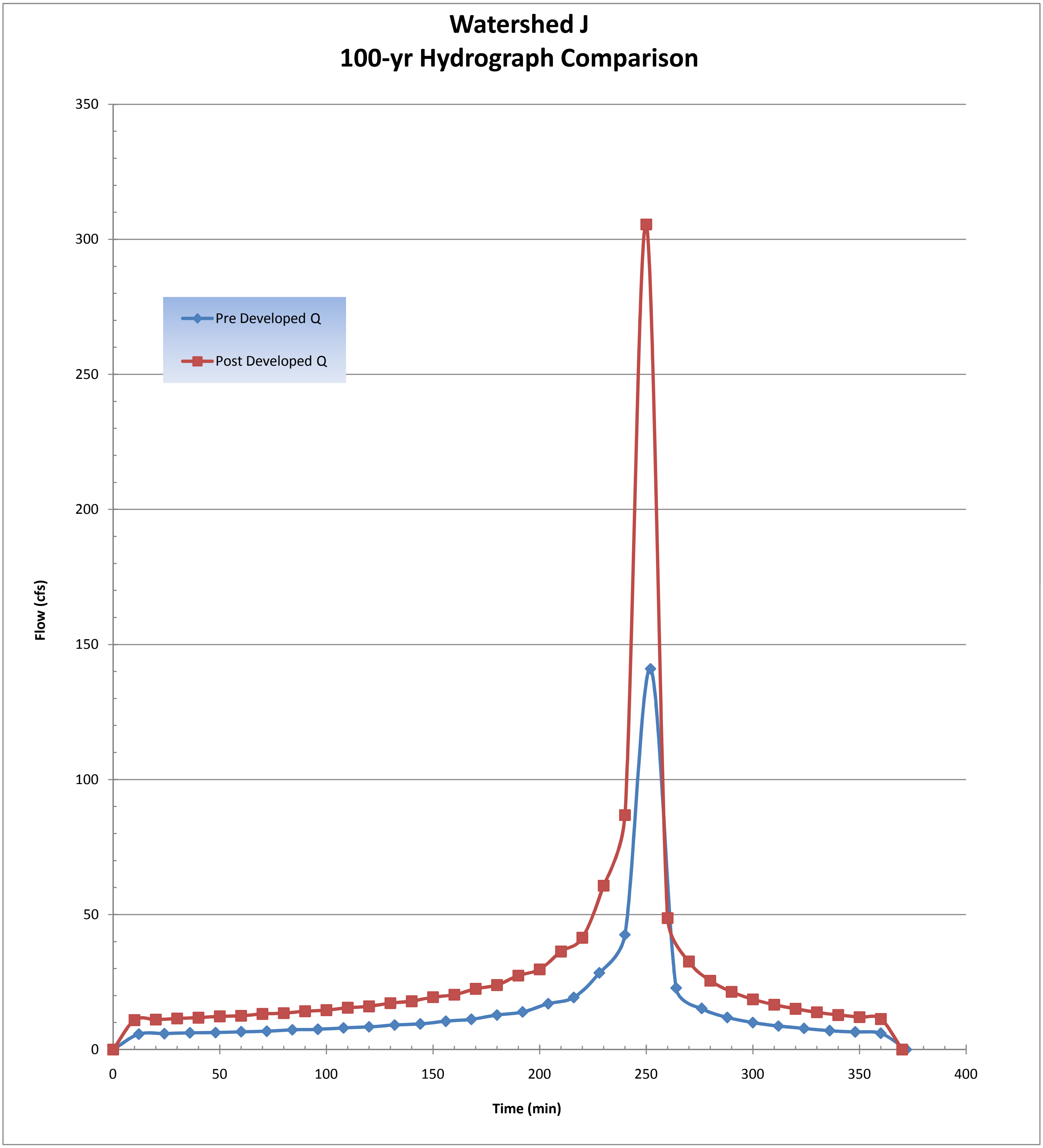
where:

A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Volume for 10-year Silt Accumulation = 657.89 tons

Silt Accumulation Basin volume = **14620** **ft^3** **Add this Volume to Basin**

Add this volume to Basin volume due to silts from cut slopes


Watershed J
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
50
100
150
200
250
300
350
400

Basin J Inflow Hydrograph

PROJECT:	POE			DESCRIPTION:	POE Basin
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.09.10	WATERSHED:	J
CHK:	G.DALZIEL	DATE:		SYSTEM:	

Notes:
This is the actual flow entering the detention basin

ONSITE RUNOFF VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Basin Inflow Hydrograph

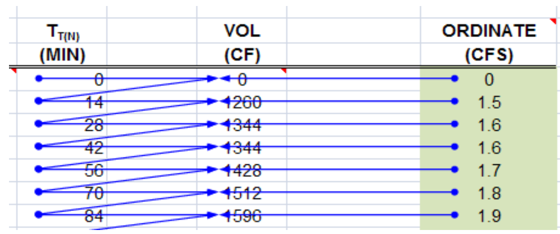
Basin Inflow Q

Q_{100}= 305.5 cfs
Tc= 10.0 min
$P_{100,6}$= 2.5 in

C_{100}= 0.90
A= 80.91 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	6540	10.9
20	6660	11.1
30	6900	11.5
40	7080	11.8
50	7380	12.3
60	7500	12.5
70	7920	13.2
80	8100	13.5
90	8520	14.2
100	8760	14.6
110	9300	15.5
120	9600	16
130	10320	17.2
140	10740	17.9
150	11640	19.4
160	12180	20.3
170	13500	22.5
180	14340	23.9
190	16440	27.4
200	17820	29.7
210	21780	36.3
220	24840	41.4
230	36420	60.7
240	52080	86.8
250	183300	305.5
260	29220	48.7
270	19560	32.6
280	15300	25.5
290	12840	21.4
300	11160	18.6
310	9960	16.6
320	9060	15.1
330	8280	13.8
340	7680	12.8
350	7200	12
360	6780	11.3
370	0	0

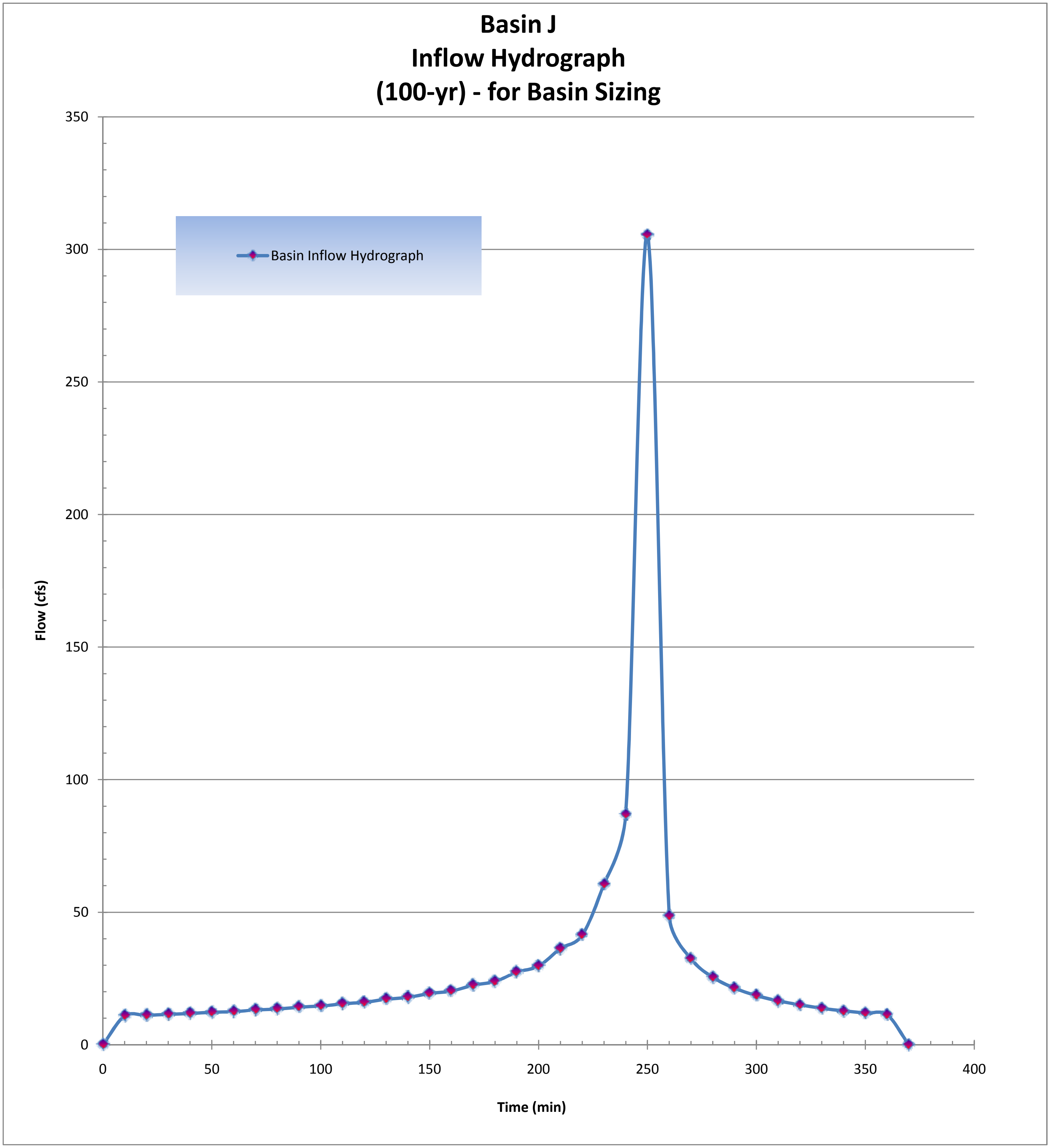
Example of Steps:



SUM= 656700 ft^3
15.08 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$
V= 15.11 acre-feet
OK


Basin J
Inflow Hydrograph
(100-yr) - for Basin Sizing
Basin Inflow Hydrograph
Flow (cfs)
Time (min)
0
50
100
150
200
250
300
350
400

Basin J Outlet

PROJECT:	**POE**			**DESCRIPTION:**	**POE Basin**
JOB #:	**11A1190**			**STATION:**	**POE**
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**J**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin**

Notes:

Required Retention Basin Volume =	325864	ft^3	
Actual Basin Inflow =	656700	ft^3	OK

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	141.0	cfs	*Basin J Predeveloped*
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	*Culvert flow is separate in this run*
Flow that does not reach detention basin (undetained):	0.0	cfs	*Assume all flow reaches basin*
Maximum flow allowed to be released by this detention basin:	141.0	cfs	

Outlet Pipe

Assume: trapezoid basin/flat bottom, one outlet pipe set above basin invert

Basin - Top of basin berm elevation =	500.80	ft
Basin flowline elevation =	496.00	ft
Maximum Basin Depth =	4.80	ft

Assume Culvert Design: free outfall, square-edge w/headwall

Outlet pipe invert from basin floor =	2.20	ft	498.20	ft
Outlet pipe diameter =	2.00	ft		

Basin Characteristics

Base Length (L)	500	ft
Base Width (W)	300	ft
W/L Ratio ®	0.60	
Side Slopes (Z)	1: 4	
Total Volume (V):	795851	ft^2

Infiltration Rate: Rate (min/inch): 71.1 Location: PT-C2 ~ *assume no infiltration*

Detention Basin Data						Outlet Pipe		Infiltration	Total
Stage	Water Surface Elevation (ft)	Depth	V_{avg} staged (ft3)	V_{avg} cumm. (ft3)		HW Elev. (ft)	Discharge Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	496.00	0.00	0	0		496.00	0.00		0.00
1	496.20	0.20	30129	30129		496.20	0.00		0.00
2	496.40	0.40	30386	60515		496.40	0.00		0.00
3	496.60	0.60	30645	91159		496.60	0.00		0.00
4	496.80	0.80	30904	122063		496.80	0.00		0.00
5	497.00	1.00	31164	153227		497.00	0.00		0.00
6	497.20	1.20	31425	184652		497.20	0.00		0.00
7	497.40	1.40	31687	216339		497.40	0.00		0.00
8	497.60	1.60	31949	248288		497.60	0.00		0.00
9	497.80	1.80	32213	280501		497.80	0.00		0.00
10	498.00	2.00	32477	312977		498.00	0.00	0.00	0.00
11	498.20	2.20	32742	345719	*	498.20	0.00		0.00
12	498.40	2.40	33008	378727		498.40	0.15		0.15
13	498.60	2.60	33274	412001		498.60	0.59		0.59
14	498.80	2.80	33542	445543		498.80	1.30		1.30
15	499.00	3.00	33810	479353		499.00	2.25		2.25
16	499.20	3.20	34079	513432		499.20	3.42		3.42
17	499.40	3.40	34349	547781		499.40	4.79		4.79
18	499.60	3.60	34620	582401		499.60	6.32		6.32
19	499.80	3.80	34891	617292		499.80	7.99		7.99
20	500.00	4.00	35164	652456		500.00	9.77		9.77

Basin J Routing

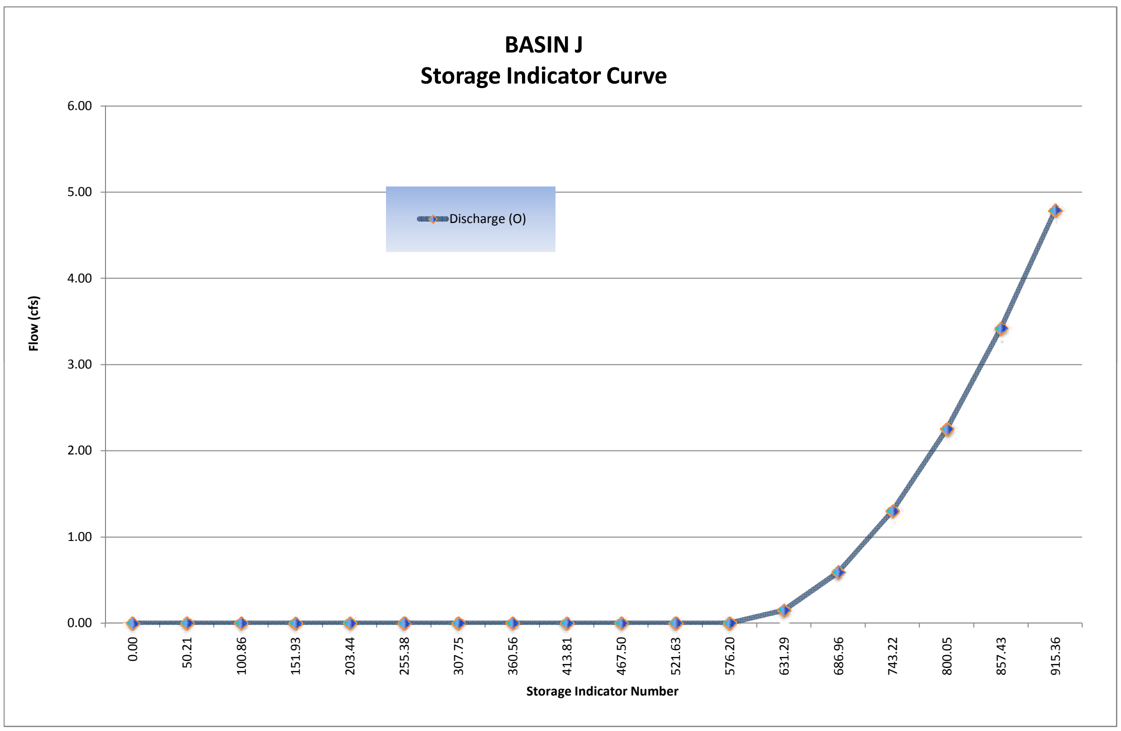
PROJECT:	POE			DESCRIPTION:	POE Basin
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	J
CHK:	G.DALZIEL	DATE:		SYSTEM:	

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

(1) Stage (ft)	(2) Discharge (O) (cfs)	(3) Storage (S) (ft^3)	(4) $O_2/2$ (cfs)	(5) S_2/delta t (cfs)	(6) *Storage Indicator #* S_2/delta t + $O_2/2$ (cfs)
496.00	0.00	0	0.00	0.00	0.00
496.20	0.00	30129	0.00	50.21	50.21
496.40	0.00	60515	0.00	100.86	100.86
496.60	0.00	91159	0.00	151.93	151.93
496.80	0.00	122063	0.00	203.44	203.44
497.00	0.00	153227	0.00	255.38	255.38
497.20	0.00	184652	0.00	307.75	307.75
497.40	0.00	216339	0.00	360.56	360.56
497.60	0.00	248288	0.00	413.81	413.81
497.80	0.00	280501	0.00	467.50	467.50
498.00	0.00	312977	0.00	521.63	521.63
498.20	0.00	345719	0.00	576.20	576.20
498.40	0.15	378727	0.08	631.21	631.29
498.60	0.59	412001	0.30	686.67	686.96
498.80	1.30	445543	0.65	742.57	743.22
499.00	2.25	479353	1.13	798.92	800.05
499.20	3.42	513432	1.71	855.72	857.43
499.40	4.79	547781	2.40	912.97	915.36
499.60	6.32	582401	3.16	970.67	973.83
499.80	7.99	617292	4.00	1028.82	1032.81
500.00	9.77	652456	4.89	1087.43	1092.31

delta t =	0.17	hrs
delta t =	10.00	min
delta t =	600	sec

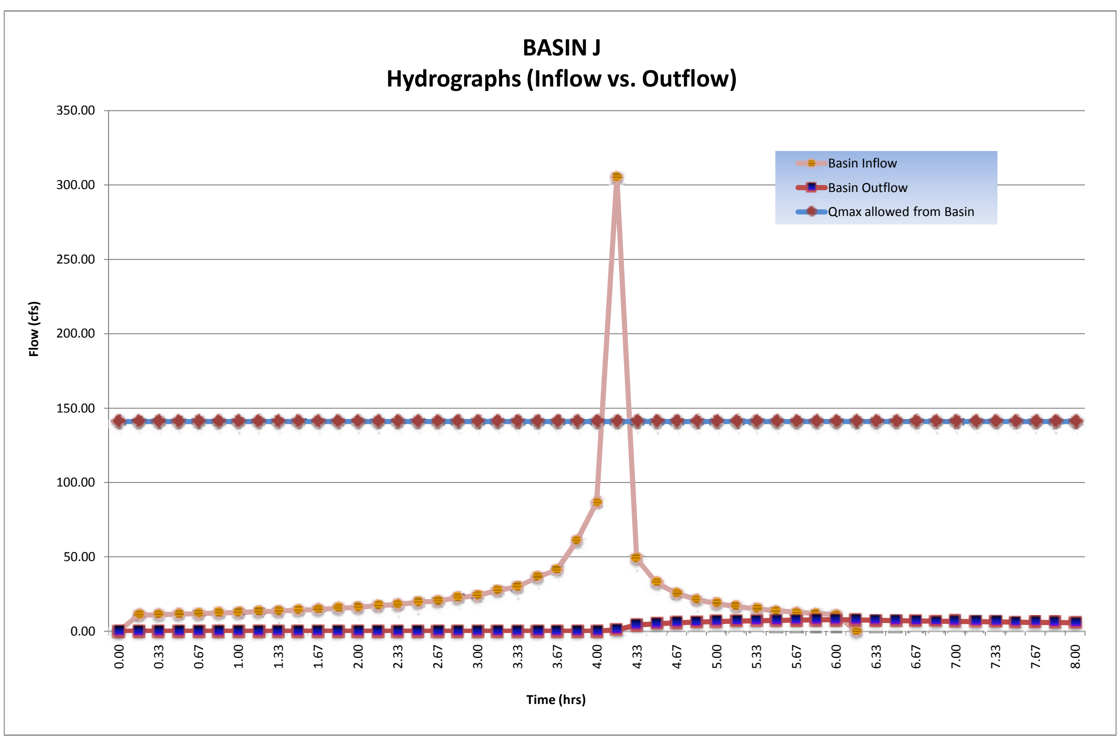


Basin J Routing

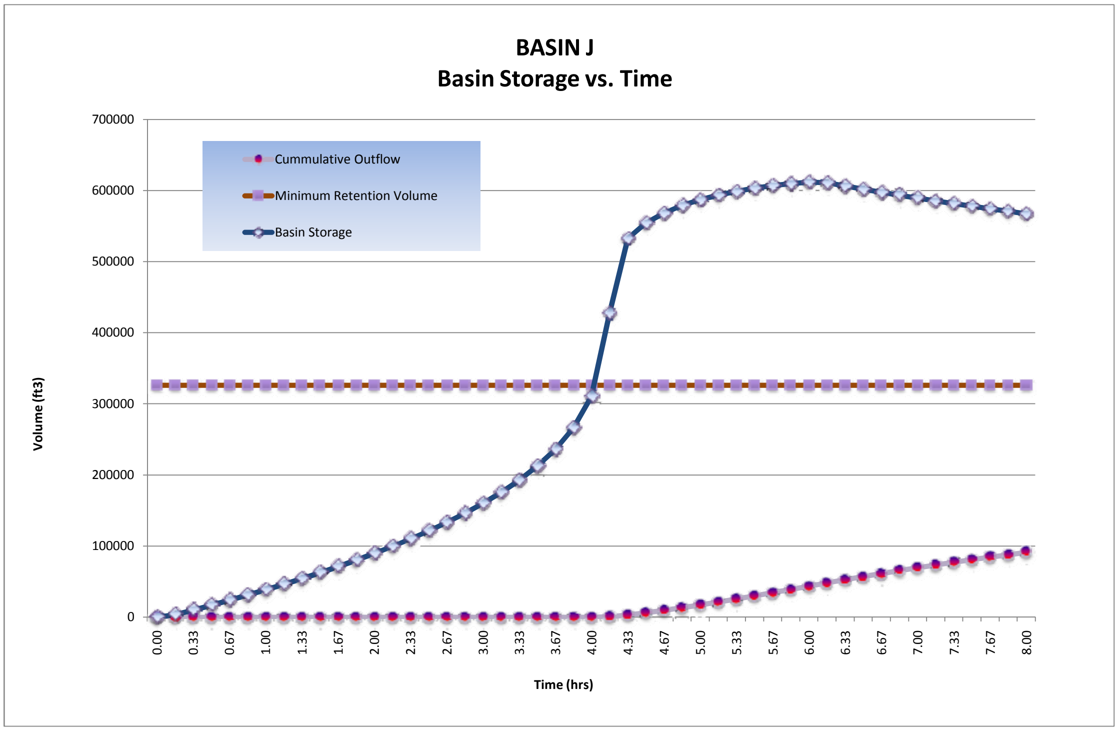
$$\frac{I_1+I_2}{2} + \left(\frac{S_1}{\Delta t} + \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

FINAL ROUTING TABLE

(1) Time (hrs)	(2) Inflow (cfs) *(Q_{post})*	(3) $(I_1+I_2)/2$ (cfs)	(4) $(S_1/\text{delta t} + O_1/2)$ (cfs) *col (6) from prev row*	(5) O_1 (cfs) *col (7) from prev row*	*Storage Indicator #* (6) $S_2/\text{delta t} + O_2/2$ (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*	Volumes: Basin Storage *(ft3)*	Volumes: Incremental Outflow *(ft3)*	Volumes: Cummulative Outflow *(ft3)*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.17	10.90	5.45	0.00	0.00	5.45	0.00	3270	0	0
0.33	11.10	11.00	5.45	0.00	16.45	0.00	9870	0	0
0.50	11.50	11.30	16.45	0.00	27.75	0.00	16650	0	0
0.67	11.80	11.65	27.75	0.00	39.40	0.00	23640	0	0
0.83	12.30	12.05	39.40	0.00	51.45	0.00	30870	0	0
1.00	12.50	12.40	51.45	0.00	63.85	0.00	38310	0	0
1.17	13.20	12.85	63.85	0.00	76.70	0.00	46020	0	0
1.33	13.50	13.35	76.70	0.00	90.05	0.00	54030	0	0
1.50	14.20	13.85	90.05	0.00	103.90	0.00	62340	0	0
1.67	14.60	14.40	103.90	0.00	118.30	0.00	70980	0	0
1.83	15.50	15.05	118.30	0.00	133.35	0.00	80010	0	0
2.00	16.00	15.75	133.35	0.00	149.10	0.00	89460	0	0
2.17	17.20	16.60	149.10	0.00	165.70	0.00	99420	0	0
2.33	17.90	17.55	165.70	0.00	183.25	0.00	109950	0	0
2.50	19.40	18.65	183.25	0.00	201.90	0.00	121140	0	0
2.67	20.30	19.85	201.90	0.00	221.75	0.00	133050	0	0
2.83	22.50	21.40	221.75	0.00	243.15	0.00	145890	0	0
3.00	23.90	23.20	243.15	0.00	266.35	0.00	159810	0	0
3.17	27.40	25.65	266.35	0.00	292.00	0.00	175200	0	0
3.33	29.70	28.55	292.00	0.00	320.55	0.00	192330	0	0
3.50	36.30	33.00	320.55	0.00	353.55	0.00	212130	0	0
3.67	41.40	38.85	353.55	0.00	392.40	0.00	235440	0	0
3.83	60.70	51.05	392.40	0.00	443.45	0.00	266070	0	0
4.00	86.80	73.75	443.45	0.00	517.20	0.00	310320	0	0
4.17	305.50	196.15	517.20	0.00	713.35	0.92	427734	552	552
4.33	48.70	177.10	713.35	0.92	889.53	4.18	532464	2508	3060
4.50	32.60	40.65	889.53	4.18	926.00	5.07	554079	3042	6102
4.67	25.50	29.05	926.00	5.07	949.98	5.70	568278	3420	9522
4.83	21.40	23.45	949.98	5.70	967.73	6.16	578790	3696	13218
5.00	18.60	20.00	967.73	6.16	981.57	6.54	586980	3924	17142
5.17	16.60	17.60	981.57	6.54	992.63	6.85	593523	4110	21252
5.33	15.10	15.85	992.63	6.85	1001.63	7.11	598845	4266	25518
5.50	13.80	14.45	1001.63	7.11	1008.97	7.31	603189	4386	29904
5.67	12.80	13.30	1008.97	7.31	1014.96	7.48	606732	4488	34392
5.83	12.00	12.40	1014.96	7.48	1019.88	7.62	609642	4572	38964
6.00	11.30	11.65	1019.88	7.62	1023.91	7.74	612024	4644	43608
6.17	0.00	5.65	1023.91	7.74	1021.82	7.68	610788	4608	48216
6.33		0.00	1021.82	7.68	1014.14	7.46	606246	4476	52692
6.50		0.00	1014.14	7.46	1006.68	7.25	601833	4350	57042
6.67		0.00	1006.68	7.25	999.43	7.04	597546	4224	61266
6.83		0.00	999.43	7.04	992.39	6.85	593379	4110	65376
7.00		0.00	992.39	6.85	985.54	6.65	589329	3990	69366
7.17		0.00	985.54	6.65	978.89	6.46	585396	3876	73242
7.33		0.00	978.89	6.46	972.43	6.28	581574	3768	77010
7.50		0.00	972.43	6.28	966.15	6.12	577854	3672	80682
7.67		0.00	966.15	6.12	960.03	5.96	574230	3576	84258
7.83		0.00	960.03	5.96	954.07	5.80	570702	3480	87738
8.00		0.00	954.07	5.80	948.27	5.65	567267	3390	91128



Basin J Routing



Detention / Retention Basin Volume Required:	**612,024**	**ft^3**
@ Stage:	**499.80**	**ft**
Freeboard:	**1.0**	**ft**
Final Total Basin Volume Provided:	**795,851**	**ft^3**
Maximum flow rate released from this basin:	**7.74**	**cfs**

>1' Freeboard

Basin **J**

Basin K Retention

PROJECT:	**POE**			**DESCRIPTION:**	**POE Basin**
JOB #:	**11A1190**			**STATION:**	**POE**
BY:	**M.BRUNING**	**DATE:**	**02.09.10**	**WATERSHED:**	**K**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:

* The difference between pre-developed and post-developed values gives the approximate volume to detain.
Stage-Storage calculations will determine accurate volume

RETENTION BASIN VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Pre-Developed volume calculations

Q_{100}= 55.1 cfs
Tc= 17.2 min
$P_{100,6}$= 2.5 in

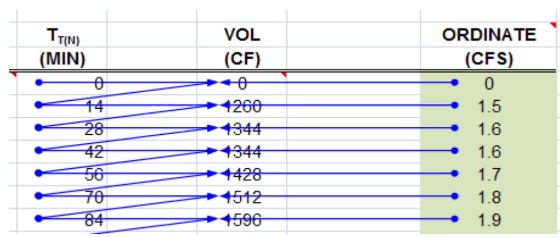
C= 0.45
A= 41.15 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
17	2856	2.8
34	2958	2.9
51	3162	3.1
68	3264	3.2
85	3570	3.5
102	3774	3.7
119	4182	4.1
136	4386	4.3
153	4998	4.9
170	5508	5.4
187	6732	6.6
204	7650	7.5
221	11220	11
238	16014	15.7
255	56202	55.1
272	8976	8.8
289	6018	5.9
306	4692	4.6
323	3978	3.9
340	3468	3.4
357	3060	3
374	0	0

SUM= 166668 ft^3
3.83 acre-feet

Check: $V = C*A*P_6$
V= 3.86 acre-feet
OK

Example of Steps:



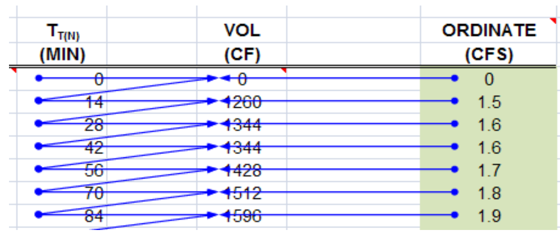
Basin K Retention

Post-Developed volume calculations

Q_{100}=	119.4	cfs			
Tc=	10.0	min	C=	0.87	
$P_{100,6}$=	2.5	in	A=	32.70	acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	2580	4.3
20	2580	4.3
30	2700	4.5
40	2760	4.6
50	2880	4.8
60	2940	4.9
70	3060	5.1
80	3180	5.3
90	3360	5.6
100	3420	5.7
110	3660	6.1
120	3780	6.3
130	4020	6.7
140	4200	7
150	4560	7.6
160	4740	7.9
170	5280	8.8
180	5580	9.3
190	6420	10.7
200	6960	11.6
210	8520	14.2
220	9720	16.2
230	14220	23.7
240	20340	33.9
250	71640	119.4
260	11400	19
270	7620	12.7
280	6000	10
290	4980	8.3
300	4380	7.3
310	3900	6.5
320	3540	5.9
330	3240	5.4
340	3000	5
350	2820	4.7
360	2640	4.4
370	0	0

Example of Steps:



SUM= 256620 ft^3
5.89 acre-feet

Check: $V = C*A*P_6$
V= 5.91 acre-feet
OK

	5.89	
	- **3.83**	
Retention volume =	**2.07**	**acre-feet**

= 89952 ft^3 **Basin Required**

Basin K Retention

WATER QUALITY VOLUME (WQV) CALCULATION

Per the Caltrans Storm Water Quality Handbook: Project Planning and Design Guide (PPDG) (May 2007)
Provide additional capacity for Water Quality

Output from Basin Sizer

Water Quality Volumes

Maximized Volume Method (in/area)*

Basin Drainage Time (hrs)	Runoff Coefficient 0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
12	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.4
24	0.16	0.21	0.27	0.31	0.37	0.42	0.46	0.52
48	0.2	0.26	0.32	0.38	0.44	0.51	0.57	0.58
72	0.22	0.29	0.37	0.43	0.51	0.58	0.66	0.73

C_{100}= 0.87
A= 13.40 acres

WQ_{72}: 0.66 in/area

Water Quality Volume (WQV) = 32104 ft^3

WQV to be added to retention volume = 0 ft^3 WQV is within Retention

If the WQV is less than retention requirement, do not add volume since WQ is addressed in Retention

SILT ACCUMULATION ANALYSIS (Long Term)

Per the United States International Boundary and Water Commission (IBWC)
Provide additional capacity for a 10-year volume of silt accumulation

Onsite Highway *Sloped* runoff area, A:	696200	ft^2
A:	15.98	acres
	10.00	years
where: R=	30.00	
K=	0.24	
Ls=	18.00	
C=	0.012	
P=	1.00	
As	1.56	tons/yr.Ac

Universal Soil Loss Equation (SDCHM 5.2.3)

$A_s = RKLsCP$

where:

A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Volume for 10-year Silt Accumulation = 248.56 tons

Silt Accumulation Basin volume = 5524 ft^3 Add this Volume to Basin

Add this volume to Basin volume due to silts from cut slopes

SILT ACCUMULATION ANALYSIS (Long Term)

Per the United States International Boundary and Water Commission (IBWC)
Provide additional capacity for a 10-year volume of silt accumulation

Onsite Highway *Sloped* runoff area, A:	144600	ft^2
A:	3.32	acres
	10.00	years
where: R=	30.00	
K=	0.24	
Ls=	18.00	
C=	0.012	
P=	1.00	
As	1.56	tons/yr.Ac

Universal Soil Loss Equation (SDCHM 5.2.3)

$A_s = RKLsCP$

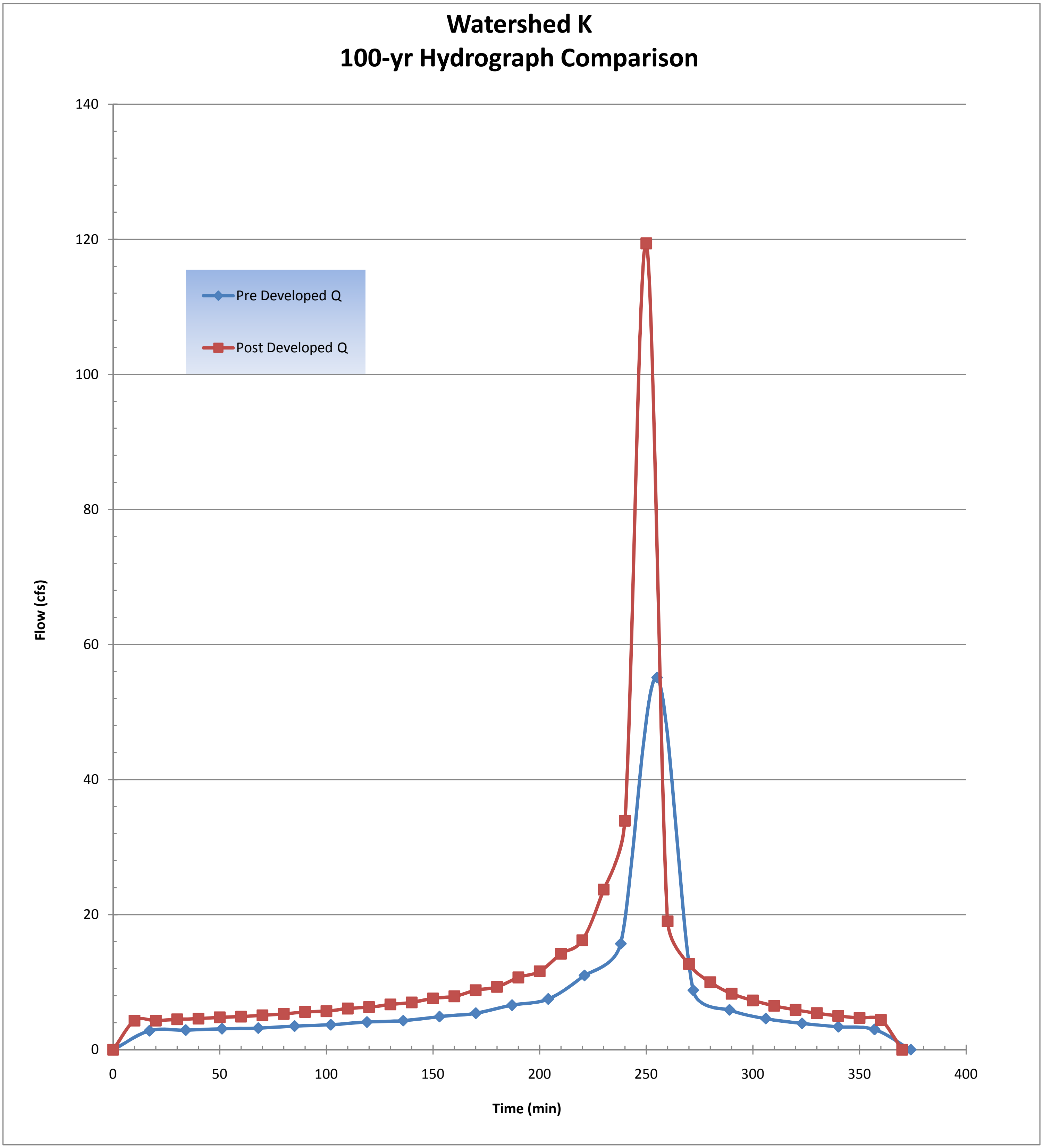
where:

A_s = the computed soil loss in tons (dry weight)
R = the rainfall erosion index for the given storm period
K = the soil erodibility factor
L = the slope length factor
s = the slope gradient factor
C = cropping management (vegetation) factor
P = erosion control practice factor

Volume for 10-year Silt Accumulation = 51.63 tons

Silt Accumulation Basin volume = 1147 ft^3 Add this Volume to Basin

Add this volume to Basin volume due to silts from cut slopes


Watershed K
100-yr Hydrograph Comparison
Pre Developed Q
Post Developed Q
Flow (cfs)
Time (min)
0
20
40
60
80
100
120
140
0
50
100
150
200
250
300
350
400

Basin K-North Inflow TcQ

PROJECT:	POE			DESCRIPTION:	POE Basin
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.09.10	WATERSHED:	K-North
CHK:	G.DALZIEL	DATE:		SYSTEM:	

BASIN AREA:

A =	516700	ft^2	SOURCE:	MICROSTATION/USGS
	11.86	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.00
INFILTRATION (.04-.16)	0.00
VEGETATION (.04-.16)	0.00
STORAGE (.04-.12)	0.00
TOTAL C =	0.00

UNDEVELOPED AREA	0%	AT	0.00	0.000
PAVED SURFACE	72%	AT	0.90	0.648
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	28%	AT	0.55	0.154
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.80
C_{25} =	0.88
C_{50} =	0.96
C_{100} =	1.00

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ **(in) = 1.80**

HIGH PT ELEVATION	535.0	ft	Northwest corner of POE
LOW POINT ELEVATION	534.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	across
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.016		< = from Table 816.6A HMA
T_t (SFF)=	2.88	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	534.0	ft	down access road
LOW POINT ELEVATION	530.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	325	ft	
SLOPE (S) = (H/L)	1.2%		
VELOCITY (SCF)	5.0	fps	<=V from Figure 816.6 Gutter, not concentrated
T_C (SH)=	1.08	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	530.0	ft	channelizes in gutter of POE road
LOW POINT ELEVATION	508.0	ft	CHANNEL DATA TYPE = TRAP'Z
ELEVATION DIFF (H)	22.0	ft	Z= 2 ANG-RAD 0.464
LENGTH (L)	201	ft	b = 8 ANG-DEG 26.565
SLOPE (S) = (H/L)	10.9%		d = 0.5 FLOWING FULL ASS'M
MANNING'S n	0.016		HMA
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	17.81	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)
T_C (CH)=	0.19	minutes	

Basin K-North Inflow TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	508.0	ft	Inlet to basin K
LOW POINT ELEVATION	506.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	369	ft	
SLOPE (S) = (H/L)	0.5%		
MANNING'S n	0.013		
PIPE DIAMETER d	2.0	ft	
HYDRAULIC RADIUS R	0.5	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	5.3	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.16	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	506.0	ft	channelizes in gutter of POE road
LOW POINT ELEVATION	498.0	ft	CHANNEL DATA; TYPE = TRAP'Z
ELEVATION DIFF (H)	8.0	ft	Z= 4; ANG-RAD 0.245
LENGTH (L)	178	ft	b = 13; ANG-DEG 14.036
SLOPE (S) = (H/L)	4.5%		d = 1; FLOWING FULL ASS'M
MANNING'S n	0.050		Basin bottom
HYDRAULIC RADIUS R	0.8	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	5.44	fps	From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$
T_C (CH)=	0.54	minutes	

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

			NOTES:
HIGH PT ELEVATION	493.0	ft	5' drop to Basin outlet and Box Culvert
LOW POINT ELEVATION	480.0	ft	
ELEVATION DIFF (H)	13.0	ft	
LENGTH (L)	1174	ft	
SLOPE (S) = (H/L)	1.1%		
MANNING'S n	0.013		
PIPE DIAMETER d	4.0	ft	
HYDRAULIC RADIUS R	1.0	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	12.1	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.62	minutes	

Tc (TOTAL) =	7.47	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

FLOW RESULTS:

COUNTY P_6

					cfs		inches
i_2 =	1.9	in/hr	X CA =	**Q_2 =**	17.6	2-year:	1.1
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	25.6	10-year:	1.6
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	35.3	25-year:	2.0
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	46.2	50-year:	2.4
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**50.0**	100-year:	2.5

Basin K-North Inflow Hydrograph

PROJECT:	**POE**			**DESCRIPTION:**	**POE Basin**
JOB #:	**11A1190**			**STATION:**	**POE**
BY:	**M.BRUNING**	**DATE:**	**02.09.10**	**WATERSHED:**	**K-North**
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	

Notes:
This is the actual flow entering the detention basin

ONSITE RUNOFF VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Basin Inflow Hydrograph

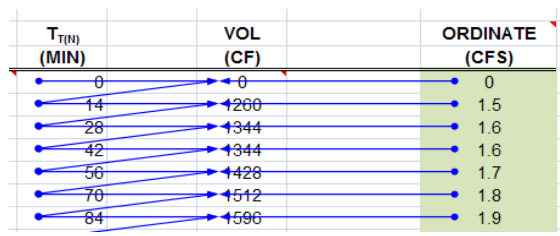
Basin Inflow Q

Q_{100}= 50.0 cfs
Tc= 10.0 min
$P_{100,6}$= 2.5 in

C_{100}= 1.00
A= 11.86 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1080	1.8
20	1080	1.8
30	1140	1.9
40	1140	1.9
50	1200	2
60	1200	2
70	1260	2.1
80	1320	2.2
90	1380	2.3
100	1440	2.4
110	1500	2.5
120	1560	2.6
130	1680	2.8
140	1740	2.9
150	1920	3.2
160	1980	3.3
170	2220	3.7
180	2340	3.9
190	2700	4.5
200	2880	4.8
210	3540	5.9
220	4020	6.7
230	5940	9.9
240	8340	13.9
250	30000	50
260	4740	7.9
270	3180	5.3
280	2520	4.2
290	2100	3.5
300	1800	3
310	1620	2.7
320	1500	2.5
330	1380	2.3
340	1260	2.1
350	1200	2
360	1080	1.8
370	0	0

Example of Steps:

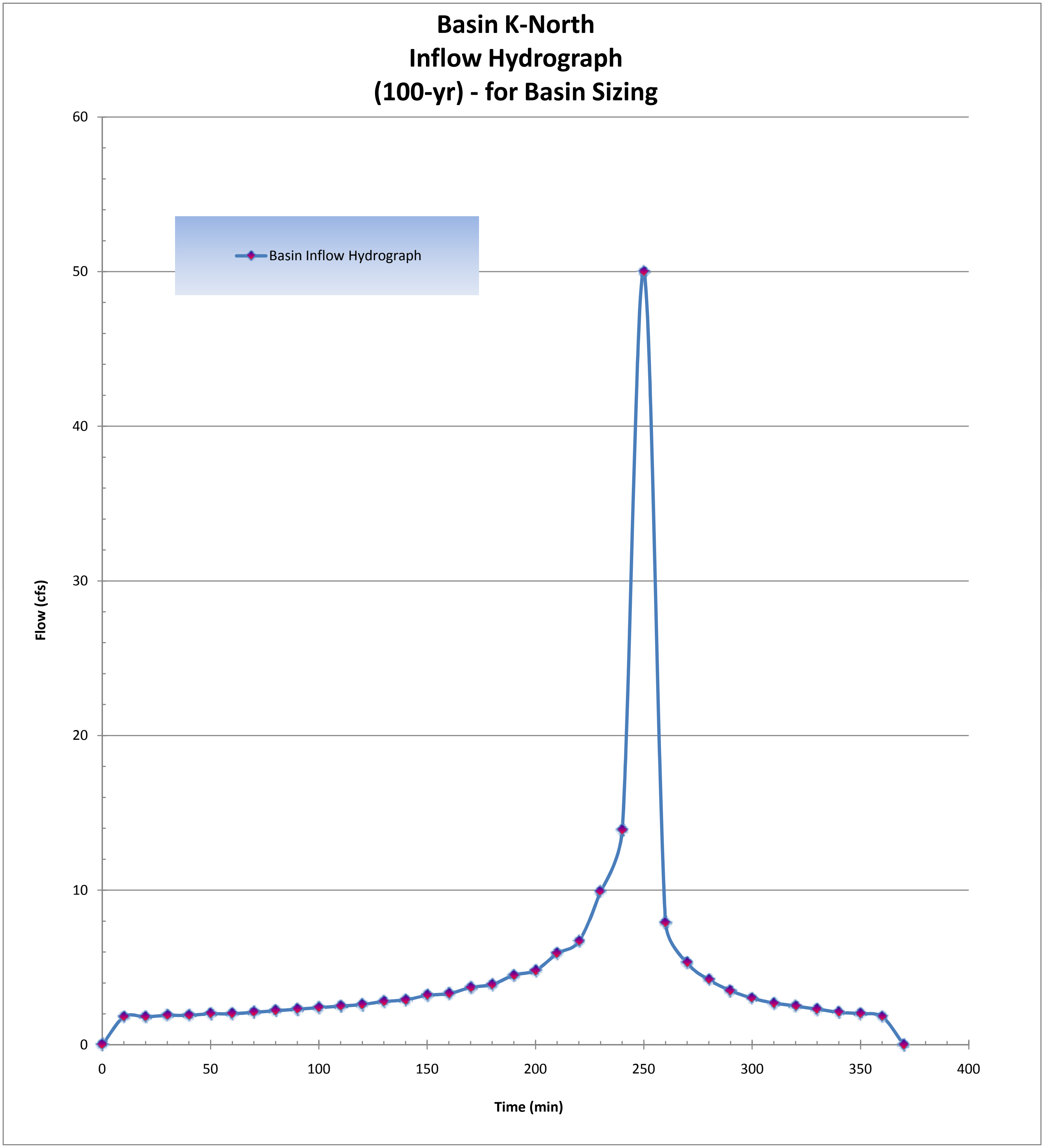


SUM= 106980 ft^3
2.46 acre-feet

Onsite Runoff Volume

Check: $V = C*A*P_6$
V= 2.47 acre-feet
OK

Basin K-North Inflow Hydrograph



Basin K-North Outlet

PROJECT:	POE			DESCRIPTION:	POE Basin
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	K
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin K-North

Notes:

Volumes:

Required Retention Basin Volume =	1147	ft^3	
Actual Basin Inflow =	106980	ft^3	OK

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	55.1	cfs	
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert K
Flow that does not reach detention basin (undetained):	0.0	cfs	Q_{100} from:
Maximum flow allowed to be released by this detention basin:	55.1	cfs	

Outlet Pipe

Assume: trapezoid basin/flat bottom, one outlet pipe set above basin invert

Basin - Top of basin berm elevation =	512.00	ft
Basin flowline elevation =	507.80	ft
Maximum Basin Depth =	4.20	ft

Assume Culvert Design: free outfall, square-edge w/headwall

Outlet pipe invert from basin floor =	0.20	ft	508.00	ft
Outlet pipe diameter =	2.00	ft		

Basin Characteristics

Base Length (L)	120	ft	avg
Base Width (W)	90	ft	avg
W/L Ratio ®	0.75		
Side Slopes (Z)	1: 4		
Total Volume (V):	61652	ft^2	

Infiltration Rate: Rate (min/inch): 71.1 Location: PT-C2 ~ *assume no infiltration*

Detention Basin Data						Outlet Pipe		Infiltration	Total
Stage	Water Surface Elevation (ft)	Depth	V_{avg} staged (ft3)	V_{avg} cumm. (ft3)		HW Elev. (ft)	Discharge Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	507.80	0.00	0	0		507.80	0.00		0.00
1	508.00	0.20	2194	2194	*	508.00	0.00		0.00
2	508.20	0.40	2264	4458		508.20	0.15		0.15
3	508.40	0.60	2333	6791		508.40	0.59		0.59
4	508.60	0.80	2404	9196		508.60	1.30		1.30
5	508.80	1.00	2476	11671		508.80	2.25		2.25
6	509.00	1.20	2548	14219		509.00	3.42		3.42
7	509.20	1.40	2621	16841		509.20	4.79		4.79
8	509.40	1.60	2695	19536		509.40	6.32		6.32
9	509.60	1.80	2770	22305		509.60	7.99		7.99
10	509.80	2.00	2845	25151		509.80	9.77	0.00	9.77
11	510.00	2.20	2921	28072		510.00	11.63		11.63
12	510.20	2.40	2998	31070		510.20	13.53		13.53
13	510.40	2.60	3076	34147		510.40	15.46		15.46
14	510.60	2.80	3155	37301		510.60	17.37		17.37
15	510.80	3.00	3234	40536		510.80	19.16		19.16
16	511.00	3.20	3314	43850		511.00	20.41		20.41
17	511.20	3.40	3395	47245		511.20	21.59		21.59
18	511.40	3.60	3477	50722		511.40	22.71		22.71
19	511.60	3.80	3560	54282		511.60	23.78		23.78
20	511.80	4.00	3643	57925		511.80	24.80		24.80

Basin K-North Routing

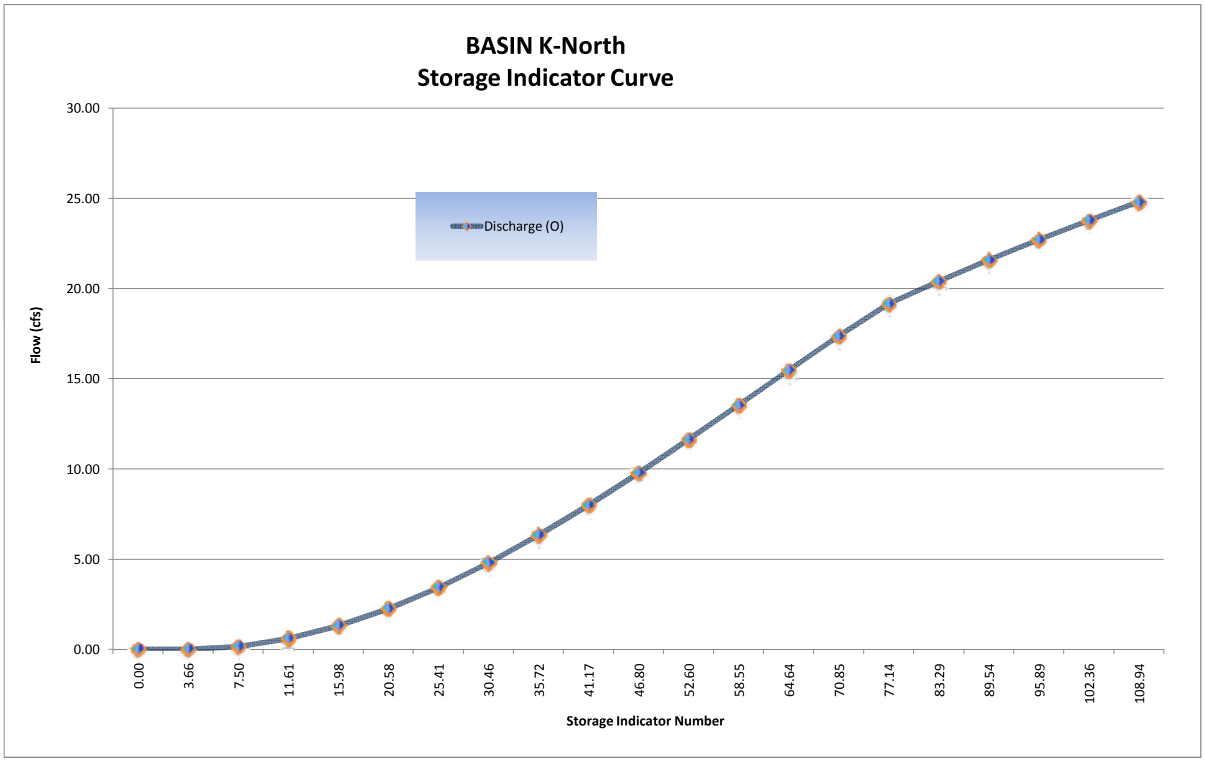
PROJECT:	POE		**DESCRIPTION:**	POE Basin	
JOB #:	11A1190		**STATION:**	POE	
BY:	M.BRUNING	**DATE:** 02.19.10	**WATERSHED:**	K	
CHK:	G.DALZIEL	**DATE:**	**SYSTEM:**	Basin	K-North

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

(1) Stage (ft)	(2) Discharge (O) (cfs)	(3) Storage (S) (ft^3)	(4) $O_2/2$ (cfs)	(5) S_2/delta t (cfs)	*Storage Indicator #* (6) S_2/delta t + $O_2/2$ (cfs)
507.80	0.00	0	0.00	0.00	0.00
508.00	0.00	2194	0.00	3.66	3.66
508.20	0.15	4458	0.08	7.43	7.50
508.40	0.59	6791	0.30	11.32	11.61
508.60	1.30	9196	0.65	15.33	15.98
508.80	2.25	11671	1.13	19.45	20.58
509.00	3.42	14219	1.71	23.70	25.41
509.20	4.79	16841	2.40	28.07	30.46
509.40	6.32	19536	3.16	32.56	35.72
509.60	7.99	22305	4.00	37.18	41.17
509.80	9.77	25151	4.89	41.92	46.80
510.00	11.63	28072	5.82	46.79	52.60
510.20	13.53	31070	6.77	51.78	58.55
510.40	15.46	34147	7.73	56.91	64.64
510.60	17.37	37301	8.69	62.17	70.85
510.80	19.16	40536	9.58	67.56	77.14
511.00	20.41	43850	10.21	73.08	83.29
511.20	21.59	47245	10.80	78.74	89.54
511.40	22.71	50722	11.36	84.54	95.89
511.60	23.78	54282	11.89	90.47	102.36
511.80	24.80	57925	12.40	96.54	108.94

delta t =	0.17	hrs
delta t =	10.00	min
delta t =	600	sec

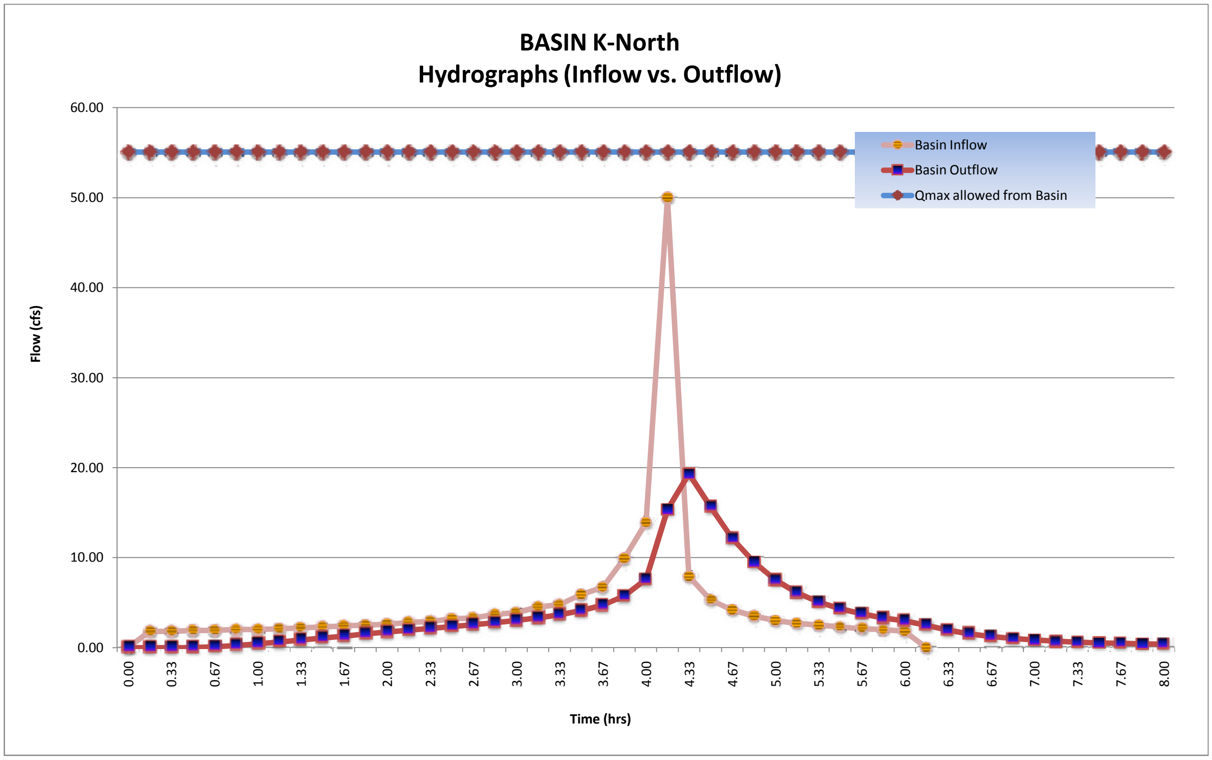


Basin K-North Routing

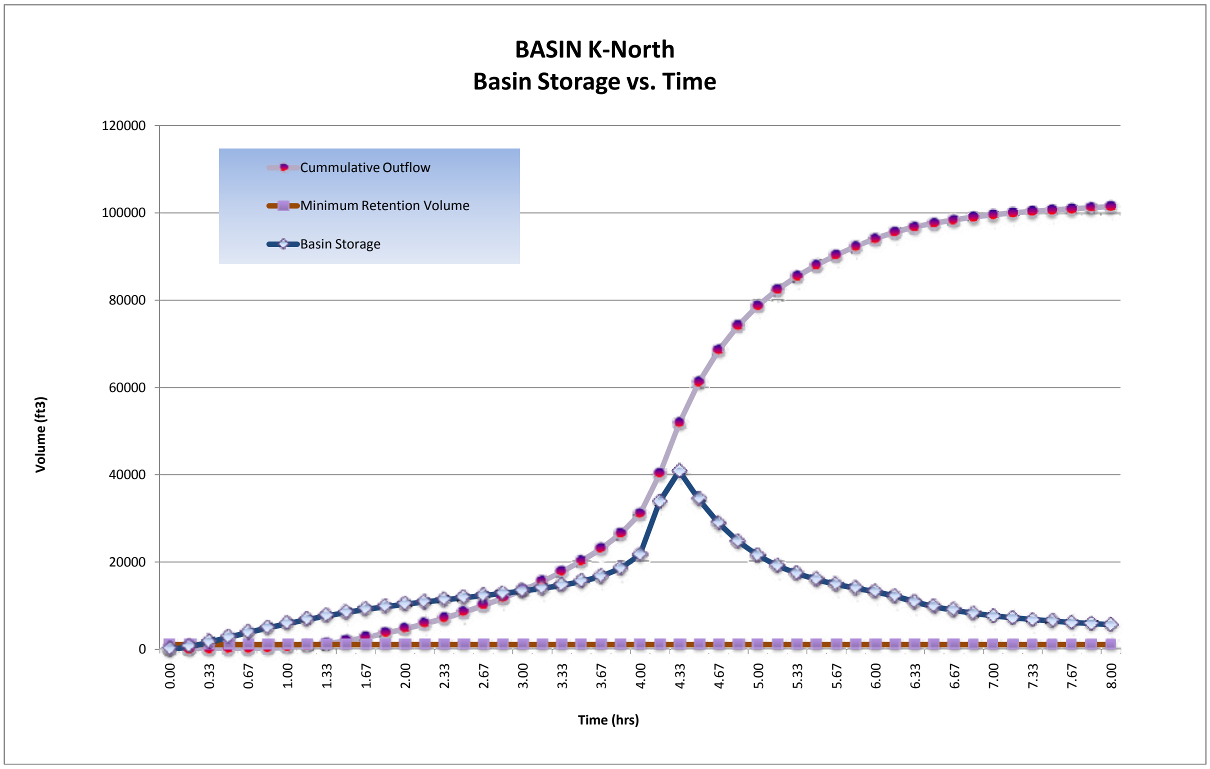
$$\frac{I_1+I_2}{2}+\left(\frac{S_1}{\Delta t}+\frac{O_1}{2}\right)-O_1=\left(\frac{S_2}{\Delta t}+\frac{O_2}{2}\right)$$

FINAL ROUTING TABLE							Volumes		
					Storage Indicator #				
(1) Time (hrs)	(2) Inflow (cfs) *(Q_{post})*	(3) $(I_1+I_2)/2$ (cfs)	(4) $(S_1/\text{delta } t + O_1/2)$ (cfs) *col (6) from prev row*	(5) O_1 (cfs) *col (7) from prev row*	(6) $S_2/\text{delta } t + O_2/2$ (cfs) *col (3)+(4)-(5)*	(7) O_2 (cfs) *(Hard input)*	Basin Storage *(ft3)*	Incremental Outflow *(ft3)*	Cummulative Outflow *(ft3)*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.17	1.80	0.90	0.00	0.00	0.90	0.00	540	0	0
0.33	1.80	1.80	0.90	0.00	2.70	0.00	1620	0	0
0.50	1.90	1.85	2.70	0.00	4.55	0.03	2721	18	18
0.67	1.90	1.90	4.55	0.03	6.42	0.11	3819	66	84
0.83	2.00	1.95	6.42	0.11	8.26	0.23	4887	138	222
1.00	2.00	2.00	8.26	0.23	10.03	0.42	5892	252	474
1.17	2.10	2.05	10.03	0.42	11.66	0.60	6816	360	834
1.33	2.20	2.15	11.66	0.60	13.21	0.85	7671	510	1344
1.50	2.30	2.25	13.21	0.85	14.61	1.08	8442	648	1992
1.67	2.40	2.35	14.61	1.08	15.88	1.28	9144	768	2760
1.83	2.50	2.45	15.88	1.28	17.05	1.52	9774	912	3672
2.00	2.60	2.55	17.05	1.52	18.08	1.73	10329	1038	4710
2.17	2.80	2.70	18.08	1.73	19.05	1.93	10851	1158	5868
2.33	2.90	2.85	19.05	1.93	19.97	2.12	11346	1272	7140
2.50	3.20	3.05	19.97	2.12	20.90	2.33	11841	1398	8538
2.67	3.30	3.25	20.90	2.33	21.82	2.55	12327	1530	10068
2.83	3.70	3.50	21.82	2.55	22.77	2.78	12828	1668	11736
3.00	3.90	3.80	22.77	2.78	23.79	3.03	13365	1818	13554
3.17	4.50	4.20	23.79	3.03	24.96	3.31	13983	1986	15540
3.33	4.80	4.65	24.96	3.31	26.30	3.66	14682	2196	17736
3.50	5.90	5.35	26.30	3.66	27.99	4.12	15558	2472	20208
3.67	6.70	6.30	27.99	4.12	30.17	4.71	16689	2826	23034
3.83	9.90	8.30	30.17	4.71	33.76	5.75	18531	3450	26484
4.00	13.90	11.90	33.76	5.75	39.91	7.60	21666	4560	31044
4.17	50.00	31.95	39.91	7.60	64.26	15.34	33954	9204	40248
4.33	7.90	28.95	64.26	15.34	77.87	19.31	40929	11586	51834
4.50	5.30	6.60	77.87	19.31	65.16	15.62	34410	9372	61206
4.67	4.20	4.75	65.16	15.62	54.29	12.17	28923	7302	68508
4.83	3.50	3.85	54.29	12.17	45.97	9.51	24729	5706	74214
5.00	3.00	3.25	45.97	9.51	39.71	7.54	21564	4524	78738
5.17	2.70	2.85	39.71	7.54	35.02	6.12	19176	3672	82410
5.33	2.50	2.60	35.02	6.12	31.50	5.09	17373	3054	85464
5.50	2.30	2.40	31.50	5.09	28.81	4.34	15984	2604	88068
5.67	2.10	2.20	28.81	4.34	26.67	3.76	14874	2256	90324
5.83	2.00	2.05	26.67	3.76	24.96	3.31	13983	1986	92310
6.00	1.80	1.90	24.96	3.31	23.55	2.97	13239	1782	94092
6.17	0.00	0.90	23.55	2.97	21.48	2.47	12147	1482	95574
6.33		0.00	21.48	2.47	19.01	1.93	10827	1158	96732
6.50		0.00	19.01	1.93	17.08	1.53	9789	918	97650
6.67		0.00	17.08	1.53	15.55	1.23	8961	738	98388
6.83		0.00	15.55	1.23	14.32	1.03	8283	618	99006
7.00		0.00	14.32	1.03	13.29	0.86	7716	516	99522
7.17		0.00	13.29	0.86	12.43	0.72	7242	432	99954
7.33		0.00	12.43	0.72	11.71	0.61	6843	366	100320
7.50		0.00	11.71	0.61	11.10	0.53	6501	318	100638
7.67		0.00	11.10	0.53	10.57	0.48	6198	288	100926
7.83		0.00	10.57	0.48	10.09	0.43	5925	258	101184
8.00		0.00	10.09	0.43	9.66	0.38	5682	228	101412

Basin K-North Routing



Basin K-North Routing



Detention/Retention Basin Volume Required:	**40,929**	**ft^3**
@ Stage:	**511.00**	**ft**
Freeboard:	**1.0**	**ft**
Final Total Basin Volume Provided:	**61,652**	**ft^3**
Maximum flow rate released from this basin:	**19.31**	**cfs**

>1' Freeboard

Basin **K-North**

Basin K-South Inflow TcQ

PROJECT:	POE			DESCRIPTION:	POE Basin
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.09.10	WATERSHED:	K-South
CHK:	G.DALZIEL	DATE:		SYSTEM:	

BASIN AREA:

A =	907800	ft^2	SOURCE:	MICROSTATION/USGS
	20.84	acres		(SCALE = 1:1)

COEFFICIENT OF RUNOFF:

KEY: User Input | Designer Tool

UNDEVELOPED AREA C (FROM HDM FIG. 819.2A)

RELIEF (.08-.35)	0.00
INFILTRATION (.04-.16)	0.00
VEGETATION (.04-.16)	0.00
STORAGE (.04-.12)	0.00
TOTAL C =	0.00

UNDEVELOPED AREA	0%	AT	0.00	0.000
PAVED SURFACE	23%	AT	0.90	0.210
COMMERCIAL AREA	0%	AT	0.85	0.000
CUT SLOPE (2:1 and 4:1)	77%	AT	0.55	0.422
TOTAL	100%			
	(100%)			

$C_{2,10}$ =	0.63
C_{25} =	0.69
C_{50} =	0.76
C_{100} =	0.79

TIME OF CONCENTRATION:

SHEET FLOW: $T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$

NOTES: $P_{2,24}$ (in) = 1.80

HIGH PT ELEVATION	535.0	ft	Northwest corner of POE
LOW POINT ELEVATION	534.0	ft	
ELEVATION DIFF (H)	1.0	ft	
LENGTH (L)	100	ft	across
SLOPE (S) = (H/L)	1.0%		
MANNING'S n	0.016		< = from Table 816.6A HMA
T_t (SFF)=	2.88	minutes	

SHALLOW CONCENTRATED FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	534.0	ft	down access road
LOW POINT ELEVATION	530.0	ft	
ELEVATION DIFF (H)	4.0	ft	
LENGTH (L)	325	ft	
SLOPE (S) = (H/L)	1.2%		
VELOCITY (SCF)	5.0	fps	<=V from Figure 816.6 Gutter, not concentrated
T_c (SH)=	1.08	minutes	

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

NOTES:

HIGH PT ELEVATION	530.0	ft	channelizes in gutter of POE road
LOW POINT ELEVATION	508.0	ft	CHANNEL DATA
ELEVATION DIFF (H)	22.0	ft	
LENGTH (L)	201	ft	
SLOPE (S) = (H/L)	10.9%		
MANNING'S n	0.016		HMA
HYDRAULIC RADIUS R	0.4	ft	R=(bdsinA+d^2cosA)/(bsinA+2d)
VELOCITY (CHANNEL)	17.81	fps	From Manning's Equation assuming flowing full: V=1.49/n($R^{2/3}S^{1/2}$)
T_c (CH)=	0.19	minutes	

CHANNEL DATA — TYPE = TRAP'Z

Z=	2	ANG-RAD	0.464
b =	8	ANG-DEG	26.565
d =	0.5	FLOWING FULL ASS'M	

Basin K-South Inflow TcQ

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	508.0	ft	Inlet to basin K
LOW POINT ELEVATION	506.0	ft	
ELEVATION DIFF (H)	2.0	ft	
LENGTH (L)	369	ft	
SLOPE (S) = (H/L)	0.5%		
MANNING'S n	0.013		
PIPE DIAMETER d	2.0	ft	
HYDRAULIC RADIUS R	0.5	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	5.3	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.16	minutes	

NOTES:

CHANNEL FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	506.0	ft
LOW POINT ELEVATION	498.0	ft
ELEVATION DIFF (H)	8.0	ft
LENGTH (L)	178	ft
SLOPE (S) = (H/L)	4.5%	
MANNING'S n	0.050	
HYDRAULIC RADIUS R	0.8	ft
VELOCITY (CHANNEL)	5.44	fps
T_C (CH)=	0.54	minutes

NOTES:

channelizes in gutter of POE road

CHANNEL DATA		TYPE =	TRAP'Z
Z=	4	ANG-RAD	0.245
b =	13	ANG-DEG	14.036
d =	1	FLOWING FULL ASS'M	

Basin bottom

R=(bdsinA+d^2cosA)/(bsinA+2d)

From Manning's Equation assuming flowing full: $V=1.49/n(R^{2/3}S^{1/2})$

STORMDRAIN FLOW: $T_t = \frac{L}{60\,V}$

HIGH PT ELEVATION	493.0	ft	5' drop to Basin outlet and Box Culvert
LOW POINT ELEVATION	480.0	ft	
ELEVATION DIFF (H)	13.0	ft	
LENGTH (L)	1174	ft	
SLOPE (S) = (H/L)	1.1%		
MANNING'S n	0.013		
PIPE DIAMETER d	4.0	ft	
HYDRAULIC RADIUS R	1.0	ft	R=D/4, Assume: flowing full
VELOCITY (STORMDRAIN)	12.1	fps	$V = \frac{K_u}{n} R^{2/3} S^{1/2}$
T_C (SD)=	1.62	minutes	

NOTES:

Tc (TOTAL) =	7.47	minutes
Minimum Tc =	10	minutes
USE Tc =	**10.00**	minutes

INTENSITY CHART: $I = 7.44\,P_6\,D^{-0.645}$

FLOW RESULTS:

COUNTY P_6

					cfs		inches
i_2 =	1.9	in/hr	X CA =	**Q_2 =**	24.4	2-year:	1.1
i_{10} =	2.7	in/hr	X CA =	**Q_{10} =**	35.5	10-year:	1.6
i_{25} =	3.4	in/hr	X CA =	**Q_{25} =**	48.8	25-year:	2.0
i_{50} =	4.0	in/hr	X CA =	**Q_{50} =**	63.9	50-year:	2.4
i_{100} =	4.2	in/hr	X CA =	**Q_{100} =**	**69.3**	100-year:	2.5

Basin K-South Inflow Hydrograph

PROJECT:	**POE**		**DESCRIPTION:**	**POE Basin**
JOB #:	**11A1190**		**STATION:**	**POE**
BY:	**M.BRUNING**	**DATE:** 02.09.10	**WATERSHED:**	**K-South**
CHK:	**G.DALZIEL**	**DATE:**	**SYSTEM:**	

Notes:
This is the actual flow entering the detention basin

ONSITE RUNOFF VOLUME

100-year, 6 hour duration storm event, use the Rational Method Hydrograph Procedure (SDCHM 6-1) ~ RatHydro

Basin Inflow Hydrograph

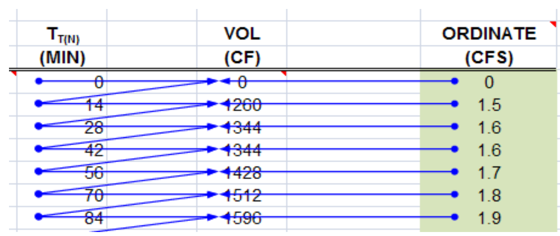
Basin Inflow Q

Q_{100}= 69.3 cfs
Tc= 10.0 min
$P_{100,6}$= 2.5 in

C_{100}= 0.79
A= 20.84 acres

$T_{T(N)}$ (MIN)	VOL (CF)	ORDINATE (CFS)
0	0	0
10	1500	2.5
20	1500	2.5
30	1560	2.6
40	1620	2.7
50	1680	2.8
60	1680	2.8
70	1800	3
80	1800	3
90	1920	3.2
100	1980	3.3
110	2100	3.5
120	2160	3.6
130	2340	3.9
140	2400	4
150	2640	4.4
160	2760	4.6
170	3060	5.1
180	3240	5.4
190	3720	6.2
200	4020	6.7
210	4920	8.2
220	5640	9.4
230	8220	13.7
240	11640	19.4
250	41580	69.3
260	6600	11
270	4440	7.4
280	3480	5.8
290	2880	4.8
300	2520	4.2
310	2220	3.7
320	2040	3.4
330	1860	3.1
340	1740	2.9
350	1620	2.7
360	1560	2.6
370	0	0

Example of Steps:

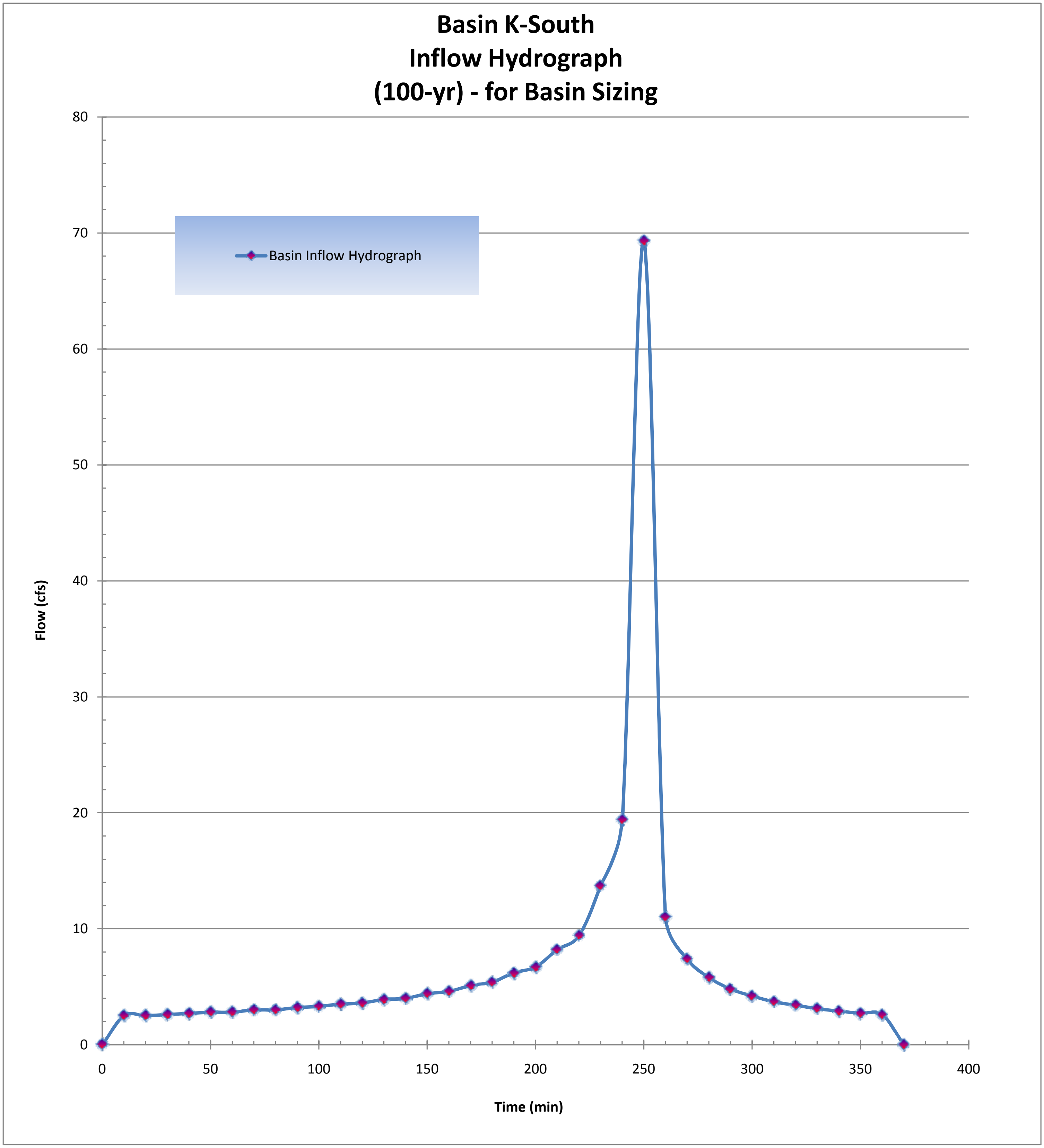


SUM= **148440** **ft^3**
3.41 **acre-feet**

Onsite Runoff Volume

Check: $V = C*A*P_6$
V= 3.43 acre-feet
OK

Basin K-South Inflow Hydrograph



Basin K-South Outlet

PROJECT:	**POE**			**DESCRIPTION:**	**POE Basin**	
JOB #:	**11A1190**			**STATION:**	**POE**	
BY:	**M.BRUNING**	**DATE:**	**02.19.10**	**WATERSHED:**	**K**	
CHK:	**G.DALZIEL**	**DATE:**		**SYSTEM:**	**Basin**	**K-South**

Notes:

Volumes:

Required Retention Basin Volume =	95476	ft^3	
Actual Basin Inflow =	148440	ft^3	OK

Flow Balance - determine maximum flow from basin

Predeveloped Peak 100-year Flow:	55.1	cfs	
Post-Developed Peak Flow through Cross Culvert:	0.0	cfs	Independent of Culvert K
Flow that does not reach detention basin	19.3	cfs	Q_{100} from: Basin Outlet K North
Maximum flow allowed to be released by this detention basin:	35.7	cfs	

Outlet Pipe

Assume: trapezoid basin/flat bottom, one outlet pipe set above basin invert

Basin - Top of basin berm elevation =	510.00	ft
Basin flowline elevation =	505.80	ft
Maximum Basin Depth =	4.20	ft

Assume Culvert Design: free outfall, square-edge w/headwall

Outlet pipe invert from basin floor =	2.20	ft	508.00	ft
Outlet pipe diameter =	2.00	ft		

Basin Characteristics

Base Length (L)	200	ft
Base Width (W)	200	ft
W/L Ratio ®	1.00	
Side Slopes (Z)	1: 4	
Total Volume (V):	197785	ft^2

Infiltration Rate: Rate (min/inch): 71.1 Location: PT-C2 *~ assume no infiltration*

Detention Basin Data						Outlet Pipe		Infiltration	Total
Stage	Water Surface Elevation (ft)	Depth	V_{avg} staged (ft3)	V_{avg} cumm. (ft3)		HW Elev. (ft)	Discharge Q_{out} (cfs)	Q_{inf} (cfs)	Q_{total} (cfs)
0	505.80	0.00	0	0		505.80	0.00		0.00
1	506.00	0.20	8065	8065		506.00	0.00		0.00
2	506.20	0.40	8195	16260		506.20	0.00		0.00
3	506.40	0.60	8327	24587		506.40	0.00		0.00
4	506.60	0.80	8459	33046		506.60	0.00		0.00
5	506.80	1.00	8591	41637		506.80	0.00		0.00
6	507.00	1.20	8725	50362		507.00	0.00		0.00
7	507.20	1.40	8859	59222		507.20	0.00		0.00
8	507.40	1.60	8994	68216		507.40	0.00		0.00
9	507.60	1.80	9130	77346		507.60	0.00		0.00
10	507.80	2.00	9267	86613		507.80	0.00		0.00
11	508.00	2.20	9404	96017	*	508.00	0.00		0.00
12	508.20	2.40	9542	105560		508.20	0.15		0.15
13	508.40	2.60	9681	115241		508.40	0.59		0.59
14	508.60	2.80	9821	125062		508.60	1.30		1.30
15	508.80	3.00	9961	135024		508.80	2.25	0.00	2.25
16	509.00	3.20	10103	145126		509.00	3.42		3.42
17	509.20	3.40	10245	155371		509.20	4.79		4.79
18	509.40	3.60	10387	165758		509.40	6.32		6.32
19	509.60	3.80	10531	176289		509.60	7.99		7.99
20	509.80	4.00	10675	186964		509.80	9.77		9.77
21	510.00	4.20	10820	197785		510.00	11.63		11.63
22	510.20	4.40	10966	208751		510.20	13.53		13.53
23	510.40	4.60	11113	219864		510.40	15.46		15.46
24	510.60	4.80	11260	231124		510.60	17.37		17.37
25	510.80	5.00	11408	242532		510.80	19.16		19.16
26	511.00	5.20	11557	254089		511.00	20.41		20.41
27	511.20	5.40	11707	265796		511.20	21.59		21.59
28	511.40	5.60	11857	277653		511.40	22.71		22.71
29	511.60	5.80	12008	289662		511.60	23.78		23.78
30	511.80	6.00	12160	301822		511.80	24.80		24.80

Basin K-South Routing

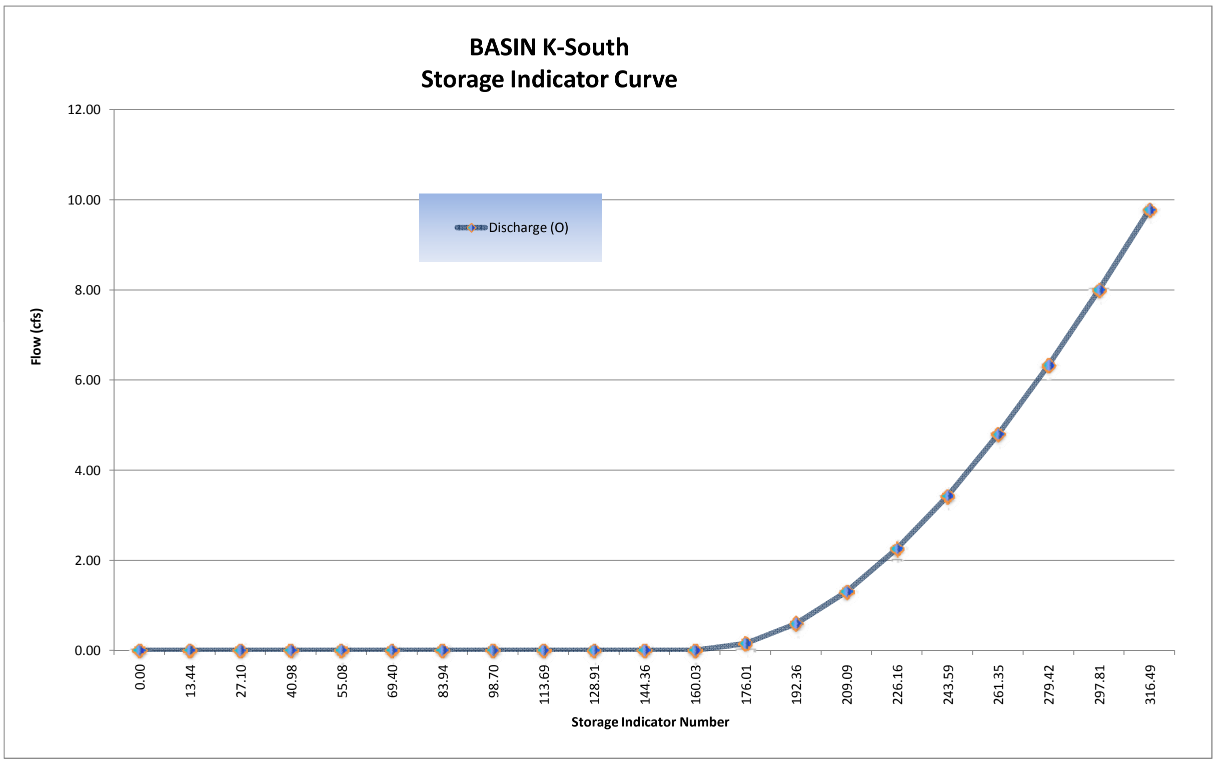
PROJECT:	POE			DESCRIPTION:	POE Basin
JOB #:	11A1190			STATION:	POE
BY:	M.BRUNING	DATE:	02.19.10	WATERSHED:	K
CHK:	G.DALZIEL	DATE:		SYSTEM:	Basin K-South

user input
linked input

STORAGE INDICATOR NUMBERS TABLE

(1) Stage (ft)	(2) Discharge (O) (cfs)	(3) Storage (S) (ft^3)	(4) $O_2/2$ (cfs)	(5) S_2/delta t (cfs)	*Storage Indicator #* (6) S_2/delta t + $O_2/2$ (cfs)
505.80	0.00	0	0.00	0.00	0.00
506.00	0.00	8065	0.00	13.44	13.44
506.20	0.00	16260	0.00	27.10	27.10
506.40	0.00	24587	0.00	40.98	40.98
506.60	0.00	33046	0.00	55.08	55.08
506.80	0.00	41637	0.00	69.40	69.40
507.00	0.00	50362	0.00	83.94	83.94
507.20	0.00	59222	0.00	98.70	98.70
507.40	0.00	68216	0.00	113.69	113.69
507.60	0.00	77346	0.00	128.91	128.91
507.80	0.00	86613	0.00	144.36	144.36
508.00	0.00	96017	0.00	160.03	160.03
508.20	0.15	105560	0.08	175.93	176.01
508.40	0.59	115241	0.30	192.07	192.36
508.60	1.30	125062	0.65	208.44	209.09
508.80	2.25	135024	1.13	225.04	226.16
509.00	3.42	145126	1.71	241.88	243.59
509.20	4.79	155371	2.40	258.95	261.35
509.40	6.32	165758	3.16	276.26	279.42
509.60	7.99	176289	4.00	293.82	297.81
509.80	9.77	186964	4.89	311.61	316.49

delta t =	0.17	hrs
delta t =	10.00	min
delta t =	600	sec

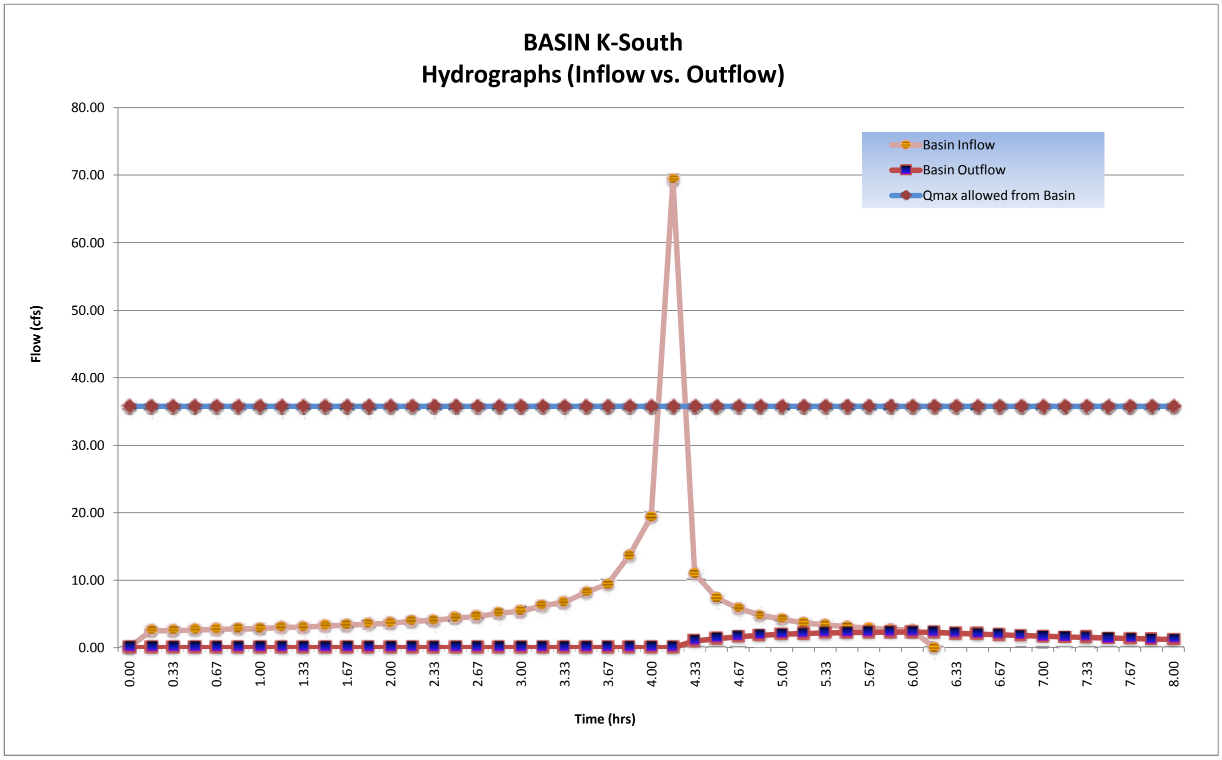


Basin K-South Routing

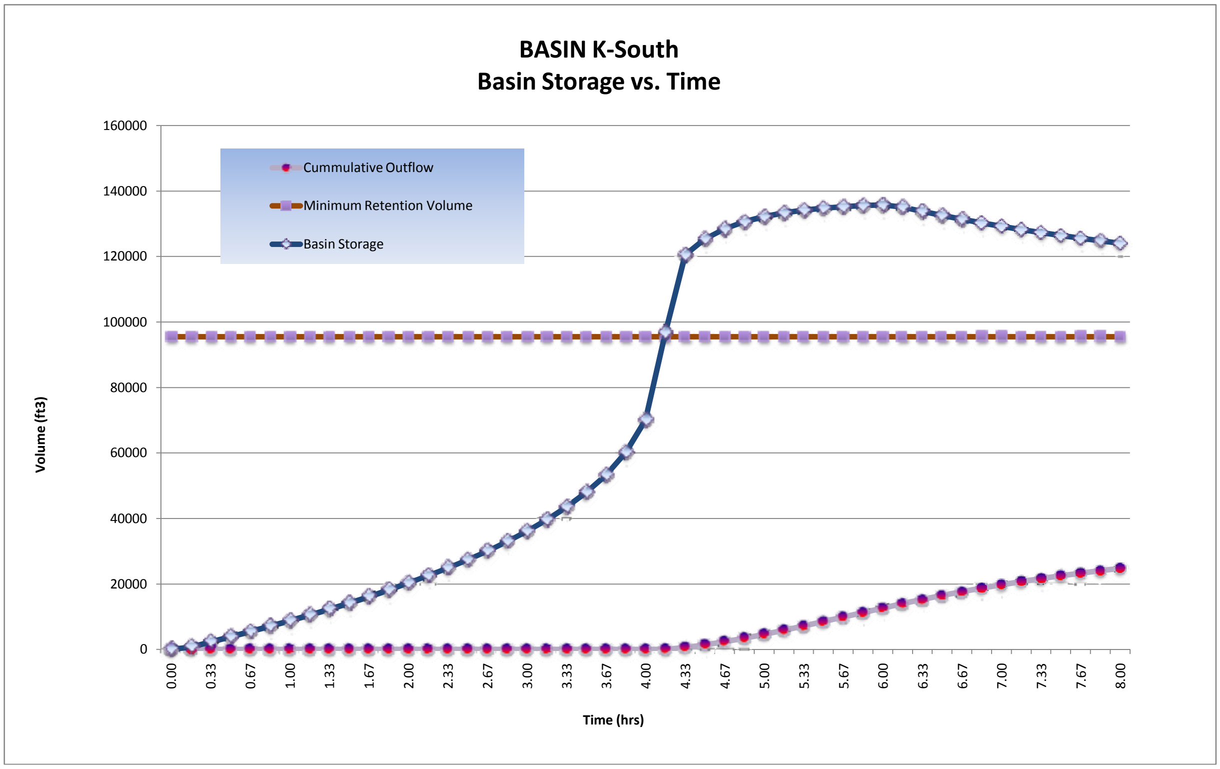
$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} + \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$

FINAL ROUTING TABLE					Storage Indicator #		Volumes		
(1)	(2)	(3)	(4)	(5)	(6)	(7)			
Time	Inflow	$(I_1+I_2)/2$	(S_1/delta t + O_1/2)	O_1	S_2/delta t + O_2/2	O_2	Basin	Incremental	Cummulative
(hrs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	Storage	Outflow	Outflow
	(Q_{post})		*col (6) from prev row*	*col (7) from prev row*	*col (3)+(4)-(5)*	*(Hard input)*	*(ft3)*	*(ft3)*	*(ft3)*
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
0.17	2.50	1.25	0.00	0.00	1.25	0.00	750	0	0
0.33	2.50	2.50	1.25	0.00	3.75	0.00	2250	0	0
0.50	2.60	2.55	3.75	0.00	6.30	0.00	3780	0	0
0.67	2.70	2.65	6.30	0.00	8.95	0.00	5370	0	0
0.83	2.80	2.75	8.95	0.00	11.70	0.00	7020	0	0
1.00	2.80	2.80	11.70	0.00	14.50	0.00	8700	0	0
1.17	3.00	2.90	14.50	0.00	17.40	0.00	10440	0	0
1.33	3.00	3.00	17.40	0.00	20.40	0.00	12240	0	0
1.50	3.20	3.10	20.40	0.00	23.50	0.00	14100	0	0
1.67	3.30	3.25	23.50	0.00	26.75	0.00	16050	0	0
1.83	3.50	3.40	26.75	0.00	30.15	0.00	18090	0	0
2.00	3.60	3.55	30.15	0.00	33.70	0.00	20220	0	0
2.17	3.90	3.75	33.70	0.00	37.45	0.00	22470	0	0
2.33	4.00	3.95	37.45	0.00	41.40	0.00	24840	0	0
2.50	4.40	4.20	41.40	0.00	45.60	0.00	27360	0	0
2.67	4.60	4.50	45.60	0.00	50.10	0.00	30060	0	0
2.83	5.10	4.85	50.10	0.00	54.95	0.00	32970	0	0
3.00	5.40	5.25	54.95	0.00	60.20	0.00	36120	0	0
3.17	6.20	5.80	60.20	0.00	66.00	0.00	39600	0	0
3.33	6.70	6.45	66.00	0.00	72.45	0.00	43470	0	0
3.50	8.20	7.45	72.45	0.00	79.90	0.00	47940	0	0
3.67	9.40	8.80	79.90	0.00	88.70	0.00	53220	0	0
3.83	13.70	11.55	88.70	0.00	100.25	0.00	60150	0	0
4.00	19.40	16.55	100.25	0.00	116.80	0.00	70080	0	0
4.17	69.30	44.35	116.80	0.00	161.15	0.01	96687	6	6
4.33	11.00	40.15	161.15	0.01	201.29	0.97	120483	582	588
4.50	7.40	9.20	201.29	0.97	209.52	1.32	125316	792	1380
4.67	5.80	6.60	209.52	1.32	214.80	1.62	128394	972	2352
4.83	4.80	5.30	214.80	1.62	218.48	1.82	130542	1092	3444
5.00	4.20	4.50	218.48	1.82	221.16	1.97	132105	1182	4626
5.17	3.70	3.95	221.16	1.97	223.14	2.08	133260	1248	5874
5.33	3.40	3.55	223.14	2.08	224.61	2.16	134118	1296	7170
5.50	3.10	3.25	224.61	2.16	225.70	2.22	134754	1332	8502
5.67	2.90	3.00	225.70	2.22	226.48	2.27	135207	1362	9864
5.83	2.70	2.80	226.48	2.27	227.01	2.31	135513	1386	11250
6.00	2.60	2.65	227.01	2.31	227.35	2.33	135711	1398	12648
6.17	0.00	1.30	227.35	2.33	226.32	2.26	135114	1356	14004
6.33		0.00	226.32	2.26	224.06	2.13	133797	1278	15282
6.50		0.00	224.06	2.13	221.93	2.01	132555	1206	16488
6.67		0.00	221.93	2.01	219.92	1.90	131382	1140	17628
6.83		0.00	219.92	1.90	218.02	1.80	130272	1080	18708
7.00		0.00	218.02	1.80	216.22	1.70	129222	1020	19728
7.17		0.00	216.22	1.70	214.52	1.60	128232	960	20688
7.33		0.00	214.52	1.60	212.92	1.51	127299	906	21594
7.50		0.00	212.92	1.51	211.41	1.43	126417	858	22452
7.67		0.00	211.41	1.43	209.98	1.35	125583	810	23262
7.83		0.00	209.98	1.35	208.63	1.28	124794	768	24030
8.00		0.00	208.63	1.28	207.35	1.23	124041	738	24768

Basin K-South Routing



Basin K-South Routing



Detention/Retention Basin Volume Required:	**135,711**	**ft³**	
@ Stage:	**509.00**	**ft**	
Freeboard:	**1.0**	**ft**	>1' Freeboard
Final Total Basin Volume Provided:	**197,785**	**ft³**	Basin **K-South**
Maximum flow rate released from this basin:	**2.33**	**cfs**	

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Appendix F IBWC and County Correspondence

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United States International Boundary and Water Commission (IBWC)

Hydraulic and Hydrological Study reports which are required to be submitted to USIBWC for review

1. Identify the type of soil, the infiltration rate, the drainage area, the slope, the time of concentration, the peak discharge or the runoff volume;
2. Provide drainage calculation worksheets;
3. Provide an analysis of the historic peak runoff rate, the historic runoff volume, the historic runoff location or spatial distribution as it crosses into Mexico, and the difference in runoff volume between historic and developed conditions. The detention/retention basin volume should be sized to reproduce historic peak flow rate, and to retain, infiltrate and or otherwise dispose (disposal of excess water should not go into Mexico);
4. Provide an analysis for silt accumulation within the basin. The basin design should include additional capacity for a 10-year volume of silt accumulation;
5. Provide an analysis for the time required for the basin to empty, or of the chance that a second storm may arrive while the basin is full of runoff from a previous storm;
6. Provide maintenance schedule or outline procedure that will be utilized to insure the basin's infiltration rate will be maintained, and to prevent unchecked vegetation growth in the pond;
7. Identify any proposed work, light poles, fences and/or associated gates located within the 60-foot wide strip adjacent to the boundary. Such work and/or structures must be submitted for review to insure they do not cause obstructions to the line-of-sight between U.S. and Mexico International Boundary monuments or markers.

Additional information

Each of these items will be reviewed by the US Section of the International Boundary and Water Commission and then provided to the Mexican Section for review and comment as well. Please schedule required project review time-periods with this in mind.
If you have any questions, please do not hesitate to contact me at **(915)-832-4748**.

Isela F. Canava
Civil Engineer
International Boundary and Water Commission
United Stated and Mexico, U.S. Section
4171 North Mesa, C-100
El Paso, Texas 79902-1441
Telephone: (915) 832-4748
Fax: (915) 832-4179
ifcanava@ibwc.state.gov

Additional IBWC Contacts

Dawi Dakhil dawidakhil@ibwc.state.gov
Jose Nunez josenunez@ibwc.state.gov

County of San Diego

JOHN L. SNYDER
DIRECTOR

DEPARTMENT OF PUBLIC WORKS

5555 OVERLAND AVE, SUITE 2188
SAN DIEGO, CALIFORNIA 92123-1295

(858) 694-2212 FAX: (858) 268-0461
Web Site: sdcdpw.org

July 3, 2007

Mr. Tim Brownson
District Hydraulic Engineer
California Department of Transportation – District 11
4050 Taylor Street
San Diego, CA 92110

FLOODPLAIN IMPACT ASSESSMENT OF PROPOSED OTAY MESA EAST POE AND SR-11

Dear Mr. Brownson:

We have reviewed your letter of May 14, 2007, requesting our endorsement of your conclusion that there is no need for a Floodplain Impact Assessment of the proposed Otay Mesa East POE and SR-11.

The subject proposed project as depicted on Exhibit 2A is partially located within the FIRM No. 06073C2183F, which determined the area as Zone X outside the 500-year floodplain. Therefore, we concurred with your conclusion that the subject proposed project does not require a Floodplain Impact Assessment.

However, with regard to flood management in East Otay Mesa all developments are subject to guidelines of the County's East Otay Mesa Specific Plan Comprehensive Flood Control Master Plan 1994. Essentially, developments within East Otay Mesa area are required to provide local or regional detention basins.

If you have any questions or need additional information, please contact me at (858) 694-3672 or by email Cid.Tesoro@sdcounty.gov.

Sincerely,

CID TESORO, Manager
Watershed Protection Program

CT/ez

cc: Hung Tran, Department of Public Works, MS 0384

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Appendix G Photo Log of Existing Conditions

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Looking north at the Western Culvert and 2nd containment Fence

Looking South at the Border Fence with Secured Opening -
this is the point of discharge for the Western watershed

Through the Border fence opening
3' x 20' RCB in Mexico, under Colina del Sol (Mex)

View of Western Discharge
Point at Border Fence

View looking east from Western Discharge point at Border

Northern side of 2nd Containment fence (3x3'x6' RCB)

Looking west along the north side of the 2nd Containment fence

Looking North at the Eastern watershed culvert (3x3'x6' RCB)

Looking southwest at western watershed discharge point

Eastern discharge point through
this Border fence opening -
flow across existing road (12 Norte, Mex)

Looking west from the eastern discharge point to the western discharge point

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Appendix H Aerial photo timeline of Border

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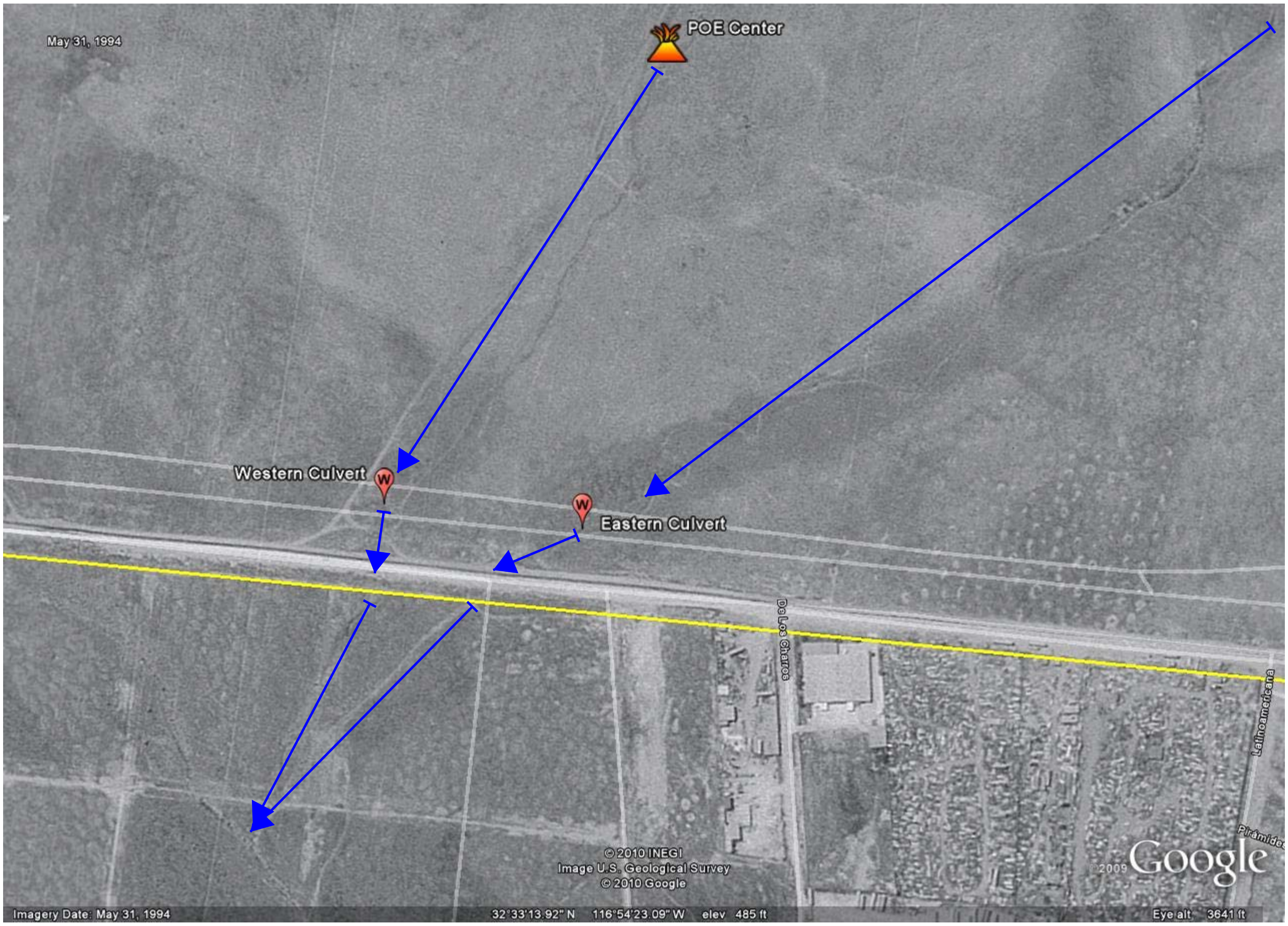
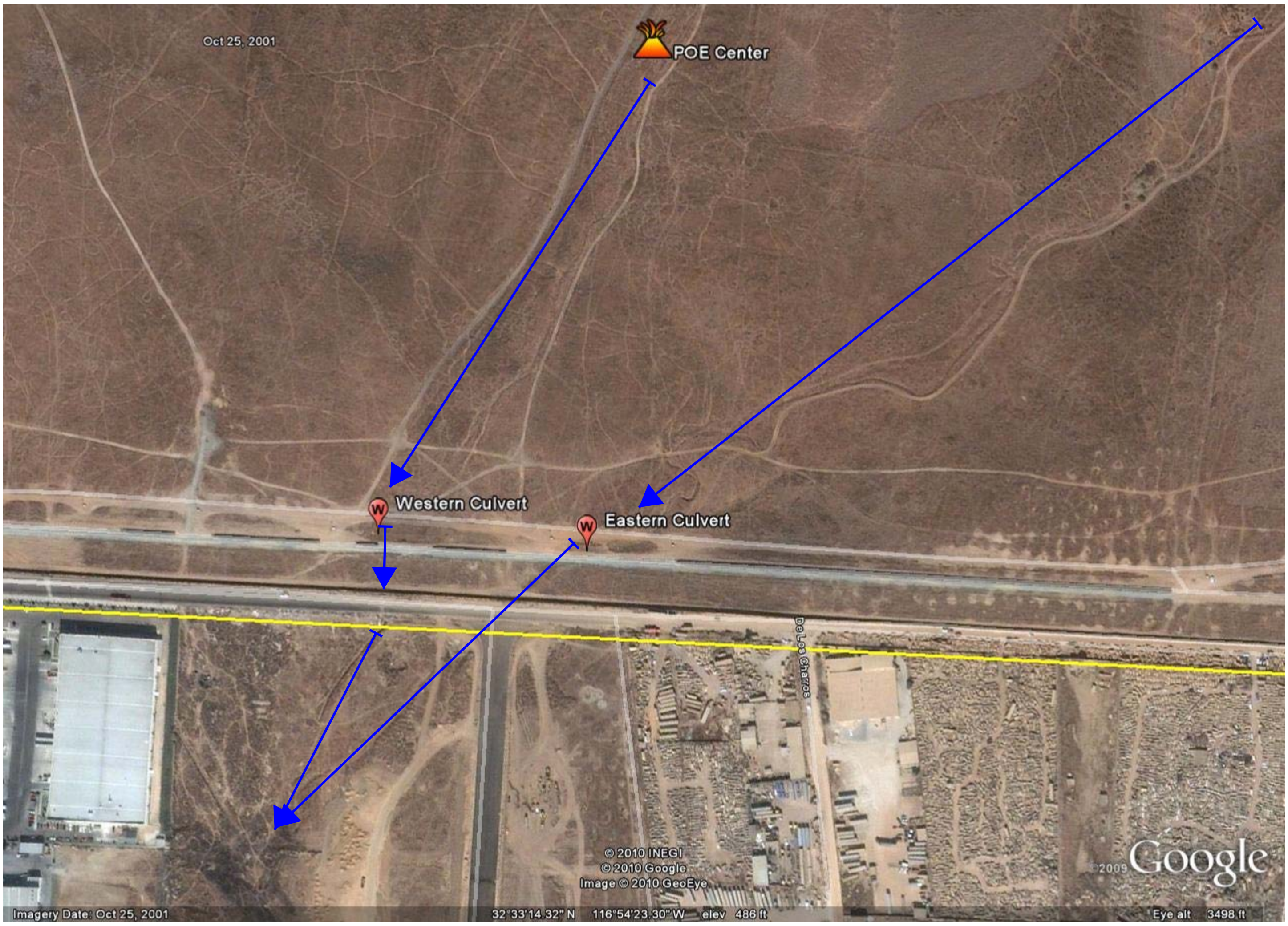
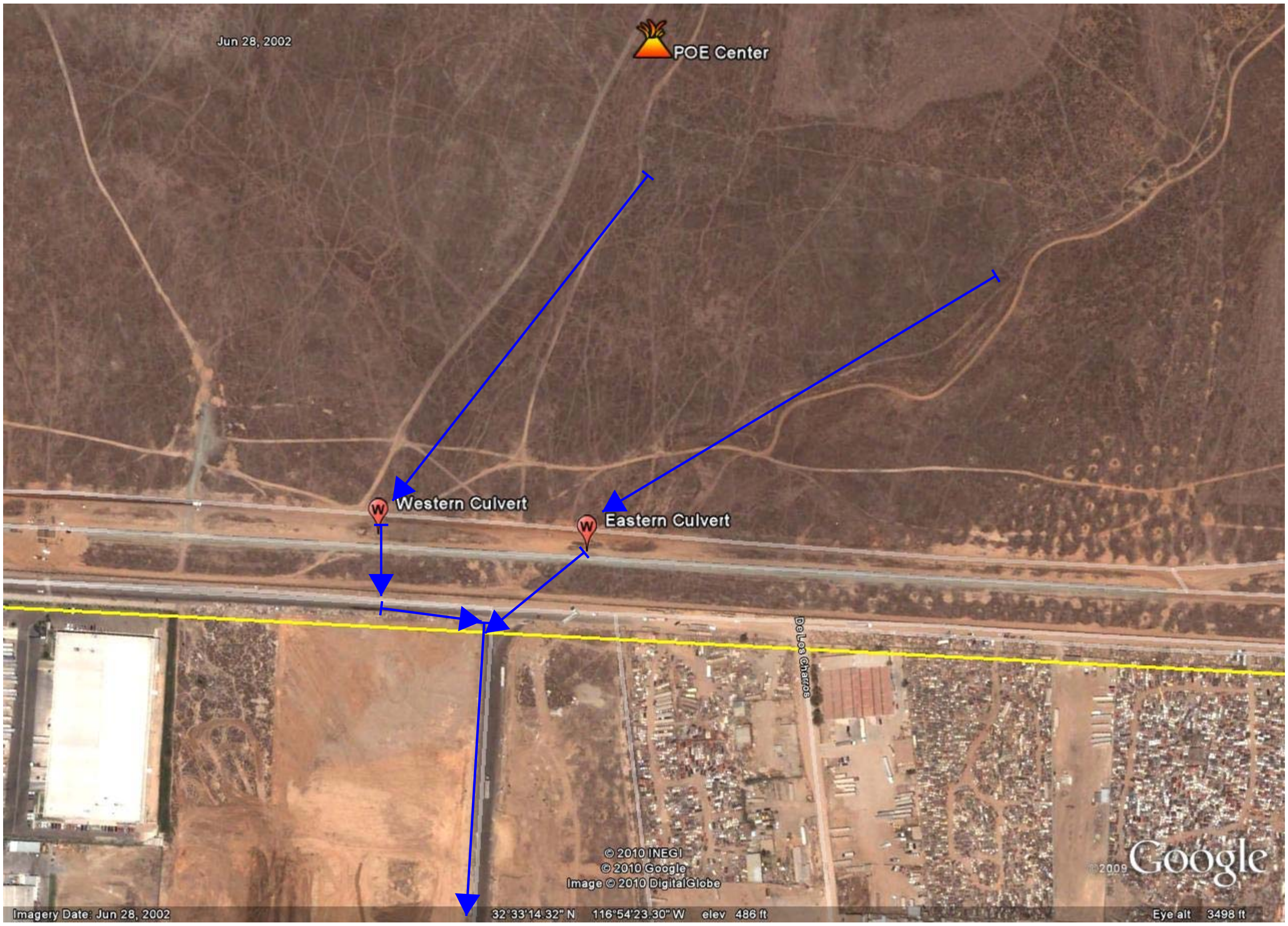


May 31, 1994 - natural conditions

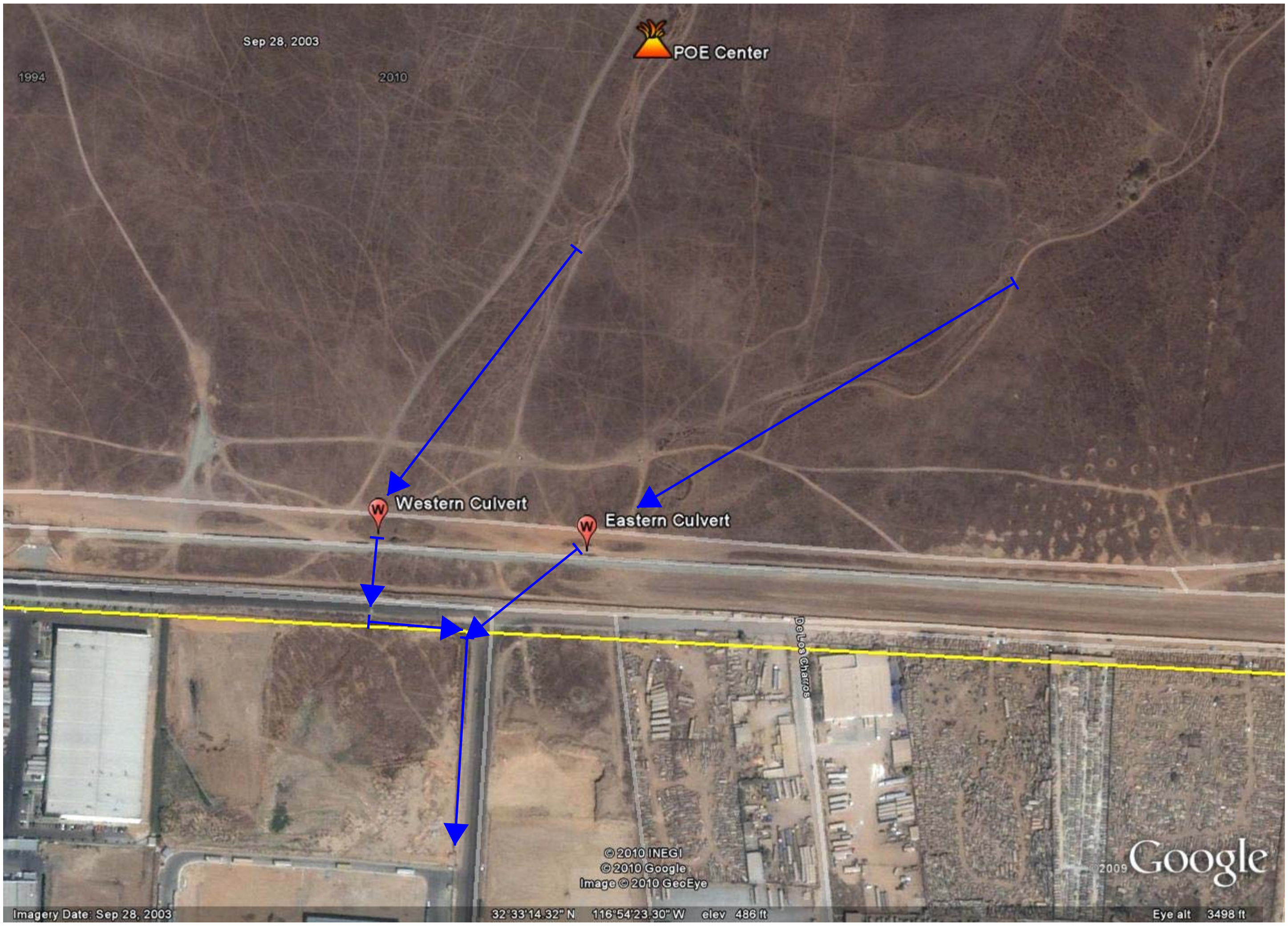
May 27, 2000 - Culverts in place (US and Mex)
and well defined channel in Mexico



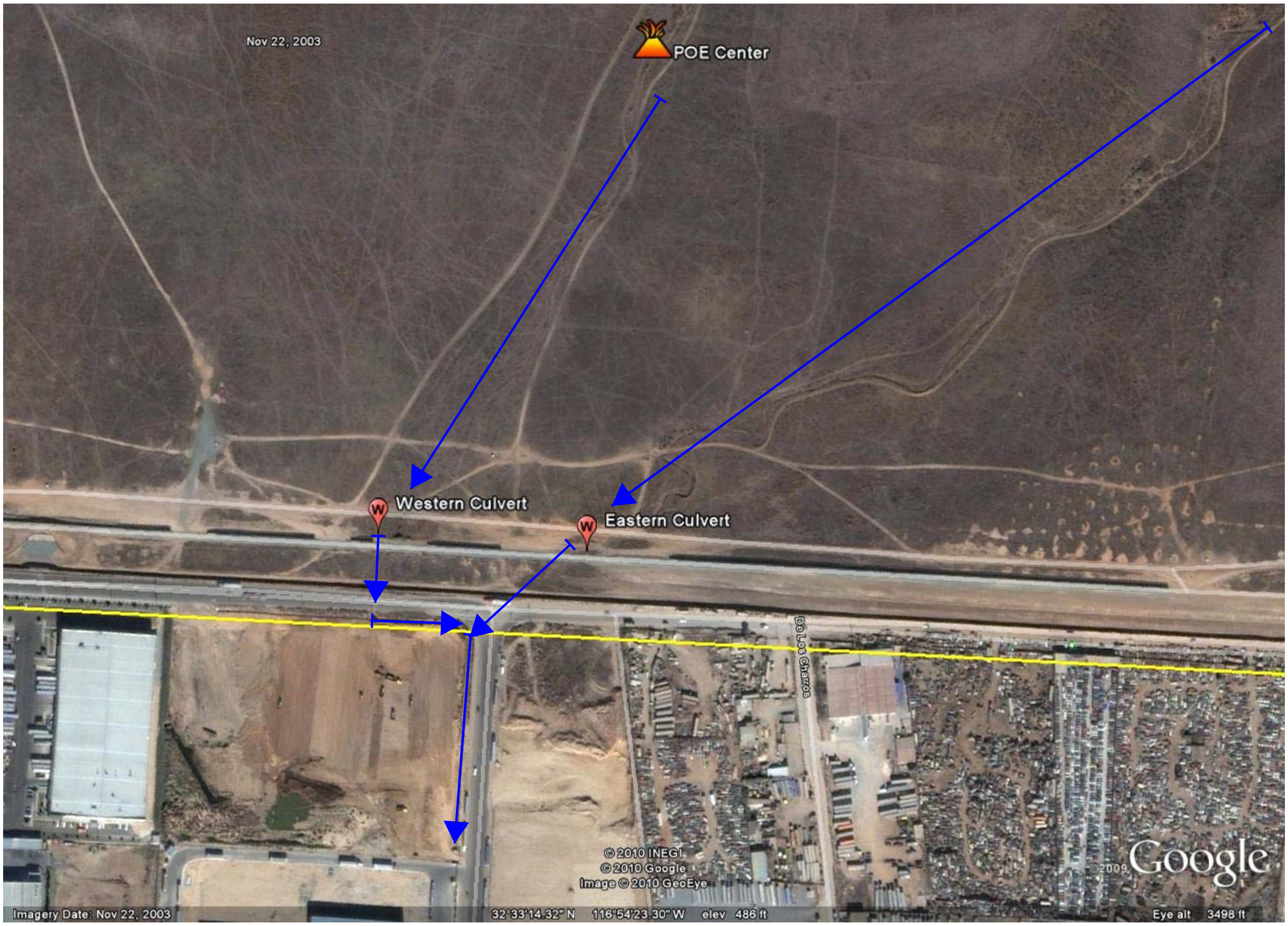
October 25, 2001 - 12 Norte (Mex) constructed



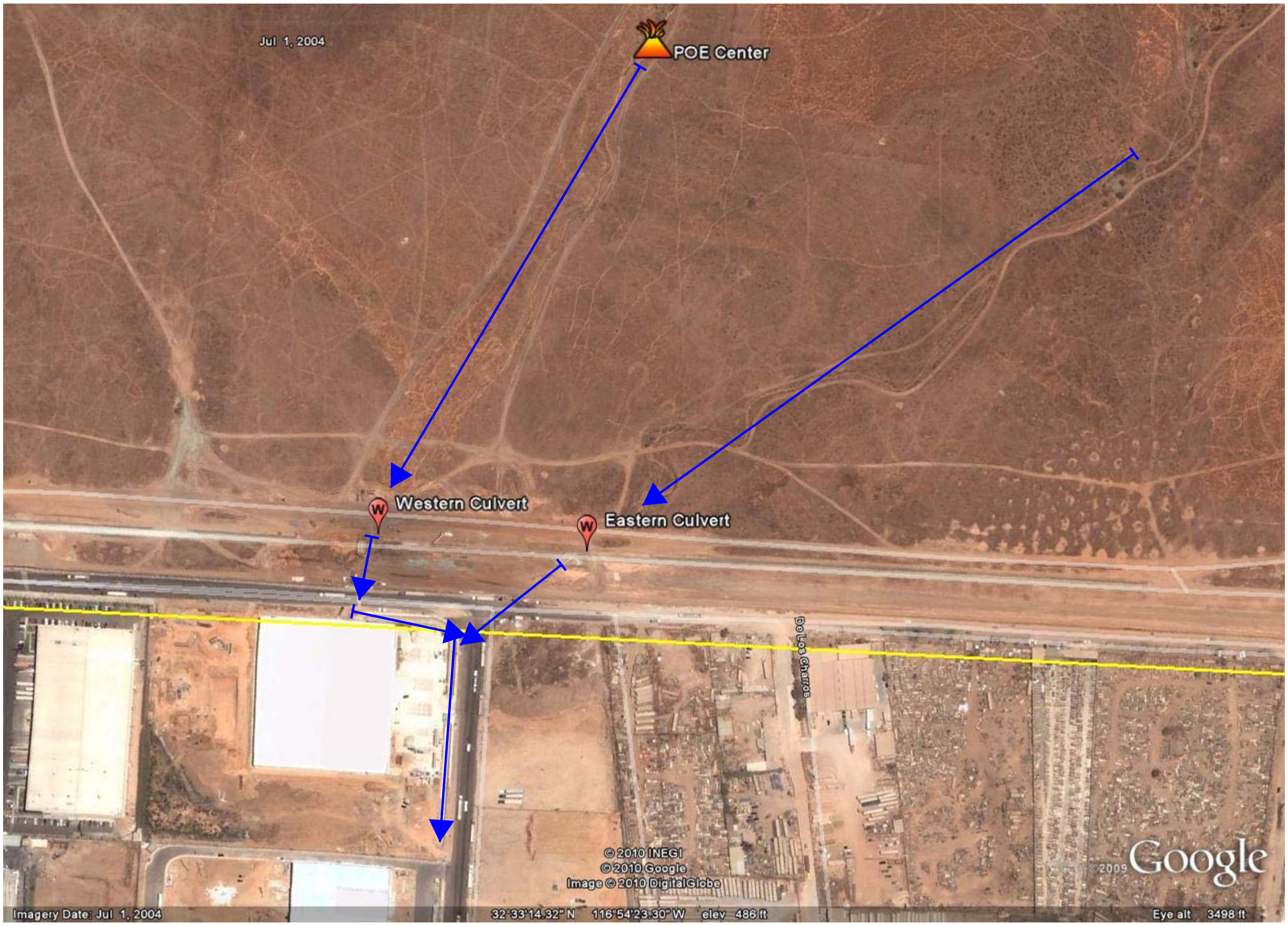
June 28, 2002 - Grading and diversion channel in Mexico



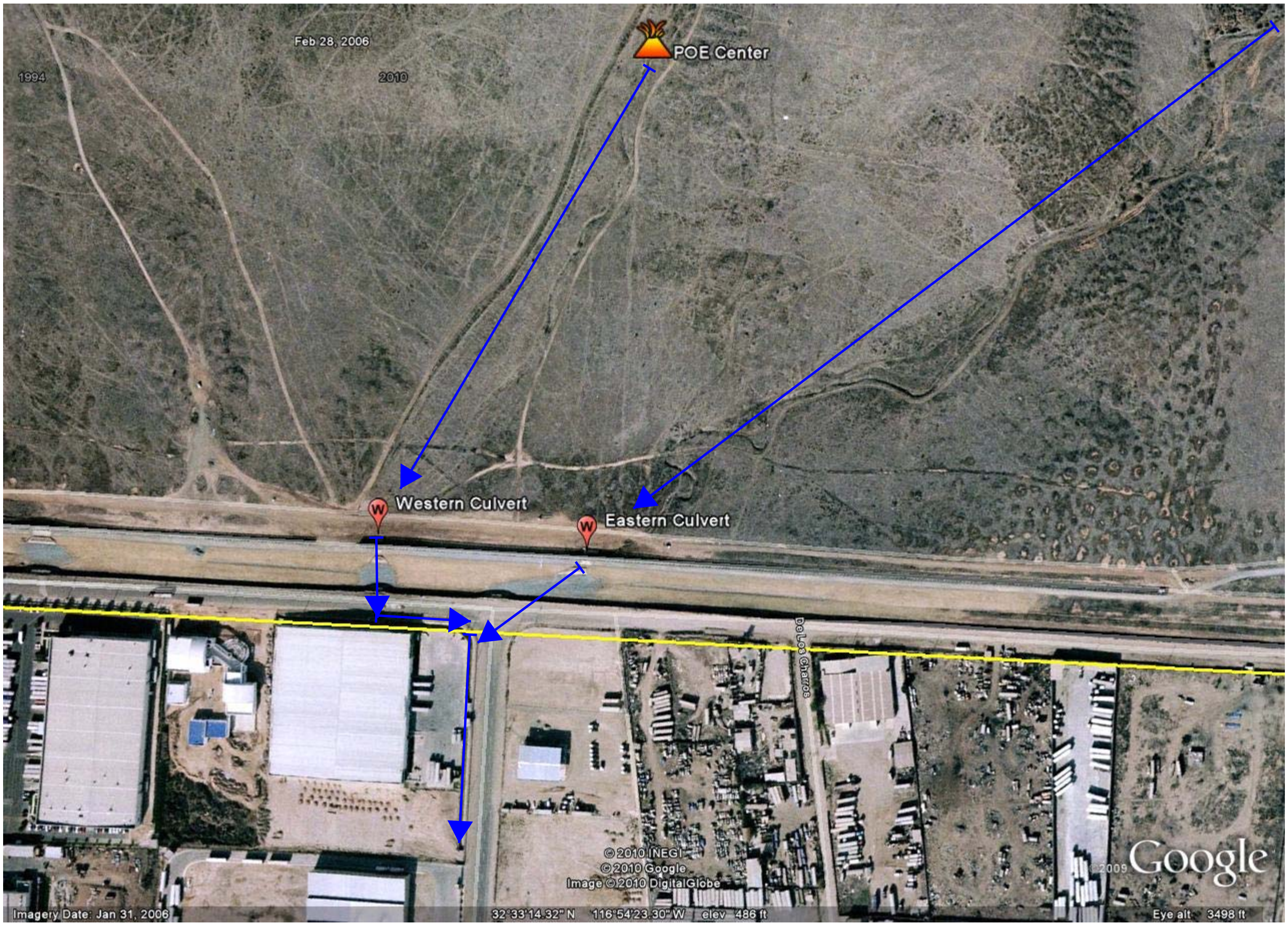
September 28, 2003 -Additional roads constructed in Mexico



November 22, 2003 - Construction and ponding in Mexico



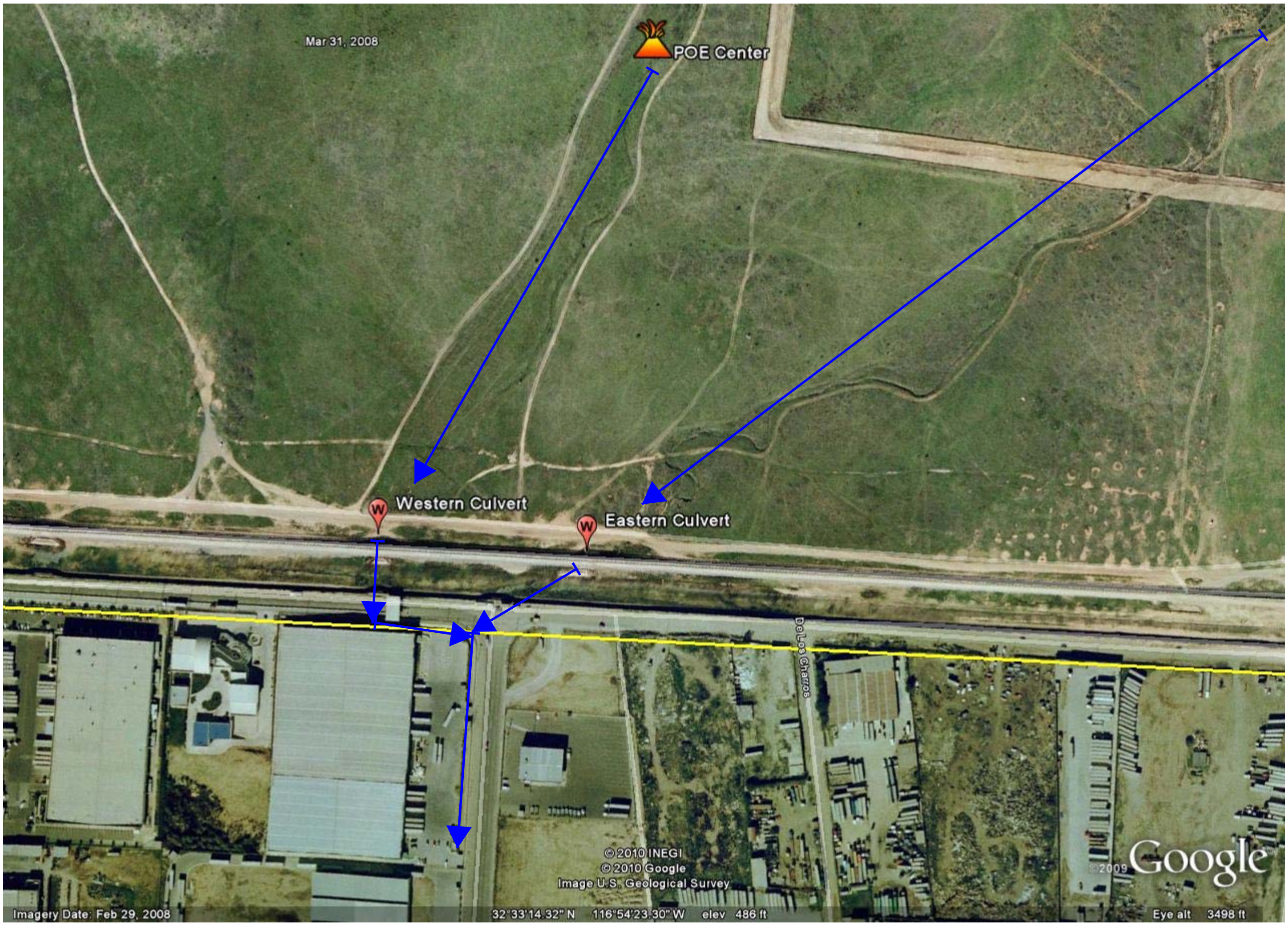
June 1, 2004 - building in place



February 28, 2006 - more construction (Mex)

May 26, 2006 - building addition (rear)

September 3, 2006



March 31, 2008 - more pavement (Mex)
and CALPINE installed (USA)

June 26, 2008 - 'present'