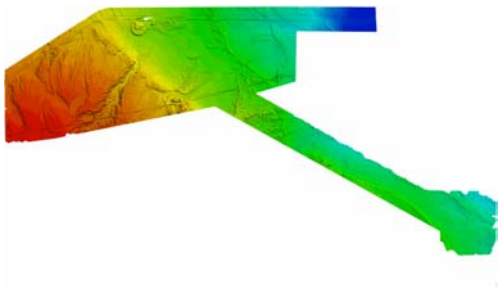
Appendix N
Initial Drainage Report

INITIAL DRAINAGE REPORT
SOLAR TWO SITE
Imperial County, California
PROJECT NO. 2000026801



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EXECUTIVE SUMMARY

Introduction

This report documents the preliminary hydrologic analysis of the Solar Two Project. The goals of this study are to:

1. Evaluate the storm runoff that impacts the site
2. Identify the locations on the proposed site which would be inundated
3. Estimate the approximate depth of flooding which could be expected

The study is not intended to provide a detailed floodplain analysis or to provide all the data necessary for design. It is intended, however, that the results provide sufficient information to support initial site layout and final design efforts.

Findings and Recommendations

1. To control flood impacts, primary considerations should be given to avoiding major washes and minimizing surface disturbing activities. The site layout should maintain local pre-development drainage patterns to the greatest extent possible.

2. Some areas within the site exhibit a lack of well defined drainage channels. Site grading to provide adequate channels and drains to convey the storm water away from the roads, buildings and other improvements may be useful to control flooding in these areas.

3. Site soils are highly erodible and storm runoff will cause both erosion and deposition of sediment. Grading plan design and details should focus on preventing erosion and managing the sediment on the site to reduce the amount of maintenance that may be required. This may require erosion protection measures such as riprap and sediment control by constructing sediment basins. Stabilization of roads, parking areas and building sites may also be done by applying an emulsion to the surface which will reduce dust and erosion.

4. Arizona Crossings (roadway dips) or low flow culverts consisting of a small diameter storm drain with a perforated stem pipe should be placed on roadways as needed to cross the minor and major channels / swales

5. Building sites should be developed per County drainage criteria, with provision for soft bottom storm water retention basins to mitigate any increase in storm water runoff.

6. Care should be taken when siting solar generating equipment on the site to avoid high risk areas such as areas which are identified with high storm water flow depths and velocities.

1.0 INTRODUCTION

1.1 General

This drainage report is prepared for Stirling Energy Systems, Inc as part of the preliminary hydrological and hydraulic studies for the Solar Two Project. The project will include an evaluation of the feasibility of constructing a solar generating facility about 17 miles west of El Centro, California in the Mohave Desert, just north of Interstate 8. The first phase of the project includes 300 MW of net power for San Diego Gas & Electric (SDG&E). The second phase of the project (Phase 2) includes the expansion of the Solar Two development from 300MW to 750MW.

The energy will be generated by solar generating equipment consisting of parabolic dish mirrors, which focus solar heat energy on a Stirling engine, which powers a generator. Approximately twelve thousand of these dishes will be constructed on the phase I project to generate the 300MW and eighteen thousand solar dishes constructed on the phase II project to generate the remaining 450MW.

The purpose of this study is to conduct a surface water investigation of the entire Solar Two project site and to evaluate potential issues related to storm water runoff. The goals of this study are to:

1. Evaluate the storm runoff which impacts the site.
2. Identify the locations on the proposed site which would be inundated.
3. Estimate the approximate depth of flooding which could be expected.

The study is not intended to provide a detailed floodplain analysis or to provide all the data necessary for design. It is intended to provide sufficient information to adequately evaluate the feasibility of the site for development of the project.

1.2 Existing Data and Reports

The following data were obtained and reviewed for the design of the proposed drainage system.

<u>USGS Maps</u>

USGS 7 ½ minute quadrangle maps of the area were obtained for the area including Tierra Del Sol, In-Ko-Pah Gorge, Jacumba, Live Oak Springs, Carrizo Mountain , Sweeney Pass, Sombrero Peak, Mount Signal, Yuha Basin, Coyote Wells, Seeley, Plaster City, Painted Gorge. These maps were obtained to provide topographic information necessary to define

the watershed which contributes runoff to the project site. The maps were obtained in digital format and provide the base for the watershed map.

Aerial Photos

High quality aerial photos of the project site and surrounding area were obtained and used to help delineate the watershed boundary and flow paths.

Mapping

Additional lower altitude photos were obtained for the purpose of preparing 2-foot contour interval mapping of the project site. Stantec prepared photo layouts, set ground control, captured aerial photography, captured airborne LIDAR data, processed ground survey and remotely sensed data, and compiled accurate topographic maps of Solar Two and related sites. Additionally, Stantec compiled the aerial photographs to create ortho-rectified digital images for use as background information during hydrology studies, engineering, and other activities.

Field Inspection

Field inspections and measurements were obtained including various culverts and railroad trestles in the vicinity of the project.

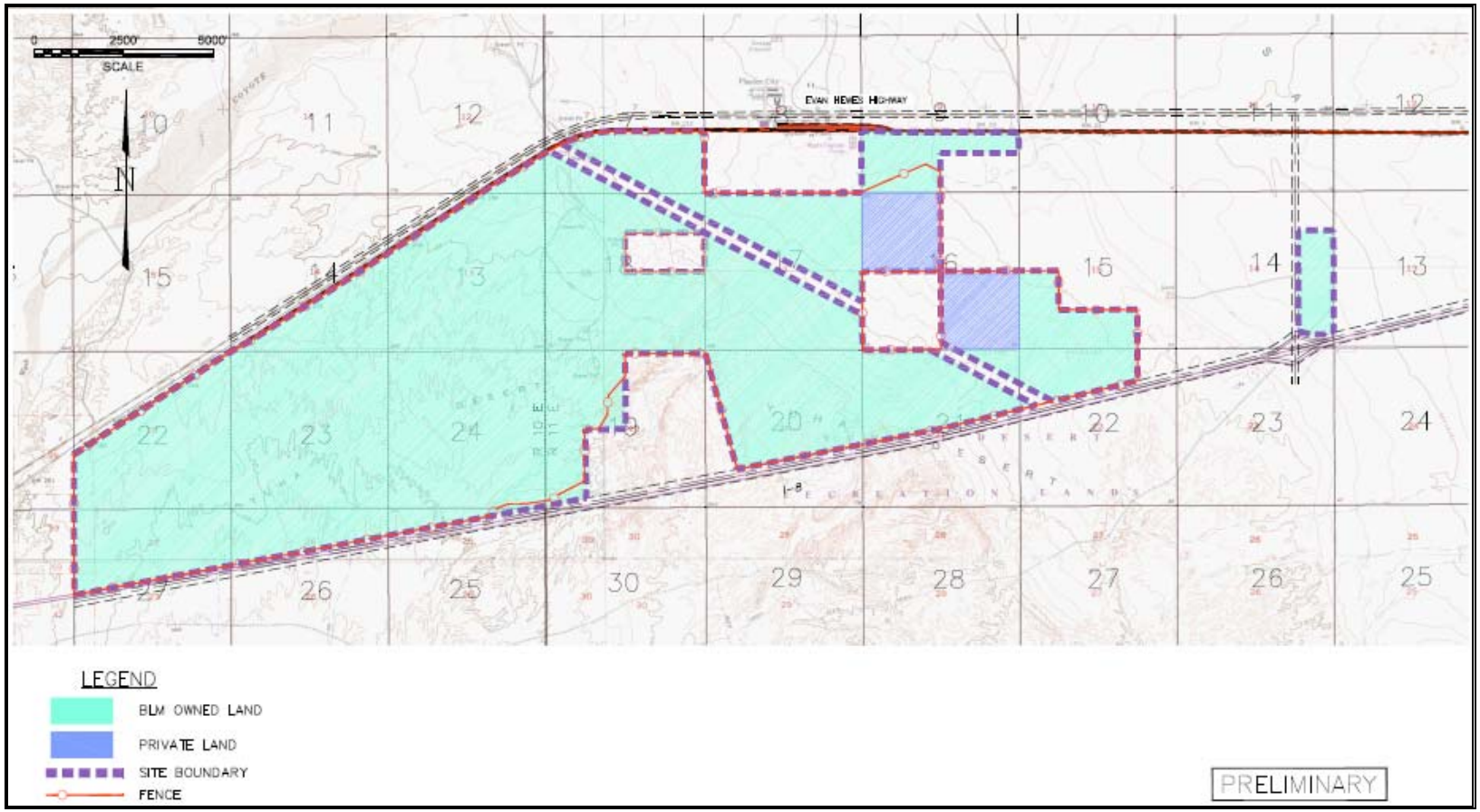
Hydrology

Hydrology methodology and data are defined in Caltrans "Highway Design Manual" (September 1, 2006) using the Regional Flood Approach. Under this approach, flood magnitude and frequency equations developed by the U.S. Geological Survey based on regional regression analysis of data from stream gaging stations (USGS Open File Report 93-419, 1994) can be used to determine estimates of flood magnitude on the basis of basin characteristics.

2.0 LOCATION

The project is located in Imperial County in southern California about 17 miles west of El Centro, California, just north of Interstate 8. The Solar Two site occupies approximately 6,341 acres of land as illustrated in Figure 2.1.

Figure 2-1. Project Location and Site Boundary



Note: The land east of Section 14 was not a part of this study.

3.0 SITE DESCRIPTION

3.1 Field Investigation

Field inspections of the site were conducted on August 28-29th, 2006 and again on November 14-16, 2006. The first trip was conducted for a general project site overview and members of Stantec, SES, BLM and URS drove several of the main roads in and around the project site. The second trip was conducted specifically for the drainage study. Drainage engineers from Stantec and URS conducted a more in-depth reconnaissance of the site. Stantec surveyors also came to the site and collected cross section elevations of some of the major washes on the site. Results of this second trip also provided information useful for preliminary siting of the proposed administrative complex on the site. Both inspections involved primarily driving the site on the existing unimproved roads and trails and due to the size of the site, a limited amount of walking and observations were made of the following:

- Observed general drainage flow paths
- Observed the culverts along the interstate
- Observed the railroad embankment and trestles
- Took photos of the site
- Evaluated the soil types with regard to drainage characteristics
- Evaluated the presence of alluvial fans / plains
- Evaluation of sediment transport processes at the site
- Evaluation of the areas east of Dunaway Road which have been previously farmed

Additionally, flown topographic maps were developed in 2008.

3.2 Site Description

The geomorphic surfaces of this portion of the Imperial Valley are characterized by gently sloped topography typical of the county terrain. The ground surface at the proposed Solar Two site slopes from the southwest to the east from an approximate high point elevation of 300 feet above mean sea level (msl) to the eastern side of the site with an elevation at sea level.

The western portion of the site west of the SDG&E transmission line is characterized by rolling terrain with well-defined washes. East of the SDG&E transmission line, the terrain is described as having uniform and gentle slopes.

Site soils are generally of three different types. Within wash areas, soils vary from silts to fine sands which are loose, un-compacted and exhibit no cohesion. Soils in these areas are deposited by fluvial action and are often uniformly graded (sorted). In higher areas, which are not subject to concentrated water flows, soils are more densely compacted and often

contain larger gravels and cobbles. In some areas, bedrock outcrops are observed which appear to be sandstones or siltstones.

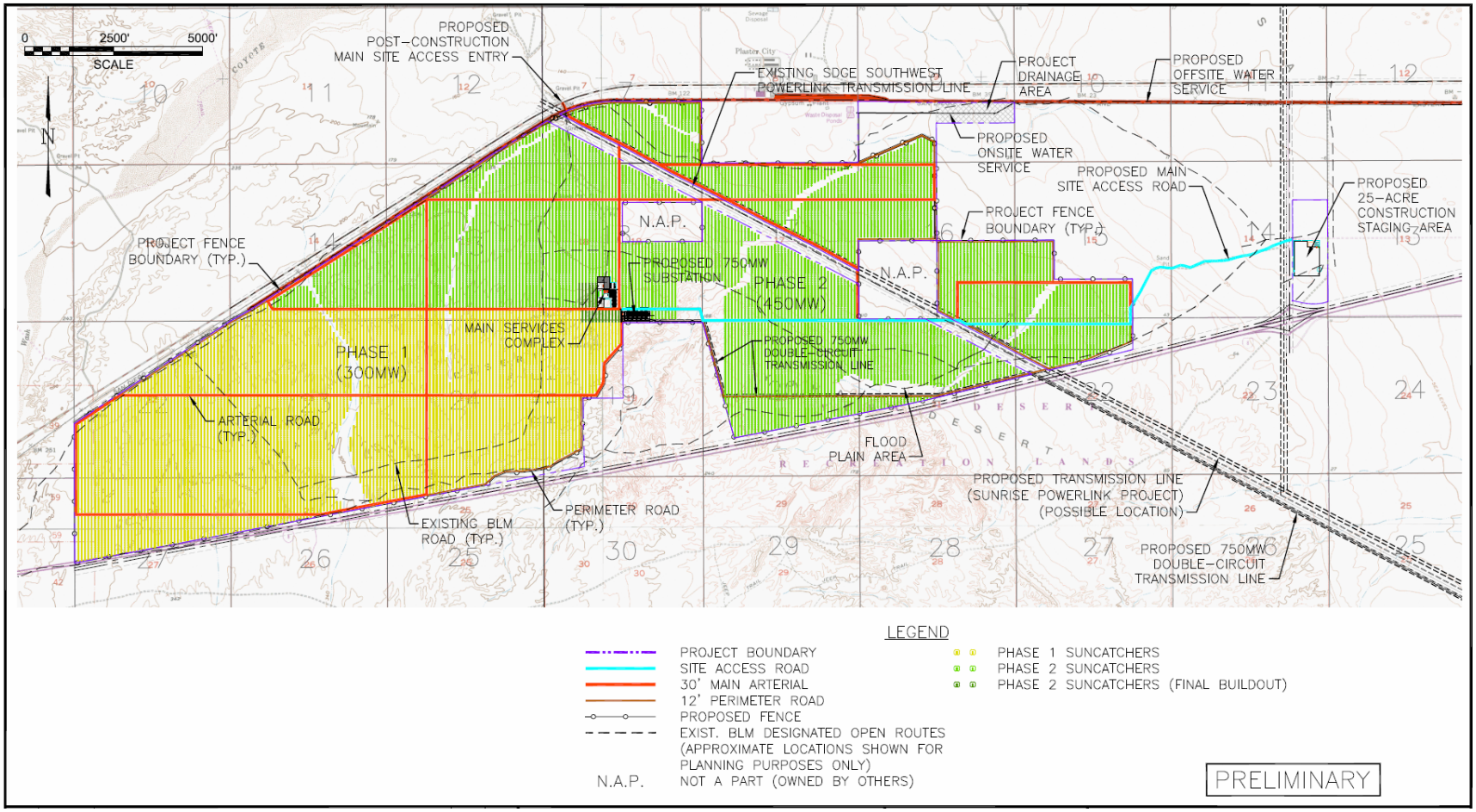
Photo of Soil Conditions

3.3 Proposed Development

The Solar Two site layout is shown on Figure 3-1. The first phase of the project (Phase I) includes the initial Solar Two development to provide 300MW of net electric power to SDG&E. Phase I electricity generating capacity is limited to 300MW by the current available transmission capacity from the SDG&E Imperial Valley Substation.

Phase I includes the construction of approximately 12,000 SunCatchers. A Main Services Building Complex, illustrated in the Figures 3-1 and 3-2, is planned to be located west of the SDG&E transmission line in a location central to both Phase I and II. Both paved arterial roads and dirt solar field access routes are planned for construction. A 750 MW Substation will be installed also west of the SDG&E transmission line and nearby the Main Services Building Complex . The second phase of the project (Phase II) includes the expansion of the Solar Two development from 300MW to 750MW. Phase II includes the construction of up to approximately 18,000 SunCatchers, for a grand total of approximately 30,000 SunCatchers for all of Solar II.

Figure 3-1. Proposed Development



4.0 FEMA FLOODPLAIN CLASSIFICATION

Only limited portions of the site have been mapped on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM). The maps are "Imperial County, California, Unincorporated Areas" and are listed below:

- Panel 060065 0775 B
- Panel 060065 0935 B
- Panel 060065 0975 B

Most of the project site is FEMA FIRM Zone C, which indicates areas of minimal flooding. There are several areas, which are designated as Zone A that indicate areas of 100-year flooding where base flood elevations and flood hazard factors have not been determined. These correspond to the major wash (Basin D/E), which is visible on the aerial mapping, as well as areas associated with ponding at the railroad trestles. FEMA has not performed a detailed study of this area to determine base flood elevations. According to the FIRM map, flow proceeds easterly across the project site exiting the eastern boundary and flowing over Dunaway Road. The project will not divert any storm water and will generally conform to the existing drainage pattern for the site. Where it exists, FEMA FIRM mapping has been incorporated into the flood plain mapping provided in subsequent sections.

5.0 HYDROLOGY

5.1 Hydrologic Setting

The project site lies within the Yuha Desert, which is part of the Sonoran Desert. The Sonoran Desert straddles part of the United States (U.S.)-Mexico border and covers large parts of the U.S. states of Arizona and California and the Mexican state of Sonora. It is one of the largest and hottest deserts in North America. The Yuha Desert lies within the Lower Colorado River Valley region of the desert. This region is one of the most arid parts of the Sonoran Desert with an average annual precipitation of approximately 3 inches. Average annual maximum and minimum temperatures are 71 degrees F and 41 degrees F. Daily maximum and minimum temperatures are 122 degrees F and 18 degrees F. Average annual pan evaporation is over 140 inches.

The project site is located generally on a gently sloping alluvial surface. On the west side of the site, slopes vary from about 2-percent to 5-percent and exhibit the characteristics of an alluvial pediment. Local slopes are much greater and the terrain varies from level to steep hills and valleys. The east side of the site is much flatter and slopes vary from 0.5-percent to 1.0-percent across this side. This part of the site exhibits the characteristics of an alluvial plain or Bajada.

5.1.1. Surface Water

There are no perennial streams within the project site. The nearest perennial stream is the New River that is approximately eight (8) miles east of the eastern end of the site and does not pose a flooding hazard to the project. The site is traversed by a number of ephemeral washes. These are normally dry streambeds, which may flow after significant rainfall. Washes fill up quickly during rains and there may be a sudden torrent of water after a thunderstorm begins upstream, such as during monsoon conditions. Solar Two buildings will not be located within the limits of defined 100-year floodplains. Solar generating facilities however could be placed in portions of the floodplain subject to some limitations depending upon the specific hydraulic parameters (depth of flow and velocity) and the ability of the foundations to withstand scour. SunCatchers located within identified 100-year flood prone areas should be evaluated for flood and scour depths which may exceed the allowable depths for the structure. Floodplains in the project site are delineated by FEMA and additional delineation will be undertaken to define other significant washes within the project site, which may pose a flooding hazard.

5.1.2. Ground Water

The project site lies within the Coyote Wells Valley Groundwater Basin. The basin is bounded on the north by impermeable meta-sedimentary rocks of the Coyote Mountains and by the Elsinore fault zone. Impermeable rocks of the Jacumba Mountains bound the basin on

the west and southwest. The U.S.-Mexico border forms the southeastern boundary. The eastern boundary is a roughly north-south line from Superstition Mountain through the Yuha Buttes to the international border. A surface drainage divide connecting the Coyote Mountains with Superstition Mountain forms part of the northeastern boundary. Palm Canyon Wash and Coyote Wash provide the main surface drainages for the basin. California Department of Water Resources (DWR) (DWR 1973; Skrivan 1977).

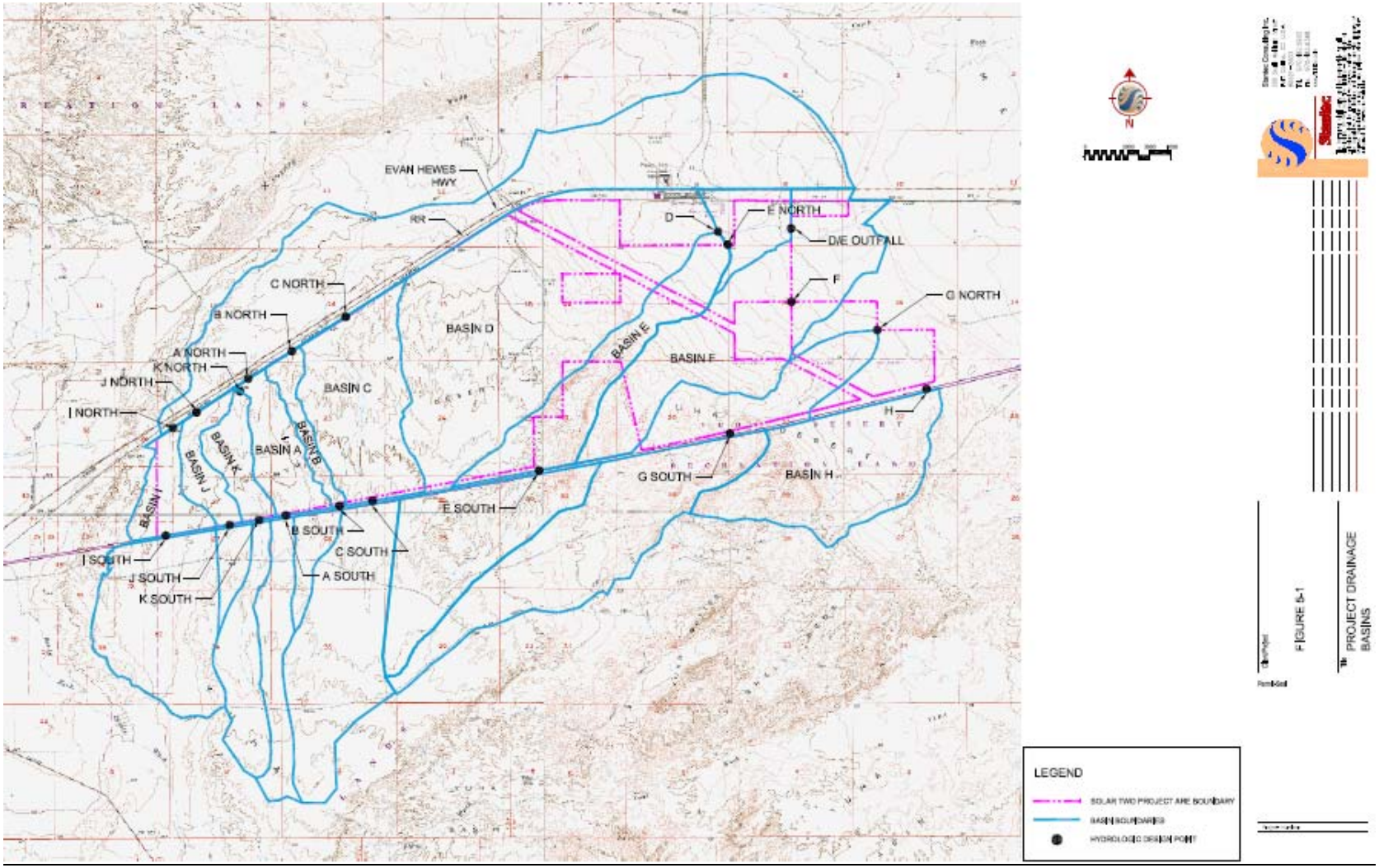
5.2 Offsite Watershed

Figure 5-1 illustrates the general drainage system in and surrounding the project area. In general, drainage in the area flows north to northeast. As shown, there are several significant basins south of Interstate 8 that generally drain northeasterly, under the Interstate and continue through the project site. In the Figure 5-1, these basins have been labeled A through H. From these basins, offsite flows collect in roadside ditches along the south side of the Interstate and are directed through culverts which pass the flow under the Interstate embankment.

The Caltrans design criteria for flow crossing the interstate is the 100-year storm (Carrington, Pers Comm, 2006). It is therefore assumed that all storm flow, up to the 100-year flood, will be passed through the culverts and into the project site. Nevertheless, flow constriction at the culverts causes some of the sediment to drop out on the south side of the highway as evident from field inspection and aerial photography. However, significant amounts of sediment are still transported through the culverts.

Typical box culvert at the freeway

Figure 5-1: Project Drainage Basins



Typical pipe culverts at the freeway

Basins A, B, C, I, J & K transverse the western portions of the project site. For these drainages, flows enter the site from south of the interstate and flows north across site, exiting to the north at Evan Hewes Highway. Basin D represents a relatively large area south of the interstate which generally contributes flow that being bound by the railroad embankment collects and flows east along the railroad tracks. Basins E, G and H represent well defined channels originating south of the interstate and flow northeast across the project site, exiting the eastern project boundary. Generally all off-site and on-site flows converge in the northeastern corner of the railroad embankment and Dunaway road beyond the eastern border of the site.

Photo of railroad trestle

The combined discharge then flows east and overtops Dunaway Road. This large wash flowing through Basins C and D are in a FEMA mapped floodplain. Areas west of Basin A

are tributary to Coyote Wash. Drainage from these areas and Coyote Wash itself do not impact the proposed site and were not evaluated.

Coyote Wash Bridge

5.3 Onsite Watershed

A number of well-defined washes cross the site. Several of these convey the larger offsite flows flowing through the culverts at Interstate 8. Others are smaller and convey onsite runoff. These eventually join with the larger washes. Several areas of the site also exhibit sheet flow conditions in areas where well-defined natural channels do not exist. Flooding conditions on the site are likely during short duration, intense thunderstorms. Given the small area of the onsite watershed in comparison with the much larger offsite watershed, onsite flow peaks may pass before the offsite flows reach the site. Since thunderstorms typically cover small aerial extents, it is possible that localized flooding will be experienced in parts of the site while other parts may remain unaffected.

Typical wash (near the freeway) which crosses the site

Most runoff crossing the site flows generally north and east, eventually reaching the railroad tracks or exiting the eastern project boundary. Flows in the westernmost basins exit the project area by continuing to flow north through existing railroad trestles. Centrally, flows reaching the railroad tracks will follow existing drainage east along the railroad until exiting the eastern site boundary.

Photo of channel running along the railroad

In general, flood hazard increases from the south to the north and from the west to the east across the project site.

5.4 Runoff Estimates

The off-site and on-site areas draining through the project site have been delineated as previously illustrated in Figure 5-1. The following table provides drainage area and projected peak discharges for each of these basins at the various hydrologic design points.

Table 5-1: Flood Discharges

Design Point	Area (Acre)	Area (mi^2)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
A-South	375	0.59	144	282	587
A-North	701	1.10	212	425	906
B-South	146	0.23	80	153	307
B-North	294	0.46	123	241	496
C-South	1,047	1.64	271	551	1,194
C-North	1,926	3.01	396	819	1,818
D	2,573	4.02	474	988	2,220
E-South	918	1.43	250	506	1,090
E-North	1,616	2.52	355	730	1,610
D/E Outfall	5,372	8.39	748	1,594	3,689
F	855	1.34	239	483	1,038
G-South	1,252	1.96	303	619	1,351
G-North	1,753	2.74	374	770	1,704
H-South	1,030	1.61	269	545	1,180
I-South	928	1.45	252	509	1,098
I-North	1,167	1.82	290	591	1,287
J-South	117	0.18	70	132	263
J-North	318	0.50	130	254	524
K-South	408	0.64	151	299	623
K-North	632	0.99	198	397	842

These values were obtained using regional equations developed by the U.S. Geological Survey for use on ungaged basins. These equations are based on regional regression analysis of data from stream gaging stations (USGS, 1994). The equations generally result in a conservative estimate of peak runoff, suitable for project planning. These data indicate that significant flows can be expected at some locations during extreme events.

6.0 HYDRAULICS

6.1 Flow Characteristics

Flood flow through the site consists of channelized flows as well as sheet flows. Precise limits of flood inundation in these areas are difficult to accurately define since the flow paths are uncertain and changing. In addition, small floods may remain in better-defined channels while larger floods will likely carry larger amounts of sediment and are more likely to break out and shift course during the flood event.

Typical sheet flow area

Erosion, sediment transport and deposition all occur on the site. In general, it appears that the sediment balance is positive, that is the net amount of sediment on the site is increasing with time. Portions of the offsite watershed are identified as alluvial fans. Construction of the interstate and railroad embankments has altered the flow conditions through the site. However, sediment is still being deposited within the site from the upstream alluvial fan areas. In addition, construction of the railroad and Dunaway Road embankments has caused sediment to become trapped on the site.

In addition to sediment deposition, erosion is also expected to occur on the site during rainfall events. Where flow is channelized, both naturally and by site grading operations, erosion can be expected to occur. Where roads are constructed, these often provide a preferential location for flow to concentrate and for erosion and sedimentation to occur.

6.2 Hydraulic Analysis

All significant drainage channels within the project area were analyzed using a combination of HEC-RAS (Version 3.1.3) and FlowMaster (Bentley) to determine the extent of inundated areas during flood events. For these channels, cross-section data were collected from flown 2-foot contour maps of the project site. Discharges presented in the previous section were

used in this analysis. Starting water surface elevations were determined by assuming critical depth (weir flow) exists at the location where flow overtops Dunaway Road downstream of the eastern boundary of the site. Manning's roughness coefficients were assigned to each cross-section based on photos of the site. Hydraulic output showing each of the channels and cross-sections can be found in Appendix A. A summary of the resulting hydraulic results are presented in Table 6-1.

Table 6-1: Hydraulic Results

Basin A					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
A-1	100-YR	906	0.44	3.6	634
	10-YR	212	0.19	2.1	575

Basin B					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
B-1	100-YR	496	1.48	6.4	93
	10-YR	123	0.88	4.2	66

Basin C					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
C-1	100-YR	1,818	1.90	5.0	504
	10-YR	396	1.17	3.8	214

Basin D					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
D-1	100-YR	2,220	2.65	7.4	311
	10-YR	474	0.98	6.9	79

Basin E					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
113	100 YR	1090	2.15	7.0	101
113	10 YR	250	1.05	4.2	71
112	100 YR	1090	1.53	5.5	206
112	10 YR	250	0.68	3.9	122
111	100 YR	1090	1.42	5.0	292
111	10 YR	250	0.87	3.4	148

Basin E					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
110	100 YR	1090	1.17	5.8	179
110	10 YR	250	0.45	3.7	155
109	100 YR	1090	1.54	6.6	122
109	10 YR	250	0.63	4.1	104
108	100 YR	1090	1.21	4.9	298
108	10 YR	250	0.71	3.1	271
107	100 YR	1090	1.07	3.8	741
107	10 YR	250	0.62	2.5	438
106	100 YR	1516	1.08	4.0	809
106	10 YR	336	0.68	2.8	494

Basin G					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
206	100 YR	1351	6.38	10.1	42
206	10 YR	303	3.51	7.5	23
205	100 YR	1351	1.41	5.2	321
205	10 YR	303	0.73	3.6	195
204	100 YR	1351	1.45	6.3	173
204	10 YR	303	0.59	4.1	148
203	100 YR	1351	2.27	5.2	162
203	10 YR	303	1.22	3.3	108

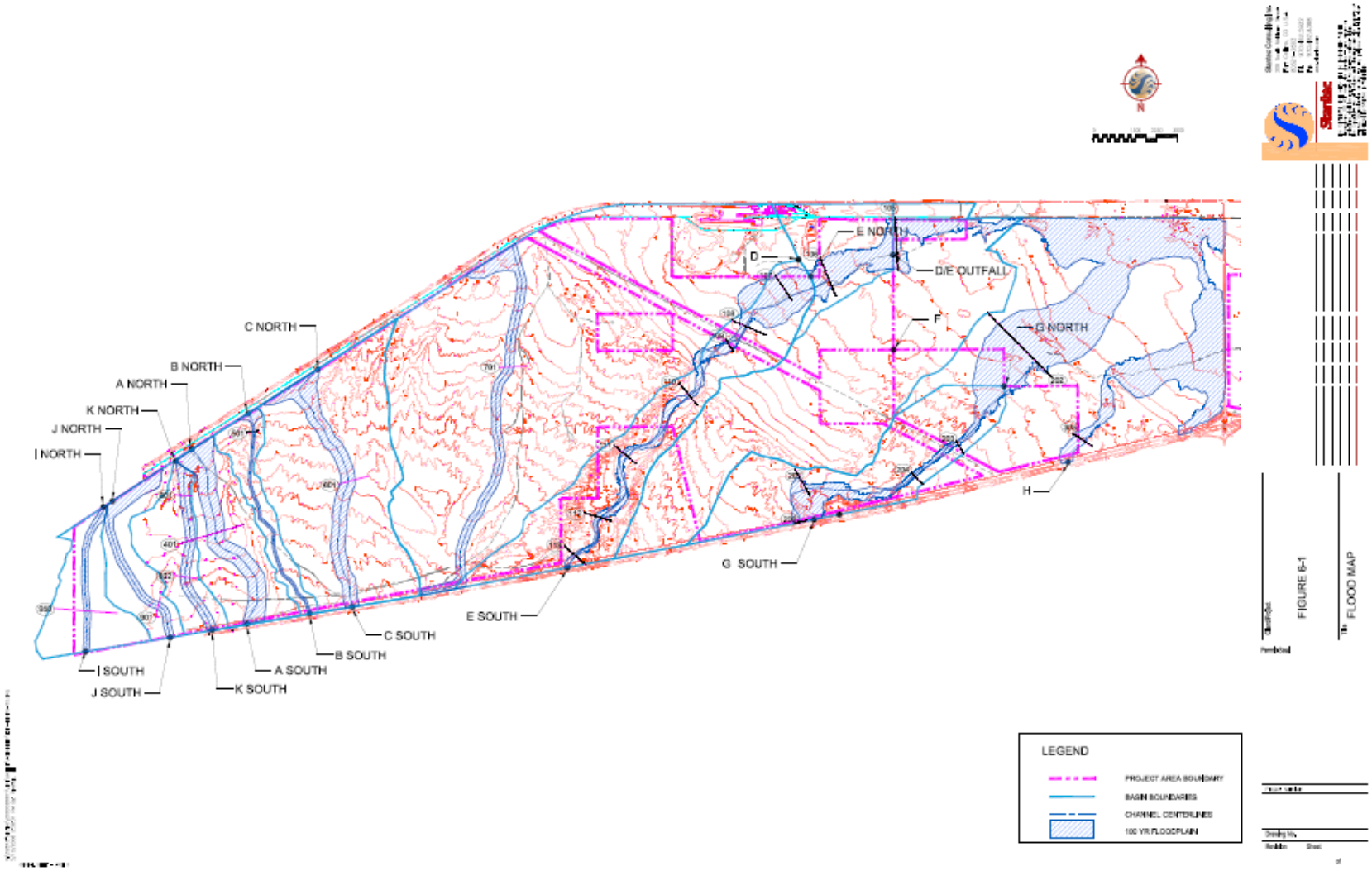
Basin H					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
305	100-YR	1622	0.76	4.8	485
305	10-YR	357	0.28	3.0	438

Basin I					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
950	100-YR	1,287	1.96	5.9	222
950	10-YR	290	1.12	4.1	127

Basin J					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
901	100-YR	524	0.99	4.2	215
901	10-YR	130	0.54	2.9	138

Basin K					
X-Sect	Event	Flow (Q) (cfs)	Depth (ft)	Velocity (ft/s)	Top Width (ft)
801	100-YR	842	0.80	4.5	330
801	10-YR	198	0.43	2.7	274
802	100-YR	842	1.38	5.1	219
802	10-YR	198	0.72	3.9	104

Figure 6-1: Project Area Flood Plain Map



7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The following conclusions can be developed based on the site observations and analyses presented.

1. The site is traversed by a number of major and more minor washes. Some areas within the site exhibit a lack of well defined drainage channels. Site grading to provide adequate channels and drains to convey the storm water away from the roads, buildings and other improvements may be useful to control flooding in these areas.

2. Site soils are highly erodible and storm runoff will cause both erosion and deposition of sediment.

3. Most drainages crossing the site originate to the south of I-8. Estimated 10, 25, and 100-year discharges estimates at the site boundary and other points of interest throughout the site have been determined and are presented in the report.

4. Hydraulic analyses have been conducted for most of the major streams crossing the project site. In general these results confirm that the major drainages crossing the site should be avoided to limit potential flood damages. Some areas exhibit a lack of a well defined channels and broad shallow flooding can be expected during flood events.

7.2 Recommendations

Based on site observations and analyses presented, the following recommendations can be offered.

1. The site layout for the Solar Two facility should be based on avoiding major washes and minimizing surface disturbing activities. The site layout should maintain local pre-development drainage patterns where feasible.

2. In areas that exhibit a lack of well defined drainage channels site grading should provide adequate channels and drains to convey the storm water away from the roads, buildings and other improvements. This may include ditches or berms along roads and upstream of buildings which will divert the runoff to culverts or channels.

3. SunCatchers located within identified 100-year flood prone areas should be evaluated for flood and scour depths which may exceed the allowable depths for the structure.

4. Given that the site soils are highly erodible, erosion and sediment deposition will occur. These processes can cause drainage channels to erode away or to shift position during larger storms and may require additional maintenance grading of dirt roads and

cleaning of any constructed drainage channels or diversions. Grading design should include provisions for either trapping the sediment to prevent it from leaving the site, or to allow it to continue through the site without being deposited on roads or in channels and culverts. Areas susceptible to increased erosion should be protected using riprap or other suitable protection.

5. Paved roadways should have a low flow unpaved swale or roadway dip as needed to convey nuisance runoff to existing drainage channels / swales.

6. Roadway dips should be used for major washes where the channel cross-section exceeds 8-feet in width and 3-feet in depth or exceeds 20-feet in width and 2-feet in depth. The roadway section at the channel flow line will be without a crown. Roadway protection could be provided by a concrete cut-off wall along the edges of the roadway with un-grouted (loose) riprap upstream and downstream of the concrete cut-off wall.

7. Arizona Crossings (roadway dips) should be placed along the roadways or low flow culverts consisting of a small diameter storm drain with a perforated stem pipe as needed to cross the minor or major channels / swales. These are based upon best management practices for erosion and sediment control.

8. It is anticipated that roadway maintenance will be required following rainfall events. For minor storm events, it is anticipated that the unpaved roadway sections may need to be bladed to remove soils deposition, along with sediment removal from stem pipe risers at the culvert locations. For major storm events, in addition to the aforementioned maintenance, roadway repairs may be required due to possible damage to pavement where the roadways cross the channels and where the flows exceed the culvert capacity.

9. Maintenance may be required where SunCatchers are constructed within flood prone areas. Scour holes around the SunCatcher foundations should be filled in with erosion resistant material. Excessive sediment deposition near the structures should be removed.

10. Localized channel grading should take place on a limited basis to improve channel hydraulics, and to control flow direction where buildings and roadways or SunCatchers are proposed.

11. Building sites should be developed per County drainage criteria, with provision for soft bottom storm water retention basins. Rainfall from paved areas and building roofs will be collected and directed to the storm water retention basins. Volume on retention or detention basins should have a total volume capacity for a three (3) inch minimum precipitation covering the entire site with no C reduction (coefficient of runoff) factors.

Volume can be considered by a combination of basin size and additional volume provided within paving and/or landscaping areas.

12. Retention basins should be designed so that the retained flows will empty within 72 hours after the storm in order to provide mosquito abatement. This can be accomplished by draining, evaporation, infiltration or a combination thereof.

13. The Main Services Complex and the 750MW substation could be protected from a 100-year flooding by berms or channels that will direct the flow around the perimeter of the building site, if required.

8.0 REFERENCES

Carrington, Pers Comm, 2006. Fred Carrington, CALTRANS Hydraulic Division, San Diego, CA.

USGS, 1994, "Regional Flood Frequency Equations, Southwestern United States Study", USGS Open File Report 93-419.

CalTrans "Highway Design Manual", 2006. California Department of Transportation, September 1, 2006.

APPENDIX A

HYDRAULIC RESULTS & OUTPUT

Basin A - XS 401

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01200	ft/ft
Discharge	906.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	290.00
0+17	288.00
0+36	286.00
0+92	284.00
2+02	282.00
3+62	280.00
5+88	280.00
9+77	278.00
12+09	276.00
17+41	276.00
19+76	278.00
21+18	280.00
21+86	282.00
22+46	284.00
23+03	286.00
23+46	288.00
23+94	290.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 290.00)	(23+94, 290.00)	0.025

Results

Normal Depth	0.44	ft

Basin A - XS 401

Results

Elevation Range	276.00 to 290.00 ft		
Flow Area		255.31	ft²
Wetted Perimeter		633.72	ft
Top Width		633.71	ft
Normal Depth		0.44	ft
Critical Depth		0.43	ft
Critical Slope		0.01237	ft/ft
Velocity		3.55	ft/s
Velocity Head		0.20	ft
Specific Energy		0.63	ft
Froude Number		0.99	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.44	ft
Critical Depth	0.43	ft
Channel Slope	0.01200	ft/ft
Critical Slope	0.01237	ft/ft

Basin B - XS 501

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Discharge	496.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	254.00
0+25	252.00
0+51	250.00
0+89	248.00
1+93	246.00
2+16	244.00
2+50	243.00
2+91	244.00
3+44	246.00
3+88	248.00
4+14	250.00
4+28	252.00
4+47	254.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 254.00)	(4+47, 254.00)	0.025

Results

Normal Depth	1.48	ft
Elevation Range	243.00 to 254.00 ft	
Flow Area	77.15	ft^2
Wetted Perimeter	92.93	ft
Top Width	92.87	ft

Basin B - XS 501

Results

Normal Depth		1.48	ft
Critical Depth		1.62	ft
Critical Slope		0.00936	ft/ft
Velocity		6.43	ft/s
Velocity Head		0.64	ft
Specific Energy		2.12	ft
Froude Number		1.24	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.48	ft
Critical Depth	1.62	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.00936	ft/ft

Basin C - XS 601

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01100	ft/ft
Discharge	1818.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	280.00
0+13	278.00
0+27	276.00
7+31	274.00
8+00	273.00
8+76	274.00
9+75	276.00
10+72	278.00
11+08	280.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 280.00)	(11+08, 280.00)	0.025

Results

Normal Depth	1.90	ft
Elevation Range	273.00 to 280.00 ft	
Flow Area	363.08	ft^2
Wetted Perimeter	504.19	ft
Top Width	504.17	ft
Normal Depth	1.90	ft
Critical Depth	1.92	ft
Critical Slope	0.01011	ft/ft
Velocity	5.01	ft/s

Basin C - XS 601

Results

Velocity Head		0.39	ft
Specific Energy		2.29	ft
Froude Number		1.04	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.90	ft
Critical Depth	1.92	ft
Channel Slope	0.01100	ft/ft
Critical Slope	0.01011	ft/ft

Basin D - XS 701

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01600	ft/ft
Discharge	2220.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	226.00
0+24	224.00
0+50	222.00
0+76	220.00
1+10	218.00
3+52	216.00
3+84	216.00
6+50	218.00
6+91	216.00
7+13	214.00
7+75	214.00
7+88	216.00
7+98	218.00
8+09	220.00
9+58	222.00
9+71	224.00
9+79	226.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 226.00)	(9+79, 226.00)	0.025

Results

Normal Depth	2.65	ft

Basin D - XS 701

Results

Elevation Range	214.00 to 226.00 ft		
Flow Area		301.62	ft²
Wetted Perimeter		311.39	ft
Top Width		311.06	ft
Normal Depth		2.65	ft
Critical Depth		2.90	ft
Critical Slope		0.00906	ft/ft
Velocity		7.36	ft/s
Velocity Head		0.84	ft
Specific Energy		3.49	ft
Froude Number		1.32	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.65	ft
Critical Depth	2.90	ft
Channel Slope	0.01600	ft/ft
Critical Slope	0.00906	ft/ft

Basin I -XS 950

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01030	ft/ft
Discharge	1287.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	300.00
11+87	280.00
22+65	300.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 300.00)	(22+65, 300.00)	0.025

Results

Normal Depth	1.96	ft
Elevation Range	280.00 to 300.00 ft	
Flow Area	216.58	ft²
Wetted Perimeter	221.52	ft
Top Width	221.49	ft
Normal Depth	1.96	ft
Critical Depth	2.00	ft
Critical Slope	0.00911	ft/ft
Velocity	5.94	ft/s
Velocity Head	0.55	ft
Specific Energy	2.50	ft
Froude Number	1.06	
Flow Type	Supercritical	

Basin I -XS 950

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.96	ft
Critical Depth	2.00	ft
Channel Slope	0.01030	ft/ft
Critical Slope	0.00911	ft/ft

Basin J -XS 901

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01030	ft/ft
Discharge	524.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	312.00
0+16	312.00
0+17	312.00
0+20	312.00
0+26	312.00
0+30	312.00
0+35	312.00
0+36	312.00
0+39	312.00
0+40	312.00
0+45	312.00
0+46	312.00
0+57	312.00
0+57	311.98
0+57	311.98
0+60	311.88
0+67	311.43
0+67	311.43
0+67	311.42
0+73	310.97
0+85	310.00
0+86	310.00
0+87	310.00
1+23	308.53
1+35	308.00
1+61	306.72
1+75	306.00

Basin J -XS 901

Input Data

Station (ft)	Elevation (ft)
1+76	306.00
1+76	306.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 312.00)	(7+10, 310.39)	0.025

Results

Normal Depth		0.99	ft
Elevation Range	302.81 to 312.00 ft		
Flow Area		124.88	ft²
Wetted Perimeter		215.22	ft
Top Width		215.21	ft
Normal Depth		0.99	ft
Critical Depth		0.98	ft
Critical Slope		0.01097	ft/ft
Velocity		4.20	ft/s
Velocity Head		0.27	ft
Specific Energy		1.26	ft
Froude Number		0.97	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Basin J -XS 901

GVF Output Data

Normal Depth	0.99	ft
Critical Depth	0.98	ft
Channel Slope	0.01030	ft/ft
Critical Slope	0.01097	ft/ft

Basin K -XS 801

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01250	ft/ft
Discharge	842.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	270.04
0+02	270.00
0+16	270.00
0+22	270.00
0+28	269.05
0+34	268.00
0+40	267.18
0+47	266.00
0+49	265.68
0+60	264.00
0+62	263.69
0+73	262.32
0+75	262.07
0+75	262.00
0+76	261.97
0+76	261.97
1+01	261.36
1+12	261.23
1+14	261.18
1+29	260.86
1+45	260.57
1+57	260.38
1+68	260.31
1+70	260.29
1+77	260.22
1+78	260.21
1+93	260.13

Basin K -XS 801

Input Data

Station (ft)	Elevation (ft)
1+96	260.11
1+98	260.11

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 270.04)	(5+99, 268.00)	0.025

Results

Normal Depth		0.80	ft
Elevation Range	259.68 to 270.04 ft		
Flow Area		185.61	ft²
Wetted Perimeter		329.06	ft
Top Width		329.05	ft
Normal Depth		0.80	ft
Critical Depth		0.83	ft
Critical Slope		0.01089	ft/ft
Velocity		4.54	ft/s
Velocity Head		0.32	ft
Specific Energy		1.12	ft
Froude Number		1.06	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Basin K -XS 801

GVF Output Data

Normal Depth	0.80	ft
Critical Depth	0.83	ft
Channel Slope	0.01250	ft/ft
Critical Slope	0.01089	ft/ft

Basin K -XS 802

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01080	ft/ft
Discharge	842.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	312.00
0+00	312.00
0+17	312.00
0+21	312.00
0+53	310.48
0+64	310.00
0+69	309.63
0+81	309.08
0+94	308.38
1+01	308.00
1+03	308.00
1+09	307.69
1+09	307.69
1+12	307.65
1+39	306.00
1+43	306.00
1+43	306.00
1+49	306.00
1+49	306.00
1+49	306.00
1+49	306.00
1+51	305.80
1+53	305.68
1+57	305.29
1+72	304.00
1+74	303.85
1+75	303.80

Basin K -XS 802

Input Data

Station (ft)	Elevation (ft)
1+78	303.47
1+81	303.26

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 312.00)	(8+48, 300.00)	0.025

Results

Normal Depth		1.38	ft
Elevation Range	296.00 to 312.00 ft		
Flow Area		164.62	ft²
Wetted Perimeter		218.46	ft
Top Width		218.43	ft
Normal Depth		1.38	ft
Critical Depth		1.40	ft
Critical Slope		0.00994	ft/ft
Velocity		5.11	ft/s
Velocity Head		0.41	ft
Specific Energy		1.79	ft
Froude Number		1.04	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Basin K -XS 802

GVF Output Data

Normal Depth	1.38	ft
Critical Depth	1.40	ft
Channel Slope	0.01080	ft/ft
Critical Slope	0.00994	ft/ft

Basin A - XS 401 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01200	ft/ft
Discharge	212.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	290.00
0+17	288.00
0+36	286.00
0+92	284.00
2+02	282.00
3+62	280.00
5+88	280.00
9+77	278.00
12+09	276.00
17+41	276.00
19+76	278.00
21+18	280.00
21+86	282.00
22+46	284.00
23+03	286.00
23+46	288.00
23+94	290.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 290.00)	(23+94, 290.00)	0.025

Results

Normal Depth	0.19	ft

Basin A - XS 401 - 10 Year

Results

Elevation Range	276.00 to 290.00 ft		
Flow Area		102.66	ft²
Wetted Perimeter		574.74	ft
Top Width		574.73	ft
Normal Depth		0.19	ft
Critical Depth		0.17	ft
Critical Slope		0.01669	ft/ft
Velocity		2.07	ft/s
Velocity Head		0.07	ft
Specific Energy		0.25	ft
Froude Number		0.86	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.19	ft
Critical Depth	0.17	ft
Channel Slope	0.01200	ft/ft
Critical Slope	0.01669	ft/ft

Basin B - XS 501 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Discharge	123.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	254.00
0+25	252.00
0+51	250.00
0+89	248.00
1+93	246.00
2+16	244.00
2+50	243.00
2+91	244.00
3+44	246.00
3+88	248.00
4+14	250.00
4+28	252.00
4+47	254.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 254.00)	(4+47, 254.00)	0.025

Results

Normal Depth	0.88	ft
Elevation Range	243.00 to 254.00 ft	
Flow Area	29.14	ft^2
Wetted Perimeter	66.01	ft
Top Width	65.98	ft

Basin B - XS 501 - 10 Year

Results

Normal Depth		0.88	ft
Critical Depth		0.92	ft
Critical Slope		0.01179	ft/ft
Velocity		4.22	ft/s
Velocity Head		0.28	ft
Specific Energy		1.16	ft
Froude Number		1.12	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.88	ft
Critical Depth	0.92	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.01179	ft/ft

Basin C - XS 601 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01100	ft/ft
Discharge	396.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	280.00
0+13	278.00
0+27	276.00
7+31	274.00
8+00	273.00
8+76	274.00
9+75	276.00
10+72	278.00
11+08	280.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 280.00)	(11+08, 280.00)	0.025

Results

Normal Depth	1.17	ft
Elevation Range	273.00 to 280.00 ft	
Flow Area	103.21	ft^2
Wetted Perimeter	213.74	ft
Top Width	213.72	ft
Normal Depth	1.17	ft
Critical Depth	1.16	ft
Critical Slope	0.01162	ft/ft
Velocity	3.84	ft/s

Basin C - XS 601 - 10 Year

Results

Velocity Head		0.23	ft
Specific Energy		1.40	ft
Froude Number		0.97	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.17	ft
Critical Depth	1.16	ft
Channel Slope	0.01100	ft/ft
Critical Slope	0.01162	ft/ft

Basin D - XS 701 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01600	ft/ft
Discharge	474.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	226.00
0+24	224.00
0+50	222.00
0+76	220.00
1+10	218.00
3+52	216.00
3+84	216.00
6+50	218.00
6+91	216.00
7+13	214.00
7+75	214.00
7+88	216.00
7+98	218.00
8+09	220.00
9+58	222.00
9+71	224.00
9+79	226.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 226.00)	(9+79, 226.00)	0.025

Results

Normal Depth	0.98	ft

Basin D - XS 701 - 10 Year

Results

Elevation Range	214.00 to 226.00 ft		
Flow Area		68.98	ft²
Wetted Perimeter		78.99	ft
Top Width		78.87	ft
Normal Depth		0.98	ft
Critical Depth		1.16	ft
Critical Slope		0.00909	ft/ft
Velocity		6.87	ft/s
Velocity Head		0.73	ft
Specific Energy		1.71	ft
Froude Number		1.30	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.98	ft
Critical Depth	1.16	ft
Channel Slope	0.01600	ft/ft
Critical Slope	0.00909	ft/ft

Basin I -XS 950 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01030	ft/ft
Discharge	290.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	300.00
11+87	280.00
22+65	300.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 300.00)	(22+65, 300.00)	0.025

Results

Normal Depth	1.12	ft
Elevation Range	280.00 to 300.00 ft	
Flow Area	70.81	ft^2
Wetted Perimeter	126.66	ft
Top Width	126.64	ft
Normal Depth	1.12	ft
Critical Depth	1.10	ft
Critical Slope	0.01111	ft/ft
Velocity	4.10	ft/s
Velocity Head	0.26	ft
Specific Energy	1.38	ft
Froude Number	0.97	
Flow Type	Subcritical	

Basin I -XS 950 - 10 Year

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.12	ft
Critical Depth	1.10	ft
Channel Slope	0.01030	ft/ft
Critical Slope	0.01111	ft/ft

Basin J -XS 901 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01030	ft/ft
Discharge	130.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	312.00
0+16	312.00
0+17	312.00
0+20	312.00
0+26	312.00
0+30	312.00
0+35	312.00
0+36	312.00
0+39	312.00
0+40	312.00
0+45	312.00
0+46	312.00
0+57	312.00
0+57	311.98
0+57	311.98
0+60	311.88
0+67	311.43
0+67	311.43
0+67	311.42
0+73	310.97
0+85	310.00
0+86	310.00
0+87	310.00
1+23	308.53
1+35	308.00
1+61	306.72
1+75	306.00

Basin J -XS 901 - 10 Year

Input Data

Station (ft)	Elevation (ft)
1+76	306.00
1+76	306.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 312.00)	(7+10, 310.39)	0.025

Results

Normal Depth		0.54	ft
Elevation Range	302.81 to 312.00 ft		
Flow Area		45.16	ft²
Wetted Perimeter		137.11	ft
Top Width		137.11	ft
Normal Depth		0.54	ft
Critical Depth		0.51	ft
Critical Slope		0.01344	ft/ft
Velocity		2.88	ft/s
Velocity Head		0.13	ft
Specific Energy		0.67	ft
Froude Number		0.88	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Basin J -XS 901 - 10 Year

GVF Output Data

Normal Depth	0.54	ft
Critical Depth	0.51	ft
Channel Slope	0.01030	ft/ft
Critical Slope	0.01344	ft/ft

Basin K - XS 801 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01250	ft/ft
Discharge	198.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	270.04
0+02	270.00
0+16	270.00
0+22	270.00
0+28	269.05
0+34	268.00
0+40	267.18
0+47	266.00
0+49	265.68
0+60	264.00
0+62	263.69
0+73	262.32
0+75	262.07
0+75	262.00
0+76	261.97
0+76	261.97
1+01	261.36
1+12	261.23
1+14	261.18
1+29	260.86
1+45	260.57
1+57	260.38
1+68	260.31
1+70	260.29
1+77	260.22
1+78	260.21
1+93	260.13

Basin K - XS 801 - 10 Year

Input Data

Station (ft)	Elevation (ft)
1+96	260.11
1+98	260.11

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 270.04)	(5+99, 268.00)	0.025

Results

Normal Depth		0.43	ft
Elevation Range	259.68 to 270.04 ft		
Flow Area		72.36	ft²
Wetted Perimeter		273.72	ft
Top Width		273.71	ft
Normal Depth		0.43	ft
Critical Depth		0.42	ft
Critical Slope		0.01434	ft/ft
Velocity		2.74	ft/s
Velocity Head		0.12	ft
Specific Energy		0.55	ft
Froude Number		0.94	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Basin K - XS 801 - 10 Year

GVF Output Data

Normal Depth	0.43	ft
Critical Depth	0.42	ft
Channel Slope	0.01250	ft/ft
Critical Slope	0.01434	ft/ft

Basin K - XS 802 - 10 Year

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01080	ft/ft
Discharge	198.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	312.00
0+00	312.00
0+17	312.00
0+21	312.00
0+53	310.48
0+64	310.00
0+69	309.63
0+81	309.08
0+94	308.38
1+01	308.00
1+03	308.00
1+09	307.69
1+09	307.69
1+12	307.65
1+39	306.00
1+43	306.00
1+43	306.00
1+49	306.00
1+49	306.00
1+49	306.00
1+49	306.00
1+51	305.80
1+53	305.68
1+57	305.29
1+72	304.00
1+74	303.85
1+75	303.80

Basin K - XS 802 - 10 Year

Input Data

Station (ft)	Elevation (ft)
1+78	303.47
1+81	303.26

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 312.00)	(8+48, 300.00)	0.025

Results

Normal Depth		0.72	ft
Elevation Range	296.00 to 312.00 ft		
Flow Area		51.28	ft²
Wetted Perimeter		103.65	ft
Top Width		103.63	ft
Normal Depth		0.72	ft
Critical Depth		0.70	ft
Critical Slope		0.01156	ft/ft
Velocity		3.86	ft/s
Velocity Head		0.23	ft
Specific Energy		0.95	ft
Froude Number		0.97	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Basin K - XS 802 - 10 Year

GVF Output Data

Normal Depth	0.72	ft
Critical Depth	0.70	ft
Channel Slope	0.01080	ft/ft
Critical Slope	0.01156	ft/ft

HEC-RAS Plan: Plan 01 River: Solar II Drainag Reach: Reach 100

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 100	113	100-YR	1090.00	218.00	220.15	220.15	220.92	0.008036	7.07	154.11	100.60	1.01
Reach 100	113	10-YR	250.00	218.00	219.05	218.93	219.33	0.006404	4.21	59.41	71.31	0.81
Reach 100	112	100-YR	1090.00	204.00	205.53	205.48	206.00	0.008195	5.51	198.11	205.62	0.95
Reach 100	112	10-YR	250.00	204.00	204.68	204.65	204.91	0.010040	3.88	64.43	122.49	0.94
Reach 100	111	100-YR	1090.00	179.05	180.47	180.47	180.86	0.010452	5.00	218.07	292.21	1.02
Reach 100	111	10-YR	250.00	179.05	179.92	179.86	180.10	0.008291	3.39	73.66	148.31	0.85
Reach 100	110	100-YR	1090.00	146.00	147.17	147.17	147.70	0.008988	5.82	187.43	178.67	1.00
Reach 100	110	10-YR	250.00	146.00	146.45	146.45	146.67	0.012204	3.74	66.80	155.20	1.01
Reach 100	109	100-YR	1090.00	114.00	115.54	115.54	116.22	0.008252	6.61	164.92	121.55	1.00
Reach 100	109	10-YR	250.00	114.00	114.63	114.60	114.88	0.009405	4.06	61.57	104.04	0.93
Reach 100	108	100-YR	1090.00	104.06	105.27	105.27	105.64	0.009895	4.88	223.34	297.76	0.99
Reach 100	108	10-YR	250.00	104.06	104.77	104.77	104.92	0.013810	3.11	80.45	271.06	1.01
Reach 100	107	100-YR	1090.00	84.00	85.07	84.98	85.24	0.006650	3.79	403.49	741.43	0.80
Reach 100	107	10-YR	250.00	84.00	84.62	84.54	84.70	0.005853	2.47	130.65	437.63	0.69
Reach 100	106	100-YR	1516.00	68.81	69.89	69.89	70.14	0.012630	4.02	377.40	809.28	1.04
Reach 100	106	10-YR	336.00	68.81	69.49	69.49	69.62	0.014824	2.81	119.58	494.28	1.01
Reach 100	105	100-YR	1516.00	50.00	51.19	50.90	51.36	0.003407	3.32	457.04	488.84	0.60
Reach 100	105	10-YR	336.00	50.00	50.63	50.37	50.67	0.001920	1.65	203.17	401.44	0.41
Reach 100	104	100-YR	6996.00	32.00	35.11	35.11	36.26	0.006187	9.15	935.25	456.29	0.97
Reach 100	104	10-YR	1329.00	32.00	33.16	33.16	33.66	0.009702	5.89	244.49	247.25	1.03
Reach 100	103	100-YR	6996.00	14.46	18.12		18.38	0.002132	5.88	2405.76	1288.66	0.59
Reach 100	103	10-YR	1329.00	14.46	16.58	16.39	16.76	0.002306	3.90	643.54	1026.44	0.54
Reach 100	102	100-YR	6996.00	8.00	10.79	10.79	12.02	0.006672	8.88	799.37	349.80	0.99
Reach 100	102	10-YR	1329.00	8.00	9.02	9.02	9.48	0.009431	5.43	244.58	267.71	1.00
Reach 100	101	100-YR	8564.00	-0.97	2.51	1.60	2.77	0.001803	5.31	2694.15	1187.80	0.54
Reach 100	101	10-YR	1594.00	-0.97	0.82	0.43	0.92	0.001693	3.00	838.38	936.32	0.45

HEC-RAS Plan: Plan 01 River: Solar II Drainag Reach: Reach 100 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 100	100	100-YR	8564.00	-8.00	-4.83	-4.83	-4.05	0.008094	7.09	1207.48	790.40	1.01
Reach 100	100	10-YR	1594.00	-8.00	-6.40	-6.40	-5.82	0.008814	6.13	260.18	226.13	1.01

HEC-RAS Plan: CHNL 200 River: Solar Drainage Reach: Channel200

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Channel200	206	100-YR	1351.00	184.22	190.60	190.60	192.20	0.006625	10.14	133.17	41.73	1.00
Channel200	206	10-YR	303.00	184.22	187.73	187.73	188.61	0.008082	7.52	40.28	22.95	1.00
Channel200	205	100-YR	1351.00	147.71	149.12	149.12	149.54	0.009981	5.18	260.96	320.52	1.01
Channel200	205	10-YR	303.00	147.71	148.44	148.42	148.64	0.011152	3.59	84.40	195.11	0.96
Channel200	204	100-YR	1351.00	99.93	101.38	101.38	102.00	0.008608	6.34	213.19	172.93	1.01
Channel200	204	10-YR	303.00	99.93	100.52	100.52	100.77	0.011585	4.05	74.76	148.19	1.01
Channel200	203	100-YR	1351.00	80.00	82.27	82.21	82.90	0.007344	6.34	213.10	153.08	0.95
Channel200	203	10-YR	303.00	80.00	81.22	81.07	81.46	0.006100	3.93	77.15	98.94	0.78
Channel200	202	100-YR	1351.00	43.85	44.83	44.83	45.06	0.011768	3.85	350.74	759.62	1.00
Channel200	202	10-YR	303.00	43.85	44.32	44.32	44.46	0.014524	3.03	99.98	363.33	1.02
Channel200	201	100-YR	1989.00	7.93	9.63	8.93	9.68	0.000688	1.72	1215.80	1213.75	0.28
Channel200	201	10-YR	429.00	7.93	8.81	8.38	8.83	0.000850	1.13	380.79	726.55	0.27
Channel200	100	100-YR	8564.00	-8.00	-4.83	-4.83	-4.05	0.008094	7.09	1207.48	790.40	1.01
Channel200	100	10-YR	1594.00	-8.00	-6.40	-6.40	-5.82	0.008817	6.13	260.15	226.11	1.01

HEC-RAS Plan: Plan 02 River: Solar II Drainag Reach: Channel 300

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Channel 300	305	100-YR	1622.00	50.00	50.76	50.76	51.11	0.010194	4.75	341.41	484.67	1.00
Channel 300	305	10-YR	357.00	50.00	50.28	50.28	50.42	0.014022	2.97	120.17	438.21	1.00
Channel 300	304	100-YR	1622.00	32.27	35.56	35.17	36.10	0.004269	5.92	274.11	145.47	0.76
Channel 300	304	10-YR	357.00	32.27	34.17	33.82	34.35	0.003115	3.35	106.55	104.89	0.59
Channel 300	302	100-YR	1719.00	4.00	5.86	5.79	6.24	0.007778	4.99	344.64	371.28	0.91
Channel 300	302	10-YR	377.00	4.00	4.97	4.97	5.22	0.011896	4.00	94.18	194.09	1.01
Channel 300	301	100-YR	1719.00	0.00	4.14		4.34	0.000862	3.74	581.80	289.80	0.37
Channel 300	301	10-YR	377.00	0.00	2.34	1.51	2.41	0.000874	2.13	180.41	156.45	0.32
Channel 300	100	100-YR	8564.00	-8.00	-4.83	-4.83	-4.05	0.008094	7.09	1207.48	790.40	1.01
Channel 300	100	10-YR	1594.00	-8.00	-6.40	-6.40	-5.82	0.008841	6.13	259.90	226.03	1.01