HYDROLOGY AND HYDRAULICS REPORT

TTM 18487

Victorville, CA
APN:3096-361-02

November 2018

PREPARED FOR:

Ed Grimes
6238 Caliente Road
Oak Hills, CA 92344

PREPARED BY:

Kimley»Horn

APPROVED BY
BILL HEMSLEY
- 3/28/19

3880 Lemon Street Suite 420
Riverside, CA 92501
(747) 900-8400

September 2018 - KHA Project #099481003

TABLE OF CONTENTS

DRAINAGE ANALYSIS

Tract 18487
Victorville, CA

INTRODUCTION

This Hydrology Report has been prepared for Tract 18487 by Kimley-Horn and Associates. The Hydrology Report is intended to comply with the requirements of the San Bernardino Hydrology Manual to assist in the development of Tract 18487. Due to the nature of the project, this report will be accompanied by a WQMP.

The project consists of a 55-lot single family residential subdivision, 1 infiltration/detention/detention basin, and onsite drainage conveyance devices. The 14.90-acre parcel is located south of Tract 16107 and north of APN 3096-361-07,3096-361-06, and 3096-361-05. The project site is bounded by Mesa View Drive on the west and Bella Pine Road on the east. The site is undeveloped and has some existing desert vegetation. **Figure 1-1** below contains an aerial photograph that depicts the project location.

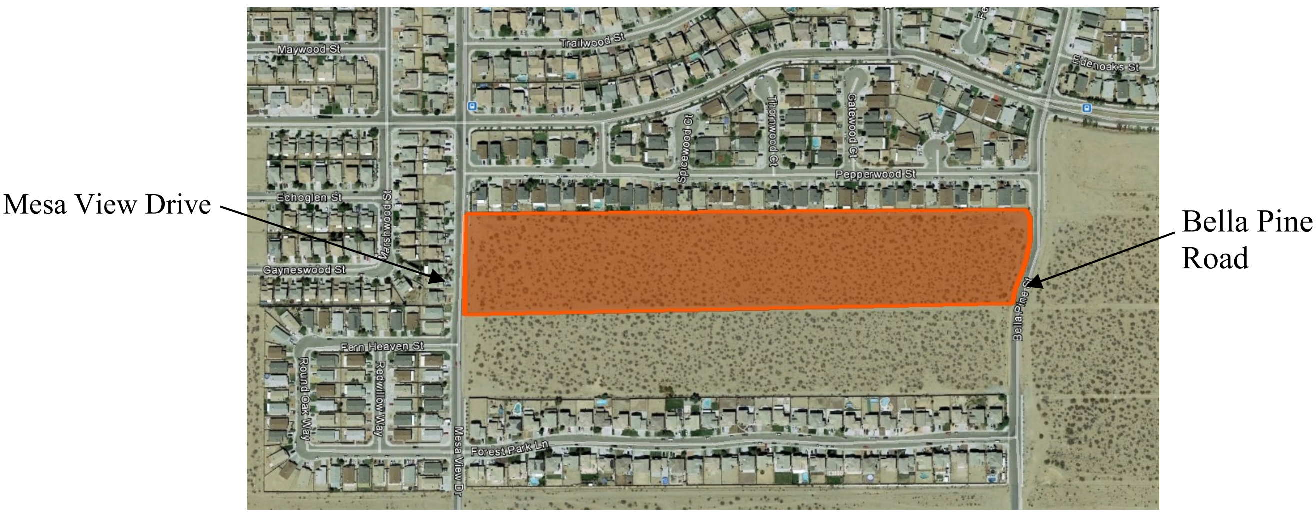
The report includes the existing and proposed condition hydrologic analysis, and sizing for the infiltration/detention basin. All off-site drainage will be conveyed around the project site. Streets and drainage conveyance devices will be designed to convey the storm flows to historic storm conveyances. The development of the project site will maintain existing drainage patterns. The proposed project is utilizing the infiltration/detention basin to meet treatment criteria for development to be in compliance with current NPDES General Permit.

Due to the development being 10 or more single family homes it will require a WQMP along with a Maintenance Agreement and Transfer (Per Planning Priority Project Checklist).

This study was performed using the following reference materials and tools:

- San Bernardino County Hydrology Manual
- Rational Method Hydrology Computer Program (Hydrowin)
- Victorville Master Plan of Drainage
- NRCS-USDA Web Soil Survey

Project location is show below in **Figure 1-1**.



SITE DISCUSSION

The project site is part of a larger watershed that drains to the Mojave River. The site does not contain any major depressions or significant hills. The project is relatively flat sloping at approximately two tenths percent (0.2%) throughout the site. The site drains from the southwest corner of the parcel to a low point located on the northern property line where ponding builds up for about 2 feet before discharging to the east along the northern boundary and reaching Bella Pine Road. There are currently no drainage facilities within the project limits. This runoff then will continue flowing north and eventually drain to the Mojave River. The elevation of the project site ranges from approximately 3232 to 3213 feet above mean sea level (msl). The existing site topography, drainage patterns, and storm water conveyance systems are shown in **Appendix A**.

The proposed development is a standalone project that will develop the existing site into 55 single family residential home sites in one phase. Researching the county storm-water facility GIS system there are currently no master plan drainage improvements existing or proposed within 2 miles of the project site.

The undeveloped site is 100% pervious. Once developed the site will be approximately 50% impervious and 50% pervious (landscape slopes, parkway landscaped areas, and infiltration/detention).

RAINFALL DATA/SOIL DATA

Per the 2010 San Bernardino County Hydrology Manual Addendum, arid regions within San Bernardino County should use NOAA Atlas 14 rainfall atlas and the associated data base (NOAA, 2006) or other local rainfall gauge data for hydrology studies. After review of available data, included Department of Water Resources rain data, the NOAA Atlas 14 rainfall data was chosen for this study due to the proximity of the nearest gage to the site. NOAA Atlas 14 also provides information for the various peak durations required to complete the hydrology analysis for the current study.

According to NOAA Atlas 14, the following are the 24 hour-storm precipitation values that have been utilized for our study:

10-year storm 24-hour intensity (inch/hour)	=	2.87
100-year storm 24-hour intensity (inch/hour)	=	5.19

Appendix A contains the site specific tabular output from NOAA Atlas 14.

The type of soil and soil conditions are major factors affecting infiltration/detention and resultant storm water runoff. The Natural Resources Conservation Service (NRCS) has classified soils into four general hydrologic soil groups for comparing infiltration and runoff rates. The groups are based on properties that influence runoff, such as water infiltration rate, texture, natural discharge and moisture condition. The runoff potential is based on the amount of runoff at the end of a long duration storm that occurs after wetting and swelling of the soil not protected by vegetation. Using NRCS-USDA Web Soil Survey online tool it was determine the hydrologic soil group classification is A. Soil group A is defined as soils having high infiltration/detention rates (low runoff potential) when thoroughly wet. Figure C-6 from the San Bernardino Hydrology Manual was used to determine the infiltration/detention rate. The infiltration/detention for the site is 0.65 in/hr.

See **Appendix A** for Web Soil Survey and Figure C-6.

Note: Final design criteria will be determined by geotechnical investigation review of infiltration/detention basin prior to final engineering design. Infiltration/detention testing is recommended.

ON-SITE RUNOFF

A Rational method analysis for the 10-year and 100-year events in accordance with the San Bernardino Hydrology Manual (SBC, 1986) and the 2010 Addendum was completed to calculate the peak discharges for existing conditions and project conditions. A review of Natural Resources Conservation Service Soil Survey Maps showed that the existing soils consisted of hydrologic group A. Soil group A is defined as soils having high infiltration rates (low runoff potential) when thoroughly wet. The combination of the soil and coverage type was used as the basis for selecting the appropriate curve numbers used to calculate the soil loss rate.

In addition, antecedent moisture condition (AMC) II was used to calculate the 10-year and AMC III or the100-year peak flows based on the AMC map (Figure ADD-1) published with the 2010 addendum. The land use for each subarea was selected based on the percent pervious that represents the area for both existing and proposed conditions. The Advance Engineering Software (AES) Hydrosoft package was used to complete the rational method analysis. The results of the rational method analysis are included in **Appendix B**.

The 100-year, 24-hr storm peak flows and volumes were calculated using the Small Area Runoff Hydrograph Development method. The Unit Hydrograph and basin routing calculations are included in **Appendix B**.

The undeveloped residential site was separated into two subareas. The first subarea flows to a low point located near the northerly property line south of the existing fence constructed by the neighboring development. At the low point water ponds for approximately 2 feet until it goes over the ridge. These confluence flows will travel easterly along the existing wall to the northeast corner of the residential site onto Bella Pine Road. The existing conditions drainage map and full output from the existing conditions hydrology AES models are provided in **Appendix B**. A summary of the existing conditions peak flows is show in the Table 1.

Table 1: Existing Conditions Hydrology Results

Sub-basin ID	Drainage Area (AC)	Q_{10} (cfs)	Q_{100} (cfs)
1	7.06	6.46	13.88
2	7.84	5.18	12.59
TOTAL	14.90	9.84	23.93

The total Q's shown above are the sum of the discharge values for each sub area. Refer to **Appendix B for the AES output.*

Due to a ridge line bisecting the site, the developed site requires an onsite storm drain system to convey flows to the infiltration/detention basin located on the southeast portion of the parcel. The proposed residential site was separated into five subareas. Four of the subareas flow into the infiltration/detention basin through the proposed storm drain system and one of the subareas flows into Mesa View Drive. The onsite discharge into Mesa View Drive is between 1.28 cfs to 2.40 cfs. The analysis on **Appendix B** establishes the contributing flows to two local catch basins located midway on the local street and two adjacent catch basins near the proposed infiltration/detention basin. The proposed conditions drainage map and full output from the proposed conditions hydrology AES models are provided in **Appendix B**.

The interior storm drain system was sized using the associated catch basin flows and it was determined that a 24-inch diameter pipe will convey the flows at a 0.64% slope within the streets. The flows will then confluence into a 36-inch diameter pipe and are conveyed into the infiltration/detention basin with a slope of 0.64%. The proposed infiltration/detention basin will have a depth of approximately 6.73 feet and a total volume of 95,905 cubic feet. See **Appendix B** for routing analysis. The total tributary area to the infiltration/detention basin is 14.9 acres.

Table 2: Proposed Hydrology Results

Sub-basin ID	Drainage Area (AC)	Q_{10} (cfs)	Q_{100} (cfs)
1	0.73	1.28	2.40
2	3.22	4.25	8.27
3	3.15	4.56	8.76
4	3.22	4.14	8.09
5	4.58	5.38	10.66
TOTAL	14.90	18.23	35.17

The total Q's shown above are the sum of the discharge values for each sub area. Refer to* ***Appendix B* *for the AES output.*

The basin will have a 24-inch diameter riser with seven (7)-3" orifices to control runoff from the infiltration/detention basin. There is a proposed emergency overflow spillway.

The onsite infiltration/detention basin was sized by routing the developed 35.17 cfs through an infiltration/detention basin routing software (Bentley PondPack V8i) in which only 95% of the pre-develop 100-year storm flow is allowed to be discharged from the infiltration/detention basin. 35.17 cfs was generated by the AES software for a 100-year one hour storm event. The small unit hydrograph peak discharge for a 100-year 24 hour event was modeled as 27.22 cfs. A conversion factor was applied to the small unit hydrograph output to conservatively model the infiltration/detention basin. See **Appendix B** for infiltration/detention basin scenario calculation summary and small unit hydrograph.

The proposed infiltration/detention basin receives a peak inflow of 35.17 cfs and discharges a peak out flow of **22.35 cfs**. The pre development discharge for the site is 23.93 cfs. The proposed basin mitigates the post development flows below the existing condition discharge for the site.

OFF-SITE RUNOFF

The offsite area was separated into two subareas as shown in the Offsite Drainage Exhibit in **Appendix B.** Currently there is cross lot drainage coming from the vacant parcels south of the property.

The existing offsite conditions drainage map and full output from the existing conditions hydrology AES models are provided in **Appendix B**. A summary of the existing offsite conditions peak flows is shown in the table below:

Table 3: Existing Offsite Conditions Hydrology Results

Sub-basin ID	Drainage Area (AC)	Q_{100} (cfs)
1	**7.39**	**15.86**
2	**7.16**	**13.14**
TOTAL	**14.55**	**29.00**

The total Q's shown above are the sum of the discharge values for each sub area. Refer to **Appendix B for the AES output.*

STORMWATER TREATMENT

A review of the Natural Resources Conservation Service Soil Survey Maps showed that the existing soils consisted of hydrologic group A. Soil group A is defined as soils having high infiltration rates (low runoff potential) when thoroughly wet. Based on this information, infiltration is the proposed BMP for this project. Drainage runoff sheet flows through the proposed street into an on-site storm drain system that discharges into an infiltration/detention basin. A drainage map is included in **Appendix B** for a visual reference of the location of the storm drain facilities.

The infiltration/detention basin has been designed to detail and treat the hydromodification volumes per the Mojave River Watershed Water Quality Management Plan Guidelines.

Storm water facilities require routine maintenance to operate efficiently. It is recommended that facilities be inspected prior to the rainy season (fall) and after each runoff producing storm event. The infiltration/detention basin shall be routinely inspected and sediment/debris build up shall be removed to maintain efficient operation of the basin.

CONCLUSION

The proposed 14.90-acre 55 lot single family subdivision will not increase the storm water discharge to the downstream system with the use of the proposed infiltration/ detention basin. The onsite run off prior to the development was 23.95 cfs and the post development run off will be 22.35 cfs. Conservative assumptions were used in sizing the proposed basin. For final design a Geotechnical report will be needed to confirm the assumptions used in this report for infiltration.

APPENDIX A

- City priority checklist
- Site Design BMP’s
- Hand Calculations
- Storm drain Masterplan
- City Watershed
- Tract Map/Parcel Map
- APN Map

STORM WATER PROGRAM

PLANNING PRIORITY PROJECT CHECKLIST

Project Name	TTM 18487	Owner Name	Ed Grimes
Project Address	Victorville Parcel Map	Owner Address	6238 Caliente Road
Developer Name	Ed Grimes	Owner Phone	
Developer Address	6238 Caliente Road		
Developer Phone			

Part 1 - Project Type	YES	NO
1. 10 or more unit homes, including single and multiple family homes, condominiums,	X	
2. An Industrial or commercial development with 100,000+ SF of impervious surface		X
3. An automotive service facility - (5,000 SF or more)		X
4. A retail gasoline outlet - (5,000 SF or more)		X
5. A restaurant (5,000 SF or more)		X
6. A parking lot with either 5,000 SF of impervious surface or with 25 or more parking spaces		X
7. A single family hillside dwelling (one acre or more surface area)		X
8. Redevelopment projects		X
9. Project location in, adjacent to or discharging directly to an ESA (as defined on back) AND creates 2,500 SF or more of impervious surface area.		X

If any of the boxes in Part 1 is checked "yes", this project will require a WQMP along with a Maintenance Agreement and Transfer

Part 2 - Project Specific Concerns/Characters	YES	NO
1. A single family hillside dwelling (less than one acre) - WQMP required		X
2. An automotive service facility (less than 5,000 SF or more) - WQMP required		X
3. a retail gasoline outlet (less than 5,000 SF or more) - WQMP required		X
4. A restaurant (less than 5,000 SF or more) WQMP required		X
5. Vehicle or equipment fueling areas (retail or private)		X
6. Commercial or Industrial waste handling or storage		X
7. Outdoor handling or storage of hazardous waste materials		X
8. Outdoor manufacturing areas		X
9. Outdoor food handling or processing		X
10. Outdoor animal care, confinement or slaughter		X
11. Outdoor horticulture activities		X

If any of the boxes in Part 2 is checked "yes", this project will require a WQMP along with a Maintenance Agreement and Transfer

Applicant Signature Print Name Title Date

Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

☑	Sediment	■
☑	Nutrients	■
☑	Trash	■
☑	Metals	■
☑	Bacteria	■
☑	Oil and Grease	■
☑	Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

California Experience

Infiltration basins have a long history of use in California, especially in the Central Valley. Basins located in Fresno were among those initially evaluated in the National Urban Runoff Program and were found to be effective at reducing the volume of runoff, while posing little long-term threat to groundwater quality (EPA, 1983; Schroeder, 1995). Proper siting of these devices is crucial as underscored by the experience of Caltrans in siting two basins in Southern California. The basin with marginal separation from groundwater and soil permeability failed immediately and could never be rehabilitated.

Advantages

- Provides 100% reduction in the load discharged to surface waters.

- The principal benefit of infiltration basins is the approximation of pre-development hydrology during which a significant portion of the average annual rainfall runoff is infiltrated and evaporated rather than flushed directly to creeks.

- If the water quality volume is adequately sized, infiltration basins can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- Infiltration basins require a minimum soil infiltration rate of 0.5 inches/hour, not appropriate at sites with Hydrologic Soil Types C and D.
- If infiltration rates exceed 2.4 inches/hour, then the runoff should be fully treated prior to infiltration to protect groundwater quality.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils.
- Upstream drainage area must be completely stabilized before construction.
- Difficult to restore functioning of infiltration basins once clogged.

Design and Sizing Guidelines

- Water quality volume determined by local requirements or sized so that 85% of the annual runoff volume is captured.
- Basin sized so that the entire water quality volume is infiltrated within 48 hours.
- Vegetation establishment on the basin floor may help reduce the clogging rate.

Construction/Inspection Considerations

- Before construction begins, stabilize the entire area draining to the facility. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction or remove the top 2 inches of soil after the site is stabililized. Stabilize the entire contributing drainage area, including the side slopes, before allowing any runoff to enter once construction is complete.
- Place excavated material such that it can not be washed back into the basin if a storm occurs during construction of the facility.
- Build the basin without driving heavy equipment over the infiltration surface. Any equipment driven on the surface should have extra-wide ("low pressure") tires. Prior to any construction, rope off the infiltration area to stop entrance by unwanted equipment.
- After final grading, till the infiltration surface deeply.
- Use appropriate erosion control seed mix for the specific project and location.

Performance

As water migrates through porous soil and rock, pollutant attenuation mechanisms include precipitation, sorption, physical filtration, and bacterial degradation. If functioning properly, this approach is presumed to have high removal efficiencies for particulate pollutants and moderate removal of soluble pollutants. Actual pollutant removal in the subsurface would be expected to vary depending upon site-specific soil types. This technology eliminates discharge to surface waters except for the very largest storms; consequently, complete removal of all stormwater constituents can be assumed.

There remain some concerns about the potential for groundwater contamination despite the findings of the NURP and Nightingale (1975; 1987a,b,c; 1989). For instance, a report by Pitt et al. (1994) highlighted the potential for groundwater contamination from intentional and unintentional stormwater infiltration. That report recommends that infiltration facilities not be sited in areas where high concentrations are present or where there is a potential for spills of toxic material. Conversely, Schroeder (1995) reported that there was no evidence of groundwater impacts from an infiltration basin serving a large industrial catchment in Fresno, CA.

Siting Criteria

The key element in siting infiltration basins is identifying sites with appropriate soil and hydrogeologic properties, which is critical for long term performance. In one study conducted in Prince George's County, Maryland (Galli, 1992), all of the infiltration basins investigated clogged within 2 years. It is believed that these failures were for the most part due to allowing infiltration at sites with rates of less than 0.5 in/hr, basing siting on soil type rather than field infiltration tests, and poor construction practices that resulted in soil compaction of the basin invert.

A study of 23 infiltration basins in the Pacific Northwest showed better long-term performance in an area with highly permeable soils (Hilding, 1996). In this study, few of the infiltration basins had failed after 10 years. Consequently, the following guidelines for identifying appropriate soil and subsurface conditions should be rigorously adhered to.

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30% clay or more than 40% of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.

- Groundwater separation should be at least 3 m from the basin invert to the measured ground water elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.

- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15% should not be considered.

- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

- Base flow should not be present in the tributary watershed.

Secondary Screening Based on Site Geotechnical Investigation

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.

- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.

- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.

- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Additional Design Guidelines

(1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.

(2) Provide pretreatment if sediment loading is a maintenance concern for the basin.

(3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.

(4) Basin invert area should be determined by the equation:

$$A = \frac{WQV}{kt}$$

where A = Basin invert area (m^2)

WQV = water quality volume (m^3)

k = 0.5 times the lowest field-measured hydraulic conductivity (m/hr)

t = drawdown time (48 hr)

(5) The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).

Maintenance

Regular maintenance is critical to the successful operation of infiltration basins. Recommended operation and maintenance guidelines include:

- Inspections and maintenance to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.
- Observe drain time for the design storm after completion or modification of the facility to confirm that the desired drain time has been obtained.
- Schedule semiannual inspections for beginning and end of the wet season to identify potential problems such as erosion of the basin side slopes and invert, standing water, trash and debris, and sediment accumulation.
- Remove accumulated trash and debris in the basin at the start and end of the wet season.
- Inspect for standing water at the end of the wet season.
- Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin.
- If erosion is occurring within the basin, revegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established.
- To avoid reversing soil development, scarification or other disturbance should only be performed when there are actual signs of clogging, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a very light tractor.

Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about $2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about $18/ft^3 for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

Infiltration basins typically consume about 2 to 3% of the site draining to them, which is relatively small. Additional space may be required for buffer, landscaping, access road, and fencing. Maintenance costs are estimated at 5 to 10% of construction costs.

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly maintained, infiltration basins have a high failure rate. Thus, it may be necessary to replace the basin with a different technology after a relatively short period of time.

References and Sources of Additional Information

Caltrans, 2002, BMP Retrofit Pilot Program Proposed Final Report, Rpt. CTSW-RT-01-050, California Dept. of Transportation, Sacramento, CA.

Galli, J. 1992. *Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland*. Metropolitan Washington Council of Governments, Washington, DC.

Hilding, K. 1996. Longevity of infiltration basins assessed in Puget Sound. *Watershed Protection Techniques* 1(3):124–125.

Maryland Department of the Environment (MDE). 2000. *Maryland Stormwater Design Manual*. http://www.mde.state.md.us/environment/wma/stormwatermanual. Accessed May 22, 2002.

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.

Nightingale, H.I., 1975, "Lead, Zinc, and Copper in Soils of Urban Storm-Runoff Retention Basins," American Water Works Assoc. Journal. Vol. 67, p. 443-446.

Nightingale, H.I., 1987a, "Water Quality beneath Urban Runoff Water Management Basins," Water Resources Bulletin, Vol. 23, p. 197-205.

Nightingale, H.I., 1987b, "Accumulation of As, Ni, Cu, and Pb in Retention and Recharge Basin Soils from Urban Runoff," Water Resources Bulletin, Vol. 23, p. 663-672.

Nightingale, H.I., 1987c, "Organic Pollutants in Soils of Retention/Recharge Basins Receiving Urban Runoff Water," Soil Science Vol. 148, pp. 39-45.

Nightingale, H.I., Harrison, D., and Salo, J.E., 1985, "An Evaluation Technique for Ground-water Quality Beneath Urban Runoff Retention and Percolation Basins," Ground Water Monitoring Review, Vol. 5, No. 1, pp. 43-50.

Oberts, G. 1994. Performance of Stormwater Ponds and Wetlands in Winter. *Watershed Protection Techniques* 1(2): 64–68.

Pitt, R., et al. 1994, *Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration*, EPA/600/R-94/051, Risk Reduction Engineering Laboratory, U.S. EPA, Cincinnati, OH.

Schueler, T. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC.

Schroeder, R.A., 1995, *Potential For Chemical Transport Beneath a Storm-Runoff Recharge (Retention) Basin for an Industrial Catchment in Fresno, CA*, USGS Water-Resource Investigations Report 93-4140.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1983, *Results of the Nationwide Urban Runoff Program: Volume 1 – Final Report*, WH-554, Water Planning Division, Washington, DC.

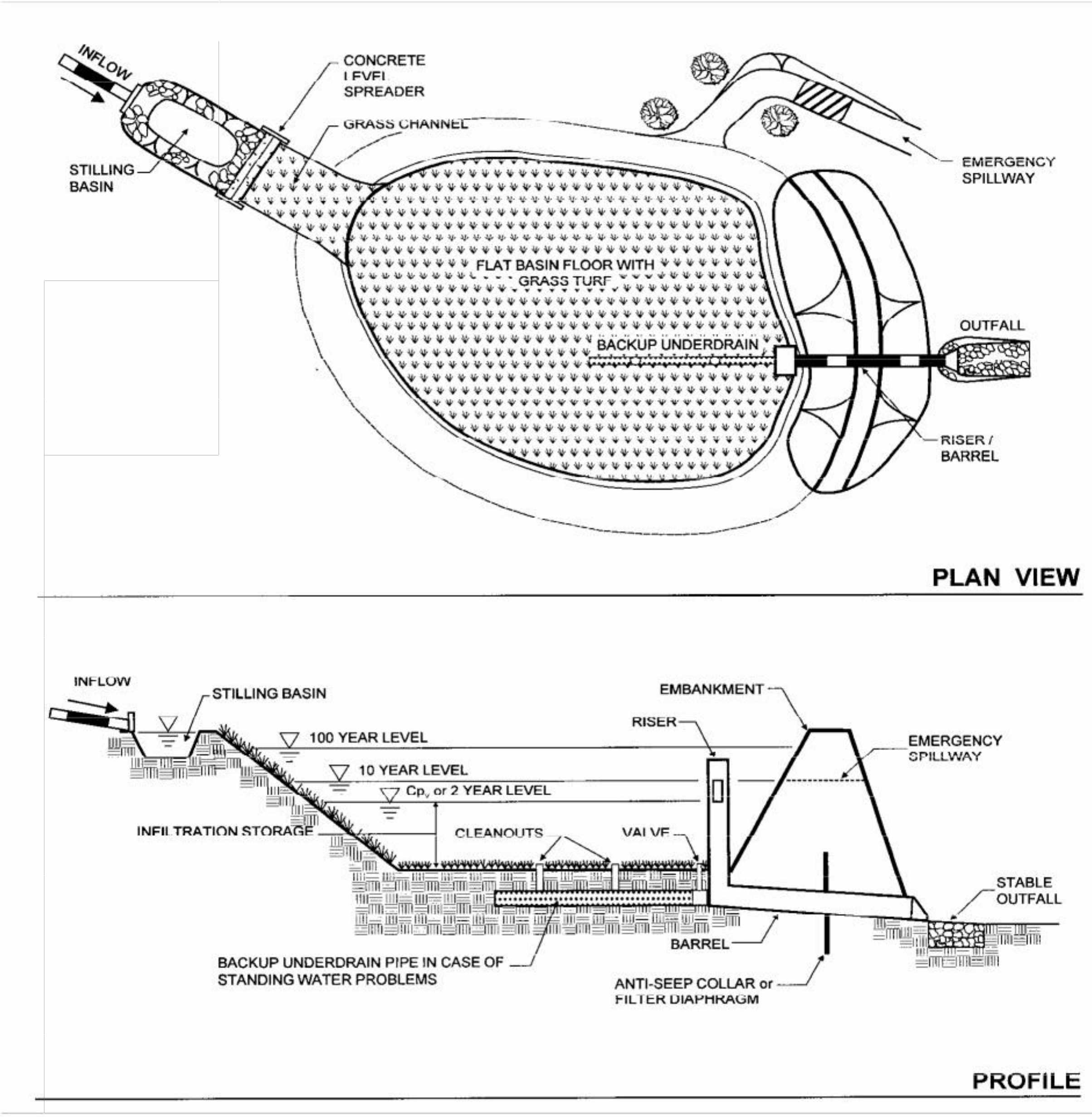
Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency Office of Water, Washington, DC.

Information Resources

Center for Watershed Protection (CWP). 1997. *Stormwater BMP Design Supplement for Cold Climates*. Prepared for U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds. Washington, DC.

Ferguson, B.K., 1994. *Stormwater Infiltration*. CRC Press, Ann Arbor, MI.

USEPA. 1993. *Guidance to Specify Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.


INFLOW
CONCRETE LEVEL SPREADER
GRASS CHANNEL
STILLING BASIN
EMERGENCY SPILLWAY
FLAT BASIN FLOOR WITH GRASS TURF
OUTFALL
BACKUP UNDERDRAIN
RISER / BARREL
PLAN VIEW
INFLOW
STILLING BASIN
EMBANKMENT
RISER
100 YEAR LEVEL
10 YEAR LEVEL
Cp, or 2 YEAR LEVEL
EMERGENCY SPILLWAY
INFILTRATION STORAGE
CLEANOUTS
VALVE
STABLE OUTFALL
BARREL
BACKUP UNDERDRAIN PIPE IN CASE OF STANDING WATER PROBLEMS
ANTI-SEEP COLLAR or FILTER DIAPHRAGM
PROFILE

Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.
- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	■
☑	Metals	▲
☑	Bacteria	▲
☑	Oil and Grease	▲
☑	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

relationships resulting from the increase of impervious cover in a watershed.

Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).
- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.
- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.
- Outlet designed to discharge the capture volume over a period of hours.
- Length to width ratio of at least 1.5:1 where feasible.
- Basin depths optimally range from 2 to 5 feet.
- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.
- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.
- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.
- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

Figure 1
Example of Extended Detention Outlet Structure

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

Summary of Design Recommendations

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

The discharge through a control orifice is calculated from:

$$Q = CA(2gH-H_o)^{0.5}$$

where:
Q = discharge (ft^3/s)
C = orifice coefficient
A = area of the orifice (ft^2)
g = gravitational constant (32.2)
H = water surface elevation (ft)
H_o= orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to H_o. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

Cost

Construction Cost

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume (ft^3).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Maintenance Cost

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

Table 1 Estimated Average Annual Maintenance Effort

Activity	Labor Hours	Equipment & Material ($)	Cost
Inspections	4	7	183
Maintenance	49	126	2282
Vector Control	0	0	0
Administration	3	0	132
Materials	-	535	535
Total	**56**	**$668**	**$3,132**

References and Sources of Additional Information

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Prepared for Chesapeake Research Consortium. Edgewater, MD. Center for Watershed Protection. Ellicott City, MD.

Denver Urban Drainage and Flood Control District. 1992. *Urban Storm Drainage Criteria Manual—Volume 3: Best Management Practices*. Denver, CO.

Emmerling-Dinovo, C. 1995. Stormwater Detention Basins and Residential Locational Decisions. *Water Resources Bulletin 31(3)*: 515–521

Galli, J. 1990. *Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices*. Metropolitan Washington Council of Governments. Prepared for Maryland Department of the Environment, Baltimore, MD.

GKY, 1989, *Outlet Hydraulics of Extended Detention Facilities* for the Northern Virginia Planning District Commission.

MacRae, C. 1996. Experience from Morphological Research on Canadian Streams: Is Control of the Two-Year Frequency Runoff Event the Best Basis for Stream Channel Protection? In *Effects of Watershed Development and Management on Aquatic Ecosystems*. American Society of Civil Engineers. Edited by L. Roesner. Snowbird, UT. pp. 144–162.

Maryland Dept of the Environment, 2000, Maryland Stormwater Design Manual: Volumes 1 & 2, prepared by MDE and Center for Watershed Protection. http://www.mde.state.md.us/environment/wma/stormwatermanual/index.html

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.

Santana, F., J. Wood, R. Parsons, and S. Chamberlain. 1994. Control of Mosquito Breeding in Permitted Stormwater Systems. Prepared for Southwest Florida Water Management District, Brooksville, FL.

Schueler, T. 1997. Influence of Ground Water on Performance of Stormwater Ponds in Florida. *Watershed Protection Techniques* 2(4):525–528.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC.

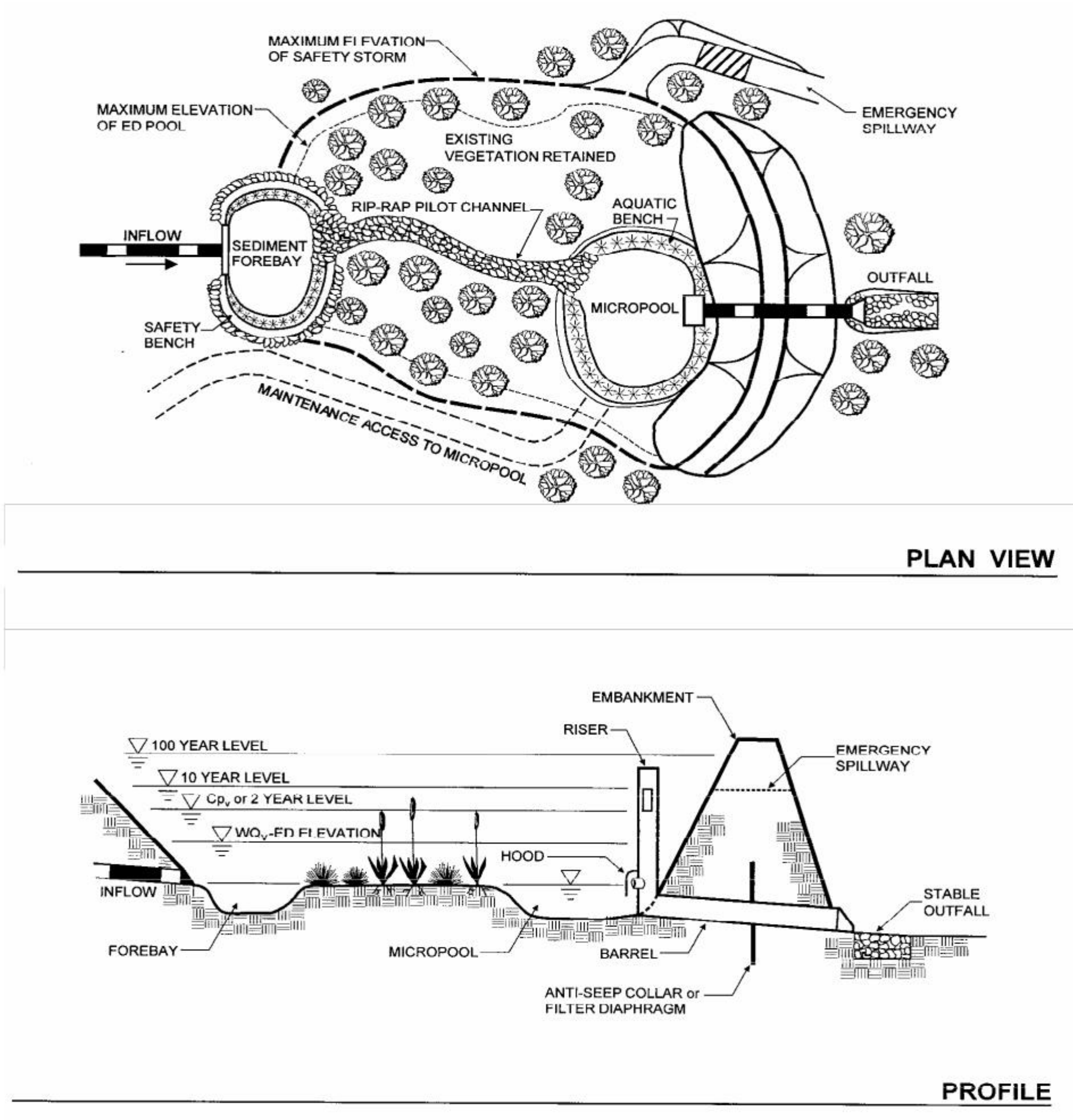
Young, G.K., et al., 1996, *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032, U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning.

Information Resources

Center for Watershed Protection (CWP), Environmental Quality Resources, and Loiederman Associates. 1997. *Maryland Stormwater Design Manual*. Draft. Prepared for Maryland Department of the Environment, Baltimore, MD.

Center for Watershed Protection (CWP). 1997. *Stormwater BMP Design Supplement for Cold Climates*. Prepared for U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. Washington, DC.

U.S. Environmental Protection Agency (USEPA). 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Schematic of an Extended Detention Basin (MDE, 2000)

NOAA Atlas 14, Volume 6, Version 2
Location name: Victorville, California, USA*
Latitude: 34.4907°, Longitude: -117.4051°
Elevation: 3231.43 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.078 (0.064-0.095)	0.112 (0.093-0.137)	0.158 (0.130-0.193)	0.195 (0.159-0.241)	0.245 (0.194-0.314)	0.284 (0.220-0.371)	0.324 (0.245-0.434)	0.365 (0.268-0.503)	0.421 (0.297-0.604)	0.465 (0.316-0.690)
10-min	0.112 (0.092-0.137)	0.161 (0.133-0.197)	0.226 (0.186-0.277)	0.279 (0.228-0.345)	0.352 (0.278-0.450)	0.408 (0.315-0.532)	0.465 (0.351-0.622)	0.524 (0.384-0.721)	0.604 (0.425-0.866)	0.666 (0.453-0.989)
15-min	0.135 (0.112-0.165)	0.195 (0.161-0.238)	0.273 (0.225-0.335)	0.338 (0.276-0.418)	0.425 (0.336-0.544)	0.493 (0.381-0.644)	0.562 (0.424-0.752)	0.633 (0.465-0.872)	0.730 (0.514-1.05)	0.805 (0.548-1.20)
30-min	0.203 (0.167-0.248)	0.292 (0.241-0.357)	0.410 (0.337-0.503)	0.506 (0.413-0.626)	0.637 (0.504-0.815)	0.739 (0.572-0.965)	0.843 (0.636-1.13)	0.949 (0.697-1.31)	1.10 (0.771-1.57)	1.21 (0.821-1.79)
60-min	0.271 (0.224-0.332)	0.391 (0.323-0.479)	0.549 (0.452-0.674)	0.678 (0.554-0.839)	0.854 (0.675-1.09)	0.990 (0.766-1.29)	1.13 (0.852-1.51)	1.27 (0.934-1.75)	1.47 (1.03-2.10)	1.62 (1.10-2.40)
2-hr	0.381 (0.315-0.465)	0.518 (0.428-0.634)	0.704 (0.580-0.864)	0.861 (0.703-1.07)	1.08 (0.855-1.39)	1.26 (0.974-1.65)	1.44 (1.09-1.93)	1.64 (1.20-2.26)	1.91 (1.35-2.74)	2.13 (1.45-3.17)
3-hr	0.478 (0.395-0.584)	0.638 (0.527-0.781)	0.860 (0.708-1.05)	1.05 (0.857-1.30)	1.32 (1.04-1.69)	1.54 (1.19-2.01)	1.77 (1.34-2.37)	2.02 (1.49-2.78)	2.38 (1.67-3.41)	2.67 (1.81-3.96)
6-hr	0.653 (0.540-0.798)	0.865 (0.714-1.06)	1.16 (0.957-1.43)	1.42 (1.16-1.76)	1.80 (1.42-2.30)	2.11 (1.63-2.76)	2.45 (1.85-3.27)	2.81 (2.07-3.87)	3.34 (2.36-4.80)	3.78 (2.58-5.62)
12-hr	0.814 (0.673-0.995)	1.12 (0.925-1.37)	1.55 (1.28-1.90)	1.93 (1.57-2.38)	2.47 (1.95-3.16)	2.93 (2.26-3.82)	3.41 (2.58-4.57)	3.95 (2.90-5.43)	4.72 (3.32-6.77)	5.36 (3.65-7.96)
24-hr	1.11 (0.985-1.28)	1.60 (1.41-1.84)	2.28 (2.01-2.63)	2.87 (2.51-3.34)	3.72 (3.16-4.48)	4.43 (3.68-5.45)	5.19 (4.20-6.54)	6.02 (4.74-7.80)	7.23 (5.46-9.75)	8.23 (6.01-11.5)
2-day	1.20 (1.06-1.38)	1.71 (1.51-1.97)	2.43 (2.15-2.81)	3.07 (2.69-3.57)	3.99 (3.39-4.81)	4.76 (3.95-5.86)	5.60 (4.53-7.05)	6.51 (5.13-8.44)	7.85 (5.93-10.6)	8.97 (6.55-12.5)
3-day	1.27 (1.13-1.47)	1.81 (1.60-2.08)	2.57 (2.27-2.97)	3.24 (2.83-3.77)	4.21 (3.57-5.07)	5.02 (4.17-6.18)	5.91 (4.78-7.44)	6.88 (5.42-8.91)	8.30 (6.28-11.2)	9.50 (6.94-13.3)
4-day	1.37 (1.22-1.58)	1.94 (1.72-2.23)	2.75 (2.43-3.17)	3.45 (3.02-4.02)	4.49 (3.80-5.41)	5.35 (4.44-6.58)	6.29 (5.09-7.92)	7.32 (5.76-9.48)	8.83 (6.67-11.9)	10.1 (7.38-14.1)
7-day	1.48 (1.32-1.71)	2.08 (1.84-2.40)	2.93 (2.59-3.38)	3.67 (3.21-4.27)	4.74 (4.02-5.71)	5.63 (4.67-6.92)	6.59 (5.34-8.30)	7.63 (6.01-9.89)	9.16 (6.92-12.4)	10.4 (7.61-14.6)
10-day	1.59 (1.41-1.83)	2.21 (1.96-2.55)	3.10 (2.74-3.58)	3.87 (3.39-4.51)	5.00 (4.23-6.02)	5.92 (4.91-7.28)	6.91 (5.60-8.70)	7.99 (6.29-10.3)	9.55 (7.22-12.9)	10.8 (7.92-15.1)
20-day	1.91 (1.70-2.20)	2.65 (2.35-3.06)	3.70 (3.27-4.28)	4.62 (4.04-5.38)	5.95 (5.04-7.16)	7.04 (5.84-8.65)	8.20 (6.64-10.3)	9.47 (7.46-12.3)	11.3 (8.52-15.2)	12.8 (9.32-17.8)
30-day	2.23 (1.98-2.57)	3.07 (2.72-3.54)	4.27 (3.77-4.94)	5.32 (4.66-6.20)	6.85 (5.80-8.24)	8.10 (6.72-9.95)	9.43 (7.64-11.9)	10.9 (8.56-14.1)	12.9 (9.77-17.5)	14.6 (10.7-20.4)
45-day	2.62 (2.32-3.01)	3.56 (3.16-4.11)	4.92 (4.34-5.68)	6.10 (5.34-7.11)	7.84 (6.64-9.43)	9.26 (7.69-11.4)	10.8 (8.74-13.6)	12.4 (9.79-16.1)	14.8 (11.2-19.9)	16.7 (12.2-23.3)
60-day	2.94 (2.61-3.39)	3.95 (3.50-4.56)	5.41 (4.78-6.25)	6.69 (5.86-7.79)	8.57 (7.26-10.3)	10.1 (8.40-12.4)	11.8 (9.54-14.8)	13.6 (10.7-17.6)	16.1 (12.2-21.7)	18.2 (13.3-25.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

mojave watershed.

Soil Map—San Bernardino County, California, Mojave River Area

Map Scale: 1:3,370 if printed on A landscape (11" x 8.5") sheet.

N

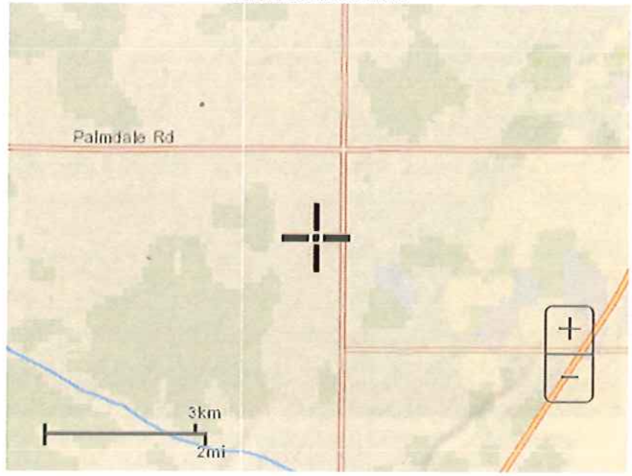
Meters: 0, 45, 90, 180, 270

Feet: 0, 150, 300, 600, 900

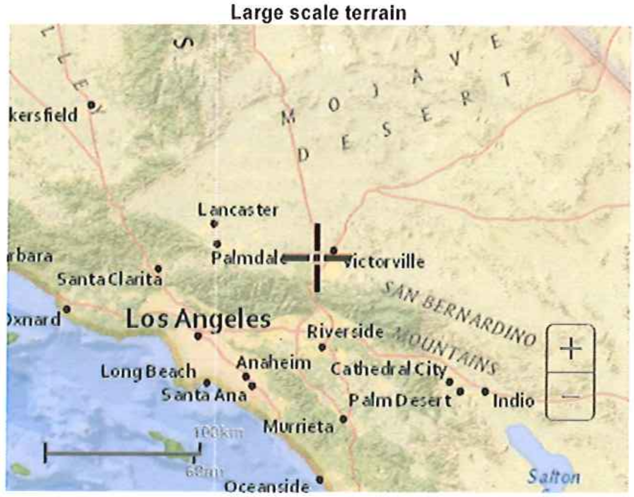
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

Maps & aerials

Small scale terrain



Large scale terrain



Large scale map

San Bernardino County, California, Mojave River Area

112—CAJON SAND, 0 TO 2 PERCENT SLOPES

Map Unit Setting

National map unit symbol: hkrj
Elevation: 1,800 to 3,200 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 66 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cajon and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cajon

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 7 inches: sand
H2 - 7 to 25 inches: sand
H3 - 25 to 45 inches: gravelly sand
H4 - 45 to 60 inches: stratified sand to loamy fine sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Sandy (R030XF012CA)
Hydric soil rating: No

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

Ex Condition → Barren

Prop. Condition → Residential

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (Continued)					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

Notes:

1. All curve numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:

   Poor-Heavily grazed, regularly burned areas, or areas of high burn potential. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.

   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Figure C-2 for definition of cover types.

ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent (2)
Natural or Agriculture	0 - 0	0
Public Park	10 - 25	15
School	30 - 50	40
Single Family Residential: (3)		
2.5 acre lots	5 - 15	10
1 acre lots	10 - 25	20
2 dwellings/acre	20 - 40	30
3-4 dwellings/acre	30 - 50	40
5-7 dwellings/acre	35 - 55	50
8-10 dwellings/acre	50 - 70	60
More than 10 dwellings/acre	65 - 90	80
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 - 100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.

2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area shall always be made, and a review of aerial photos, where available, may assist in estimating the percentage of impervious cover in developed areas.

3. For typical equestrian subdivisions increase impervious area 5 percent over the values recommended in the table above.

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

ACTUAL IMPERVIOUS COVER FOR DEVELOPED AREAS

C.5. ANTECEDENT MOISTURE CONDITION (AMC)

The definitions for the AMC classifications are:

AMC I: Lowest runoff potential. The watershed soils are dry enough to allow satisfactory grading or cultivation to take place.

AMC II: Moderate runoff potential; an average study condition.

AMC III: Highest runoff potential. The watershed is practically saturated from antecedent rains. Heavy rainfall or light rainfall and low temperatures have occurred within the last five days.

For runoff hydrograph studies based on this manual it is assumed that a low AMC index (high loss rates) will be used in developing short return period storms, and a moderate to high AMC index (low loss rates) will be used in developing longer return period storms (e.g., 100 year). For the purposes of design hydrology, AMC I will be used for the 2- and 5-year return frequency storms. For the case of 10-, 25-, 50-year return frequency design storms, AMC II will be used. For 100-year storm analysis, AMC III shall be used. In detention basin design studies, AMC III conditions shall be considered in order to identify any downstream flooding potential.

C.5.1. Adjustment of Curve Numbers (CN) for AMC

The CN values selected for a particular soil cover type and quality also depend upon the AMC condition assumed. The CN values listed in Figure C-3 correspond to AMC II and require adjustment in order to represent either AMC I or AMC III. Table C.1 provides the necessary CN adjustments to account for AMC changes for hydrologic studies in San Bernardino County.

TABLE C.1. CURVE NUMBER RELATIONSHIPS

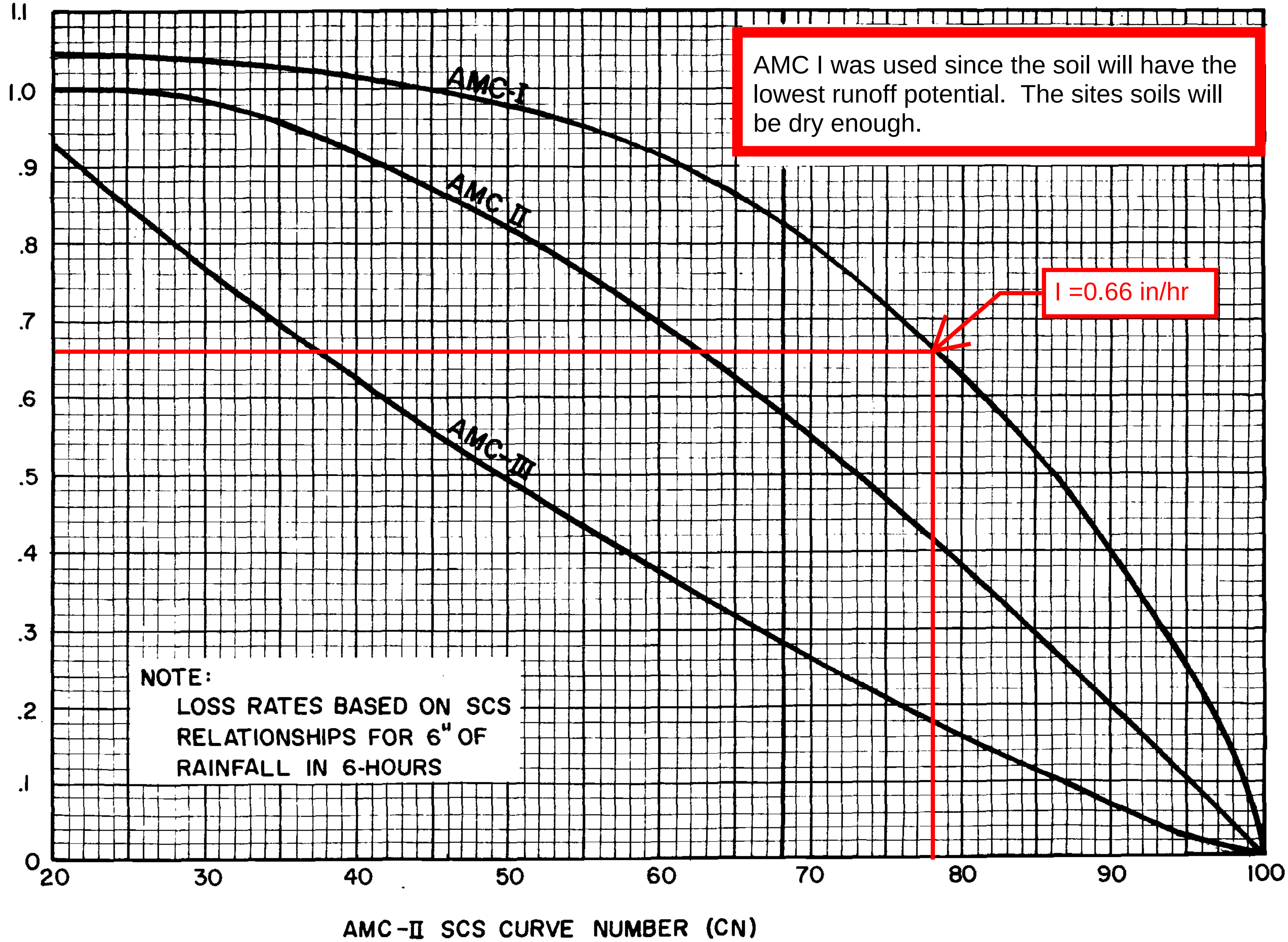
CN for AMC Condition II	Corresponding CN for AMC Condition I	III
100	100	100
95	87	99
90	78	98
85	70	97
80	63	94
75	57	91
70	51	87
65	45	83
60	40	79
55	35	75
50	31	70
45	27	65
40	23	60
35	19	55
30	15	50
25	12	45
20	9	39
15	7	33
10	4	26
5	2	17
0	0	0

C.6. ESTIMATION OF LOSS RATES

In estimating loss rates for design hydrology, a watershed curve number (CN) is determined for each soil-cover complex within the watershed using Figure C-3. The working range of CN values is between 0 and 98, where a low CN indicates low runoff potential (high infiltration), and a high CN indicates high runoff potential (low infiltration). Selection of a CN takes into account the major factors affecting loss rates on pervious surfaces including the hydrologic soil group, cover type and quality, and antecedent moisture condition (AMC).

Also included in the CN selection are the effects of "initial abstraction" (Ia) which represents the combined effects of other effective rainfall losses including depression storage, vegetation interception, evaporation, and transpiration, among other factors.

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL



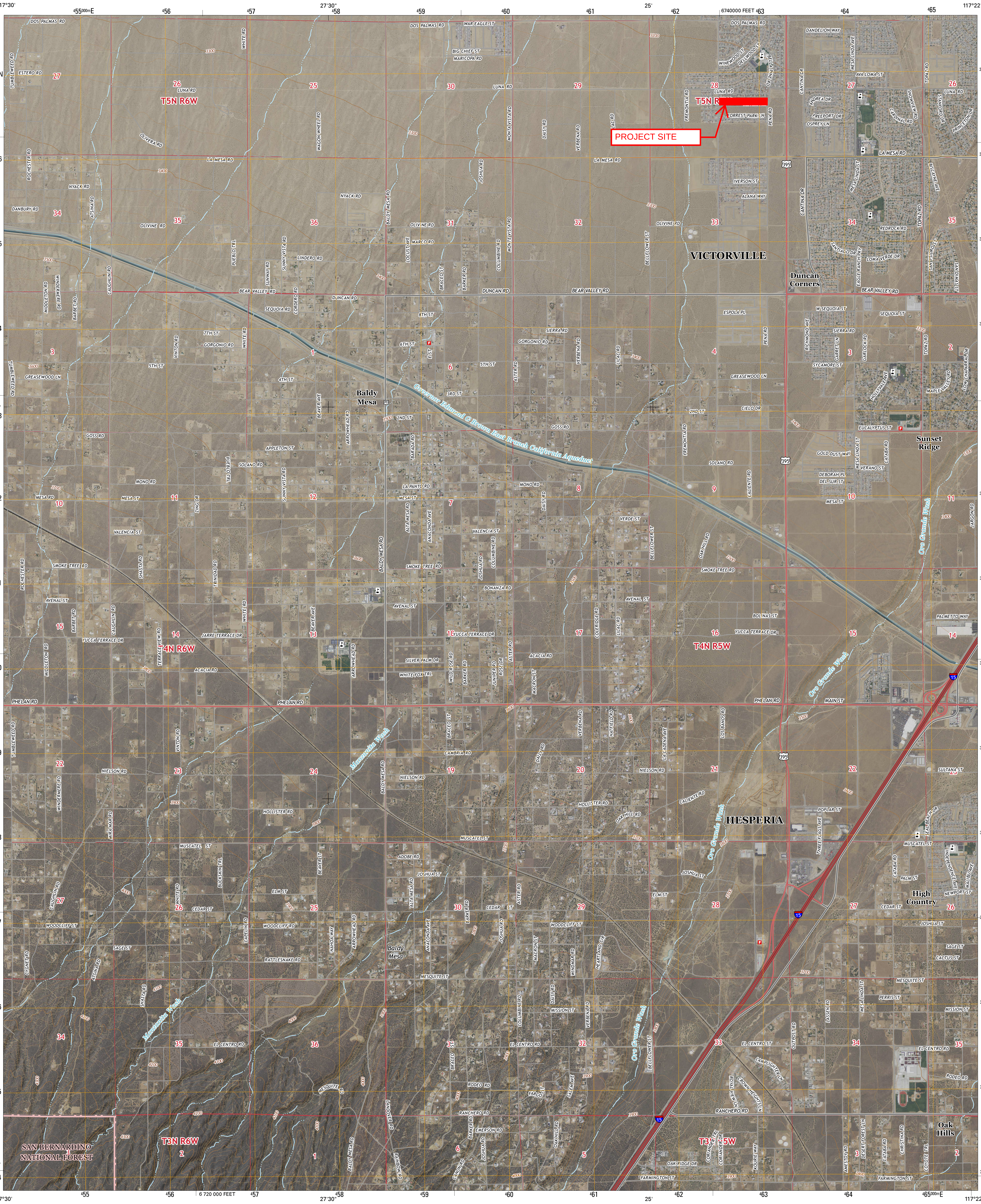
INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
US Topo

BALDY MESA QUADRANGLE
CALIFORNIA-SAN BERNARDINO CO.
7.5-MINUTE SERIES



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and 1 000-meter grid: Universal Transverse Mercator, Zone 11S
10 000-foot ticks: California Coordinate System of 1983 (zone 5)

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery ... NAIP, April 2012
Roads ... HERE, ©2013 - 2014
Roads within US Forest Service Lands ... FSTopo Data with limited Forest Service updates, 2012 - 2015
Names ... GNIS, 2015
Hydrography ... National Hydrography Dataset, 2012
Contours ... National Elevation Dataset, 2000
Boundaries ... Multiple sources; see metadata file 1972 - 2015
Public Land Survey System ... BLM, 2011

UTM GRID AND 2015 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000-m Square ID
MU
Grid Zone Designation
11S

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.18

QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Shadow Mountains SE
2 Adelanto
3 Victorville
4 Phelan
5 Hesperia
6 Telegraph Peak
7 Cajon
8 Silverwood Lake

ROAD CLASSIFICATION
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route
FS Primary Route
FS Passenger Route
FS High Clearance Route

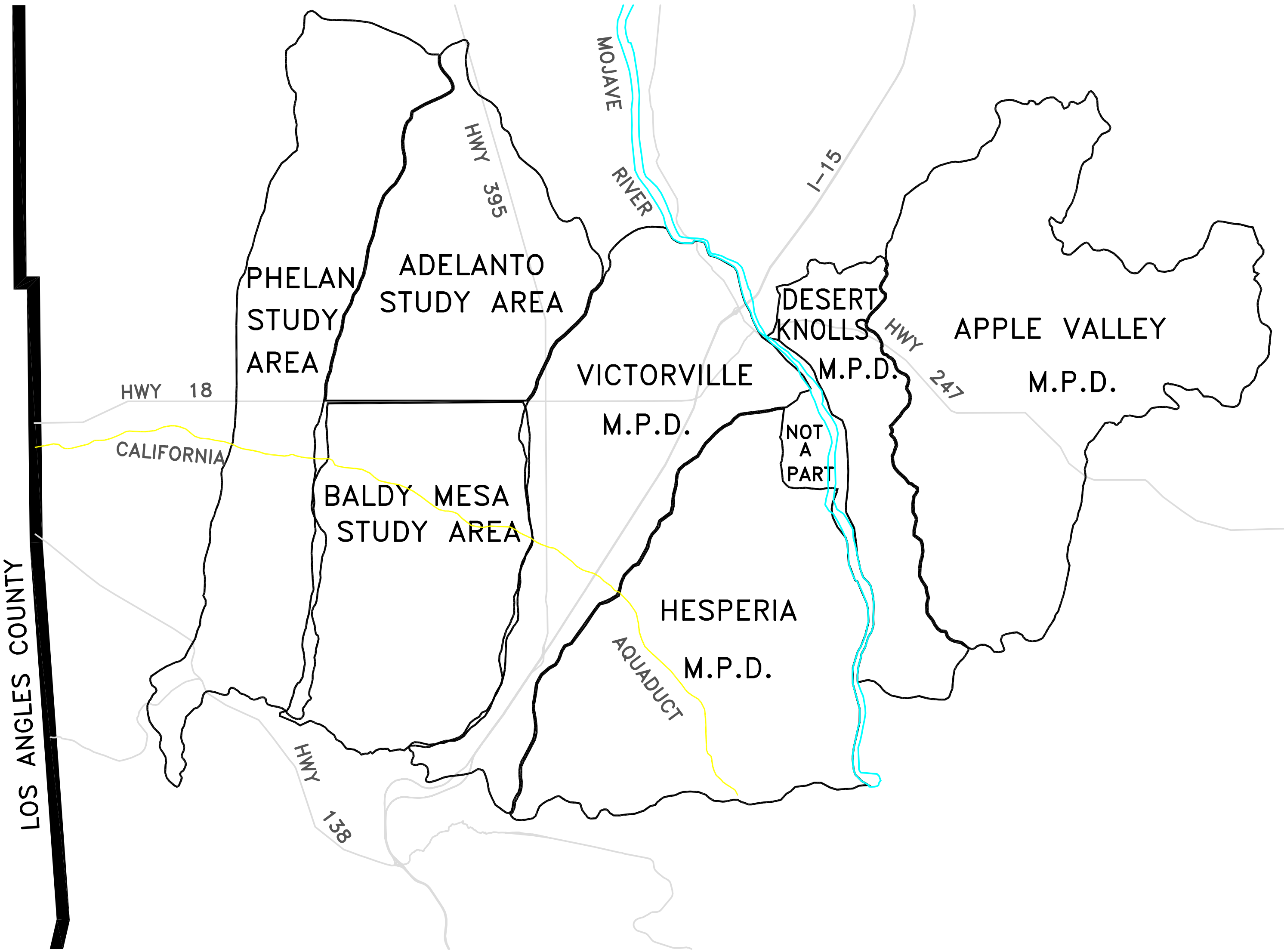
Check with local Forest Service unit for current travel conditions and restrictions.

BALDY MESA, CA
2015

NSN. 7643016355591
NGA REF NO. USGSX24K22247

STATISTICS

Area	20,105 Sq. Mi.
Width	210 Mi
Length	135 Mi
Max. Elev.	11,502 Ft.
Min. Elev.	Sea Level



SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT
HIGH DESERT VICTORVILLE AREA

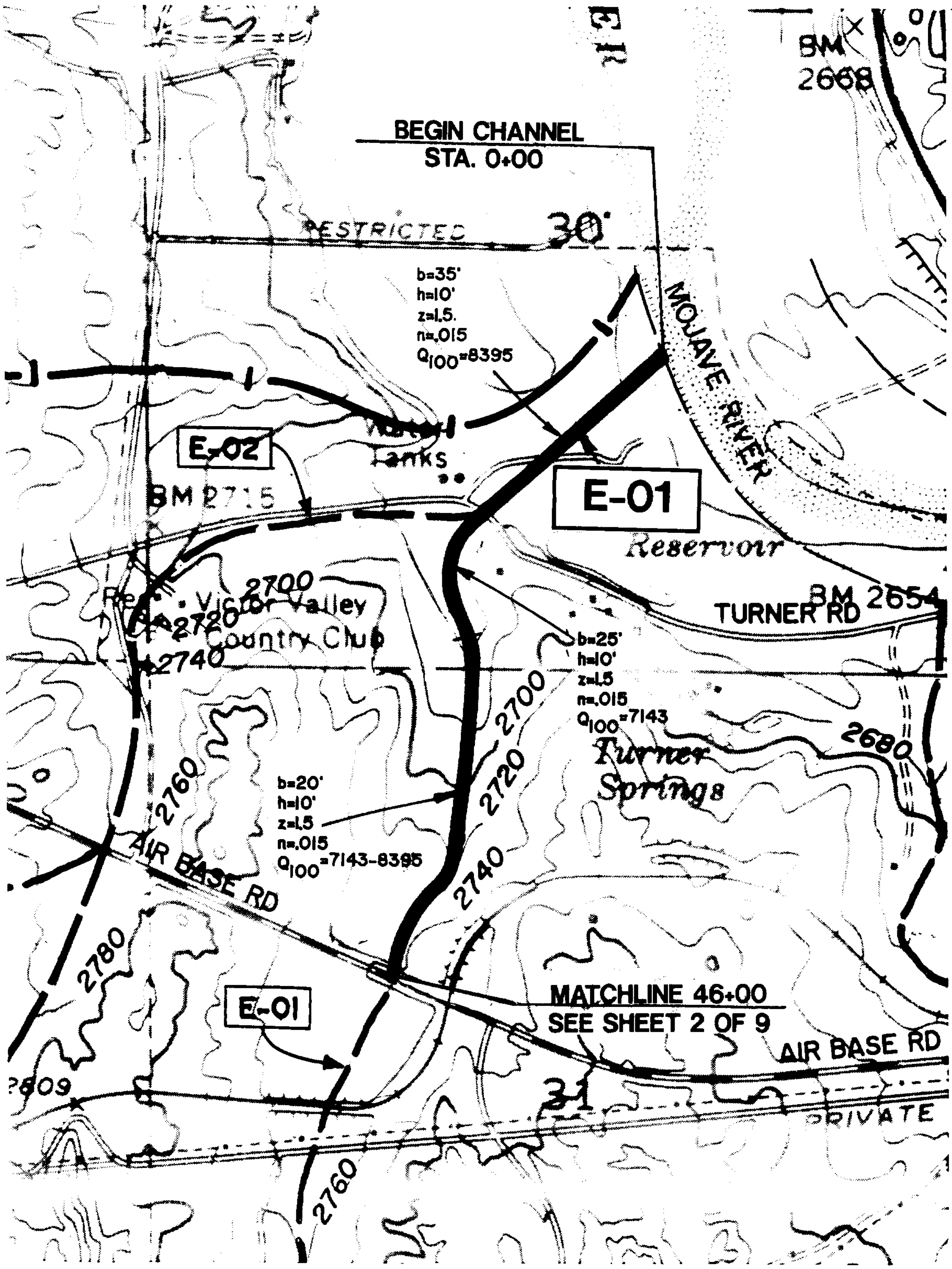
Line B-01. The existing earth channel requires additional excavation, levee construction, and concrete lining as determined by this master plan. There is an existing Mojave River levee that the proposed facility will have to drain through. The proposed containment levees for this facility will tie into the existing River levee, with the top of levee for each at the same elevation. The levees will be required from the floodway upstream to the E Street culvert. The 100-year flow depth in line B-01 is approximately two feet higher than the River at their confluence.

Line C-01. This analysis determined that the Mojave River floodplain in the vicinity of this facility extends to the Atchison, Topeka and Santa Fe Railroad. The proposed alignment takes flows to the Mojave River floodway and thus the entire 2000-foot reach of channel is located in the floodplain. Additionally, an existing at-grade culvert through the Railroad requires this entire facility to be leveed from the floodway upstream to the Railroad. This facility should have a very low priority as construction of the Mojave River levee must be completed before there is a need for this reach. The 100-year flow depth in line C-01 is approximately three feet below the depth of the River at their confluence. Although plans, profiles, and cost estimates are based on the channel extending to the floodway, it is recommended that the floodplain be maintained and the proposed facility end at the Railroad.

Line D-01. This facility requires a five-foot levee at its confluence with the Mojave River approximately 150 feet downstream of Turner Road. The levee requirements are gradually reduced to zero approximately 1050 feet upstream of Turner Road. This channel outlets to a smaller swale that parallels the Mojave River and eventually combines with the River to form a broader cross-section. The 100-year flow depth in line D-01 is almost five feet above the River flow depth at their confluence.

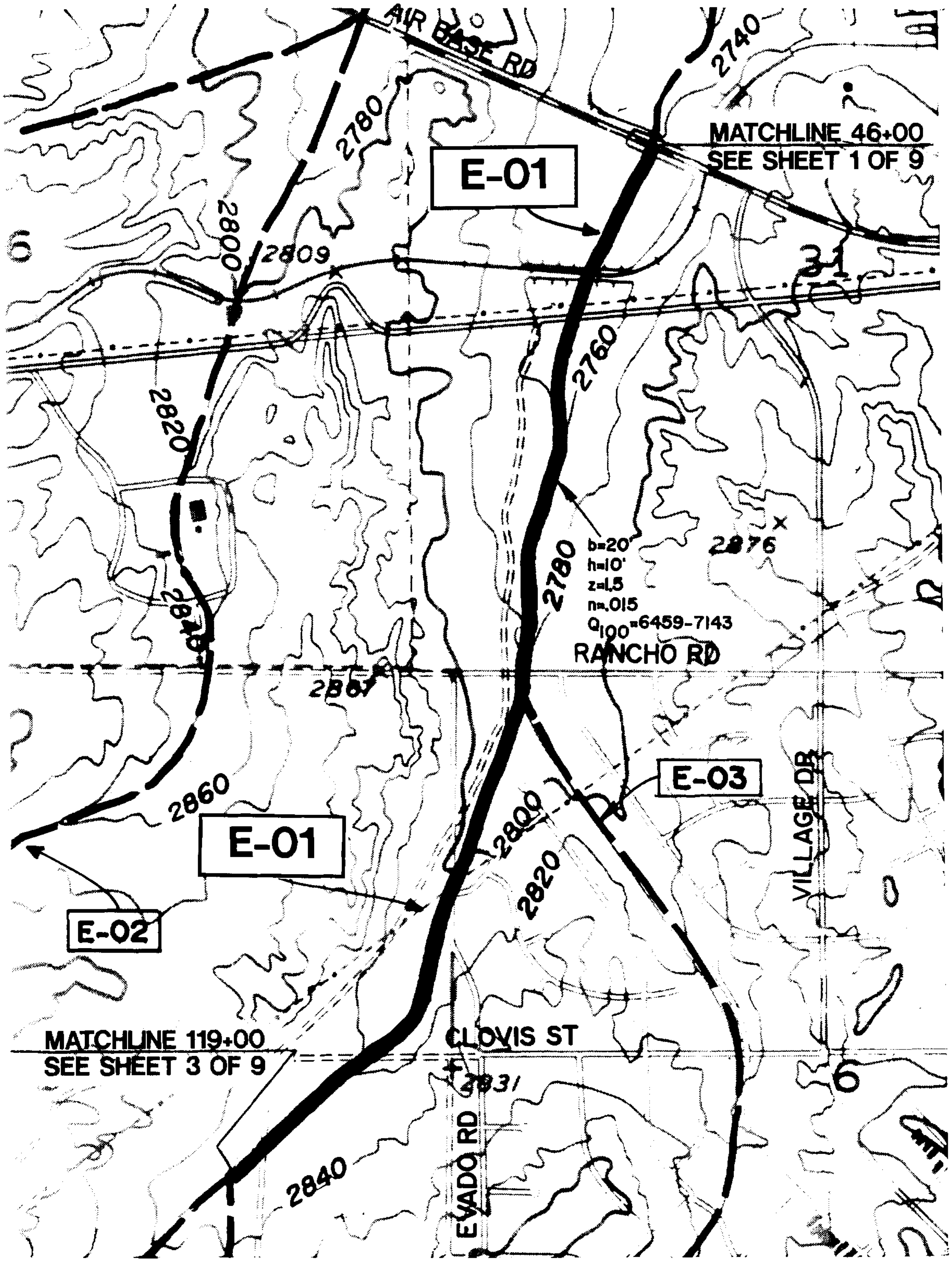
Line E-01. This facility is the only proposed regional outlet that will not require containment levees. The steep bank of the Mojave River near this outlet allows this facility to be excavated to the floodway. The 100-year flow depth in line E-01 is less than two feet above the flow depth of the River at their confluence.

Line F-01. This facility drains to an existing at-grade culvert through the Atchison, Topeka and Santa Fe Railroad. The existing culvert will need to be replaced with a larger one to insure that flows do not pond behind and possibly overtop the Railroad. A two-foot containment levee will be required upstream of the railroad to direct flows to the culvert. The 100-year flow depth in line F-01 is just over one foot above the flow depth of the River at their confluence.



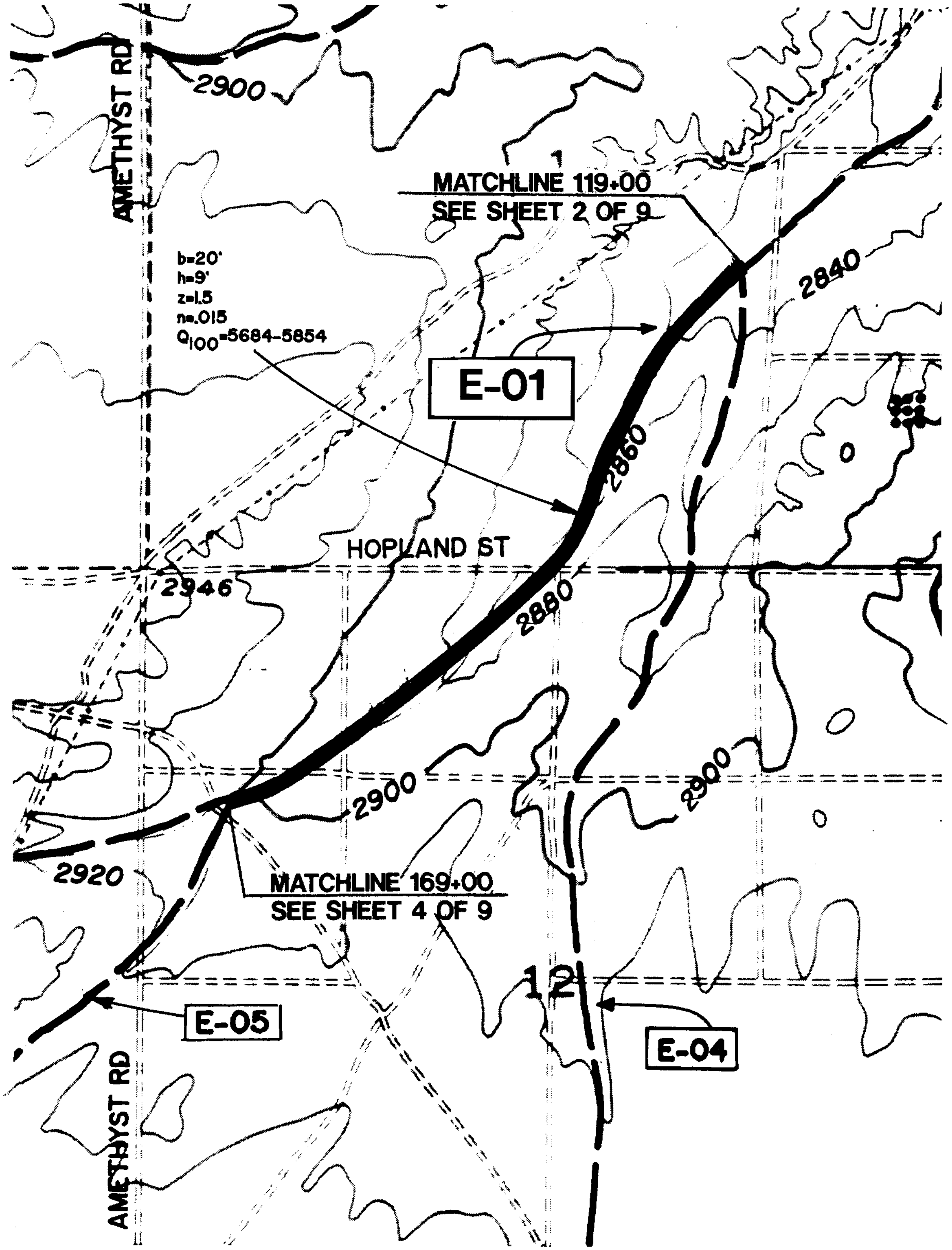
LEGEND			
	PROPOSED FACILITY		FLOODPLAIN
	FACILITY SHOWN ELSEWHERE		FLOODWAY
	WATERSHED BOUNDARY		DETENTION BASIN

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 1 OF 9	SCALE 1"=1000' WILLIAMSON & SCHMID



LEGEND		
	PROPOSED FACILITY	FLOODPLAIN
	FACILITY SHOWN ELSEWHERE	FLOODWAY
	WATERSHED BOUNDARY	DETENTION BASIN

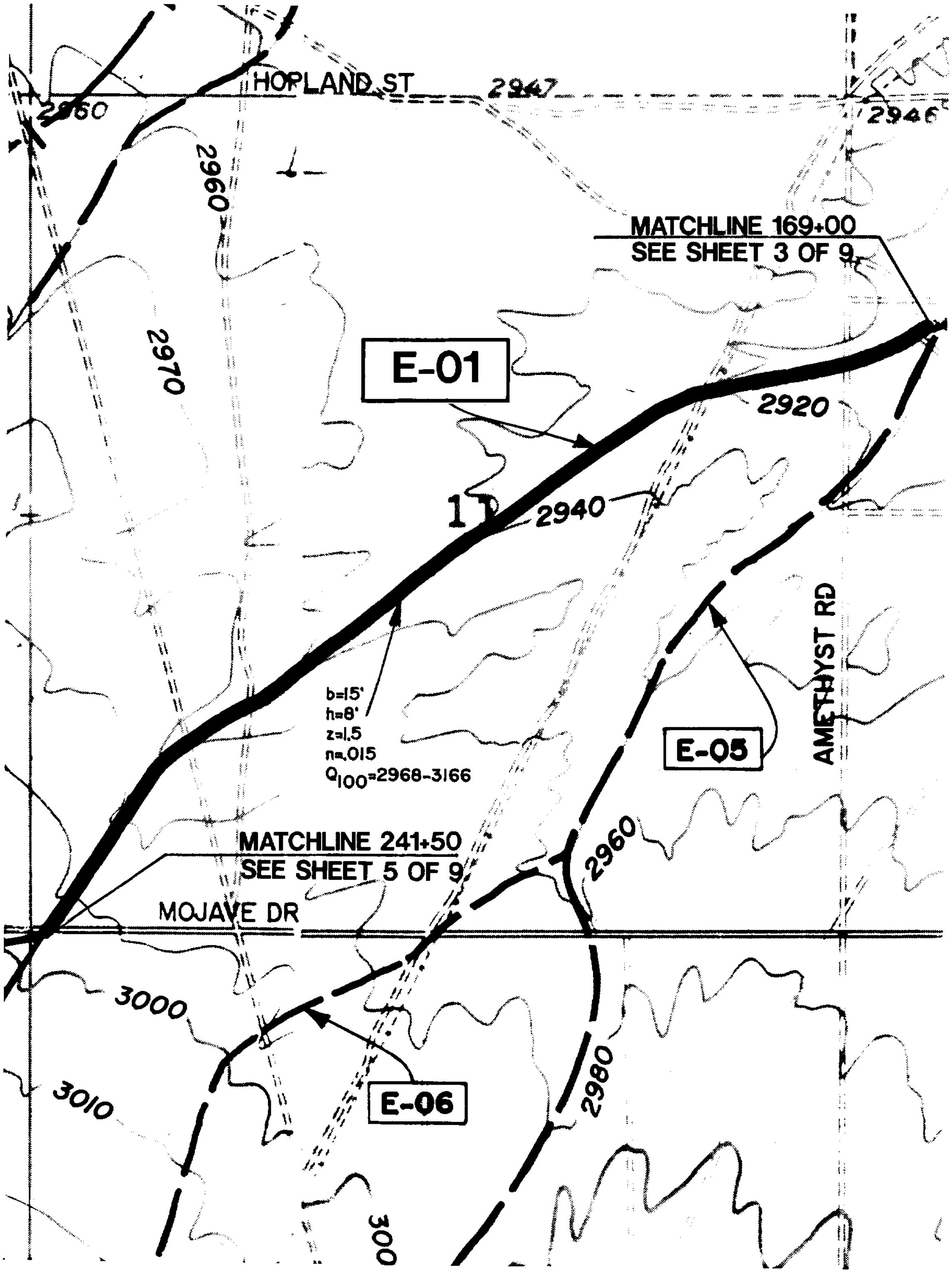
VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 2 OF 9	W S SCALE 1"=1000' WILLIAMSON & SCHMID



LEGEND

- PROPOSED FACILITY
- FACILITY SHOWN ELSEWHERE
- WATERSHED BOUNDARY
- FLOODPLAIN
- FLOODWAY
- DETENTION BASIN

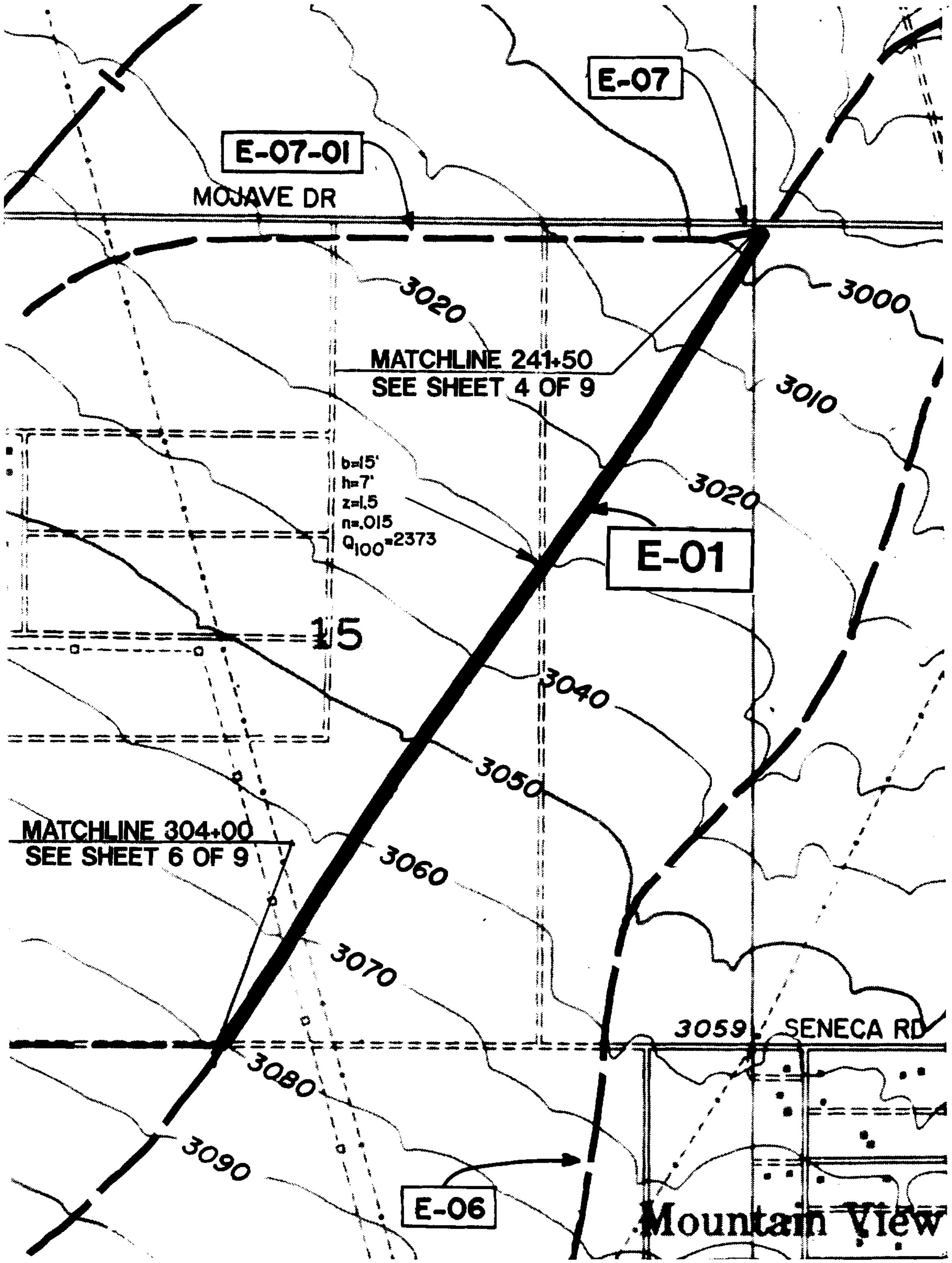
VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 3 OF 9	W S SCALE 1"=1000' WILLIAMSON & SCHMID



LEGEND

- PROPOSED FACILITY
- FACILITY SHOWN ELSEWHERE
- WATERSHED BOUNDARY
- FLOODPLAIN
- FLOODWAY
- DETENTION BASIN

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 4 OF 9	WS WILLIAMSON & SCHMID SCALE 1"=1000'



LEGEND

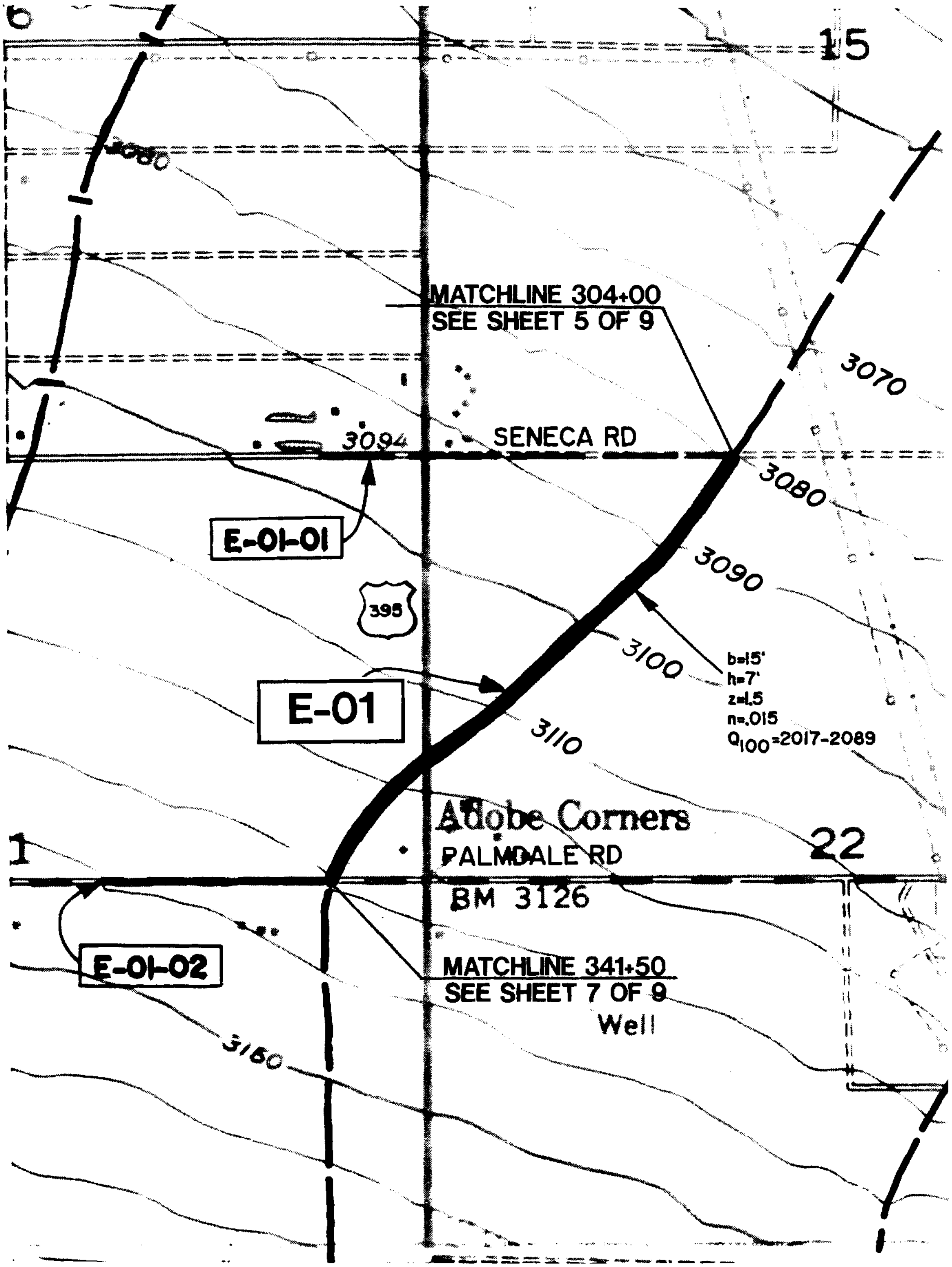
	PROPOSED FACILITY		FLOODPLAIN
	FACILITY SHOWN ELSEWHERE		FLOODWAY
	WATERSHED BOUNDARY		DETENTION BASIN

VICTORVILLE MASTER PLAN OF DRAINAGE

COMPREHENSIVE STORM DRAIN PLAN
LINE E-01
SHEET 5 OF 9

SCALE 1"=1000'

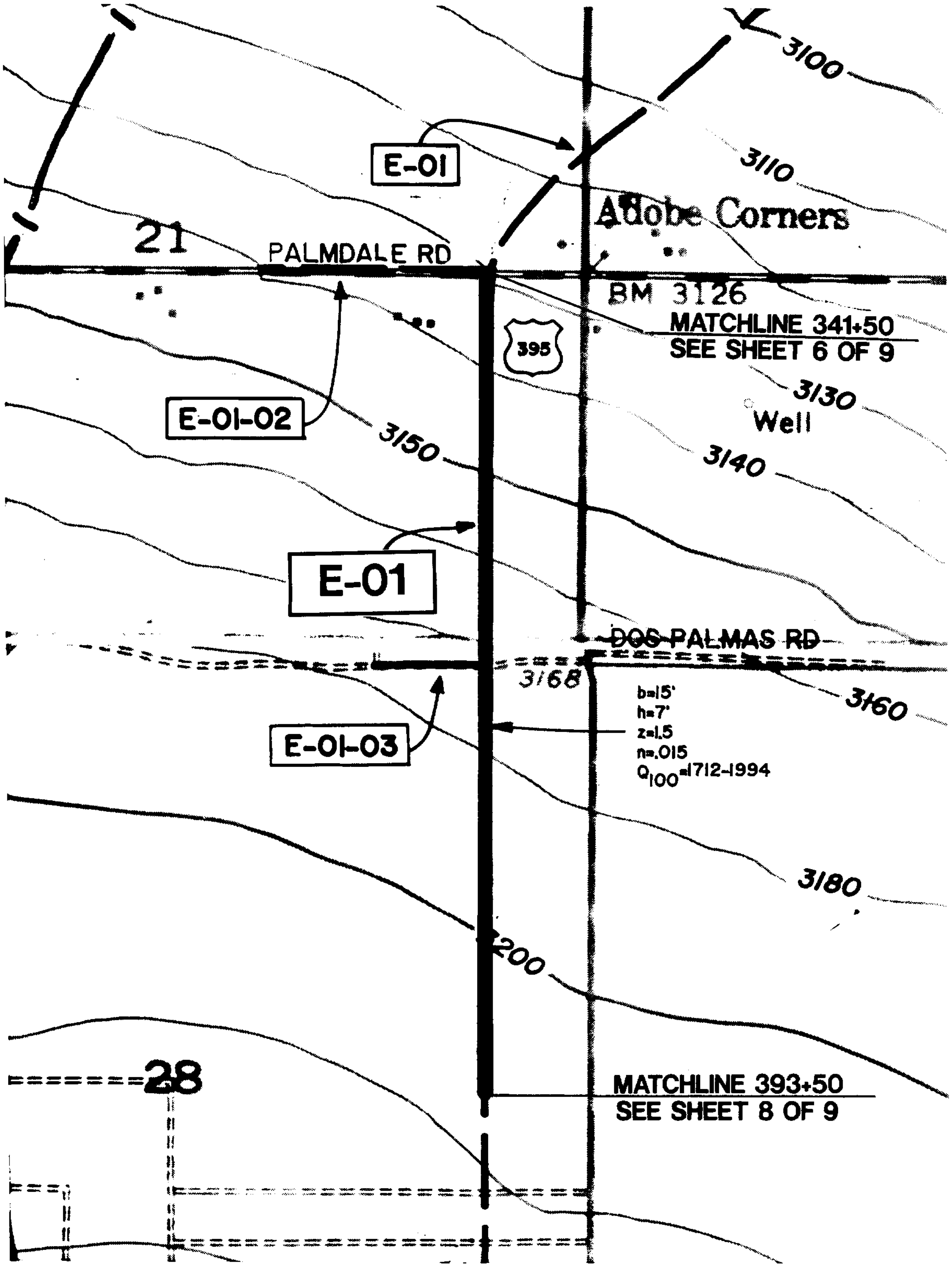
WILLIAMSON & SCHMID



LEGEND

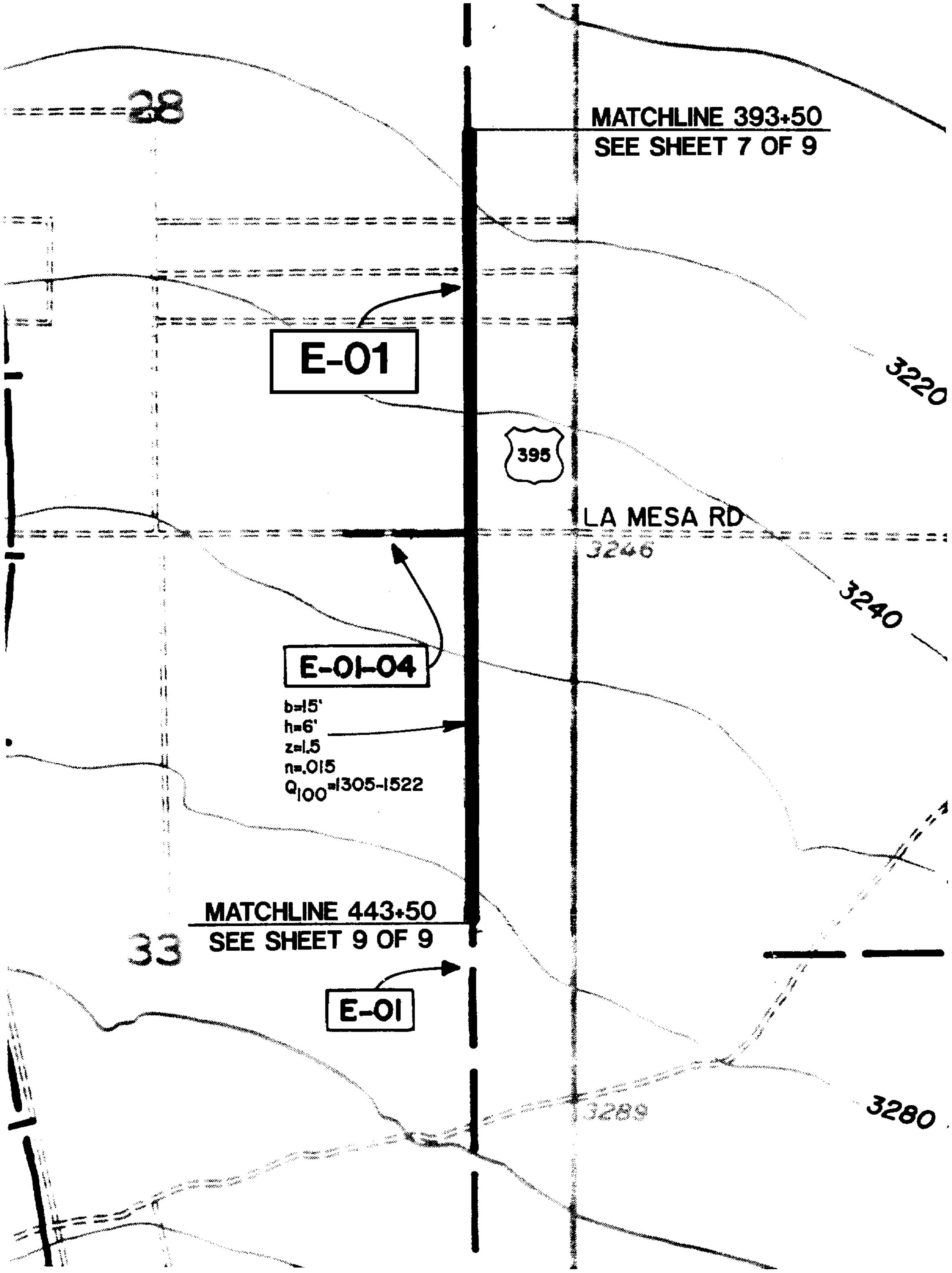
- PROPOSED FACILITY
- FACILITY SHOWN ELSEWHERE
- WATERSHED BOUNDARY
- FLOODPLAIN
- FLOODWAY
- DETENTION BASIN

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 6 OF 9	WS SCALE 1"=1000' WILLIAMSON & SCHMID



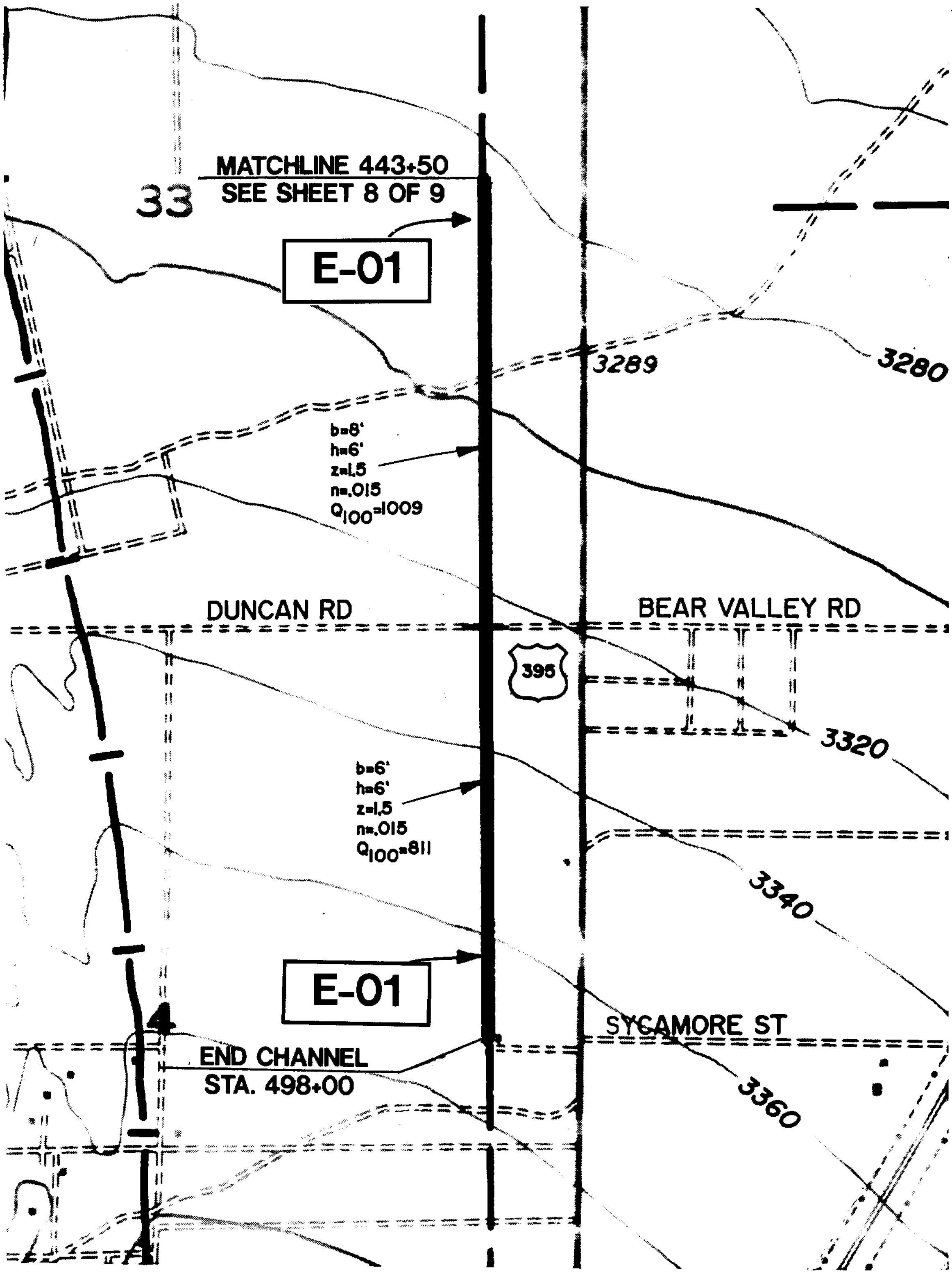
LEGEND		
PROPOSED FACILITY		FLOODPLAIN
FACILITY SHOWN ELSEWHERE		FLOODWAY
WATERSHED BOUNDARY		DETENTION BASIN

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 7 OF 9	SCALE 1"=1000' WILLIAMSON & SCHMID



LEGEND		
	PROPOSED FACILITY	FLOODPLAIN
	FACILITY SHOWN ELSEWHERE	FLOODWAY
	WATERSHED BOUNDARY	DETENTION BASIN

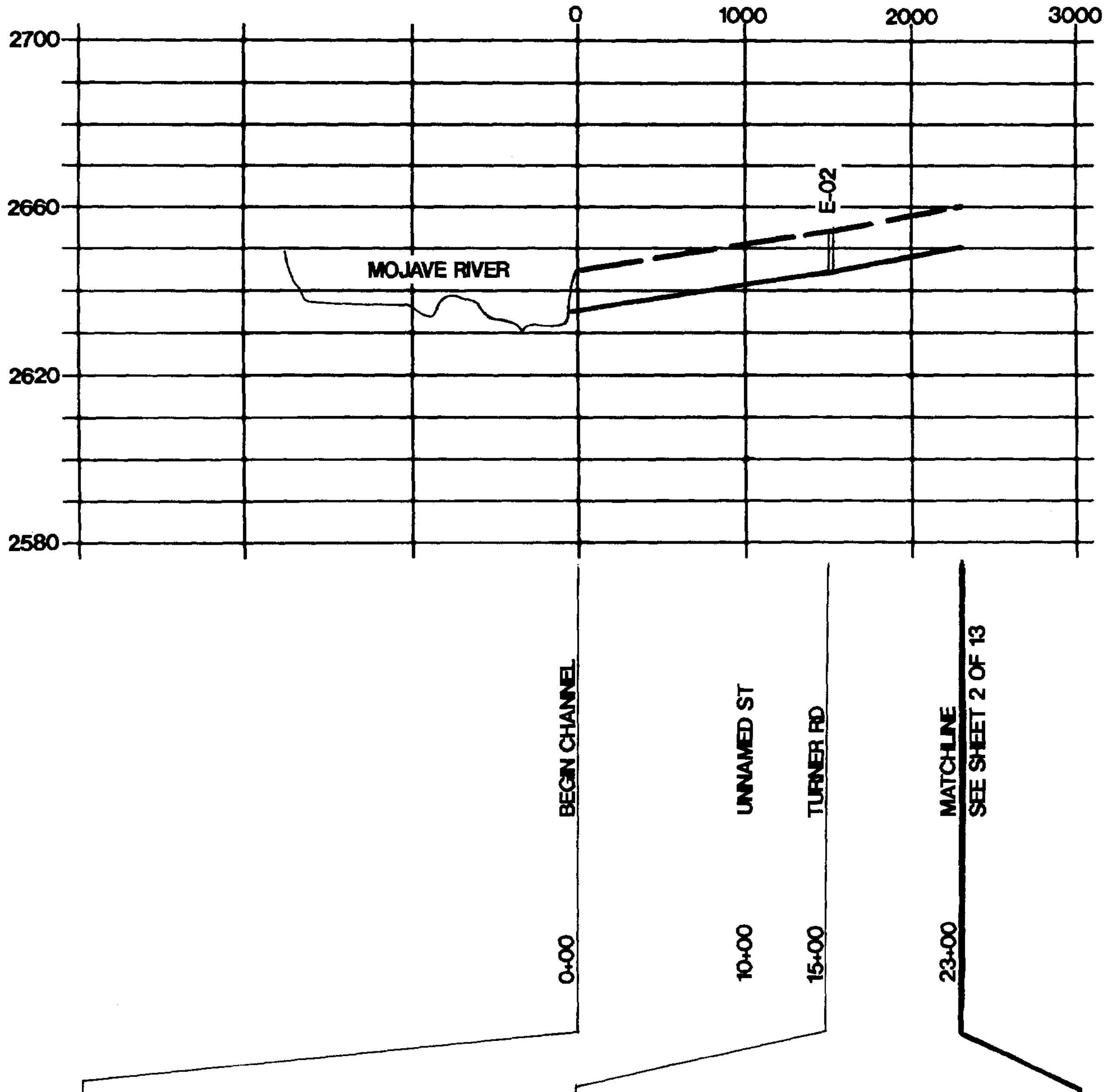
VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 8 OF 9	W S SCALE 1"=1000' WILLIAMSON & SCHMID



LEGEND

- PROPOSED FACILITY
- FACILITY SHOWN ELSEWHERE
- WATERSHED BOUNDARY
- FLOODPLAIN
- FLOODWAY
- DETENTION BASIN

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 9 OF 9	SCALE 1"=1000' WILLIAMSON & SCHMID



LENGTH	1500	800
SLOPE	.007	.009
FLOW	Q_{100}=8395	Q_{100}=7143
SIZE	b=35', h=10', z=1.5	b=25', h=10', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL	

LEGEND

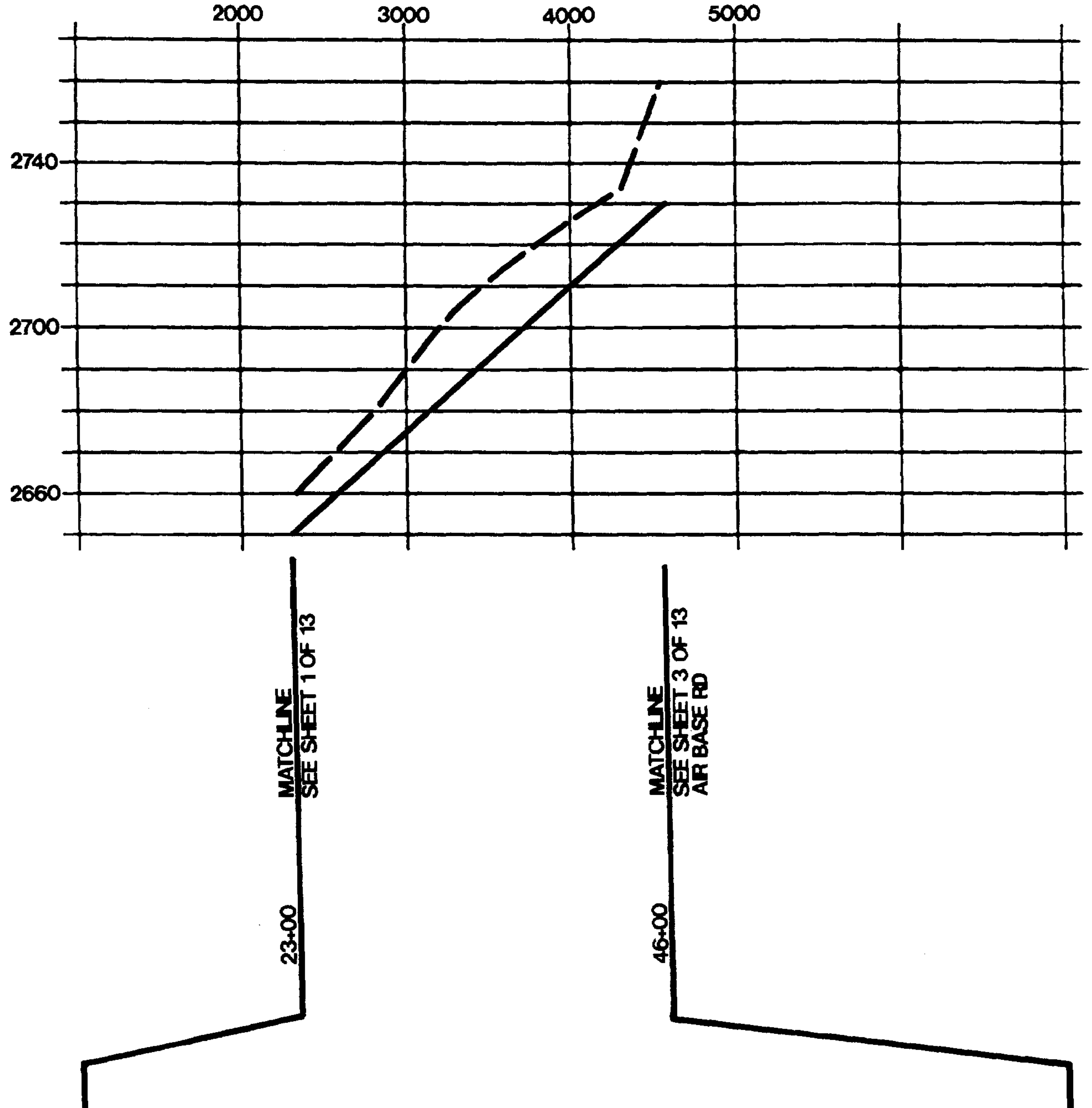
- - - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE

COMPREHENSIVE STORM DRAIN PLAN
LINE E-01
SHEET 1 OF 13

SCALE
H: 1"=1000'
V: 1"=40'

WILLIAMSON & SCHMID

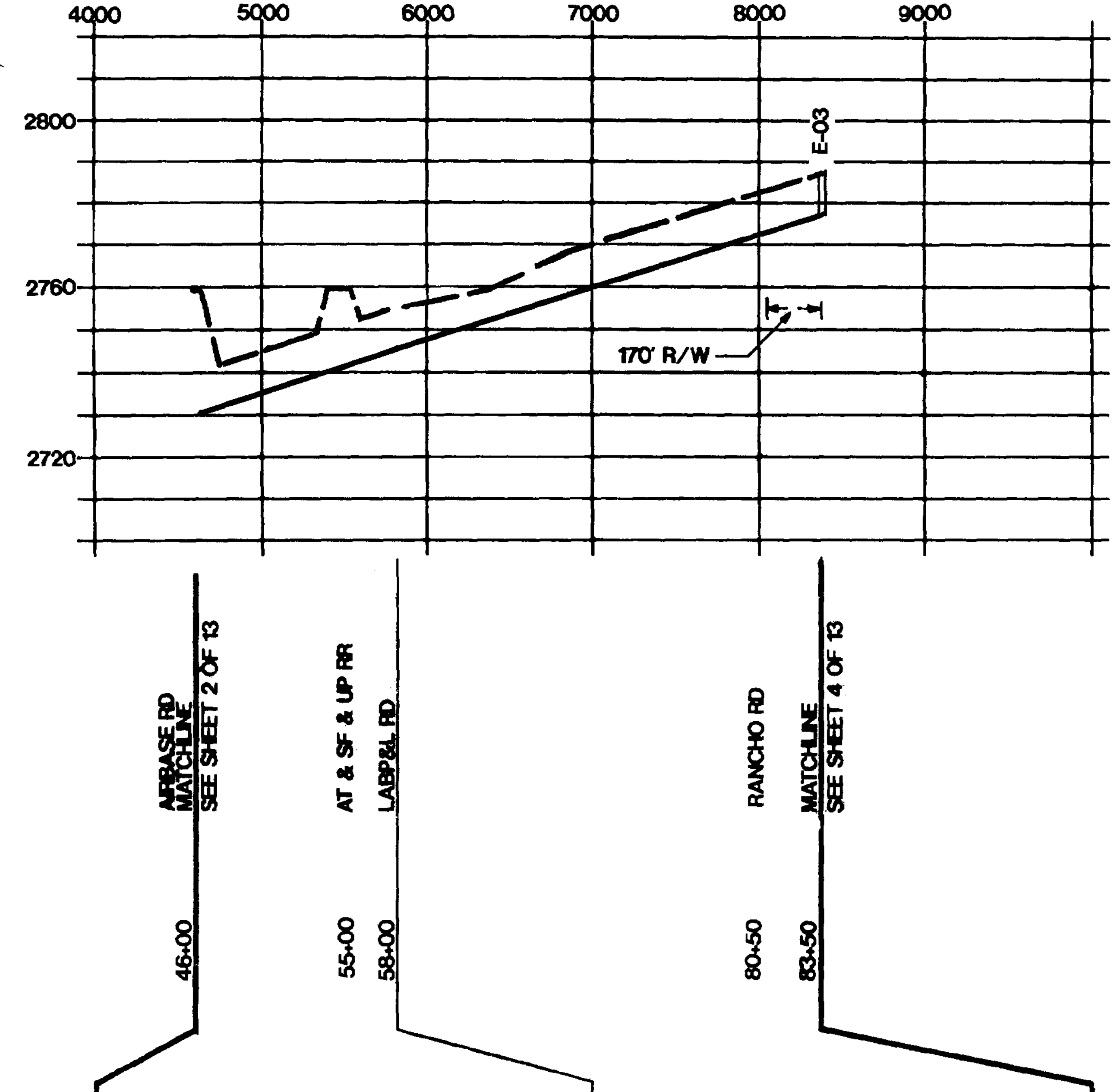


LENGTH	2300
SLOPE	.035
FLOW	Q_{100}=7143
SIZE	b=20', h=10', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL

LEGEND

- - - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 2 OF 13	W S WILLIAMSON & SCHMID SCALE H: 1"=1000' V: 1"=40'

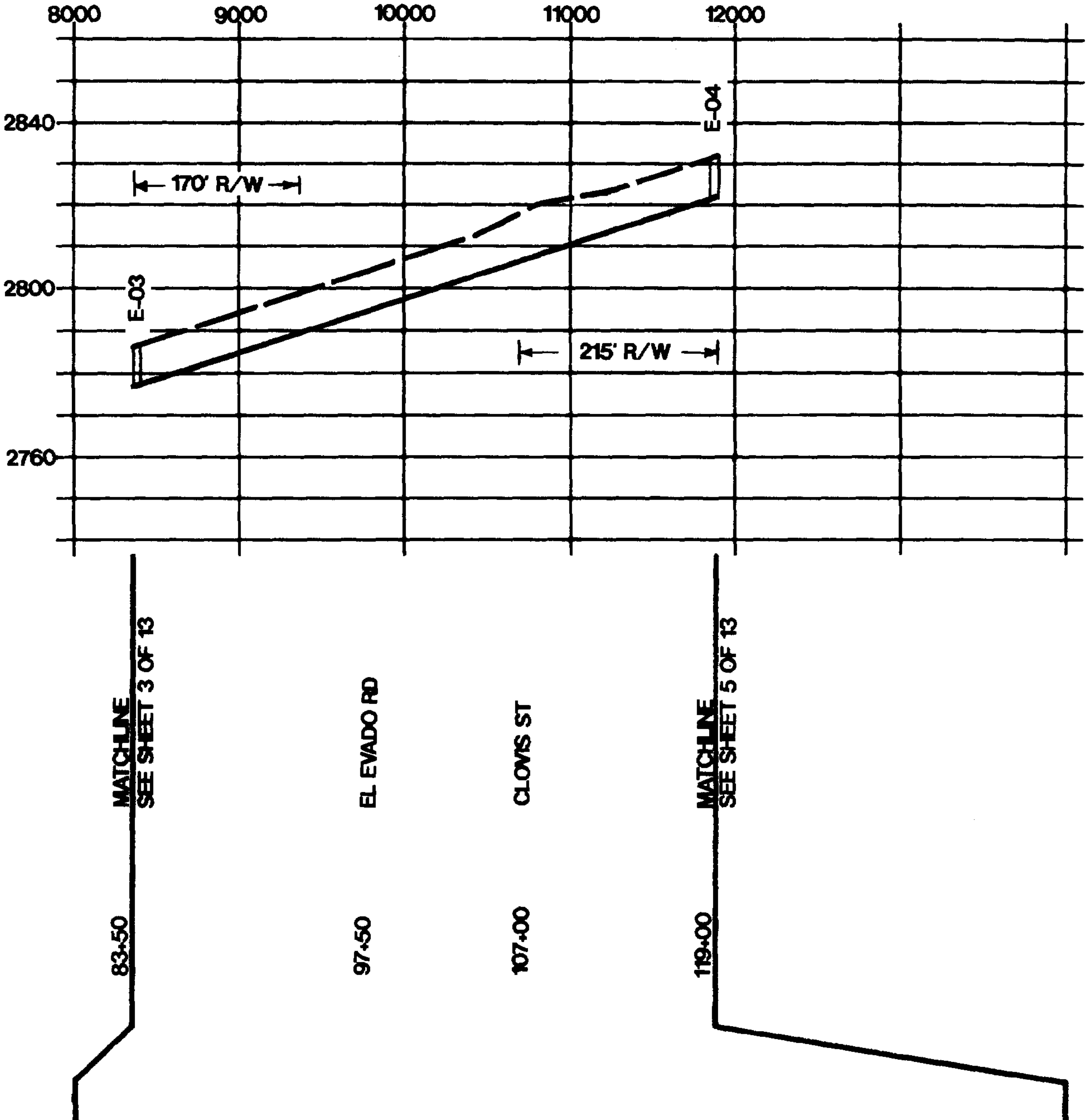


LENGTH	1200	2550
SLOPE	.013	
FLOW	Q_{100}=7143	
SIZE	b=20', h=10', z=1.5	
TYPE	CONCRETE TRAPEZOIDAL CHANNEL	

LEGEND

- - - - - - - LEVEE
— — — — NATURAL GROUND
——————— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 3 OF 13	W S SCALE H: 1"=1000' V: 1"=40' WILLIAMSON & SCHMID



LENGTH	3550
SLOPE	.013
FLOW	Q_{100}=6459
SIZE	b=20', h=10', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL

LEGEND

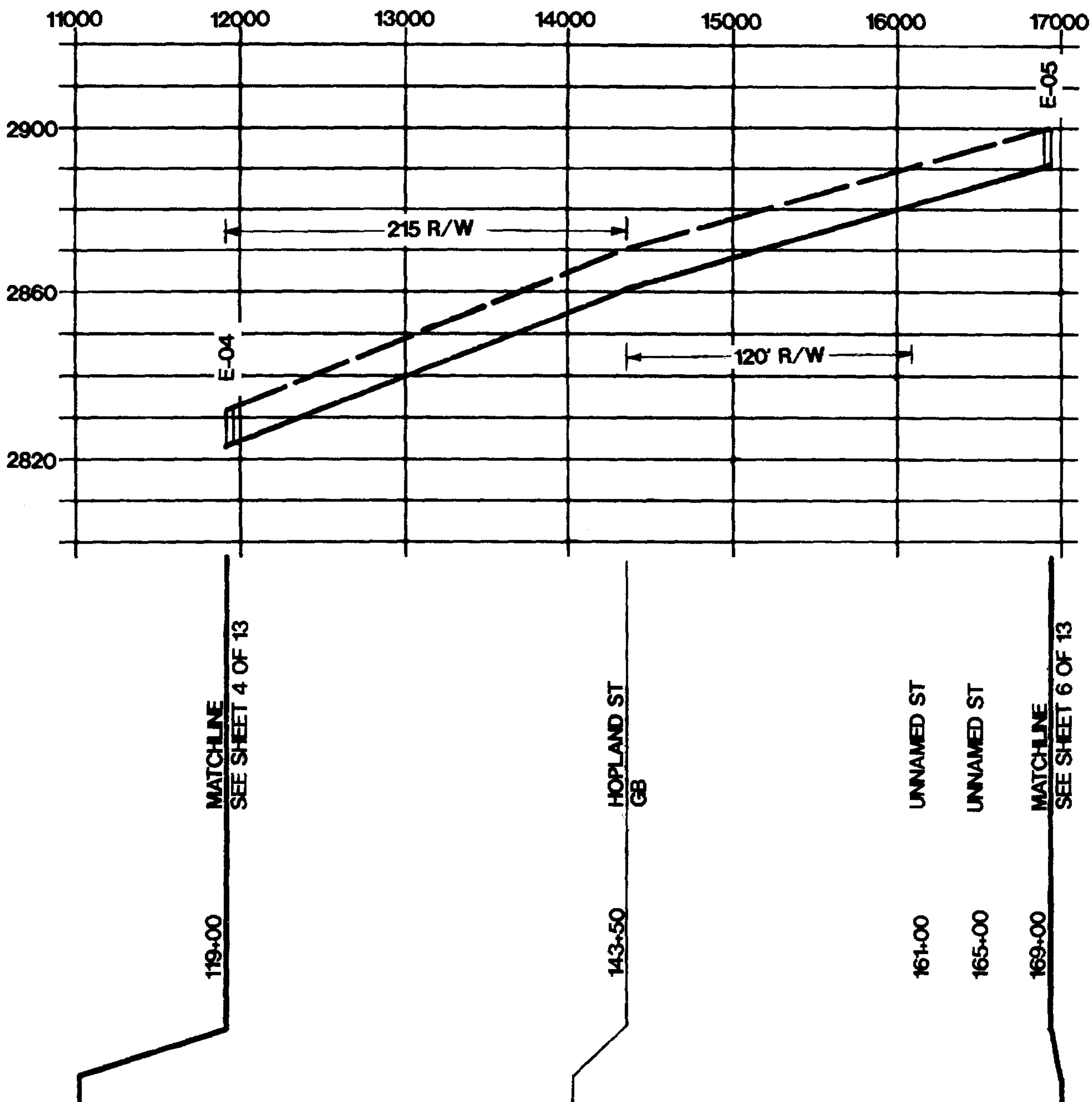
- - - - - - - LEVEE
— — — — NATURAL GROUND
———— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE

COMPREHENSIVE STORM DRAIN PLAN
LINE E-01
SHEET 4 OF 13

SCALE
H: 1"=1000'
V: 1"=40'

WILLIAMSON & SCHMID

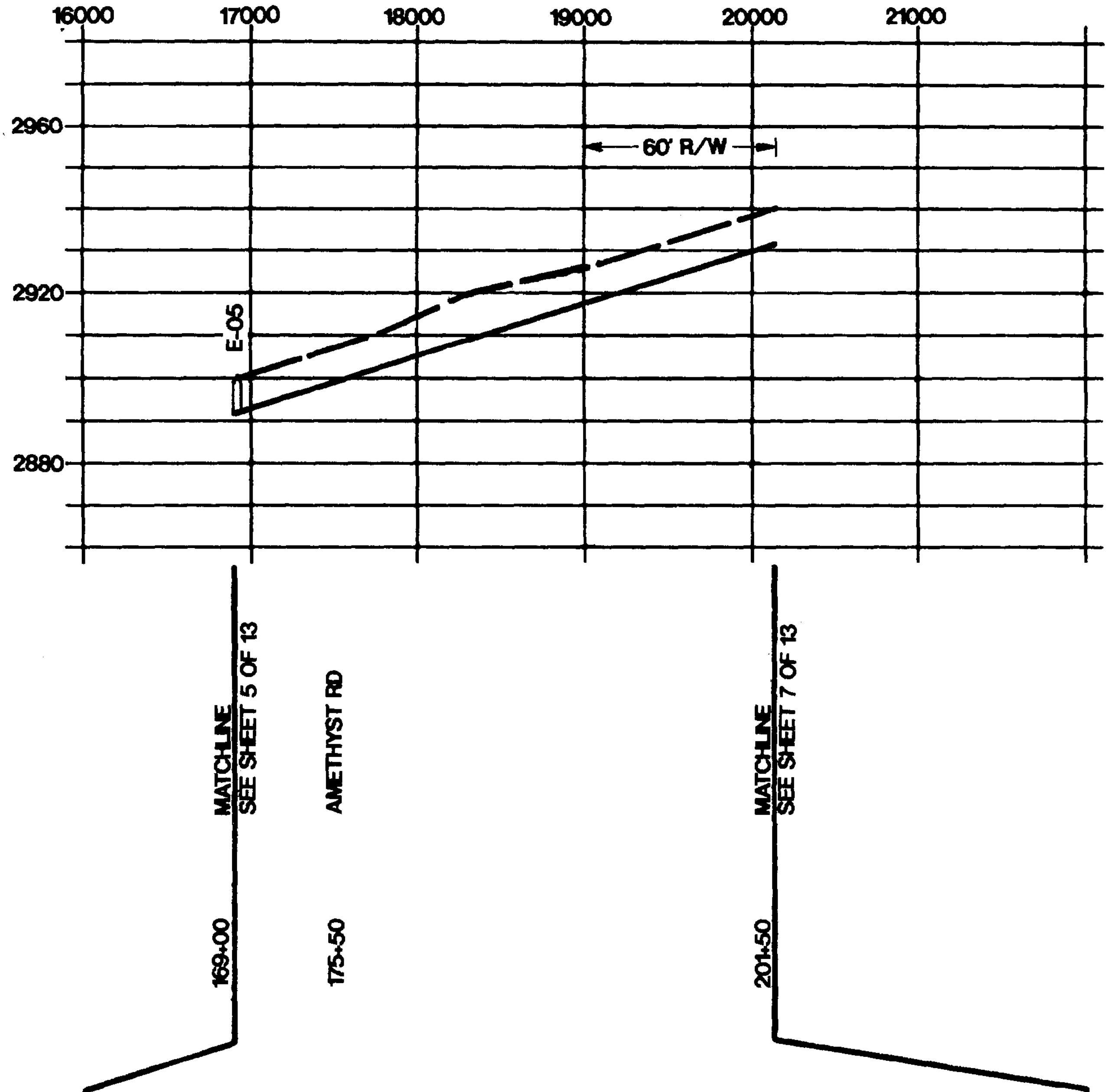


LENGTH	2450	2550
SLOPE	.016	.012
FLOW	Q_{100}=5854	Q_{100}=5684
SIZE	b=20', h=9', z=1.5	
TYPE	CONCRETE TRAPEZOIDAL CHANNEL	

LEGEND

- - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 5 OF 13	SCALE H: 1"=1000' V: 1"=40' WILLIAMSON & SCHMID



LENGTH	3250
SLOPE	.012
FLOW	Q_{100}=3166
SIZE	b=15', h=8', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL

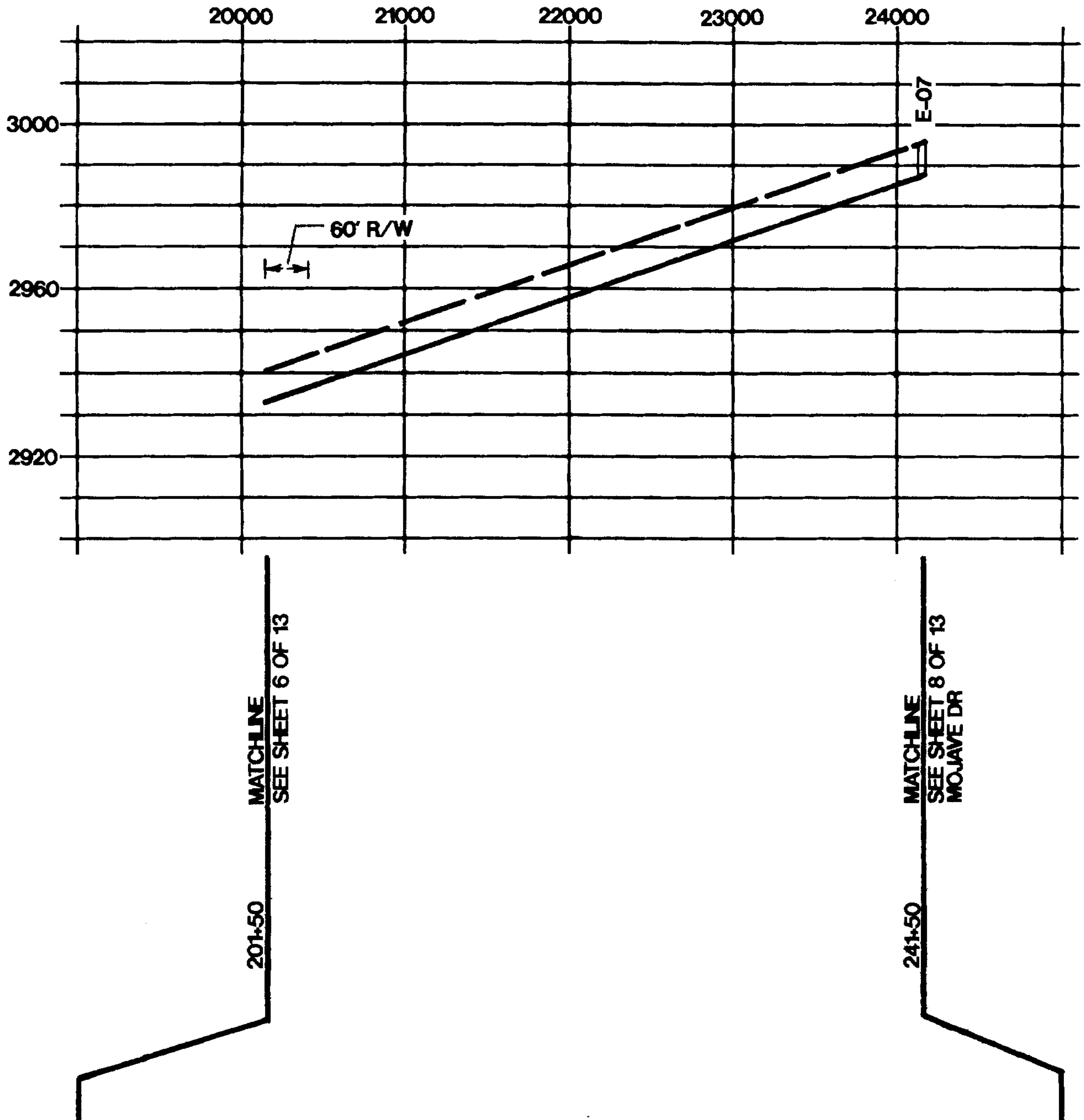
LEGEND
- - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE

COMPREHENSIVE STORM DRAIN PLAN
LINE E-01

SCALE
H: 1"=1000'
V: 1"=40'

WILLIAMSON & SCHMID



LENGTH	4000
SLOPE	.014
FLOW	Q_{100}=2968
SIZE	b=15', h=8', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL

LEGEND

- - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE

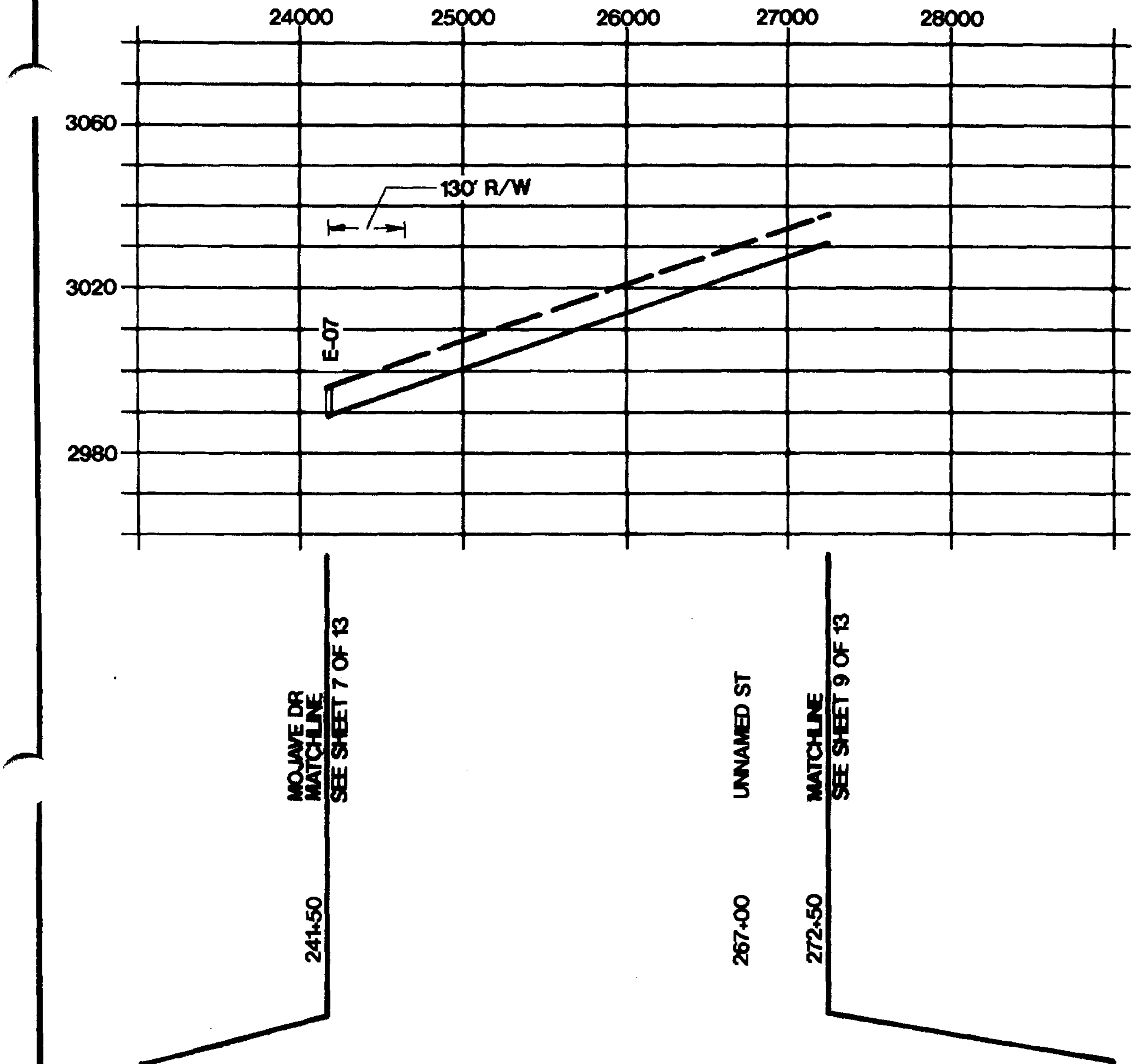
COMPREHENSIVE STORM DRAIN PLAN

LINE E-01

SHEET 7 OF 13

SCALE
H: 1"=1000'
V: 1"=40'

WILLIAMSON & SCHMID

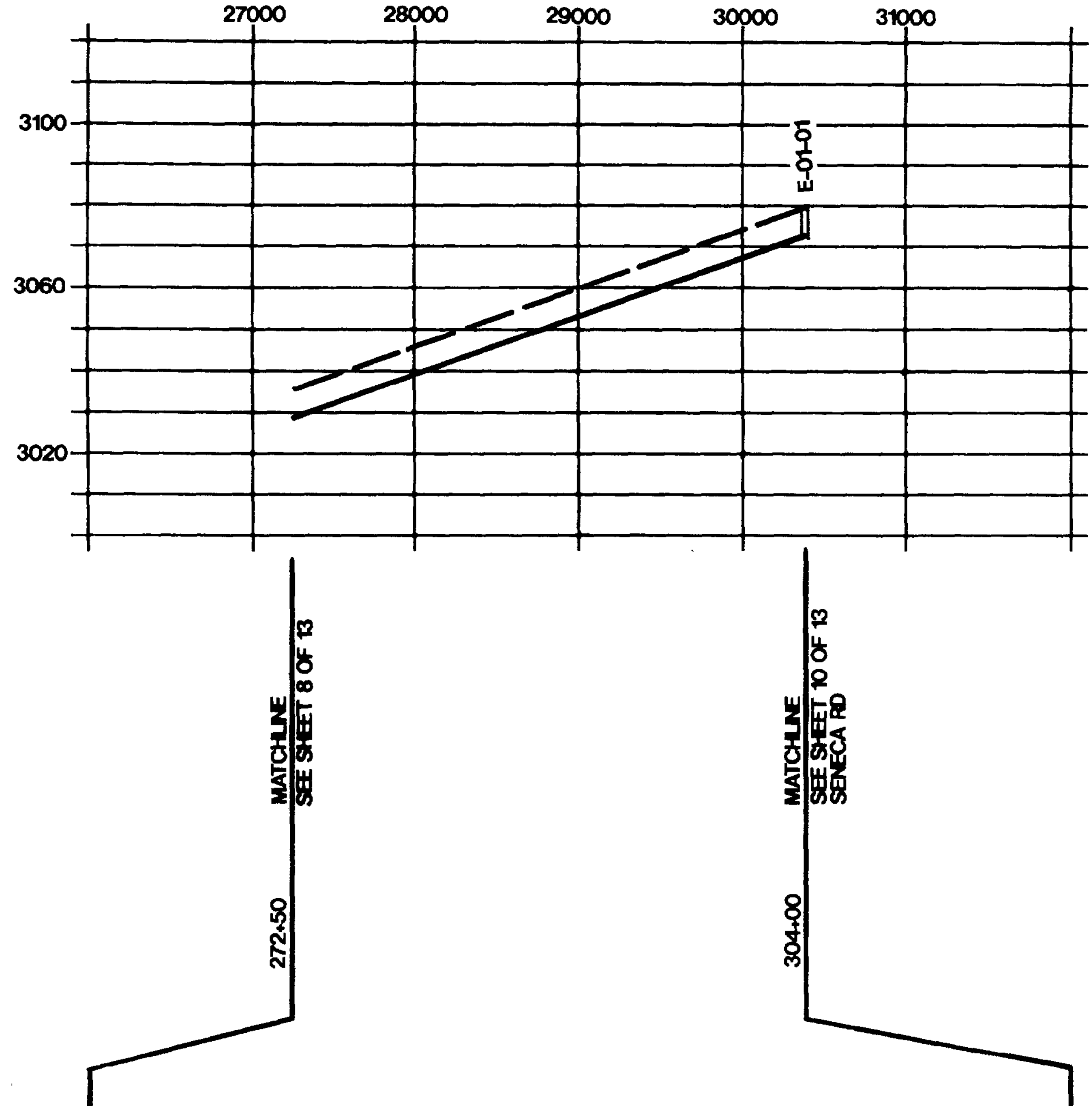


LENGTH	3100
SLOPE	.013
FLOW	Q_{100}=2373
SIZE	b=15', h=7', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL

LEGEND

- - - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 8 OF 13	SCALE H: 1"=1000' V: 1"=40' WILLIAMSON & SCHMID



LENGTH	3150
SLOPE	.013
FLOW	Q_{100}=2373
SIZE	b=15', h=7', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL

LEGEND

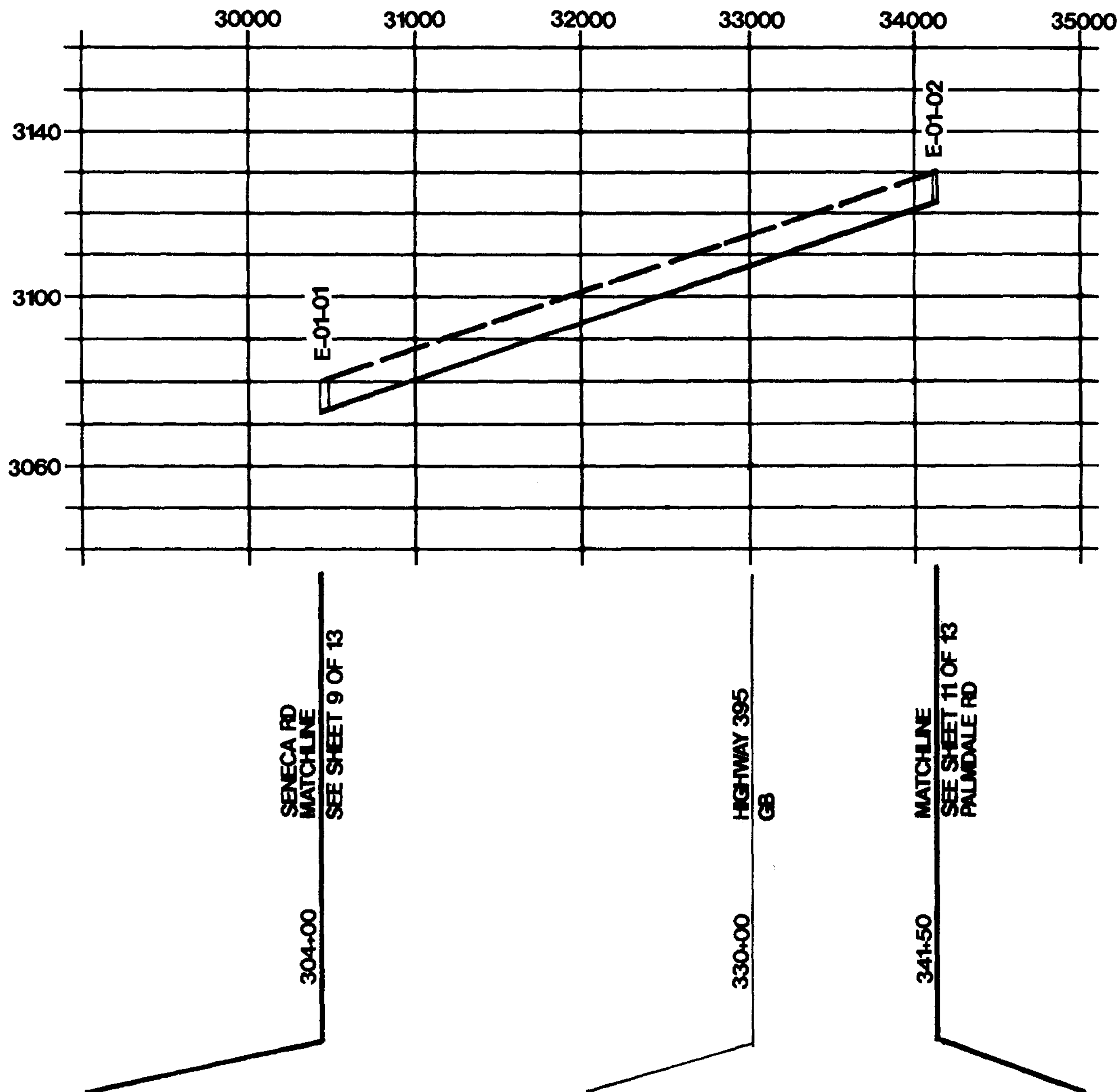
- - - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE

COMPREHENSIVE STORM DRAIN PLAN
LINE E-01
SHEET 9 OF 13

SCALE
H: 1"=1000'
V: 1"=40'

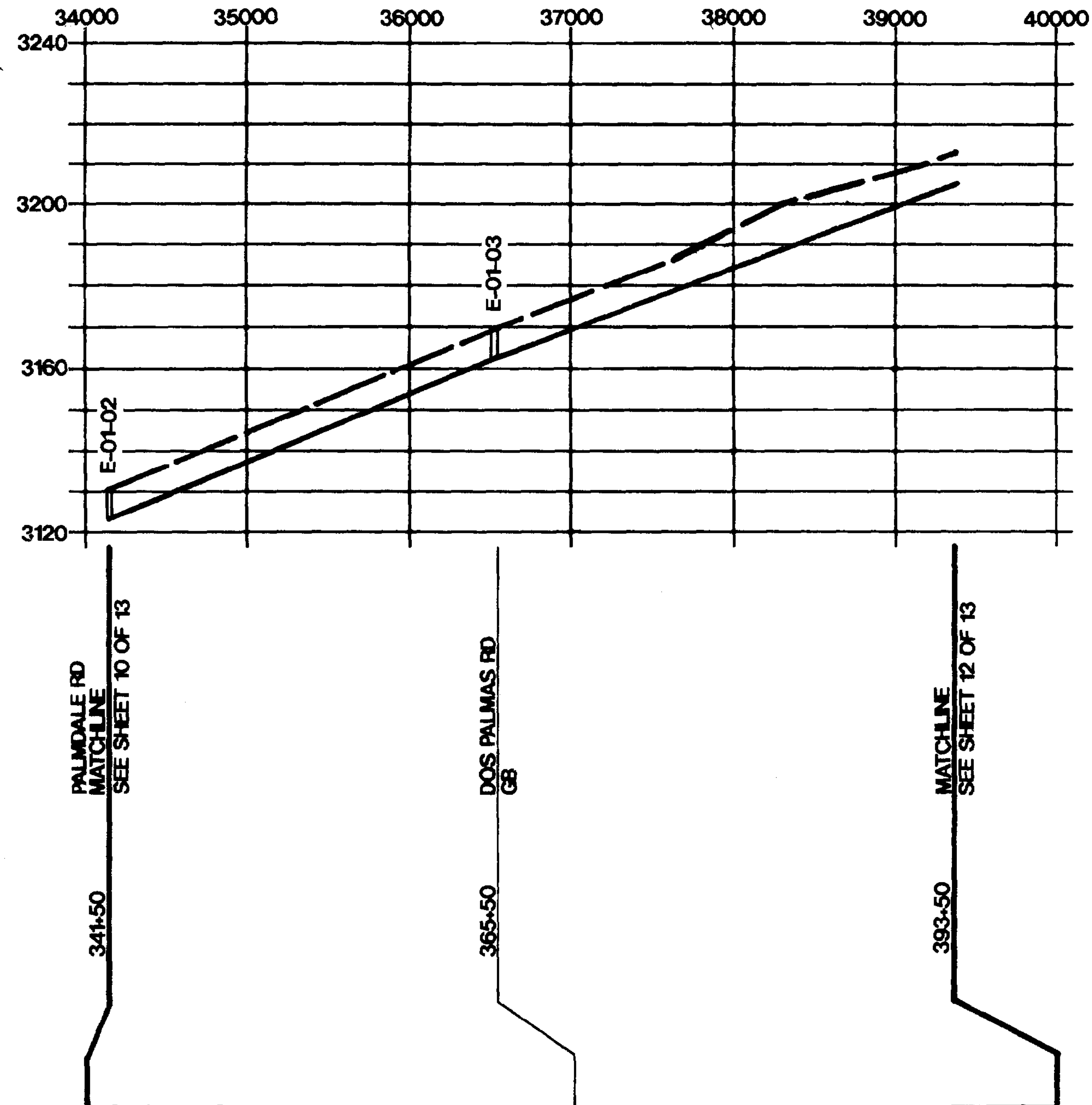
WILLIAMSON & SCHMID



LENGTH	2600	1150
SLOPE	.013	.014
FLOW	Q_{100}=2089	Q_{100}=2017
SIZE	b=15', h=7', z=1.5	
TYPE	CONCRETE TRAPEZOIDAL CHANNEL	

LEGEND
- - - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 10 OF 13	SCALE H: 1"=1000' V: 1"=40' WILLIAMSON & SCHMID

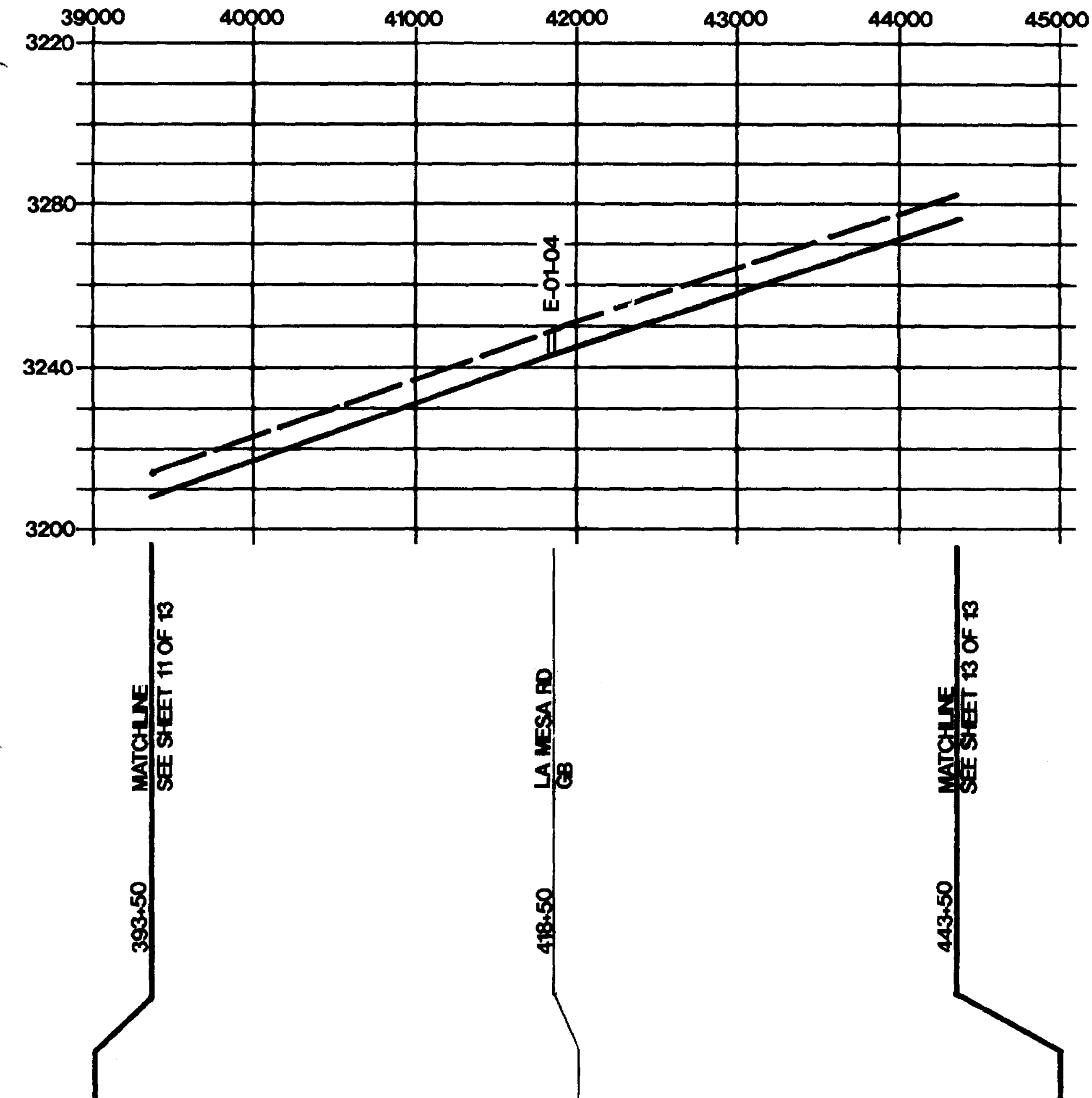


LENGTH	2400	2800
SLOPE	.017	.016
FLOW	Q_{100}=1994	Q_{100}=1712
SIZE	b=15', h=7', z=1.5	
TYPE	CONCRETE TRAPEZOIDAL CHANNEL	

LEGEND

- - - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 11 OF 13	SCALE H: 1"=1000' V: 1"=40' WS WILLIAMSON & SCHMID

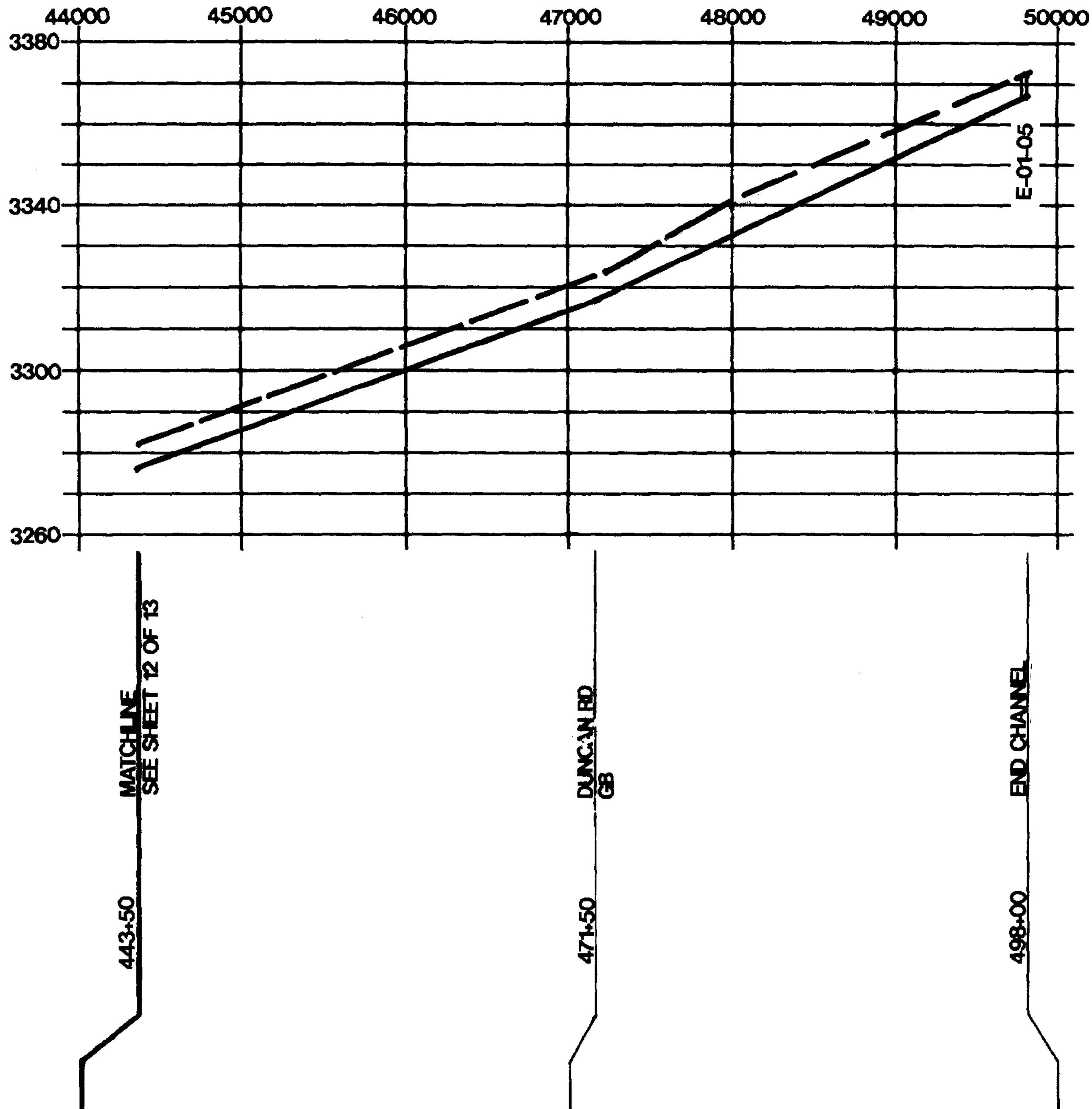


LENGTH	2500	2500
SLOPE	.014	.013
FLOW	Q_{100}=1522	Q_{100}=1305
SIZE	b=15', h=6', z=1.5	
TYPE	CONCRETE TRAPEZOIDAL CHANNEL	

LEGEND

- - - - - - - LEVEE
— — — NATURAL GROUND
——— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 12 OF 13	SCALE H: 1"=1000' V: 1"=40' WILLIAMSON & SCHMID



LENGTH	2800	2650
SLOPE	.016	.019
FLOW	Q_{100}=1009	Q_{100}=811
SIZE	b=8', h=6', z=1.5	b=6', h=6', z=1.5
TYPE	CONCRETE TRAPEZOIDAL CHANNEL	

LEGEND

- - - - - - - LEVEE
— — — — NATURAL GROUND
———— PROPOSED FLOWLINE

VICTORVILLE MASTER PLAN OF DRAINAGE	COMPREHENSIVE STORM DRAIN PLAN LINE E-01 SHEET 13 OF 13	SCALE H: 1"=1000' V: 1"=40' WILLIAMSON & SCHMID

FACILITY DESCRIPTION	FACILITY QUANTITY	UNIT TYPE	UNIT COST	FACILITY COST
STA 0+00 TO STA 15+00				
TRAP CHANNEL B=35' H=10' Z=1.5				
EXCAVATION	1,500	L.F.	56	84,000
CONCRETE LINING	1,500	L.F.	306	459,000
FENCING	3,000	L.F.	7.5	22,500
RIGHT-OF-WAY (105' WIDTH)	1,500	L.F.	108	162,000
CULVERT (4)-12.5'x10'	2	EA.	226,500	453,000
STA 15+00 TO STA 23+00				
TRAP CHANNEL B=25' H=10' Z=1.5				
EXCAVATION	800	L.F.	44	35,200
CONCRETE LINING	800	L.F.	257	205,600
FENCING	1,600	L.F.	7.5	12,000
RIGHT-OF-WAY (95' WIDTH)	800	L.F.	98	78,400
STA 23+00 TO STA 119+00				
TRAP CHANNEL B=20' H=10' Z=1.5				
EXCAVATION	9,600	L.F.	39	374,400
CONCRETE LINING	9,600	L.F.	232	2,227,200
FENCING	19,200	L.F.	7.5	144,000
RIGHT-OF-WAY (90' WIDTH)	7,100	L.F.	93	660,300
RIGHT-OF-WAY (90' WIDTH)	1,200	L.F.	46	55,200
CULVERT (3)-12'x10'	4	EA.	172,500	690,000
STA 119+00 TO STA 169+00				
TRAP CHANNEL B=20' H=9' Z=1.5				
EXCAVATION	5,000	L.F.	34	170,000
CONCRETE LINING	5,000	L.F.	219	1,095,000
FENCING	10,000	L.F.	7.5	75,000
RIGHT-OF-WAY (87' WIDTH)	1,800	L.F.	90	162,000
RIGHT-OF-WAY (87' WIDTH)	3,200	L.F.	45	144,000
CULVERT (3)-11.5'x9'	3	EA.	162,500	487,500
STA 169+00 TO STA 241+50				
TRAP CHANNEL B=15' H=8' Z=1.5				
EXCAVATION	7,250	L.F.	24	174,000
CONCRETE LINING	7,250	L.F.	181	1,312,250
FENCING	14,500	L.F.	7.5	108,750
RIGHT-OF-WAY (79' WIDTH)	5,850	L.F.	82	479,700
RIGHT-OF-WAY (79' WIDTH)	1,400	L.F.	41	57,400
CULVERT (3)-9'x8'	2	EA.	135,500	271,000

FACILITY DESCRIPTION	FACILITY QUANTITY	UNIT TYPE	UNIT COST	FACILITY COST
STA 241+50 TO STA 393+50				
TRAP CHANNEL B=15' H=7' Z=1.5				
EXCAVATION	15,200	L.F.	20	304,000
CONCRETE LINING	15,200	L.F.	168	2,553,600
FENCING	30,400	L.F.	7.5	228,000
RIGHT-OF-WAY (76' WIDTH)	14,700	L.F.	79	1,161,300
RIGHT-OF-WAY (76' WIDTH)	500	L.F.	39	19,500
CULVERT (3)-8.5'x7'	5	EA.	125,500	627,500
STA 393+50 TO STA 443+50				
TRAP CHANNEL B=15' H=6' Z=1.5				
EXCAVATION	5,000	L.F.	16	80,000
CONCRETE LINING	5,000	L.F.	154	770,000
FENCING	10,000	L.F.	7.5	75,000
RIGHT-OF-WAY (73' WIDTH)	5,000	L.F.	75	375,000
CULVERT (3)-8'x6'	1	EA.	115,500	115,500
STA 443+50 TO STA 471+50				
TRAP CHANNEL B=8' H=6' Z=1.5				
EXCAVATION	2,800	L.F.	11	30,800
CONCRETE LINING	2,800	L.F.	120	336,000
FENCING	5,600	L.F.	7.5	42,000
RIGHT-OF-WAY (46' WIDTH)	2,800	L.F.	48	134,400
CULVERT (2)-8.5'x6'	1	EA.	87,000	87,000
STA 471+50 TO STA 498+00				
TRAP CHANNEL B=6' H=6' Z=1.5				
EXCAVATION	2,650	L.F.	10	26,500
CONCRETE LINING	2,650	L.F.	110	291,500
FENCING	5,300	L.F.	7.5	39,750
RIGHT-OF-WAY (44' WIDTH)	2,650	L.F.	45	119,250
			SUBTOTAL	17,616,000
			30% CONT.	5,284,800
			TOTAL	22,900,800

VESTING TENTATIVE TRACT MAP
No. 18487
CITY OF VICTORVILLE

BENCH MARK
V-212 3248.52
LA MESA & HIGHWAY 395 146' E/O EAST EP HWY 395 & 87' SE OF FIRE HYDRANT
VICTORVILLE CITY BENCHMARKS
JANUARY 15, 2003

LEGAL DESCRIPTION

THE SOUTH ½ OF THE NORTH ½ OF THE NORTH ½ OF THE SOUTHEAST ¼ OF SECTION 28, TOWNSHIP 5 NORTH, RANGE 5 WEST, SAN BERNARDINO BASE AND MERIDIAN, ACCORDING TO THE OFFICIAL PLAT THEREOF.

APN: 3096-361-02-0-000

OWNER

MR. ED GRIMES
5238 CALIENTE BLVD.
OAKHILLS, CA 92344
PHONE (760) 949-1716

LAND USE

EX. – VACANT LAND
PROP. – SINGLE FAMILY R-1

AREA

GROSS = 830,254 SF (19.06 AC)
NET = 723,173 SF (16.60 AC)

ZONING

EX. – R-1
PROP. – R-1
MIN LOT SIZE 7200 SF

DENSITY

RESIDENTIAL
55 LOTS/14.9 AC=3.89 LOTS/AC

LOT BREAKDOWN
LOTS 1-55 RESIDENTIAL LOTS
LOT A – LANDSCAPE (LMAD) 10FT WIDE
LOT B – LANDSCAPE (LMAD) 10FT WIDE
LOT C – LANDSCAPE (LMAD) 10FT WIDE
LOT D – LANDSCAPE (LMAD) 10FT WIDE
LOT E – DRAINAGE BASIN, ASSESSMENT DISTRICT (DFAD)
REMAINDER – COMMERCIAL

EXISTING EASEMENTS

EASEMENTS SHOWN ON THIS PLAT ARE BASED ON A COPY OF TITLE INSURANCE REPORT BY FIRST AMERICAN TITLE COMPANY DATED JULY 26, 2007 AS ORDER NO. NHSB-2649796. CCL DOES NOT ACCEPT RESPONSIBILITY FOR THE COMPLETENESS OR ACCURACY OF THIS REPORT.

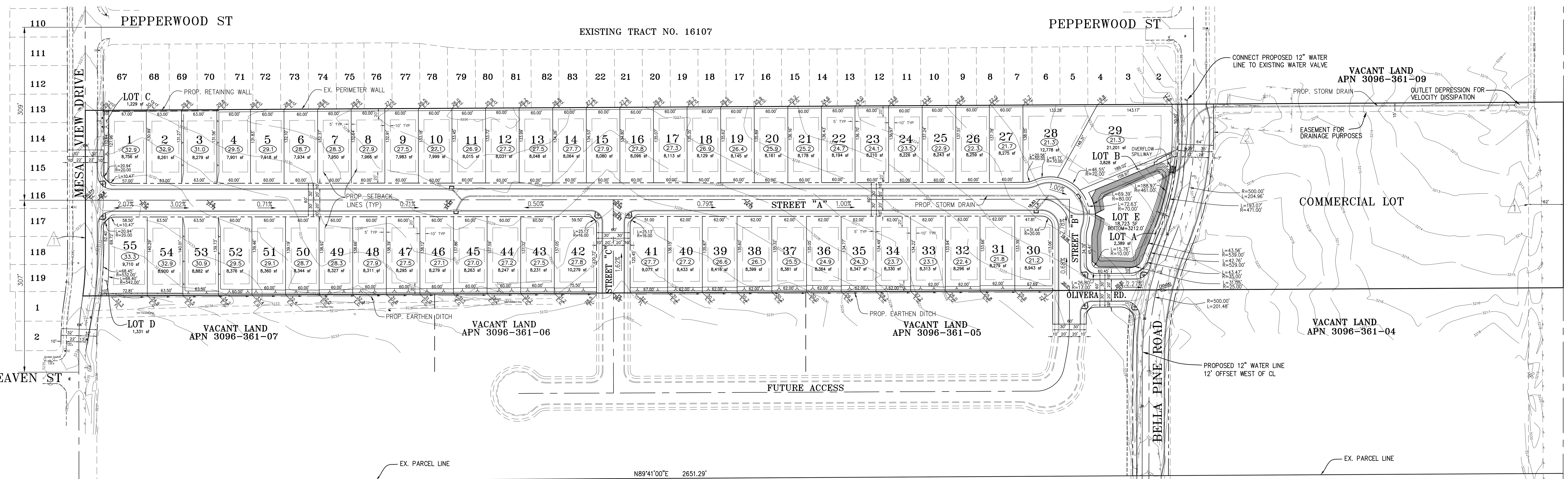
1. AN OFFER OF DEDICATION FOR STREETS, HIGHWAYS, SEWERS, DRAINAGE, PUBLIC UTILITIES, AND PUBLIC ACCESS PURPOSES AND INCIDENTAL PURPOSES, RECORDED JUNE 24, 1993 AS INSTRUMENT NO. 93-269747 OF OFFICIAL RECORDS.

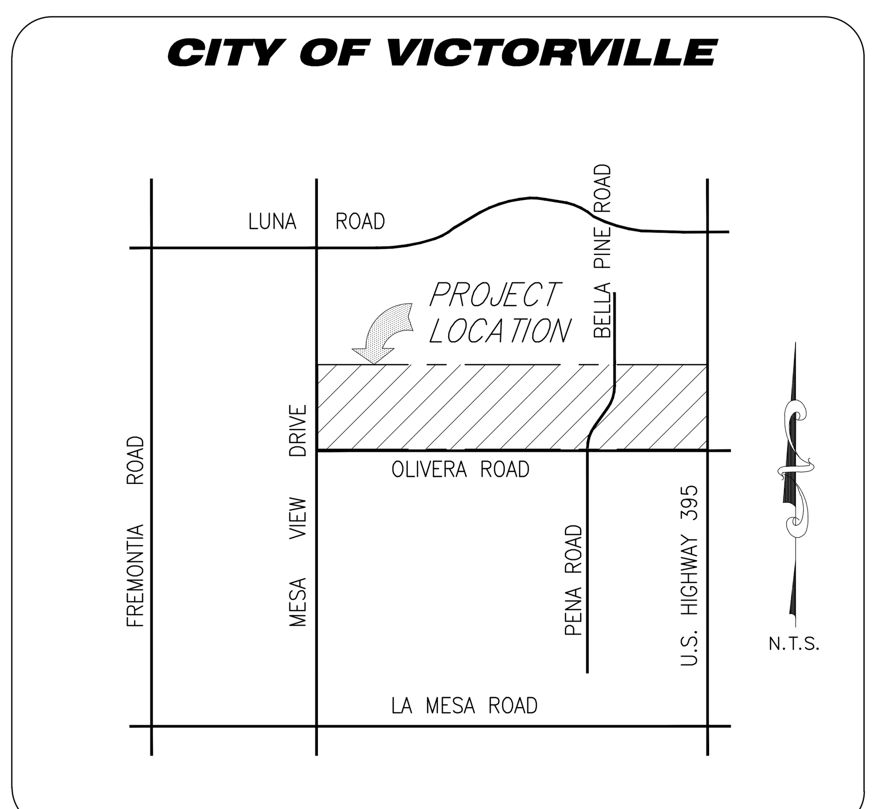
2. AN EASEMENT FOR STREETS, HIGHWAYS, SEWERS, DRAINAGE, PUBLIC UTILITIES, AND PUBLIC ACCESS AND INCIDENTAL PURPOSES, RECORDED MAY 19, 2004 AS INSTRUMENT NO. 2004-0351207 OF OFFICIAL RECORDS.

I HEREBY CERTIFY THAT THIS TRACT MAP WAS PREPARED UNDER MY SUPERVISION AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND THAT ALL EASEMENTS OF RECORD ARE SHOWN PER TITLE REPORT BY TICOR TITLE, DATED FEBRUARY 1, 2017, TITLE REFERENCE NO. 00277774-993-SS1.

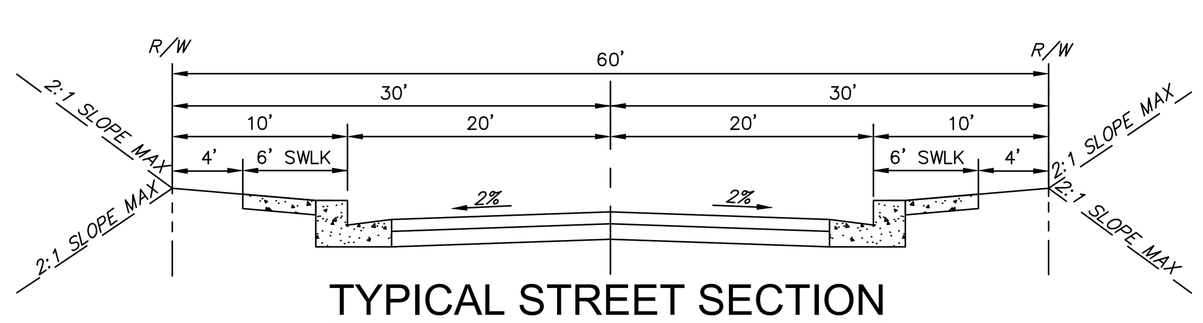
BOBBY KOHLTFARBER DATE
PE NO. 68141

SCALE: 1"=100'

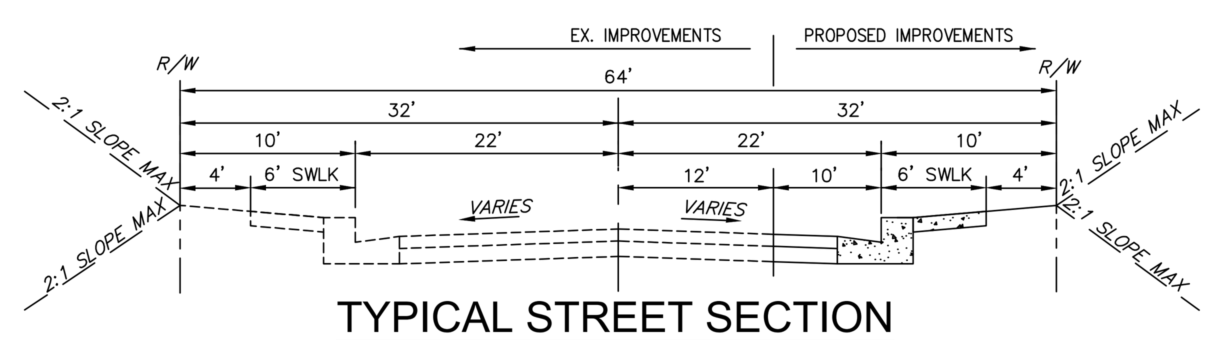




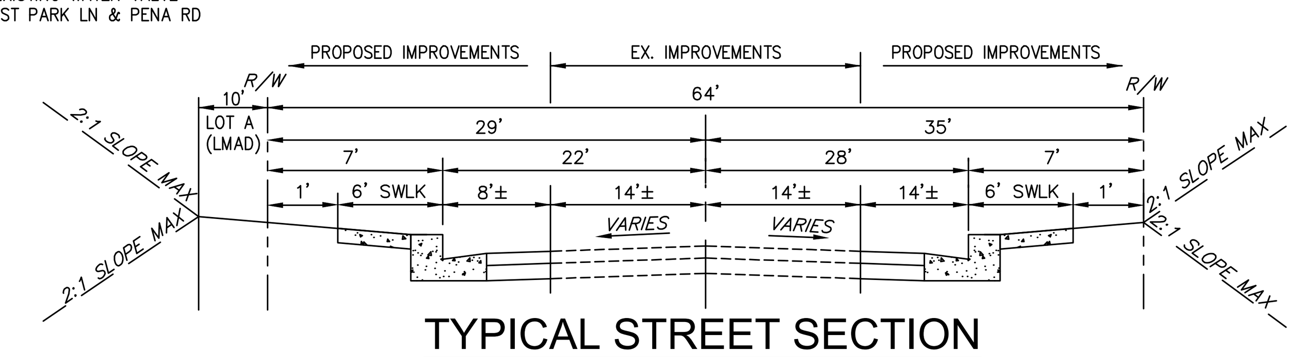
VICINITY MAP
N.T.S



TYPICAL STREET SECTION
STREET "A", STREET "B", STREET "C" AND OLIVERA ROAD
N.T.S.



TYPICAL STREET SECTION
MESA VIEW DRIVE
N.T.S.



TYPICAL STREET SECTION
PENA ROAD/BELLA PINE ROAD
N.T.S.

PREPARED FOR:
MR. ED GRIMES
5238 CALIENTE BLVD.
OAKHILLS, CA 92344
PHONE (760) 949-1716

Kimley»Horn
3880 LEMON STREET, SUITE 420
RIVERSIDE, CA 92501
(714) 786-6316

PLOT DATE: 11-19-18

CITY OF VICTORVILLE
VESTING TENTATIVE TRACT MAP NO. 18487

SCALE: 1"=100'
DESIGNED: LNJ
DRAWN: AS
CHECKED: DL
099481003
SHEET NO.
1 OF 1

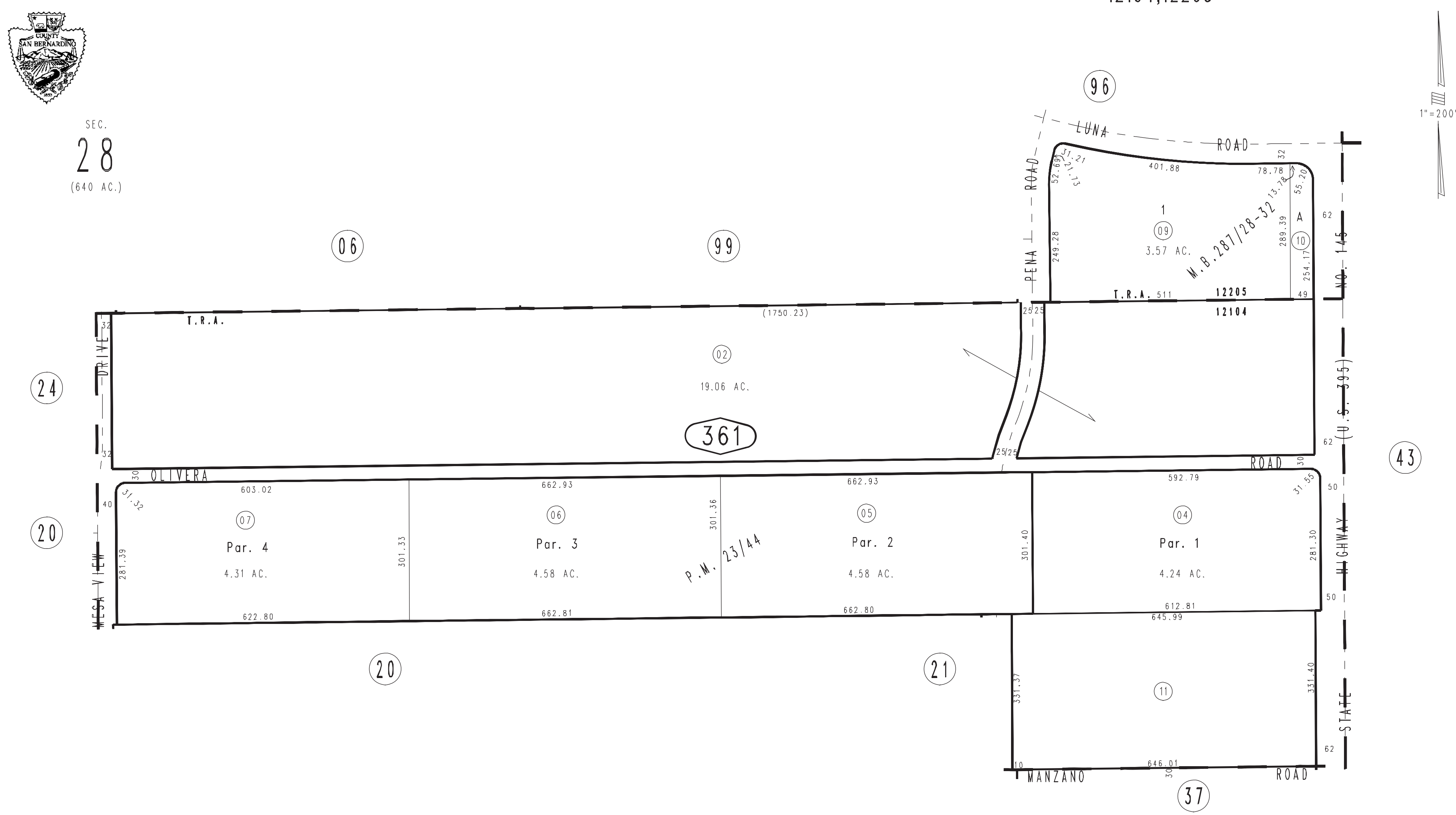
FILE:K:\RIV_LDEV\099481003 Victorville Parcel Map\Design\CADD\Plan Sheets\TTM\099481003-VTTM.dwg

THIS MAP IS FOR THE PURPOSE OF AD VALOREM TAXATION ONLY.

N.1/2, S.E.1/4, Sec. 28, T.5N., R.5W., S.B.M.

City of Victorville
Tax Rate Area
12104,12205

3096 – 36



Assessor's Map
Book 3096 Page 36
San Bernardino County

REVISED
03/10/10 LH
04/29/10 LH

Ptn. Tract No. 16107-1, M.B. 287/28-32
Parcel Map No. 2619, P.M. 23/44

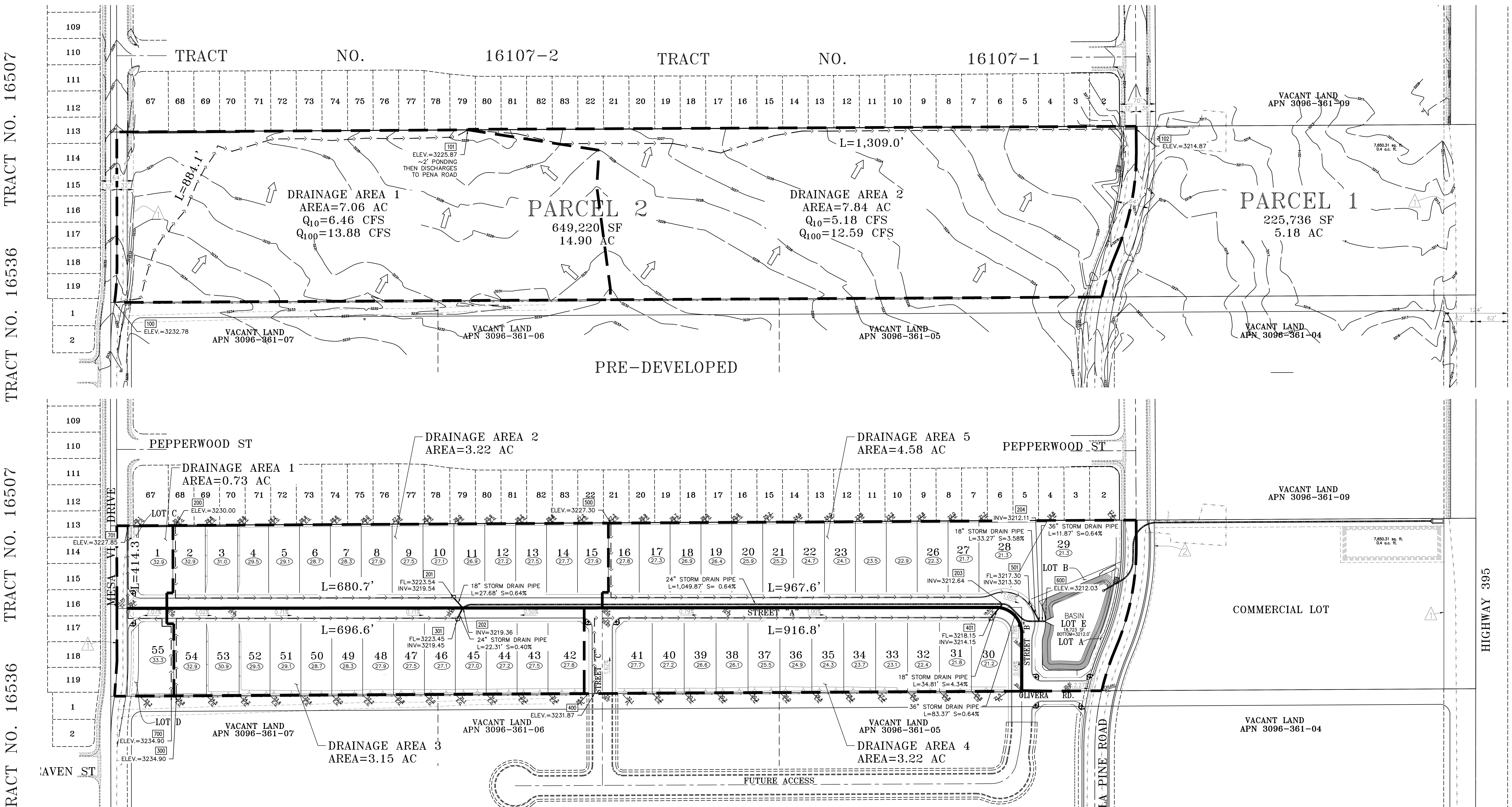
DEC. 1991

APPENDIX B

- Site Plan with Drainage Arrows and Facilities
- Site Plan with Sub Watersheds
- Rational Method Data (Hydrology AES Models)
- Small Unit Hydrographs
- Infiltration/detention Basin Analysis

DRAINAGE EXHIBIT
TENTATIVE PARCEL MAP NO. 18487
CITY OF VICTORVILLE

BENCH MARK
V-212 3248.52
LA MESA & HIGHWAY 395 146' E/O EAST EP
HWY 395 & 87' SE OF FIRE HYDRANT
VICTORVILLE CITY BENCHMARKS
JANUARY 15, 2003



SCALE: 1"=100'

LEGEND

- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR
- SHEET FLOW
- HYDROLOGY NODE

NOTES

PRE-DEVELOPED CONDITIONS:

Q_{10} = 9.84 CFS

Q_{100} = 23.92 CFS

POST-DEVELOPED CONDITIONS:

Q_{10} = 18.23 CFS

Q_{100} = 35.17 CFS

PRE & POST DEVELOPMENT EXHIBIT

PREPARED FOR:
MR. ED GRIMES
5238 CALIENTE BLVD.
OAKHILLS, CA 92344
PHONE (760) 949-1716

Kimley»Horn
3880 LEMON STREET SUITE 420
RIVERSIDE, CA 92501
PHONE: 747-900-8400 WWW.KIMLEY-HORN.COM

PLOT DATE: 11-19-18

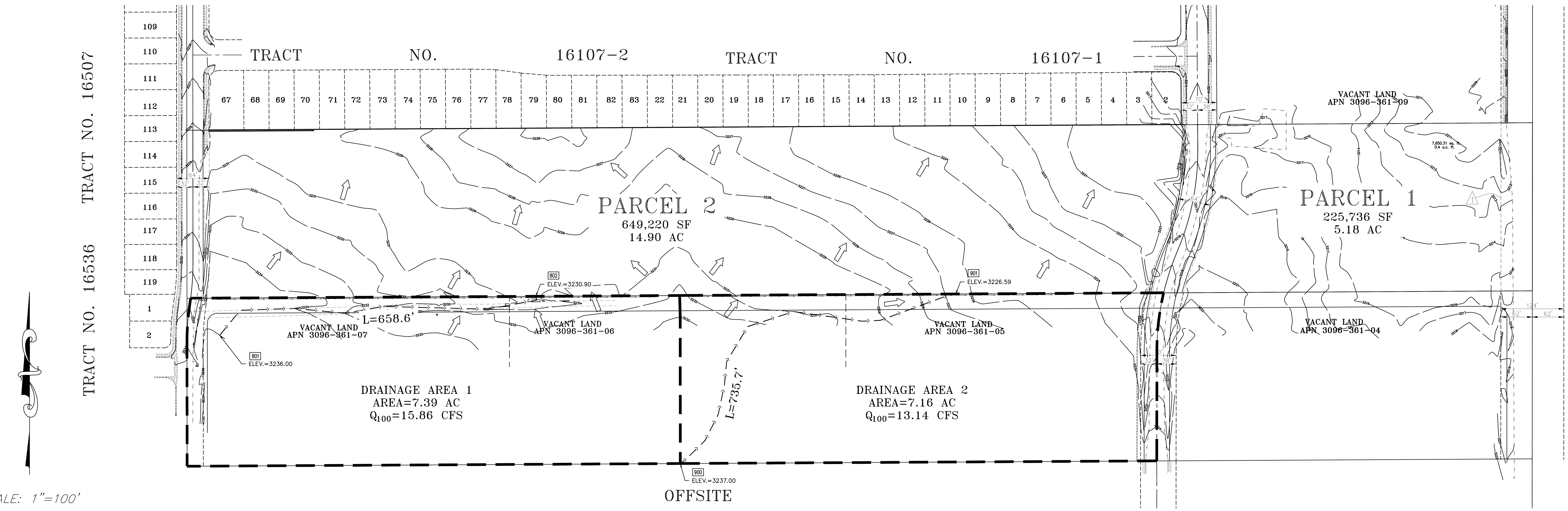
CITY OF VICTORVILLE
DRAINAGE EXHIBIT
VESTING TENTATIVE PARCEL MAP
NO. 18487

SCALE: 1"=100'
DESIGNED: LA
DRAWN: LA
CHECKED: BK
099481003
SHEET NO.
1 OF **2**

CCL DWG FILE: K:\RIV_LDEV\099481003 Victorville Parcel Map\Design\CADD\Currents\099481003-HYDROLOGY EXHIBIT.dwg

DRAINAGE EXHIBIT
TENTATIVE PARCEL MAP NO. 18487
CITY OF VICTORVILLE

BENCH MARK
V-212 3248.52
LA MESA & HIGHWAY 395 146' E/O EAST EP
HWY 395 & 87' SE OF FIRE HYDRANT
VICTORVILLE CITY BENCHMARKS
JANUARY 15, 2003



SCALE: 1"=100'

LEGEND

DRAINAGE BASIN BOUNDARY

EXISTING CONTOUR

SHEET FLOW

HYDROLOGY NODE 700

NOTES

OFFSITE CONDITIONS:

DRAINAGE AREA 1

Q_{100} = 15.86 CFS

DRAINAGE AREA 2

Q_{100} = 13.14 CFS

PREPARED FOR:

MR. ED GRIMES
5238 CALIENTE BLVD.
OAKHILLS, CA 92344
PHONE (760) 949-1716

Kimley»Horn

3880 LEMON STREET SUITE 420
RIVERSIDE, CA 92501
PHONE: 747-900-8400 WWW.KIMLEY-HORN.COM

PLOT DATE: 10-30-18

OFFSITE EXHIBIT

CITY OF VICTORVILLE
DRAINAGE EXHIBIT
VESTING TENTATIVE PARCEL MAP
NO. 18487

SCALE: 1"=100'
DESIGNED: LA
DRAWN: LA
CHECKED: BK
099481003
SHEET NO.
2 OF 2

CCL DWG FILE: K:\RIV_LDEV\099481003 Victorville Parcel Map\Design\CADD\Currents\099481003-HYDROLOGY EXHIBIT.dwg

Rational Method Data (Hydrology AES Models)
Pre-Development

```
____________________________________________________________________________
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2011 Advanced Engineering Software (aes)
             Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                           Analysis prepared by:

                      Kimley-Horn and Associates, Inc.
                             765 The City Drive
                                 Suite 200
                              Orange, CA 92868

 ************************** DESCRIPTION OF STUDY **************************
* VESTING TENTATIVE PARCEL MAP 18487                                       *
* REV 5-22-18                                                              *
* 10VPEX.RES                                                               *
 **************************************************************************

  FILE NAME: 10VPEX.DAT
  TIME/DATE OF STUDY: 12:12 05/24/2018
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   10.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   8.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 1.00
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.678
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.130
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =   10.00   1-HOUR INTENSITY(INCH/HOUR) = 0.6848
  SLOPE OF INTENSITY DURATION CURVE = 0.7000

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   884.10
  ELEVATION DATA: UPSTREAM(FEET) =   3232.78  DOWNSTREAM(FEET) =   3225.87

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   20.901
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.433
```

```
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
NATURAL POOR COVER
"BARREN"                  A        7.06      0.42     1.000    78   20.90
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
SUBAREA RUNOFF(CFS) =      6.46
TOTAL AREA(ACRES) =      7.06   PEAK FLOW RATE(CFS) =      6.46

****************************************************************************
FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  51
----------------------------------------------------------------------------
>>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
>>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
ELEVATION DATA: UPSTREAM(FEET) =   3225.87  DOWNSTREAM(FEET) =   3214.87
CHANNEL LENGTH THRU SUBAREA(FEET) =  1309.00   CHANNEL SLOPE =  0.0084
CHANNEL BASE(FEET) =    0.00   "Z" FACTOR =   3.000
MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   2.00
*  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.150
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
NATURAL POOR COVER
"BARREN"                  A        7.84      0.42     1.000    78
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       9.07
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.82
AVERAGE FLOW DEPTH(FEET) =   1.03   TRAVEL TIME(MIN.) =   7.73
Tc(MIN.) =   28.63
SUBAREA AREA(ACRES) =     7.84       SUBAREA RUNOFF(CFS) =    5.18
EFFECTIVE AREA(ACRES) =     14.90     AREA-AVERAGED Fm(INCH/HR) =   0.42
AREA-AVERAGED Fp(INCH/HR) =   0.42  AREA-AVERAGED Ap =   1.00
TOTAL AREA(ACRES) =       14.9         PEAK FLOW RATE(CFS) =       9.84

END OF SUBAREA CHANNEL FLOW HYDRAULICS:
DEPTH(FEET) =  1.07   FLOW VELOCITY(FEET/SEC.) =   2.89
LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =    2193.10 FEET.
============================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)     =       14.9  TC(MIN.) =     28.63
EFFECTIVE AREA(ACRES) =     14.90  AREA-AVERAGED Fm(INCH/HR)=  0.42
AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap = 1.000
PEAK FLOW RATE(CFS)   =       9.84
============================================================================
============================================================================
END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2011 Advanced Engineering Software (aes)
             Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                           Analysis prepared by:

                      Kimley-Horn and Associates, Inc.
                             765 The City Drive
                                 Suite 200
                              Orange, CA 92868

 ************************** DESCRIPTION OF STUDY **************************
* VESTING TENTATIVE PARCEL MAP 18487                                       *
* REV 05-22-18                                                             *
* VP100EX.RES                                                              *
 **************************************************************************

  FILE NAME: VP100EX.DAT
  TIME/DATE OF STUDY: 11:35 05/24/2018
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   8.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 1.00
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.678
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.130
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =  100.00   1-HOUR INTENSITY(INCH/HOUR) = 1.1300
  SLOPE OF INTENSITY DURATION CURVE = 0.7000

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   884.10
  ELEVATION DATA: UPSTREAM(FEET) =   3232.78  DOWNSTREAM(FEET) =   3225.87

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   20.901
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  2.364
```

```
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  NATURAL POOR COVER
  "BARREN"                   A        7.06      0.18     1.000    93   20.90
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.18
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =     13.88
  TOTAL AREA(ACRES) =      7.06   PEAK FLOW RATE(CFS) =     13.88

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   3225.87  DOWNSTREAM(FEET) =   3214.87
  CHANNEL LENGTH THRU SUBAREA(FEET) =  1309.00   CHANNEL SLOPE =  0.0084
  CHANNEL BASE(FEET) =    0.00   "Z" FACTOR =   3.000
  MANNING'S FACTOR = 0.030   MAXIMUM DEPTH(FEET) =   2.00
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.964
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  NATURAL POOR COVER
  "BARREN"                   A        7.84      0.18     1.000    93
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.18
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      20.19
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   3.44
  AVERAGE FLOW DEPTH(FEET) =   1.40   TRAVEL TIME(MIN.) =   6.34
  Tc(MIN.) =   27.24
  SUBAREA AREA(ACRES) =     7.84       SUBAREA RUNOFF(CFS) =   12.59
  EFFECTIVE AREA(ACRES) =     14.90     AREA-AVERAGED Fm(INCH/HR) =   0.18
  AREA-AVERAGED Fp(INCH/HR) =   0.18  AREA-AVERAGED Ap =   1.00
  TOTAL AREA(ACRES) =       14.9         PEAK FLOW RATE(CFS) =      23.92

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  1.49   FLOW VELOCITY(FEET/SEC.) =   3.59
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =    2193.10 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       14.9  TC(MIN.) =     27.24
  EFFECTIVE AREA(ACRES) =     14.90  AREA-AVERAGED Fm(INCH/HR)=  0.18
  AREA-AVERAGED Fp(INCH/HR) =  0.18  AREA-AVERAGED Ap = 1.000
  PEAK FLOW RATE(CFS)   =     23.92
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

```
____________________________________________________________________________
****************************************************************************
          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
        (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
        (c) Copyright 1983-2011 Advanced Engineering Software (aes)
          Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                          Analysis prepared by:
                      Kimley-Horn and Associates, Inc.
                            765 The City Drive
                                Suite 200
                            Orange, CA 92868
  ************************** DESCRIPTION OF STUDY **************************
* VESTING TENTATIVE PARCEL MAP 18487                                       *
* KR 10/30/18                                                              *
* VPOFF1.RES                                                               *
 **************************************************************************

  FILE NAME: VPOFF1.DAT
  TIME/DATE OF STUDY: 17:15 10/30/2018
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   8.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 1.00
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.678
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.130
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =  100.00   1-HOUR INTENSITY(INCH/HOUR) = 1.1300
  SLOPE OF INTENSITY DURATION CURVE = 0.7000

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
    HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
    WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 0.167 0.0150
```

```
 GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
   1. Relative Flow-Depth =  0.00 FEET
      as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
   2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
 *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
  OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
 *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
 FLOW PROCESS FROM NODE    801.00 TO NODE    802.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   658.60
 ELEVATION DATA: UPSTREAM(FEET) =   3236.00  DOWNSTREAM(FEET) =   3230.90

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   18.613
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  2.564
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 NATURAL POOR COVER
 "BARREN"                  A       7.39      0.18     1.000    93   18.61
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.18
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
 SUBAREA RUNOFF(CFS) =     15.86
 TOTAL AREA(ACRES) =      7.39   PEAK FLOW RATE(CFS) =     15.86
============================================================================
 END OF STUDY SUMMARY:
 TOTAL AREA(ACRES)     =       7.4  TC(MIN.) =     18.61
 EFFECTIVE AREA(ACRES) =      7.39  AREA-AVERAGED Fm(INCH/HR)=  0.18
 AREA-AVERAGED Fp(INCH/HR) =  0.18  AREA-AVERAGED Ap = 1.000
 PEAK FLOW RATE(CFS)   =      15.86
============================================================================
============================================================================
 END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2011 Advanced Engineering Software (aes)
             Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                           Analysis prepared by:

                      Kimley-Horn and Associates, Inc.
                             765 The City Drive
                                 Suite 200
                              Orange, CA 92868

 ************************** DESCRIPTION OF STUDY **************************
 * VESTING TENTATIVE PARCEL MAP 18487                                       *
 * REV 05-22-18                                                             *
 * VPOFF2.RES                                                               *
 **************************************************************************

  FILE NAME: VPOFF2.DAT
  TIME/DATE OF STUDY: 11:07 05/24/2018
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   8.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 1.00
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.678
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.130
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =  100.00   1-HOUR INTENSITY(INCH/HOUR) = 1.1300
  SLOPE OF INTENSITY DURATION CURVE = 0.7000

  *ANTECEDENT MOISTURE CONDITION (AMC) I ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE    900.00 TO NODE    901.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   735.70
  ELEVATION DATA: UPSTREAM(FEET) =   3237.00  DOWNSTREAM(FEET) =   3226.59

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   17.246
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  2.705
```

```
  SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  NATURAL POOR COVER
  "BARREN"                   A        7.16      0.67     1.000    61   17.25
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.67
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =     13.14
  TOTAL AREA(ACRES) =      7.16   PEAK FLOW RATE(CFS) =     13.14
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        7.2  TC(MIN.) =     17.25
  EFFECTIVE AREA(ACRES) =      7.16  AREA-AVERAGED Fm(INCH/HR)=  0.67
  AREA-AVERAGED Fp(INCH/HR) =  0.67  AREA-AVERAGED Ap = 1.000
  PEAK FLOW RATE(CFS)   =      13.14
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

Rational Method Data (Hydrology AES Models)
Post-Development

```
____________________________________________________________________________
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2011 Advanced Engineering Software (aes)
             Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                           Analysis prepared by:

                      Kimley-Horn and Associates, Inc.
                             765 The City Drive
                                 Suite 200
                              Orange, CA 92868

 ************************** DESCRIPTION OF STUDY **************************
* VESTING TENTATIVE PARCEL MAP 18487                                       *
* REV 5-22-18                                                              *
* VP10P.RES                                                                *
 **************************************************************************

  FILE NAME: VP10P.DAT
  TIME/DATE OF STUDY: 14:35 05/22/2018
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   10.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   8.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 1.00
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.678
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.130
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =   10.00   1-HOUR INTENSITY(INCH/HOUR) = 0.6848
  SLOPE OF INTENSITY DURATION CURVE = 0.7000

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE    700.00 TO NODE    701.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   414.30
  ELEVATION DATA: UPSTREAM(FEET) =   3234.90  DOWNSTREAM(FEET) =   3227.85

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.788
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.436
```

```
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        0.73      0.98     0.500    32    9.79
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      1.28
  TOTAL AREA(ACRES) =      0.73   PEAK FLOW RATE(CFS) =      1.28

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   680.70
  ELEVATION DATA: UPSTREAM(FEET) =   3230.00  DOWNSTREAM(FEET) =   3223.54

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   13.418
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.954
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        3.22      0.98     0.500    32   13.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      4.25
  TOTAL AREA(ACRES) =      3.22   PEAK FLOW RATE(CFS) =      4.25

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3219.54  DOWNSTREAM(FEET) =  3219.36
  FLOW LENGTH(FEET) =    27.68   MANNING'S N =  0.013
  DEPTH OF FLOW IN  15.0 INCH PIPE IS  10.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.73
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       4.25
  PIPE TRAVEL TIME(MIN.) =   0.10    Tc(MIN.) =   13.52
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     708.38 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    202.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.52
  RAINFALL INTENSITY(INCH/HR) =   1.94
  AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       3.22
  TOTAL STREAM AREA(ACRES) =       3.22
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       4.25

****************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    301.00 IS CODE =  21
----------------------------------------------------------------------------
```

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   696.60
  ELEVATION DATA: UPSTREAM(FEET) =   3234.90  DOWNSTREAM(FEET) =   3223.45

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.133
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  2.096
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"        A        3.15      0.98     0.500    32   12.13
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      4.56
  TOTAL AREA(ACRES) =      3.15   PEAK FLOW RATE(CFS) =      4.56

****************************************************************************
  FLOW PROCESS FROM NODE    301.00 TO NODE    202.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3219.45  DOWNSTREAM(FEET) =  3219.36
  FLOW LENGTH(FEET) =    22.31   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS  10.9 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.06
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      4.56
  PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =   12.22
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    202.00 =     718.91 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    202.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.22
  RAINFALL INTENSITY(INCH/HR) =   2.09
  AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       3.15
  TOTAL STREAM AREA(ACRES) =       3.15
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      4.56

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        4.25   13.52    1.944  0.98( 0.49) 0.50       3.2     200.00
      2        4.56   12.22    2.085  0.98( 0.49) 0.50       3.2     300.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        8.78   12.22    2.085  0.98( 0.49) 0.50       6.1     300.00
      2        8.41   13.52    1.944  0.98( 0.49) 0.50       6.4     200.00
```

```
  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       8.78    Tc(MIN.) =    12.22
  EFFECTIVE AREA(ACRES) =       6.06   AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.50
  TOTAL AREA(ACRES) =        6.4
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    202.00 =     718.91 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    203.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3219.36  DOWNSTREAM(FEET) =  3212.64
  FLOW LENGTH(FEET) =  1049.87   MANNING'S N =  0.013
  DEPTH OF FLOW IN  21.0 INCH PIPE IS  12.9 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.69
  ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       8.78
  PIPE TRAVEL TIME(MIN.) =   3.08    Tc(MIN.) =   15.30
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    203.00 =    1768.78 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    203.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   15.30
  RAINFALL INTENSITY(INCH/HR) =   1.78
  AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       6.06
  TOTAL STREAM AREA(ACRES) =       6.37
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.78

****************************************************************************
  FLOW PROCESS FROM NODE    400.00 TO NODE    401.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   916.80
  ELEVATION DATA: UPSTREAM(FEET) =   3231.87  DOWNSTREAM(FEET) =   3218.15

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   13.799
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.916
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A       3.22      0.98     0.500    32   13.80
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.98
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      4.14
  TOTAL AREA(ACRES) =      3.22   PEAK FLOW RATE(CFS) =      4.14

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    203.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
```

```
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.80
  RAINFALL INTENSITY(INCH/HR) =   1.92
  AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       3.22
  TOTAL STREAM AREA(ACRES) =       3.22
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       4.14

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        8.78   15.30    1.782  0.98( 0.49) 0.50       6.1     300.00
      1        8.41   16.62    1.682  0.98( 0.49) 0.50       6.4     200.00
      2        4.14   13.80    1.916  0.98( 0.49) 0.50       3.2     400.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       12.87   13.80    1.916  0.98( 0.49) 0.50       8.7     400.00
      2       12.53   15.30    1.782  0.98( 0.49) 0.50       9.3     300.00
      3       11.87   16.62    1.682  0.98( 0.49) 0.50       9.6     200.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      12.87    Tc(MIN.) =    13.80
  EFFECTIVE AREA(ACRES) =       8.69   AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.50
  TOTAL AREA(ACRES) =       9.6
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    203.00 =    1768.78 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    204.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3212.64  DOWNSTREAM(FEET) =  3212.11
  FLOW LENGTH(FEET) =    83.37   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  15.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.24
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      12.87
  PIPE TRAVEL TIME(MIN.) =   0.22    Tc(MIN.) =   14.02
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    204.00 =    1852.15 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    204.00 TO NODE    204.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   14.02
  RAINFALL INTENSITY(INCH/HR) =   1.89
  AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.98
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       8.69
  TOTAL STREAM AREA(ACRES) =       9.59
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      12.87
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    500.00 TO NODE    501.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   967.60
  ELEVATION DATA: UPSTREAM(FEET) =   3227.30  DOWNSTREAM(FEET) =   3217.30

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   15.183
  *  10 YEAR RAINFALL INTENSITY(INCH/HR) =  1.792
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        4.58      0.98     0.500    32   15.18
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.97
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      5.38
  TOTAL AREA(ACRES) =      4.58   PEAK FLOW RATE(CFS) =      5.38

****************************************************************************
  FLOW PROCESS FROM NODE    501.00 TO NODE    204.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3213.30  DOWNSTREAM(FEET) =  3212.11
  FLOW LENGTH(FEET) =    33.27   MANNING'S N =  0.013
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   8.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   9.53
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       5.38
  PIPE TRAVEL TIME(MIN.) =   0.06    Tc(MIN.) =   15.24
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    204.00 =    1000.87 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    204.00 TO NODE    204.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   15.24
  RAINFALL INTENSITY(INCH/HR) =   1.79
  AREA-AVERAGED Fm(INCH/HR) =  0.49
  AREA-AVERAGED Fp(INCH/HR) =  0.97
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       4.58
  TOTAL STREAM AREA(ACRES) =       4.58
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       5.38

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       12.87   14.02    1.895  0.98( 0.49) 0.50       8.7     400.00
      1       12.53   15.53    1.764  0.98( 0.49) 0.50       9.3     300.00
      1       11.87   16.85    1.666  0.98( 0.49) 0.50       9.6     200.00
      2        5.38   15.24    1.787  0.97( 0.49) 0.50       4.6     500.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
```

```
 STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
 NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
    1       18.23   14.02    1.895  0.98( 0.49) 0.50      12.9     400.00
    2       17.97   15.24    1.787  0.98( 0.49) 0.50      13.7     500.00
    3       17.81   15.53    1.764  0.98( 0.49) 0.50      13.9     300.00
    4       16.74   16.85    1.666  0.98( 0.49) 0.50      14.2     200.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
PEAK FLOW RATE(CFS) =      18.23    Tc(MIN.) =    14.02
EFFECTIVE AREA(ACRES) =      12.90   AREA-AVERAGED Fm(INCH/HR) =  0.49
AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap =  0.50
TOTAL AREA(ACRES) =       14.2
LONGEST FLOWPATH FROM NODE    300.00 TO NODE    204.00 =    1852.15 FEET.

****************************************************************************
FLOW PROCESS FROM NODE    204.00 TO NODE    600.00 IS CODE =  31
----------------------------------------------------------------------------
>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
ELEVATION DATA: UPSTREAM(FEET) =  3212.11  DOWNSTREAM(FEET) =  3212.03
FLOW LENGTH(FEET) =    11.87   MANNING'S N =  0.013
DEPTH OF FLOW IN  24.0 INCH PIPE IS  19.3 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) =   6.74
ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
PIPE-FLOW(CFS) =      18.23
PIPE TRAVEL TIME(MIN.) =   0.03    Tc(MIN.) =   14.05
LONGEST FLOWPATH FROM NODE    300.00 TO NODE    600.00 =    1864.02 FEET.
============================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)     =       14.2  TC(MIN.) =     14.05
EFFECTIVE AREA(ACRES) =     12.90  AREA-AVERAGED Fm(INCH/HR)=  0.49
AREA-AVERAGED Fp(INCH/HR) =  0.98  AREA-AVERAGED Ap = 0.500
PEAK FLOW RATE(CFS)   =      18.23

** PEAK FLOW RATE TABLE **
 STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
 NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
    1       18.23   14.05    1.892  0.98( 0.49) 0.50      12.9     400.00
    2       17.97   15.27    1.785  0.98( 0.49) 0.50      13.7     500.00
    3       17.81   15.56    1.761  0.98( 0.49) 0.50      13.9     300.00
    4       16.74   16.88    1.664  0.98( 0.49) 0.50      14.2     200.00
============================================================================
============================================================================
END OF RATIONAL METHOD ANALYSIS
```

```
____________________________________________________________________________
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
         (c) Copyright 1983-2011 Advanced Engineering Software (aes)
             Ver. 18.0  Release Date: 07/01/2011  License ID 1499

                           Analysis prepared by:

                      Kimley-Horn and Associates, Inc.
                             765 The City Drive
                                 Suite 200
                              Orange, CA 92868

 ************************** DESCRIPTION OF STUDY **************************
* VESTING TENTATIVE PARCEL MAP 18487                                       *
* REV 5-22-18                                                              *
* VP100P.RES                                                               *
 **************************************************************************

  FILE NAME: VP100P.DAT
  TIME/DATE OF STUDY: 14:10 05/22/2018
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   8.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 1.00
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*
  10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  0.678
  100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.130
  COMPUTED RAINFALL INTENSITY DATA:
  STORM EVENT =  100.00   1-HOUR INTENSITY(INCH/HOUR) = 1.1300
  SLOPE OF INTENSITY DURATION CURVE = 0.7000

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.50    2.00 0.0312 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE    700.00 TO NODE    701.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   414.30
  ELEVATION DATA: UPSTREAM(FEET) =   3234.90  DOWNSTREAM(FEET) =   3227.85

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.788
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.021
```

```
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        0.73      0.74     0.500    52    9.79
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      2.40
  TOTAL AREA(ACRES) =      0.73   PEAK FLOW RATE(CFS) =      2.40

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   680.70
  ELEVATION DATA: UPSTREAM(FEET) =   3230.00  DOWNSTREAM(FEET) =   3223.54

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   13.418
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.224
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        3.22      0.74     0.500    52   13.42
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      8.27
  TOTAL AREA(ACRES) =      3.22   PEAK FLOW RATE(CFS) =      8.27

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3219.54  DOWNSTREAM(FEET) =  3219.36
  FLOW LENGTH(FEET) =    27.68   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS  14.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.46
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       8.27
  PIPE TRAVEL TIME(MIN.) =   0.08    Tc(MIN.) =   13.50
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     708.38 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    202.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.50
  RAINFALL INTENSITY(INCH/HR) =   3.21
  AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       3.22
  TOTAL STREAM AREA(ACRES) =       3.22
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.27

****************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    301.00 IS CODE =  21
----------------------------------------------------------------------------
```

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   696.60
  ELEVATION DATA: UPSTREAM(FEET) =   3234.90  DOWNSTREAM(FEET) =   3223.45

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.133
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.459
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        3.15      0.74     0.500    52   12.13
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      8.76
  TOTAL AREA(ACRES) =      3.15   PEAK FLOW RATE(CFS) =      8.76

****************************************************************************
  FLOW PROCESS FROM NODE    301.00 TO NODE    202.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3219.45  DOWNSTREAM(FEET) =  3219.36
  FLOW LENGTH(FEET) =    22.31   MANNING'S N =  0.013
  DEPTH OF FLOW IN  21.0 INCH PIPE IS  15.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.71
  ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       8.76
  PIPE TRAVEL TIME(MIN.) =   0.08    Tc(MIN.) =   12.21
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    202.00 =     718.91 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    202.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.21
  RAINFALL INTENSITY(INCH/HR) =   3.44
  AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       3.15
  TOTAL STREAM AREA(ACRES) =       3.15
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.76

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1        8.27   13.50    3.210  0.74( 0.37) 0.50       3.2     200.00
      2        8.76   12.21    3.444  0.74( 0.37) 0.50       3.2     300.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       16.85   12.21    3.444  0.74( 0.37) 0.50       6.1     300.00
      2       16.36   13.50    3.210  0.74( 0.37) 0.50       6.4     200.00
```

```
  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      16.85    Tc(MIN.) =    12.21
  EFFECTIVE AREA(ACRES) =       6.06   AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.50
  TOTAL AREA(ACRES) =        6.4
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    202.00 =     718.91 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    203.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3219.36  DOWNSTREAM(FEET) =  3212.64
  FLOW LENGTH(FEET) =  1049.87   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  18.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.55
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      16.85
  PIPE TRAVEL TIME(MIN.) =   2.67    Tc(MIN.) =   14.89
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    203.00 =    1768.78 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    203.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   14.89
  RAINFALL INTENSITY(INCH/HR) =   3.00
  AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       6.06
  TOTAL STREAM AREA(ACRES) =       6.37
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      16.85

****************************************************************************
  FLOW PROCESS FROM NODE    400.00 TO NODE    401.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   916.80
  ELEVATION DATA: UPSTREAM(FEET) =   3231.87  DOWNSTREAM(FEET) =   3218.15

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   13.799
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.162
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        3.22      0.74     0.500    52   13.80
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =      8.09
  TOTAL AREA(ACRES) =      3.22   PEAK FLOW RATE(CFS) =      8.09

****************************************************************************
  FLOW PROCESS FROM NODE    401.00 TO NODE    203.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
```

```
  ELEVATION DATA: UPSTREAM(FEET) =  3214.15  DOWNSTREAM(FEET) =  3212.64
  FLOW LENGTH(FEET) =    34.81   MANNING'S N =  0.013
  DEPTH OF FLOW IN  15.0 INCH PIPE IS   8.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  11.46
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =        8.09
  PIPE TRAVEL TIME(MIN.) =   0.05    Tc(MIN.) =   13.85
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    203.00 =     951.61 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    203.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.85
  RAINFALL INTENSITY(INCH/HR) =   3.15
  AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       3.22
  TOTAL STREAM AREA(ACRES) =       3.22
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.09

  ** CONFLUENCE DATA **
```

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	16.85	14.89	2.998	0.74(0.37)	0.50	6.1	300.00
1	16.36	16.18	2.828	0.74(0.37)	0.50	6.4	200.00
2	8.09	13.85	3.153	0.74(0.37)	0.50	3.2	400.00

```
  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
```

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	24.69	13.85	3.153	0.74(0.37)	0.50	8.9	400.00
2	24.49	14.89	2.998	0.74(0.37)	0.50	9.3	300.00
3	23.50	16.18	2.828	0.74(0.37)	0.50	9.6	200.00

```
  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      24.69    Tc(MIN.) =    13.85
  EFFECTIVE AREA(ACRES) =       8.86   AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.50
  TOTAL AREA(ACRES) =        9.6
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    203.00 =    1768.78 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    204.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3212.64  DOWNSTREAM(FEET) =  3212.11
  FLOW LENGTH(FEET) =    83.37   MANNING'S N =  0.013
  DEPTH OF FLOW IN  30.0 INCH PIPE IS  19.5 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.32
  ESTIMATED PIPE DIAMETER(INCH) =  30.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      24.69
  PIPE TRAVEL TIME(MIN.) =   0.19    Tc(MIN.) =   14.04
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    204.00 =    1852.15 FEET.

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    204.00 TO NODE    204.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   14.04
  RAINFALL INTENSITY(INCH/HR) =   3.12
  AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       8.86
  TOTAL STREAM AREA(ACRES) =       9.59
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      24.69

****************************************************************************
  FLOW PROCESS FROM NODE    500.00 TO NODE    501.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   967.60
  ELEVATION DATA: UPSTREAM(FEET) =   3227.30  DOWNSTREAM(FEET) =   3217.30

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   15.183
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  2.957
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "5-7 DWELLINGS/ACRE"       A        4.58      0.74     0.500    52   15.18
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.500
  SUBAREA RUNOFF(CFS) =     10.66
  TOTAL AREA(ACRES) =      4.58   PEAK FLOW RATE(CFS) =     10.66

****************************************************************************
  FLOW PROCESS FROM NODE    501.00 TO NODE    204.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3213.30  DOWNSTREAM(FEET) =  3212.11
  FLOW LENGTH(FEET) =    33.27   MANNING'S N =  0.013
  DEPTH OF FLOW IN  15.0 INCH PIPE IS  10.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  11.22
  ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      10.66
  PIPE TRAVEL TIME(MIN.) =   0.05    Tc(MIN.) =   15.23
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    204.00 =    1000.87 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    204.00 TO NODE    204.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   15.23
  RAINFALL INTENSITY(INCH/HR) =   2.95
  AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74
  AREA-AVERAGED Ap =  0.50
  EFFECTIVE STREAM AREA(ACRES) =       4.58
```

```
  TOTAL STREAM AREA(ACRES) =       4.58
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      10.66

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       24.69   14.04    3.124  0.74( 0.37) 0.50       8.9     400.00
      1       24.49   15.08    2.971  0.74( 0.37) 0.50       9.3     300.00
      1       23.50   16.38    2.804  0.74( 0.37) 0.50       9.6     200.00
      2       10.66   15.23    2.950  0.74( 0.37) 0.50       4.6     500.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       35.17   14.04    3.124  0.74( 0.37) 0.50      13.1     400.00
      2       35.12   15.08    2.971  0.74( 0.37) 0.50      13.8     300.00
      3       35.03   15.23    2.950  0.74( 0.37) 0.50      13.9     500.00
      4       33.55   16.38    2.804  0.74( 0.37) 0.50      14.2     200.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      35.17    Tc(MIN.) =    14.04
  EFFECTIVE AREA(ACRES) =      13.08   AREA-AVERAGED Fm(INCH/HR) =  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap =  0.50
  TOTAL AREA(ACRES) =       14.2
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    204.00 =    1852.15 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    204.00 TO NODE    600.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =  3212.11  DOWNSTREAM(FEET) =  3212.03
  FLOW LENGTH(FEET) =    11.87   MANNING'S N =  0.013
  DEPTH OF FLOW IN  33.0 INCH PIPE IS  22.5 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.14
  ESTIMATED PIPE DIAMETER(INCH) =  33.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      35.17
  PIPE TRAVEL TIME(MIN.) =   0.02    Tc(MIN.) =   14.06
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    600.00 =    1864.02 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       14.2  TC(MIN.) =     14.06
  EFFECTIVE AREA(ACRES) =     13.08  AREA-AVERAGED Fm(INCH/HR)=  0.37
  AREA-AVERAGED Fp(INCH/HR) =  0.74  AREA-AVERAGED Ap = 0.500
  PEAK FLOW RATE(CFS)   =      35.17

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       35.17   14.06    3.120  0.74( 0.37) 0.50      13.1     400.00
      2       35.12   15.11    2.967  0.74( 0.37) 0.50      13.8     300.00
      3       35.03   15.26    2.947  0.74( 0.37) 0.50      13.9     500.00
      4       33.55   16.41    2.801  0.74( 0.37) 0.50      14.2     200.00
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

Small Unit Hydrographs

LOW LOSS FRACTION AMC II POST-DEVELOPMENT 10 YEAR

==

*** NON-HOMOGENEOUS WATERSHED AREA-AVERAGED LOSS RATE (Fm)

AND LOW LOSS FRACTION ESTIMATIONS FOR AMC II:

TOTAL 24-HOUR DURATION RAINFALL DEPTH = 2.87 (inches)

SOIL-COVER TYPE	AREA (Acres)	PERCENT OF PERVIOUS AREA	SCS CURVE NUMBER	LOSS RATE Fp(in./hr.)	YIELD
1	14.90	50.00	32.	0.975	0.460

TOTAL AREA (Acres) = 14.90

AREA-AVERAGED LOSS RATE, $\bar{F}m$ (in./hr.) = 0.488

AREA-AVERAGED LOW LOSS FRACTION, $\bar{Y}$ = 0.540

==

10-YEAR POST-DEVELOPED

Small Area Unit Hydrograph Analysis

Hydrologic Data:

Rational Method Peak Flow Rate Calibration Coefficient (XK) :ALLOWABLE VALUES ARE [.1] TO [2.] (Recommended Value = 0.9)	.9
Catchment Total Area (Acres) :ALLOWABLE VALUES ARE [.001] TO [999.99]	14.9
Soil-Loss Rate (Phi-Index), Fm, (in/hr) :ALLOWABLE VALUES ARE [.0] TO [9.99]	0.488
Low Loss Fraction, Ybar :ALLOWABLE VALUES ARE [0.] TO [1.]	0.540
Time of Concentration (minutes) for Total Catchment :ALLOWABLE VALUES ARE [5.] TO [60.]	14.06
Return Frequency (Years) :ALLOWABLE VALUES ARE [2] TO [500]	10

Point Rainfall Options

- (•) Use Orange County "Valley" Rainfall Values for 2-, 5-, 10-, 25-, 50- and 100- Year Return Frequency
- ( ) Enter User Specified Point Rainfall Values

Small Area Unit Hydrograph Analysis

Point Rainfall Values (inches)

5-minute Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [2.]	0.195
30-minute Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [4.]	0.506
1-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [6.]	0.678
3-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [8.]	1.05
6-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [12.]	1.42
24-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [20.]	2.87

Calculate | Exit Program | Back to Main | Previous Page

RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) = 14.90
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.488
LOW LOSS FRACTION = 0.540
TIME OF CONCENTRATION(MIN.) = 14.06
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 10
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.19
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.51
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.68
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.05
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.42
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.87

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 1.54
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 2.02

****

TIME (HOURS)	VOLUME (AF)	Q (CFS)	0.	5.0	10.0	15.0	20.0
0.07	0.0000	0.00	Q	.	.	.	.
0.30	0.0036	0.38	Q	.	.	.	.
0.53	0.0109	0.38	Q	.	.	.	.
0.77	0.0183	0.38	Q	.	.	.	.
1.00	0.0257	0.38	Q	.	.	.	.
1.24	0.0332	0.39	Q	.	.	.	.
1.47	0.0407	0.39	Q	.	.	.	.
1.71	0.0483	0.39	Q	.	.	.	.
1.94	0.0559	0.40	Q	.	.	.	.
2.17	0.0636	0.40	Q	.	.	.	.
2.41	0.0714	0.40	Q	.	.	.	.
2.64	0.0792	0.41	Q	.	.	.	.
2.88	0.0871	0.41	Q	.	.	.	.
3.11	0.0951	0.41	Q	.	.	.	.
3.35	0.1032	0.42	Q	.	.	.	.
3.58	0.1113	0.42	Q	.	.	.	.
3.81	0.1195	0.42	Q	.	.	.	.
4.05	0.1277	0.43	Q	.	.	.	.
4.28	0.1361	0.43	Q	.	.	.	.
4.52	0.1445	0.44	Q	.	.	.	.
4.75	0.1530	0.44	Q	.	.	.	.
4.99	0.1616	0.45	Q	.	.	.	.
5.22	0.1703	0.45	Q	.	.	.	.

5.45	0.1791	0.46	Q . . . .
5.69	0.1879	0.46	Q . . . .
5.92	0.1969	0.47	Q . . . .
6.16	0.2060	0.47	Q . . . .
6.39	0.2152	0.48	Q . . . .
6.63	0.2244	0.48	Q . . . .
6.86	0.2338	0.49	Q . . . .
7.10	0.2434	0.49	Q . . . .
7.33	0.2530	0.50	.Q . . . .
7.56	0.2628	0.51	.Q . . . .
7.80	0.2727	0.52	.Q . . . .
8.03	0.2827	0.52	.Q . . . .
8.27	0.2929	0.53	.Q . . . .
8.50	0.3032	0.54	.Q . . . .
8.74	0.3137	0.55	.Q . . . .
8.97	0.3243	0.55	.Q . . . .
9.20	0.3351	0.56	.Q . . . .
9.44	0.3461	0.57	.Q . . . .
9.67	0.3573	0.58	.Q . . . .
9.91	0.3687	0.59	.Q . . . .
10.14	0.3803	0.61	.Q . . . .
10.38	0.3921	0.61	.Q . . . .
10.61	0.4041	0.63	.Q . . . .
10.84	0.4164	0.64	.Q . . . .
11.08	0.4290	0.66	.Q . . . .
11.31	0.4419	0.67	.Q . . . .
11.55	0.4551	0.69	.Q . . . .
11.78	0.4686	0.70	.Q . . . .
12.02	0.4824	0.73	.Q . . . .
12.25	0.4960	0.68	.Q . . . .
12.48	0.5091	0.67	.Q . . . .
12.72	0.5222	0.68	.Q . . . .
12.95	0.5358	0.72	.Q . . . .
13.19	0.5499	0.74	.Q . . . .
13.42	0.5647	0.79	.Q . . . .
13.66	0.5803	0.81	.Q . . . .
13.89	0.5966	0.88	.Q . . . .
14.13	0.6140	0.91	.Q . . . .
14.36	0.6317	0.92	.Q . . . .
14.59	0.6500	0.97	.Q . . . .
14.83	0.6700	1.10	. Q . . . .
15.06	0.6921	1.19	. Q . . . .
15.30	0.7175	1.43	. Q . . . .
15.53	0.7473	1.64	. Q . . . .
15.77	0.7875	2.51	. Q . . . .
16.00	0.8503	3.97	. Q . . . .
16.23	1.0127	12.80	. . . Q . .
16.47	1.1558	1.99	. Q . . . .
16.70	1.1876	1.29	. Q . . . .
16.94	1.2101	1.03	. Q . . . .
17.17	1.2287	0.89	.Q . . . .

17.41	1.2454	0.84	.Q	.	.	.	.
17.64	1.2610	0.76	.Q	.	.	.	.
17.87	1.2752	0.70	.Q	.	.	.	.
18.11	1.2883	0.65	.Q	.	.	.	.
18.34	1.3015	0.72	.Q	.	.	.	.
18.58	1.3151	0.68	.Q	.	.	.	.
18.81	1.3279	0.65	.Q	.	.	.	.
19.05	1.3402	0.62	.Q	.	.	.	.
19.28	1.3521	0.60	.Q	.	.	.	.
19.52	1.3635	0.58	.Q	.	.	.	.
19.75	1.3744	0.56	.Q	.	.	.	.
19.98	1.3851	0.54	.Q	.	.	.	.
20.22	1.3954	0.53	.Q	.	.	.	.
20.45	1.4055	0.51	.Q	.	.	.	.
20.69	1.4152	0.50	Q	.	.	.	.
20.92	1.4247	0.49	Q	.	.	.	.
21.16	1.4340	0.47	Q	.	.	.	.
21.39	1.4431	0.46	Q	.	.	.	.
21.62	1.4520	0.45	Q	.	.	.	.
21.86	1.4607	0.44	Q	.	.	.	.
22.09	1.4692	0.44	Q	.	.	.	.
22.33	1.4775	0.43	Q	.	.	.	.
22.56	1.4857	0.42	Q	.	.	.	.
22.80	1.4937	0.41	Q	.	.	.	.
23.03	1.5016	0.40	Q	.	.	.	.
23.26	1.5094	0.40	Q	.	.	.	.
23.50	1.5171	0.39	Q	.	.	.	.
23.73	1.5246	0.39	Q	.	.	.	.
23.97	1.5320	0.38	Q	.	.	.	.
24.20	1.5393	0.37	Q	.	.	.	.
24.44	1.5429	0.00	Q	.	.	.	.

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
0%	1448.2
10%	98.4
20%	28.1
30%	28.1
40%	14.1
50%	14.1
60%	14.1
70%	14.1
80%	14.1
90%	14.1

LOW LOSS FRACTION AMC III POST-DEVELOPMENT 100 YEAR

==

*** NON-HOMOGENEOUS WATERSHED AREA-AVERAGED LOSS RATE (Fm)

AND LOW LOSS FRACTION ESTIMATIONS FOR AMC III:

TOTAL 24-HOUR DURATION RAINFALL DEPTH = 5.19 (inches)

SOIL-COVER TYPE	AREA (Acres)	PERCENT OF PERVIOUS AREA	SCS CURVE NUMBER	LOSS RATE Fp(in./hr.)	YIELD
1	14.90	50.00	32.(AMC II)	0.742	0.563

TOTAL AREA (Acres) = 14.90

AREA-AVERAGED LOSS RATE, $\bar{F}m$ (in./hr.) = 0.371

AREA-AVERAGED LOW LOSS FRACTION, $\bar{Y}$ = 0.437

==

100-YEAR POST-DEVELOPED

Small Area Unit Hydrograph Analysis

Hydrologic Data:

Rational Method Peak Flow Rate Calibration Coefficient (XK) :ALLOWABLE VALUES ARE [.1] TO [2.] (Recommended Value = 0.9)	.9
Catchment Total Area (Acres) :ALLOWABLE VALUES ARE [.001] TO [999.99]	14.90
Soil-Loss Rate (Phi-Index), Fm, (in/hr) :ALLOWABLE VALUES ARE [.0] TO [9.99]	0.371
Low Loss Fraction, Ybar :ALLOWABLE VALUES ARE [0.] TO [1.]	0.437
Time of Concentration (minutes) for Total Catchment :ALLOWABLE VALUES ARE [5.] TO [60.]	14.06
Return Frequency (Years) :ALLOWABLE VALUES ARE [2] TO [500]	100

Point Rainfall Options

- (•) Use Orange County "Valley" Rainfall Values for 2-, 5-, 10-, 25-, 50- and 100- Year Return Frequency
- ( ) Enter User Specified Point Rainfall Values

Small Area Unit Hydrograph Analysis

Point Rainfall Values (inches)

5-minute Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [2.]	0.324
30-minute Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [4.]	0.843
1-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [6.]	1.13
3-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [8.]	1.77
6-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [12.]	2.45
24-hour Point Rainfall Value :ALLOWABLE VALUES ARE [.001] TO [20.]	5.19

Calculate | Exit Program

Back to Main | Previous Page

RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) = 14.90
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.371
LOW LOSS FRACTION = 0.437
TIME OF CONCENTRATION(MIN.) = 14.06
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 100
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.32
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.84
1-HOUR POINT RAINFALL VALUE(INCHES) = 1.13
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.77
6-HOUR POINT RAINFALL VALUE(INCHES) = 2.45
24-HOUR POINT RAINFALL VALUE(INCHES) = 5.19

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 3.45
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 2.99

```
****************************************************************************
 TIME     VOLUME      Q   0.       7.5      15.0      22.5      30.0
(HOURS)    (AF)     (CFS)
----------------------------------------------------------------------------
 0.07     0.0000     0.00  Q        .         .         .         .
 0.30     0.0086     0.89  .Q       .         .         .         .
 0.53     0.0258     0.89  .Q       .         .         .         .
 0.77     0.0432     0.90  .Q       .         .         .         .
 1.00     0.0606     0.90  .Q       .         .         .         .
 1.24     0.0782     0.91  .Q       .         .         .         .
 1.47     0.0960     0.92  .Q       .         .         .         .
 1.71     0.1138     0.93  .Q       .         .         .         .
 1.94     0.1318     0.93  .Q       .         .         .         .
 2.17     0.1499     0.94  .Q       .         .         .         .
 2.41     0.1682     0.95  .Q       .         .         .         .
 2.64     0.1866     0.96  .Q       .         .         .         .
 2.88     0.2051     0.96  .Q       .         .         .         .
 3.11     0.2238     0.97  .Q       .         .         .         .
 3.35     0.2427     0.98  .Q       .         .         .         .
 3.58     0.2617     0.99  .Q       .         .         .         .
 3.81     0.2809     0.99  .Q       .         .         .         .
 4.05     0.3002     1.00  .Q       .         .         .         .
 4.28     0.3197     1.01  .Q       .         .         .         .
 4.52     0.3394     1.02  .Q       .         .         .         .
 4.75     0.3593     1.03  .Q       .         .         .         .
 4.99     0.3794     1.04  .Q       .         .         .         .
 5.22     0.3996     1.05  .Q       .         .         .         .
 5.45     0.4201     1.06  .Q       .         .         .         .
 5.69     0.4407     1.07  .Q       .         .         .         .
```

5.92	0.4616	1.09	.Q . . . .
6.16	0.4827	1.09	.Q . . . .
6.39	0.5040	1.11	.Q . . . .
6.63	0.5256	1.12	.Q . . . .
6.86	0.5473	1.13	.Q . . . .
7.10	0.5694	1.14	.Q . . . .
7.33	0.5917	1.16	.Q . . . .
7.56	0.6143	1.17	.Q . . . .
7.80	0.6372	1.19	.Q . . . .
8.03	0.6603	1.20	.Q . . . .
8.27	0.6838	1.22	.Q . . . .
8.50	0.7076	1.23	.Q . . . .
8.74	0.7317	1.26	.Q . . . .
8.97	0.7562	1.27	.Q . . . .
9.20	0.7810	1.30	.Q . . . .
9.44	0.8062	1.31	.Q . . . .
9.67	0.8319	1.34	.Q . . . .
9.91	0.8579	1.35	.Q . . . .
10.14	0.8844	1.38	.Q . . . .
10.38	0.9114	1.40	.Q . . . .
10.61	0.9389	1.44	.Q . . . .
10.84	0.9669	1.46	.Q . . . .
11.08	0.9955	1.50	.Q . . . .
11.31	1.0247	1.52	. Q . . . .
11.55	1.0545	1.56	. Q . . . .
11.78	1.0851	1.59	. Q . . . .
12.02	1.1164	1.64	. Q . . . .
12.25	1.1472	1.54	. Q . . . .
12.48	1.1767	1.51	. Q . . . .
12.72	1.2064	1.55	. Q . . . .
12.95	1.2371	1.63	. Q . . . .
13.19	1.2690	1.67	. Q . . . .
13.42	1.3024	1.77	. Q . . . .
13.66	1.3372	1.83	. Q . . . .
13.89	1.3738	1.96	. Q . . . .
14.13	1.4124	2.03	. Q . . . .
14.36	1.4509	1.94	. Q . . . .
14.59	1.4895	2.05	. Q . . . .
14.83	1.5317	2.32	. Q . . . .
15.06	1.5784	2.50	. Q . . . .
15.30	1.6317	3.00	. Q . . . .
15.53	1.6938	3.42	. Q . . . .
15.77	1.7766	5.13	. Q . . . .
16.00	1.9176	9.44	. . Q . . .
16.23	2.2726	27.22	. . . . Q .
16.47	2.5754	4.06	. Q . . . .
16.70	2.6410	2.72	. Q . . . .
16.94	2.6884	2.17	. Q . . . .
17.17	2.7278	1.90	. Q . . . .
17.41	2.7645	1.89	. Q . . . .
17.64	2.7994	1.72	. Q . . . .

```
 17.87     2.8314     1.59  . Q      .       .       .       .
 18.11     2.8611     1.48  .Q       .       .       .       .
 18.34     2.8911     1.62  . Q      .       .       .       .
 18.58     2.9216     1.54  . Q      .       .       .       .
 18.81     2.9508     1.48  .Q       .       .       .       .
 19.05     2.9789     1.42  .Q       .       .       .       .
 19.28     3.0058     1.37  .Q       .       .       .       .
 19.52     3.0319     1.32  .Q       .       .       .       .
 19.75     3.0571     1.28  .Q       .       .       .       .
 19.98     3.0816     1.25  .Q       .       .       .       .
 20.22     3.1054     1.21  .Q       .       .       .       .
 20.45     3.1286     1.18  .Q       .       .       .       .
 20.69     3.1512     1.15  .Q       .       .       .       .
 20.92     3.1732     1.13  .Q       .       .       .       .
 21.16     3.1948     1.10  .Q       .       .       .       .
 21.39     3.2159     1.08  .Q       .       .       .       .
 21.62     3.2365     1.06  .Q       .       .       .       .
 21.86     3.2568     1.04  .Q       .       .       .       .
 22.09     3.2767     1.02  .Q       .       .       .       .
 22.33     3.2962     1.00  .Q       .       .       .       .
 22.56     3.3153     0.98  .Q       .       .       .       .
 22.80     3.3342     0.97  .Q       .       .       .       .
 23.03     3.3527     0.95  .Q       .       .       .       .
 23.26     3.3710     0.94  .Q       .       .       .       .
 23.50     3.3890     0.92  .Q       .       .       .       .
 23.73     3.4067     0.91  .Q       .       .       .       .
 23.97     3.4242     0.90  .Q       .       .       .       .
 24.20     3.4414     0.88  .Q       .       .       .       .
 24.44     3.4500     0.00  Q        .       .       .       .
-----------------------------------------------------------------------
-----------------------------------------------------------------------
```

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
0%	1448.2
10%	84.4
20%	28.1
30%	28.1
40%	14.1
50%	14.1
60%	14.1
70%	14.1
80%	14.1
90%	14.1

Infiltration/detention Basin Analysis

Project Summary

Title	Victorville Parcel Map
Engineer	
Company	Kimley-Horn and Associates
Date	5/24/2018

Notes	Due to a ridge line bisecting the site, the develop site requires an onsite storm drain system to convey flows to the infiltration basin located on the southeast portion of the parcel. The interior storm drain system was sized using the associated catch basin flows and it was determined that a 24-inch diameter pipe will conveyed the flows at a 0.64% slope within the streets to the catch basin adjacent to the infiltration basin. The flows will then confluence into a 36-inch diameter pipe and are conveyed into the basin. The basin will have a 24 inch diameter riser with seven (7) 3” orifices to control runoff from the infiltration basin.The onsite infiltration basin was sized by routing the developed 35.17 cfs.

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
On-site Area	Post-Development 100	0	269,730.000	1,000.000	35.17

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
O-1	Post-Development 100	0	250,204.000	1,020.000	22.35

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
Underground Vault (IN)	Post-Development 100	0	276,570.000	1,000.000	35.17	(N/A)	(N/A)
Underground Vault (OUT)	Post-Development 100	0	250,204.000	1,020.000	22.35	3,217.51	87,186.000

Subsection: Read Hydrograph
Label: On-site Area

Peak Discharge	35.17 ft³/s
Time to Peak	1,000.000 min
Hydrograph Volume	269,730.000 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 50.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.000	0.00	1.15	1.19	1.24	1.27
250.000	1.30	1.36	1.41	1.46	1.51
500.000	1.59	1.68	1.78	1.89	2.05
750.000	1.95	2.29	2.62	3.23	6.63
1,000.000	35.17	3.51	2.44	1.91	1.83
1,250.000	1.62	1.46	1.34	1.27	1.19
1,500.000	1.14	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Addition Summary
Label: O-1

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
Outlet-1	Underground Vault

Node Inflows

Inflow Type	Element	Volume (ft^3)	Time to Peak (min)	Flow (Peak) (ft^3/s)
Flow (From)	Outlet-1	250,203.578	1,020.000	22.35
Flow (In)	O-1	250,203.578	1,020.000	22.35

Subsection: Time vs. Elevation
Label: Underground Vault (IN)

Time vs. Elevation (ft)

Output Time increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	3,211.00	3,211.00	3,211.01	3,211.01	3,211.03
25.000	3,211.04	3,211.06	3,211.08	3,211.11	3,211.13
50.000	3,211.17	3,211.20	3,211.23	3,211.26	3,211.30
75.000	3,211.33	3,211.36	3,211.40	3,211.43	3,211.46
100.000	3,211.49	3,211.53	3,211.56	3,211.59	3,211.61
125.000	3,211.64	3,211.67	3,211.69	3,211.71	3,211.73
150.000	3,211.75	3,211.77	3,211.79	3,211.81	3,211.82
175.000	3,211.84	3,211.85	3,211.87	3,211.88	3,211.89
200.000	3,211.91	3,211.92	3,211.93	3,211.94	3,211.95
225.000	3,211.96	3,211.97	3,211.97	3,211.98	3,211.99
250.000	3,212.00	3,212.00	3,212.01	3,212.02	3,212.02
275.000	3,212.03	3,212.04	3,212.04	3,212.05	3,212.05
300.000	3,212.06	3,212.07	3,212.07	3,212.08	3,212.09
325.000	3,212.09	3,212.10	3,212.11	3,212.11	3,212.12
350.000	3,212.12	3,212.13	3,212.14	3,212.14	3,212.15
375.000	3,212.16	3,212.16	3,212.17	3,212.17	3,212.18
400.000	3,212.19	3,212.19	3,212.20	3,212.20	3,212.21
425.000	3,212.22	3,212.22	3,212.23	3,212.23	3,212.24
450.000	3,212.24	3,212.25	3,212.26	3,212.26	3,212.27
475.000	3,212.28	3,212.28	3,212.29	3,212.29	3,212.30
500.000	3,212.31	3,212.31	3,212.32	3,212.33	3,212.33
525.000	3,212.34	3,212.35	3,212.35	3,212.36	3,212.37
550.000	3,212.38	3,212.38	3,212.39	3,212.40	3,212.41
575.000	3,212.41	3,212.42	3,212.43	3,212.44	3,212.44
600.000	3,212.45	3,212.46	3,212.47	3,212.48	3,212.48
625.000	3,212.49	3,212.50	3,212.51	3,212.52	3,212.53
650.000	3,212.54	3,212.54	3,212.55	3,212.56	3,212.57
675.000	3,212.58	3,212.59	3,212.60	3,212.61	3,212.62
700.000	3,212.63	3,212.64	3,212.65	3,212.66	3,212.67
725.000	3,212.68	3,212.69	3,212.70	3,212.70	3,212.71
750.000	3,212.72	3,212.72	3,212.73	3,212.74	3,212.75
775.000	3,212.76	3,212.77	3,212.78	3,212.79	3,212.80
800.000	3,212.81	3,212.82	3,212.84	3,212.85	3,212.87
825.000	3,212.88	3,212.90	3,212.91	3,212.93	3,212.95
850.000	3,212.96	3,212.98	3,213.00	3,213.02	3,213.04
875.000	3,213.06	3,213.09	3,213.11	3,213.14	3,213.16
900.000	3,213.19	3,213.22	3,213.26	3,213.31	3,213.36
925.000	3,213.43	3,213.50	3,213.57	3,213.66	3,213.75
950.000	3,213.85	3,213.98	3,214.17	3,214.43	3,214.74
975.000	3,215.10	3,215.49	3,215.92	3,216.34	3,216.70
1,000.000	3,217.01	3,217.24	3,217.40	3,217.49	3,217.51
1,025.000	3,217.49	3,217.42	3,217.31	3,217.15	3,216.97
1,050.000	3,216.75	3,216.56	3,216.42	3,216.31	3,216.22

Subsection: Time vs. Elevation
Label: Underground Vault (IN)

Time vs. Elevation (ft)

Output Time increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
1,075.000	3,216.16	3,216.11	3,216.07	3,216.04	3,216.02
1,100.000	3,215.99	3,215.97	3,215.95	3,215.93	3,215.90
1,125.000	3,215.88	3,215.85	3,215.82	3,215.80	3,215.77
1,150.000	3,215.74	3,215.71	3,215.68	3,215.65	3,215.62
1,175.000	3,215.59	3,215.56	3,215.53	3,215.50	3,215.47
1,200.000	3,215.44	3,215.42	3,215.39	3,215.36	3,215.33
1,225.000	3,215.30	3,215.27	3,215.24	3,215.21	3,215.18
1,250.000	3,215.15	3,215.12	3,215.09	3,215.05	3,215.02
1,275.000	3,214.99	3,214.96	3,214.92	3,214.89	3,214.85
1,300.000	3,214.82	3,214.78	3,214.74	3,214.71	3,214.67
1,325.000	3,214.64	3,214.61	3,214.57	3,214.54	3,214.50
1,350.000	3,214.47	3,214.43	3,214.40	3,214.37	3,214.33
1,375.000	3,214.30	3,214.27	3,214.23	3,214.20	3,214.17
1,400.000	3,214.14	3,214.10	3,214.07	3,214.04	3,214.01
1,425.000	3,213.98	3,213.94	3,213.91	3,213.88	3,213.85
1,450.000	3,213.81	3,213.78	3,213.75	3,213.72	3,213.69
1,475.000	3,213.66	3,213.63	3,213.60	3,213.57	3,213.54
1,500.000	3,213.51	3,213.48	3,213.45	3,213.43	3,213.40
1,525.000	3,213.37	3,213.35	3,213.32	3,213.29	3,213.27
1,550.000	3,213.24	3,213.22	3,213.20	3,213.17	3,213.15
1,575.000	3,213.12	3,213.10	3,213.08	3,213.06	3,213.04
1,600.000	3,213.01	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time vs. Volume
Label: Underground Vault

Time vs. Volume (ft³)

Output Time increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Volume (ft³)	Volume (ft³)	Volume (ft³)	Volume (ft³)	Volume (ft³)
0.000	0.000	17.000	69.000	155.000	275.000
25.000	429.000	617.000	840.000	1,095.000	1,385.000
50.000	1,708.000	2,049.000	2,389.000	2,729.000	3,070.000
75.000	3,411.000	3,752.000	4,094.000	4,436.000	4,777.000
100.000	5,119.000	5,454.000	5,773.000	6,074.000	6,360.000
125.000	6,632.000	6,889.000	7,133.000	7,364.000	7,584.000
150.000	7,792.000	7,990.000	8,178.000	8,356.000	8,524.000
175.000	8,684.000	8,835.000	8,979.000	9,115.000	9,245.000
200.000	9,368.000	9,484.000	9,595.000	9,701.000	9,801.000
225.000	9,897.000	9,988.000	10,075.000	10,157.000	10,236.000
250.000	10,311.000	10,384.000	10,456.000	10,528.000	10,600.000
275.000	10,672.000	10,745.000	10,817.000	10,889.000	10,961.000
300.000	11,033.000	11,106.000	11,177.000	11,249.000	11,320.000
325.000	11,391.000	11,462.000	11,532.000	11,603.000	11,673.000
350.000	11,742.000	11,812.000	11,881.000	11,950.000	12,019.000
375.000	12,088.000	12,157.000	12,225.000	12,293.000	12,361.000
400.000	12,429.000	12,496.000	12,564.000	12,631.000	12,698.000
425.000	12,765.000	12,832.000	12,898.000	12,965.000	13,031.000
450.000	13,097.000	13,164.000	13,231.000	13,299.000	13,368.000
475.000	13,437.000	13,507.000	13,578.000	13,649.000	13,721.000
500.000	13,794.000	13,867.000	13,941.000	14,016.000	14,092.000
525.000	14,169.000	14,246.000	14,325.000	14,404.000	14,483.000
550.000	14,564.000	14,645.000	14,727.000	14,811.000	14,895.000
575.000	14,980.000	15,066.000	15,153.000	15,240.000	15,329.000
600.000	15,418.000	15,508.000	15,599.000	15,692.000	15,785.000
625.000	15,879.000	15,974.000	16,070.000	16,168.000	16,265.000
650.000	16,364.000	16,465.000	16,567.000	16,672.000	16,779.000
675.000	16,888.000	17,000.000	17,113.000	17,228.000	17,345.000
700.000	17,465.000	17,582.000	17,693.000	17,798.000	17,898.000
725.000	17,993.000	18,082.000	18,166.000	18,245.000	18,320.000
750.000	18,389.000	18,460.000	18,540.000	18,628.000	18,723.000
775.000	18,827.000	18,938.000	19,056.000	19,182.000	19,314.000
800.000	19,454.000	19,599.000	19,752.000	19,910.000	20,074.000
825.000	20,244.000	20,419.000	20,600.000	20,786.000	20,978.000
850.000	21,174.000	21,380.000	21,599.000	21,832.000	22,079.000
875.000	22,341.000	22,617.000	22,908.000	23,212.000	23,529.000
900.000	23,861.000	24,246.000	24,728.000	25,303.000	25,971.000
925.000	26,730.000	27,579.000	28,517.000	29,542.000	30,653.000
950.000	31,848.000	33,501.000	35,983.000	39,289.000	43,409.000
975.000	48,337.000	54,071.000	60,610.000	67,192.000	73,009.000
1,000.000	78,128.000	82,254.000	85,049.000	86,651.000	87,186.000
1,025.000	86,765.000	85,487.000	83,443.000	80,713.000	77,411.000
1,050.000	73,894.000	70,831.000	68,510.000	66,745.000	65,395.000

Subsection: Time vs. Volume
Label: Underground Vault

Time vs. Volume (ft^3)

Output Time increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Volume (ft^3)	Volume (ft^3)	Volume (ft^3)	Volume (ft^3)	Volume (ft^3)
1,075.000	64,356.000	63,550.000	62,919.000	62,418.000	62,015.000
1,100.000	61,675.000	61,348.000	61,009.000	60,656.000	60,290.000
1,125.000	59,912.000	59,521.000	59,118.000	58,702.000	58,273.000
1,150.000	57,833.000	57,387.000	56,942.000	56,499.000	56,057.000
1,175.000	55,616.000	55,177.000	54,739.000	54,302.000	53,866.000
1,200.000	53,432.000	52,997.000	52,560.000	52,119.000	51,677.000
1,225.000	51,231.000	50,783.000	50,333.000	49,880.000	49,425.000
1,250.000	48,967.000	48,507.000	48,047.000	47,586.000	47,123.000
1,275.000	46,660.000	46,197.000	45,735.000	45,272.000	44,810.000
1,300.000	44,349.000	43,888.000	43,429.000	42,972.000	42,516.000
1,325.000	42,062.000	41,609.000	41,157.000	40,707.000	40,259.000
1,350.000	39,812.000	39,367.000	38,925.000	38,486.000	38,050.000
1,375.000	37,616.000	37,185.000	36,757.000	36,332.000	35,909.000
1,400.000	35,489.000	35,072.000	34,656.000	34,243.000	33,833.000
1,425.000	33,425.000	33,020.000	32,619.000	32,222.000	31,828.000
1,450.000	31,438.000	31,052.000	30,670.000	30,292.000	29,918.000
1,475.000	29,549.000	29,183.000	28,822.000	28,464.000	28,110.000
1,500.000	27,760.000	27,415.000	27,075.000	26,740.000	26,409.000
1,525.000	26,084.000	25,764.000	25,448.000	25,137.000	24,831.000
1,550.000	24,530.000	24,233.000	23,940.000	23,652.000	23,368.000
1,575.000	23,088.000	22,812.000	22,541.000	22,274.000	22,010.000
1,600.000	21,751.000	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Elevation vs. Volume Curve
Label: Underground Vault

Elevation-Volume

Pond Elevation (ft)	Pond Volume (ft^3)
3,211.00	0.000
3,212.00	10,348.910
3,213.00	21,574.120
3,214.00	33,702.590
3,215.00	46,761.520
3,216.00	61,763.580
3,217.00	77,935.350
3,218.00	95,905.870

Subsection: Outlet Input Data
Label: Composite Outlet Structure - 1

Requested Pond Water Surface Elevations	
Minimum (Headwater)	3,211.00 ft
Increment (Headwater)	1.00 ft
Maximum (Headwater)	3,218.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Stand Pipe	Riser - 1	Forward	TW	3,216.00	3,218.00
Orifice-Circular	Orifice - 2	Forward	TW	3,211.50	3,218.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Subsection: Outlet Input Data
Label: Composite Outlet Structure - 1

Structure ID: Orifice - 2 Structure Type: Orifice-Circular	
Number of Openings	7
Elevation	3,211.50 ft
Orifice Diameter	3.0 in
Orifice Coefficient	0.600

Structure ID: Riser - 1 Structure Type: Stand Pipe	
Number of Openings	1
Elevation	3,216.00 ft
Diameter	24.0 in
Orifice Area	3.1 ft²
Orifice Coefficient	0.600
Weir Length	6.28 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	True

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	10
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Subsection: Individual Outlet Curves
Label: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
3,211.00	0.00	(N/A)	0.00
3,211.50	0.00	(N/A)	0.00
3,212.00	1.01	(N/A)	0.00
3,213.00	1.94	(N/A)	0.00
3,214.00	2.55	(N/A)	0.00
3,215.00	3.04	(N/A)	0.00
3,216.00	3.46	(N/A)	0.00
3,217.00	3.83	(N/A)	0.00
3,218.00	4.18	(N/A)	0.00

Computation Messages
HW & TW below invert
Upstream HW & DNstream TW < Inv.El
H =.38
H =1.38
H =2.38
H =3.38
H =4.38
H =5.38
H =6.38

Subsection: Individual Outlet Curves
Label: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
3,211.00	0.00	(N/A)	0.00
3,211.50	0.00	(N/A)	0.00
3,212.00	0.00	(N/A)	0.00
3,213.00	0.00	(N/A)	0.00
3,214.00	0.00	(N/A)	0.00
3,215.00	0.00	(N/A)	0.00
3,216.00	0.00	(N/A)	0.00
3,217.00	15.12	(N/A)	0.00
3,218.00	21.38	(N/A)	0.00

Computation Messages
HW & TW < Inv.El.=3216.000
HW & TW < Inv.El.=3216.000
HW & TW < Inv.El.=3216.000
HW & TW < Inv.El.=3216.000
HW & TW < Inv.El.=3216.000
HW & TW < Inv.El.=3216.000
Weir: H =0ft
Orifice: H =1.00; Riser orifice equation controlling.
Orifice: H =2.00; Riser orifice equation controlling.

Subsection: Composite Rating Curve
Label: Composite Outlet Structure - 1

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
3,211.00	0.00	(N/A)	0.00
3,211.50	0.00	(N/A)	0.00
3,212.00	1.01	(N/A)	0.00
3,213.00	1.94	(N/A)	0.00
3,214.00	2.55	(N/A)	0.00
3,215.00	3.04	(N/A)	0.00
3,216.00	3.46	(N/A)	0.00
3,217.00	18.95	(N/A)	0.00
3,218.00	25.56	(N/A)	0.00

Contributing Structures
None Contributing
None Contributing
Orifice - 2
Orifice - 2
Orifice - 2
Orifice - 2
Riser - 1 + Orifice - 2
Riser - 1 + Orifice - 2
Riser - 1 + Orifice - 2

Subsection: Diverted Hydrograph
Label: Outlet-1

Peak Discharge	22.35 ft³/s
Time to Peak	1,020.000 min
Hydrograph Volume	250,203.579 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
100.000	0.00	0.05	0.12	0.18	0.23
125.000	0.29	0.34	0.38	0.43	0.47
150.000	0.51	0.55	0.59	0.62	0.66
175.000	0.69	0.72	0.74	0.77	0.80
200.000	0.82	0.84	0.87	0.89	0.91
225.000	0.92	0.94	0.96	0.98	0.99
250.000	1.01	1.02	1.02	1.03	1.03
275.000	1.04	1.05	1.05	1.06	1.06
300.000	1.07	1.08	1.08	1.09	1.09
325.000	1.10	1.10	1.11	1.12	1.12
350.000	1.13	1.13	1.14	1.14	1.15
375.000	1.16	1.16	1.17	1.17	1.18
400.000	1.18	1.19	1.20	1.20	1.21
425.000	1.21	1.22	1.22	1.23	1.23
450.000	1.24	1.25	1.25	1.26	1.26
475.000	1.27	1.27	1.28	1.29	1.29
500.000	1.30	1.30	1.31	1.32	1.32
525.000	1.33	1.33	1.34	1.35	1.35
550.000	1.36	1.37	1.37	1.38	1.39
575.000	1.39	1.40	1.41	1.42	1.42
600.000	1.43	1.44	1.45	1.45	1.46
625.000	1.47	1.48	1.49	1.49	1.50
650.000	1.51	1.52	1.53	1.53	1.54
675.000	1.55	1.56	1.57	1.58	1.59
700.000	1.60	1.61	1.62	1.63	1.64
725.000	1.64	1.65	1.66	1.66	1.67
750.000	1.68	1.68	1.69	1.70	1.70
775.000	1.71	1.72	1.73	1.74	1.75
800.000	1.76	1.78	1.79	1.80	1.82
825.000	1.83	1.84	1.86	1.87	1.89
850.000	1.91	1.92	1.94	1.95	1.96
875.000	1.98	1.99	2.01	2.02	2.04
900.000	2.05	2.07	2.10	2.13	2.16
925.000	2.20	2.24	2.29	2.34	2.40
950.000	2.46	2.54	2.63	2.76	2.91
975.000	3.08	3.24	3.43	8.66	14.23
1,000.000	19.03	20.54	21.57	22.16	22.35
1,025.000	22.20	21.73	20.98	19.98	18.45
1,050.000	15.08	12.15	9.92	8.23	6.94

Subsection: Diverted Hydrograph
Label: Outlet-1

HYDROGRAPH ORDINATES (ft^3/s)
Output Time Increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)
1,075.000	5.94	5.17	4.57	4.09	3.70
1,100.000	3.46	3.45	3.44	3.43	3.42
1,125.000	3.41	3.40	3.38	3.37	3.36
1,150.000	3.35	3.34	3.32	3.31	3.30
1,175.000	3.29	3.27	3.26	3.25	3.24
1,200.000	3.23	3.21	3.20	3.19	3.18
1,225.000	3.16	3.15	3.14	3.13	3.11
1,250.000	3.10	3.09	3.07	3.06	3.05
1,275.000	3.03	3.02	3.00	2.98	2.97
1,300.000	2.95	2.93	2.91	2.90	2.88
1,325.000	2.86	2.85	2.83	2.81	2.79
1,350.000	2.78	2.76	2.74	2.73	2.71
1,375.000	2.70	2.68	2.66	2.65	2.63
1,400.000	2.62	2.60	2.58	2.57	2.55
1,425.000	2.53	2.51	2.49	2.47	2.45
1,450.000	2.43	2.42	2.40	2.38	2.36
1,475.000	2.34	2.32	2.30	2.29	2.27
1,500.000	2.25	2.23	2.22	2.20	2.18
1,525.000	2.17	2.15	2.13	2.12	2.10
1,550.000	2.09	2.07	2.06	2.04	2.03
1,575.000	2.02	2.00	1.99	1.97	1.96
1,600.000	1.95	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Elevation-Volume-Flow Table (Pond)
Label: Underground Vault

Infiltration	
Infiltration Method (Computed)	Constant
Infiltration Rate (Constant)	0.05 ft³/s

Initial Conditions	
Elevation (Water Surface, Initial)	3,211.00 ft
Volume (Initial)	0.000 ft³
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	5.000 min

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (acres)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
3,211.00	0.00	0.000	0.000	0.00	0.00	0.00
3,211.50	0.00	5,174.455	0.000	0.05	0.05	34.55
3,212.00	1.01	10,348.910	0.000	0.05	1.06	70.06
3,213.00	1.94	21,574.120	0.000	0.05	1.99	145.82
3,214.00	2.55	33,702.590	0.000	0.05	2.60	227.28
3,215.00	3.04	46,761.520	0.000	0.05	3.09	314.83
3,216.00	3.46	61,763.580	0.000	0.05	3.51	415.27
3,217.00	18.95	77,935.350	0.000	0.05	19.00	538.57
3,218.00	25.56	95,905.870	0.000	0.05	25.61	664.98

Subsection: Level Pool Pond Routing Summary
Label: Underground Vault (IN)

Infiltration	
Infiltration Method (Computed)	Constant
Infiltration Rate (Constant)	0.05 ft³/s

Initial Conditions	
Elevation (Water Surface, Initial)	3,211.00 ft
Volume (Initial)	0.000 ft³
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	5.000 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	35.17 ft³/s	Time to Peak (Flow, In)	1,000.000 min
Infiltration (Peak)	0.05 ft³/s	Time to Peak (Infiltration)	105.000 min
Flow (Peak Outlet)	22.35 ft³/s	Time to Peak (Flow, Outlet)	1,020.000 min

Elevation (Water Surface, Peak)	3,217.51 ft
Volume (Peak)	87,186.003 ft³

Mass Balance (ft³)	
Volume (Initial)	0.000 ft³
Volume (Total Inflow)	276,570.000 ft³
Volume (Total Infiltration)	4,630.000 ft³
Volume (Total Outlet Outflow)	250,204.000 ft³
Volume (Retained)	21,158.000 ft³
Volume (Unrouted)	-578.000 ft³
Error (Mass Balance)	0.2 %

Subsection: Pond Infiltration Hydrograph
Label: Underground Vault (INF)

Peak Discharge	0.05 ft³/s
Time to Peak	605.000 min
Hydrograph Volume	4,615.314 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
10.000	0.00	0.00	0.00	0.00	0.01
35.000	0.01	0.01	0.01	0.02	0.02
60.000	0.02	0.03	0.03	0.03	0.04
85.000	0.04	0.04	0.05	0.05	0.05
110.000	0.05	0.05	0.05	0.05	0.05
135.000	0.05	0.05	0.05	0.05	0.05
160.000	0.05	0.05	0.05	0.05	0.05
185.000	0.05	0.05	0.05	0.05	0.05
210.000	0.05	0.05	0.05	0.05	0.05
235.000	0.05	0.05	0.05	0.05	0.05
260.000	0.05	0.05	0.05	0.05	0.05
285.000	0.05	0.05	0.05	0.05	0.05
310.000	0.05	0.05	0.05	0.05	0.05
335.000	0.05	0.05	0.05	0.05	0.05
360.000	0.05	0.05	0.05	0.05	0.05
385.000	0.05	0.05	0.05	0.05	0.05
410.000	0.05	0.05	0.05	0.05	0.05
435.000	0.05	0.05	0.05	0.05	0.05
460.000	0.05	0.05	0.05	0.05	0.05
485.000	0.05	0.05	0.05	0.05	0.05
510.000	0.05	0.05	0.05	0.05	0.05
535.000	0.05	0.05	0.05	0.05	0.05
560.000	0.05	0.05	0.05	0.05	0.05
585.000	0.05	0.05	0.05	0.05	0.05
610.000	0.05	0.05	0.05	0.05	0.05
635.000	0.05	0.05	0.05	0.05	0.05
660.000	0.05	0.05	0.05	0.05	0.05
685.000	0.05	0.05	0.05	0.05	0.05
710.000	0.05	0.05	0.05	0.05	0.05
735.000	0.05	0.05	0.05	0.05	0.05
760.000	0.05	0.05	0.05	0.05	0.05
785.000	0.05	0.05	0.05	0.05	0.05
810.000	0.05	0.05	0.05	0.05	0.05
835.000	0.05	0.05	0.05	0.05	0.05
860.000	0.05	0.05	0.05	0.05	0.05
885.000	0.05	0.05	0.05	0.05	0.05
910.000	0.05	0.05	0.05	0.05	0.05
935.000	0.05	0.05	0.05	0.05	0.05
960.000	0.05	0.05	0.05	0.05	0.05

Subsection: Pond Infiltration Hydrograph
Label: Underground Vault (INF)

HYDROGRAPH ORDINATES (ft^3/s)
Output Time Increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)
985.000	0.05	0.05	0.05	0.05	0.05
1,010.000	0.05	0.05	0.05	0.05	0.05
1,035.000	0.05	0.05	0.05	0.05	0.05
1,060.000	0.05	0.05	0.05	0.05	0.05
1,085.000	0.05	0.05	0.05	0.05	0.05
1,110.000	0.05	0.05	0.05	0.05	0.05
1,135.000	0.05	0.05	0.05	0.05	0.05
1,160.000	0.05	0.05	0.05	0.05	0.05
1,185.000	0.05	0.05	0.05	0.05	0.05
1,210.000	0.05	0.05	0.05	0.05	0.05
1,235.000	0.05	0.05	0.05	0.05	0.05
1,260.000	0.05	0.05	0.05	0.05	0.05
1,285.000	0.05	0.05	0.05	0.05	0.05
1,310.000	0.05	0.05	0.05	0.05	0.05
1,335.000	0.05	0.05	0.05	0.05	0.05
1,360.000	0.05	0.05	0.05	0.05	0.05
1,385.000	0.05	0.05	0.05	0.05	0.05
1,410.000	0.05	0.05	0.05	0.05	0.05
1,435.000	0.05	0.05	0.05	0.05	0.05
1,460.000	0.05	0.05	0.05	0.05	0.05
1,485.000	0.05	0.05	0.05	0.05	0.05
1,510.000	0.05	0.05	0.05	0.05	0.05
1,535.000	0.05	0.05	0.05	0.05	0.05
1,560.000	0.05	0.05	0.05	0.05	0.05
1,585.000	0.05	0.05	0.05	0.05	(N/A)

Subsection: Pond Routed Hydrograph (total out)
Label: Underground Vault (OUT)

Peak Discharge	22.35 ft³/s
Time to Peak	1,020.000 min
Hydrograph Volume	250,203.579 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
100.000	0.00	0.05	0.12	0.18	0.23
125.000	0.29	0.34	0.38	0.43	0.47
150.000	0.51	0.55	0.59	0.62	0.66
175.000	0.69	0.72	0.74	0.77	0.80
200.000	0.82	0.84	0.87	0.89	0.91
225.000	0.92	0.94	0.96	0.98	0.99
250.000	1.01	1.02	1.02	1.03	1.03
275.000	1.04	1.05	1.05	1.06	1.06
300.000	1.07	1.08	1.08	1.09	1.09
325.000	1.10	1.10	1.11	1.12	1.12
350.000	1.13	1.13	1.14	1.14	1.15
375.000	1.16	1.16	1.17	1.17	1.18
400.000	1.18	1.19	1.20	1.20	1.21
425.000	1.21	1.22	1.22	1.23	1.23
450.000	1.24	1.25	1.25	1.26	1.26
475.000	1.27	1.27	1.28	1.29	1.29
500.000	1.30	1.30	1.31	1.32	1.32
525.000	1.33	1.33	1.34	1.35	1.35
550.000	1.36	1.37	1.37	1.38	1.39
575.000	1.39	1.40	1.41	1.42	1.42
600.000	1.43	1.44	1.45	1.45	1.46
625.000	1.47	1.48	1.49	1.49	1.50
650.000	1.51	1.52	1.53	1.53	1.54
675.000	1.55	1.56	1.57	1.58	1.59
700.000	1.60	1.61	1.62	1.63	1.64
725.000	1.64	1.65	1.66	1.66	1.67
750.000	1.68	1.68	1.69	1.70	1.70
775.000	1.71	1.72	1.73	1.74	1.75
800.000	1.76	1.78	1.79	1.80	1.82
825.000	1.83	1.84	1.86	1.87	1.89
850.000	1.91	1.92	1.94	1.95	1.96
875.000	1.98	1.99	2.01	2.02	2.04
900.000	2.05	2.07	2.10	2.13	2.16
925.000	2.20	2.24	2.29	2.34	2.40
950.000	2.46	2.54	2.63	2.76	2.91
975.000	3.08	3.24	3.43	8.66	14.23
1,000.000	19.03	20.54	21.57	22.16	22.35
1,025.000	22.20	21.73	20.98	19.98	18.45
1,050.000	15.08	12.15	9.92	8.23	6.94

Subsection: Pond Routed Hydrograph (total out)
Label: Underground Vault (OUT)

HYDROGRAPH ORDINATES (ft^3/s)
Output Time Increment = 5.000 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)	Flow (ft^3/s)
1,075.000	5.94	5.17	4.57	4.09	3.70
1,100.000	3.46	3.45	3.44	3.43	3.42
1,125.000	3.41	3.40	3.38	3.37	3.36
1,150.000	3.35	3.34	3.32	3.31	3.30
1,175.000	3.29	3.27	3.26	3.25	3.24
1,200.000	3.23	3.21	3.20	3.19	3.18
1,225.000	3.16	3.15	3.14	3.13	3.11
1,250.000	3.10	3.09	3.07	3.06	3.05
1,275.000	3.03	3.02	3.00	2.98	2.97
1,300.000	2.95	2.93	2.91	2.90	2.88
1,325.000	2.86	2.85	2.83	2.81	2.79
1,350.000	2.78	2.76	2.74	2.73	2.71
1,375.000	2.70	2.68	2.66	2.65	2.63
1,400.000	2.62	2.60	2.58	2.57	2.55
1,425.000	2.53	2.51	2.49	2.47	2.45
1,450.000	2.43	2.42	2.40	2.38	2.36
1,475.000	2.34	2.32	2.30	2.29	2.27
1,500.000	2.25	2.23	2.22	2.20	2.18
1,525.000	2.17	2.15	2.13	2.12	2.10
1,550.000	2.09	2.07	2.06	2.04	2.03
1,575.000	2.02	2.00	1.99	1.97	1.96
1,600.000	1.95	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Pond Inflow Summary
Label: Underground Vault (IN)

Summary for Hydrograph Addition at 'Underground Vault'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	On-site Area

Node Inflows

Inflow Type	Element	Volume (ft^3)	Time to Peak (min)	Flow (Peak) (ft^3/s)
Flow (From)	On-site Area	269,730.000	1,000.000	35.17
Flow (In)	Underground Vault	276,570.000	1,000.000	35.17

Index