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| DATE | JAN 29 2010 |
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January 29, 2010

Mr. Alan Solomon
Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

**RE: Blythe Solar Power Project, Docket No. 09-AFC-6**
**Data response to DR-BIO-58 (Post Development Drainage Conditions report)**

Dear Mr. Solomon,

Attached please find the above referenced data response for the Palo Verde I, LLC Blythe Solar Power Project. This report is in response to Data Request #58 in the Blythe Solar Power Project Data Requests Set 1 (#1-260).

Please feel free to call me directly at 510/524-4517 if you have any questions on this supplemental submittal or any other aspects of our Data Responses.

Sincerely,

Alice L. Harron
Senior Director, Development

Solar Millennium LLC
1625 Shattuck Ave. Suite 270
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AECOM


# Post-Development Drainage Conditions

**Submitted in Response to DR-BIO-58**
**January 29, 2010**

**Docket No. 09-AFC-6**
**Palo Verde Solar I, LLC**

*This report has been prepared for:*

*Palo Verde I, LLC  c/o Solar Millennium*
*1625 Shattuck Ave., Suite 270*
*Berkeley, CA 94709-1611*

*Alice Harron, Sr. Director, Development & Permitting*
*(510) 524-4517*

*This report was prepared by:*

*AECOM Inc.*
*999 Town & Country Road*
*Orange, CA 92686*

*Project Manager:  Bill Hagmaier, P.E.*

*Senior Drainage Engineer:  Matt Brown, P.E.*

*Drainage Engineer:  Enrique Triana, Ph.D.*

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# 1. PROJECT DESCRIPTION

## 1.1 Introduction

This report describes the post-development drainage conditions for the Blythe Solar Power Project Site, and is an addendum to the "Blythe Solar Power Project – Pre-Development Drainage Conditions" report (Pre-Development Report), published by AECOM on November 25, 2009, and is prepared in response to Data Request DR-BIO-58, issued December 7, 2009. A detailed description of the project and project background is provided in the Pre-Development Report and summarized below. This addendum discusses the FLO-2D model modifications between the pre-development drainage conditions presented in the Pre-Development Report and post-development drainage conditions and compares results between the two models.

The conditions and descriptions for the site on which Palo Verde Solar I, LLC propose to locate a solar power plant near Desert Center, is described in the Pre-Development Report. As discussed in the Pre-Development Report, the general area surrounding the proposed project site consists of approximately 9,400 acres located 8 miles west of Blythe, California and 2.5 miles north of Highway I–10. The total area of land currently proposed for development is approximately 7,030 acres.

## 1.2 Upstream Offsite Flow Patterns

The proposed solar field improvements will not change the existing upstream offsite drainage patterns.

## 1.3 Onsite Flow Patterns

The proposed onsite drainage improvements seek to achieve consistency with the existing flow patterns as nearly as possible. For this reason several channels have been proposed adjacent to or across the site. Four of these channels intercept the flows prior to their entry to the site then re-direct them around or through the site and convey them to the same locations where they exit the site under existing conditions (Figure 1). Several additional smaller channels have been designed to collect runoff from the solar fields and convey them to the same locations where they exit the site under existing conditions. Each of the proposed offsite channels are being sized to contain the peak flow of the 100-year, 24-hour storm event and will include necessary earth compaction and soil cement side-slope protection along key reaches (e.g., directional transitions, proposed-to-natural channel transitions, and reaches with significant design velocities).

The north-half portion of the solar proposed development will be graded so that the runoff will be conveyed through a network of channels to the Central channel. The Central channel will convey the flow to the east where it discharges to the existing wide shallow flow regime adjacent to the knoll along the east side of the project site. The North Channel will intercept

upstream off-site runoff from a portion of the McCoy Mountains and will convey flows along the north edge of the site to a diffuser located at the northeast corner of the site. This diffuser will release the flow in a southern direction through a spreader fan diffuser located on the northeast corner of the site. The flows will be released into the existing wide shallow wash adjacent to the existing knoll along the east side of the project site. This flow direction replicates the existing flow patterns for this drainage area.

The West channel is designed to collect a portion of flows from the McCoy Mountains tributary to the west side of the site. The south channel flows through the site and collects additional onsite runoff from the south-half of the solar fields in the proposed development. This channel will connect directly to the existing dry wash south of the solar field and also to the outlet in a spreader fan diffuser at the southeast end of the site to return the flow to existing conditions.

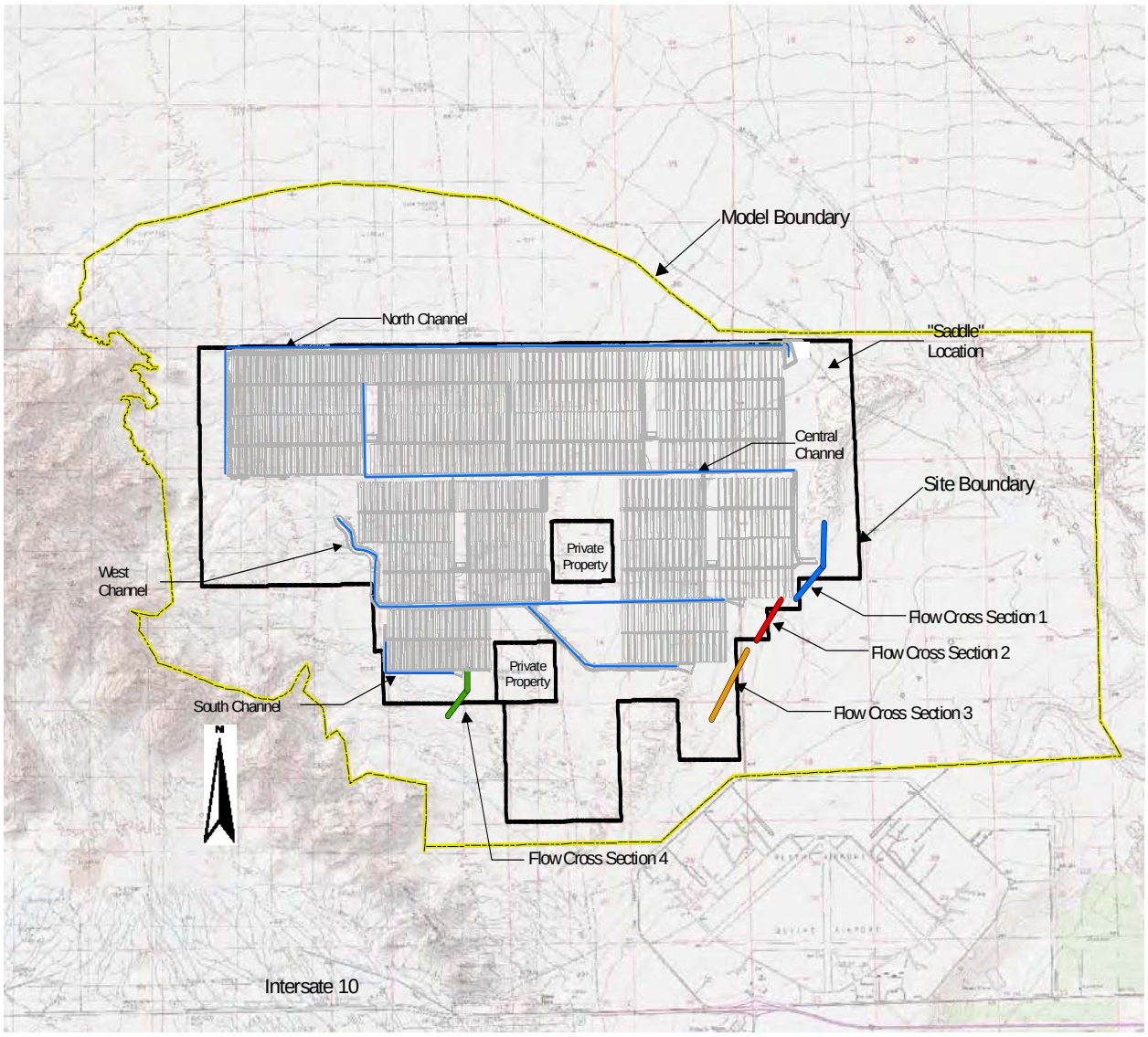



**Figure 1. Model Boundary, Flow Cross Sections, and Channel Locations**

# 2. METHODOLOGY

Post-development drainage at the Blythe site was analyzed using FLO-2D Version 2007.06, a physical process model that routes rainfall-runoff and flood hydrographs over unconfined flow surfaces or in channels. The FLO-2D software was also used to analyze pre-development drainage.

Drainage conditions were simulated for a 48-hour period for the 10-, 25-, and 100-year hydrologic events using the same base model configuration and parameters for all three hydrologic events. The remainder of this section describes key user-selected model parameters used for this study. Differences in spatial configuration, elevation, manning's n values, infiltration data, inflow data, and outflow data between the two models is discussed below.

## 2.1 Spatial Configuration

The model boundary was extended slightly to the north and the west to include McCoy Wash to determine the flow patterns on the east side of the development. Figure 1 shows the pre-development model boundary and the post-development model boundary. The grid element size remained the same between the pre- and post-development models.

## 2.2 Elevation

Grid elevations, both inside and outside the site boundary, were interpolated from a combination of an AutoCAD file with the proposed site design, high-resolution (1.0-foot contour) LIDAR data inside the project site and low-resolution (20-foot contour) USGS data outside the site. The post-development model uses the same elevation data outside the site boundary as the pre-development model. The FLO-2D model package tools were utilized to perform interpolation, assigning representative elevations to each grid element.

## 2.3 Manning's 'n' Values

The main channels described in the Onsite Flow Patterns section are reported to have a Manning's 'n' value of 0.025. A shapefile was created in GIS to represent the Manning's n value for the channels, and merged with shapefiles representing the Manning's n values for all other locations within the model boundary (presented in the Pre-Development Report). The FLO-2D model package tools were utilized to perform interpolation of the shapefiles and assign a Mannings's 'n' to each grid element.

## 2.4 Rainfall-Runoff Modeling

The SCS Curve Number was changed from 80 (pre-development model CN number) to 85 (post-development model CN number) for all grid elements within the project site as part of this model to reflect expected soils conditions after the site grading.

## 2.5 Flow Control Structures

The grading plan for the site incorporated levee structures at the upstream side of numerous grad control/drop structures in all of the primary channels such that onsite detention was provided. These detention areas provide control of the increased flow rates and flow volumes associated with the higher CN value for the post-development condition. A levee structure was also incorporated in the model to reflect expected flow conditions where a directional deficiency with the current grading was identified. This structure was placed along the east boundary of the mid-central portion of the site to prevent intrusion of the flood in the solar fields. The grading plans will be adjusted by raising the field in this location to preclude flow back into the fields.

## 2.6 Outflow from the FLO-2D Model

The Flow Analysis Cross Section locations chosen for pre-development conditions were estimated to quantify the majority of the outflow from the site as discussed in the Pre-Development Report. Cross Sections 1 and 4 were modified to capture all of the flow out of the diffusers in these locations. Figure 1 shows the location of the revised Flow Analysis Cross Sections. Appendices A, B, and C provide the maximum modeled water depth, the maximum velocity and the maximum water surface elevations for the three storms analyzed.

## 3. RESULTS AND CONCLUSIONS

Review of the maps in Appendices A, B, and C and comparison with the corresponding pre-development maps from the Pre-Development Report provides several conclusions about the general flow characteristics:

- In general, relative small changes are observed between maximum flow rates and total flow volumes between pre-development and post development conditions within the FLO-2D models for Sections 2 and 4.

- The post-development condition at Section 1 generally shows an increase in both flow rate and volume compared to the pre-development condition. The post-development condition at Section 3 generally shows a decrease in both flow rate and volume compared to the pre-development condition. Some minor adjustments to the grading design as part of final engineering should create a more balanced condition at these two locations.

- The combined use of conveyance channels and diffusers in the post-development conditions are intended resemble the areas of concentration in the "Flow Areas" defined by the pre-development model. Areas of concentration for the flow areas are shown on the flow depth maps in the Appendices (Sheets 1 of 4).

- There are several areas in various channels where water pools in the model. The design of the channel requires a series of 'drops' in the channel alignment. These drop structures area preceded by a weir across the channel that creates pools of water in the flatter parts of the channels. This creates a series of linear detention basins to control the flow and volume across the site.

- Water is currently retained at the diffusers after the flow recedes due to their lower elevation with respect of the natural topography in their surroundings. This will be adjusted in the final design process so that no standing water remains on the site longer than 48 hours.

- High flow depths and velocities occur in the West channel where the channel bends from south-flowing to east-flowing. Additional drop structures will be added to this area as part of the final design to control velocity and scour. The flow depths are contained within the channel and are not an issue.

- Tables 1, 2, and 3 below provide a summary of peak flow rate (cfs) and total flow volume (acre-feet) at the four "Flow Analysis Cross Sections" defined in the pre-development FLO-2D model and Flow Analysis Cross Sections defined in the post-development model. These values are also shown on the maps in the Appendices (Sheets 3 of 3).

TABLE 1
10-Year Storm Event FLO2D RESULTS

| Flow Analysis Cross Section | Peak Flow Rate (cfs) | | Total Flow Volume (ac-ft) | |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| 1 | 310 | 591 | 164 | 448 |
| 2 | 0 | 0 | 0 | 0 |
| 3 | 23 | 10 | 9 | 2 |
| 4 | 0 | 0 | 0 | 0 |
| Total | | | 175 | 450 |

TABLE 2
25-Year Storm Event FLO2D RESULTS

| Flow Analysis Cross Section | Peak Flow Rate (cfs) | | Total Flow Volume (ac-ft) | |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| 1 | 726 | 617 | 348 | 632 |
| 2 | 0 | 0 | 0 | 0 |
| 3 | 199 | 43 | 101 | 37 |
| 4 | 0 | 0 | 0 | 0 |
| Total | | | 449 | 669 |

TABLE 3
100-Year Storm Event FLO2D RESULTS

| Flow Analysis Cross Section | Peak Flow Rate (cfs) | | Total Flow Volume (ac-ft) | |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| 1 | 1478 | 1502 | 1508 | 1876 |
| 2 | 75 | 58 | 59 | 52 |
| 3 | 823 | 494 | 594 | 375 |
| 4 | 96 | 117 | 76 | 92 |
| Total | | | 2237 | 2395 |

- The comparison of the flow volumes which are described in the Pre-Development report and shown in the maps (3 of 3) in the appendices can be observed:

a. Flow Analysis – Cross Section 1. The volume of flow associated with this cross section includes flow from the North Channel and the Central Channel. The total flow at this cross section is increased in the post development condition compared to the pre development condition at all storm events. This increase is primarily attributed to the change in CN value and some minor modifications to sub-basin contributions. Some adjustment to these flow levels can be achieved in the final engineering design by providing additional detention at the drop structures in the primary channels and by flow balancing the sub-basins between Section 1 and Section 3.
b. Flow Analysis – Cross Section 2. The volume of flow at this cross section is non existent at most all storm events except the 100 year storm. Even at the 100 year storm event, the flows are very low and are generally balanced at the pre and post development levels.
c. Flow Analysis – Cross Section 3. The volume of flow at this cross section is associated with flow from the West Channel. This channel includes flow from off-site areas upstream of the project site as well as contributions from the project site. The volume of flow at this section is nearly non-existent for a 10 year storm, minimal for a 25 year storm, and only at the 100 year storm is there any flow that leaves the site. In all cases there is less flow in the post development condition than in the pre-development condition. This can generally be attributed to the amount of flow storage that occurs at the drop structures within the West Channel as well as some reduction of contributing area associated with the sub-basin areas on the project site. Some adjustment to these flow levels can be achieved in the final engineering design by providing less detention at the drop structures in the primary channel and by flow balancing the sub-basins between Section 1 and Section 3.
d. Flow Analysis – Cross Section 4. The volume of flow at this cross section is non existent at most all storm events except the 100 year storm. Even at the 100 year storm event, the flows are low and are generally balanced at the pre and post development levels. There is a slight increase in the post development condition compared to the pre development condition that is likely due to the concentration of flows into the channel from the project site area compared to the overland flow in the predevelopment condition. Even at the 100 year storm event however, there is little to no flow that leaves the project area and the flow all appears to infiltrate into the ground without leaving the site just as it does in the pre development condition.

The comparison of the peak flows can be observed as follows:

a. Peak Flow – Cross Section 1. The peak flows at this section become more balanced the higher the flow levels become. This is primarily associated with the aspect of flow channelization on site as well as partially due to the volume of flow within the channels. At the highest level storm, the peak flow is generally balanced between the pre and post development condition and does not create any downstream issues.

b. Peak Flow – Cross Section 2. The volume of flow, and therefore the associated peak flow at this cross section is non existent at most all storm events except the 100 year storm. Even at the 100 year storm event, the peak flows are very low and are generally balanced at the pre and post development levels.
c. Peak Flow – Cross Section 3. The peak flow rate at this section is generally substantially less in the post development condition than in the pre-development condition. This lower peak flow rate can generally be attributed to the extent of flow control structures that have been proposed as part of the site design for the primary channels. These flow control structures as well as some minor modification to the sub-basin contributions lead to a lower peak flow at this section. Some adjustment to these flow levels can be achieved in the final engineering design by providing less detention at the drop structures in the primary channel and by flow balancing the sub-basins between Section 1 and Section 3.
d. Peak Flow – Cross Section 4. The volume of flow, and therefore the associated peak flow at this cross section is non existent at most all storm events except the 100 year storm. There is a small increase of the peak flow in the post development condition which is a function of the channelization of the flow in this area as part of the site design. The peak flow does not appear to greatly change the flow at this location and the volume of water passing this section line is negligible as observed on the water surface maps.

- In general, the results presented above portray peak flow rates and total flow volumes that are less than those results presented in the August 2009 Drainage Report. Comparison of results between this report and the August 2009 report must include qualification of model assumptions utilized for each report, as summarized below.

    1. The August 2009 Drainage Report was prepared to analyze the post-development drainage flows on a full graded site with no localized depressions, no detention, and to size drainage channels to convey the storm events around and through the site to avoid damage to the project infrastructure. The HEC-RAS model is the appropriate tool for this type of flow modeling. This post-development report was prepared to analyze flows on the proposed conditions with detailed design of channels and surface slopes. FLO-2D is the appropriate model for this type of flow. The comparison of channelized flow to overland flow will naturally create differences.

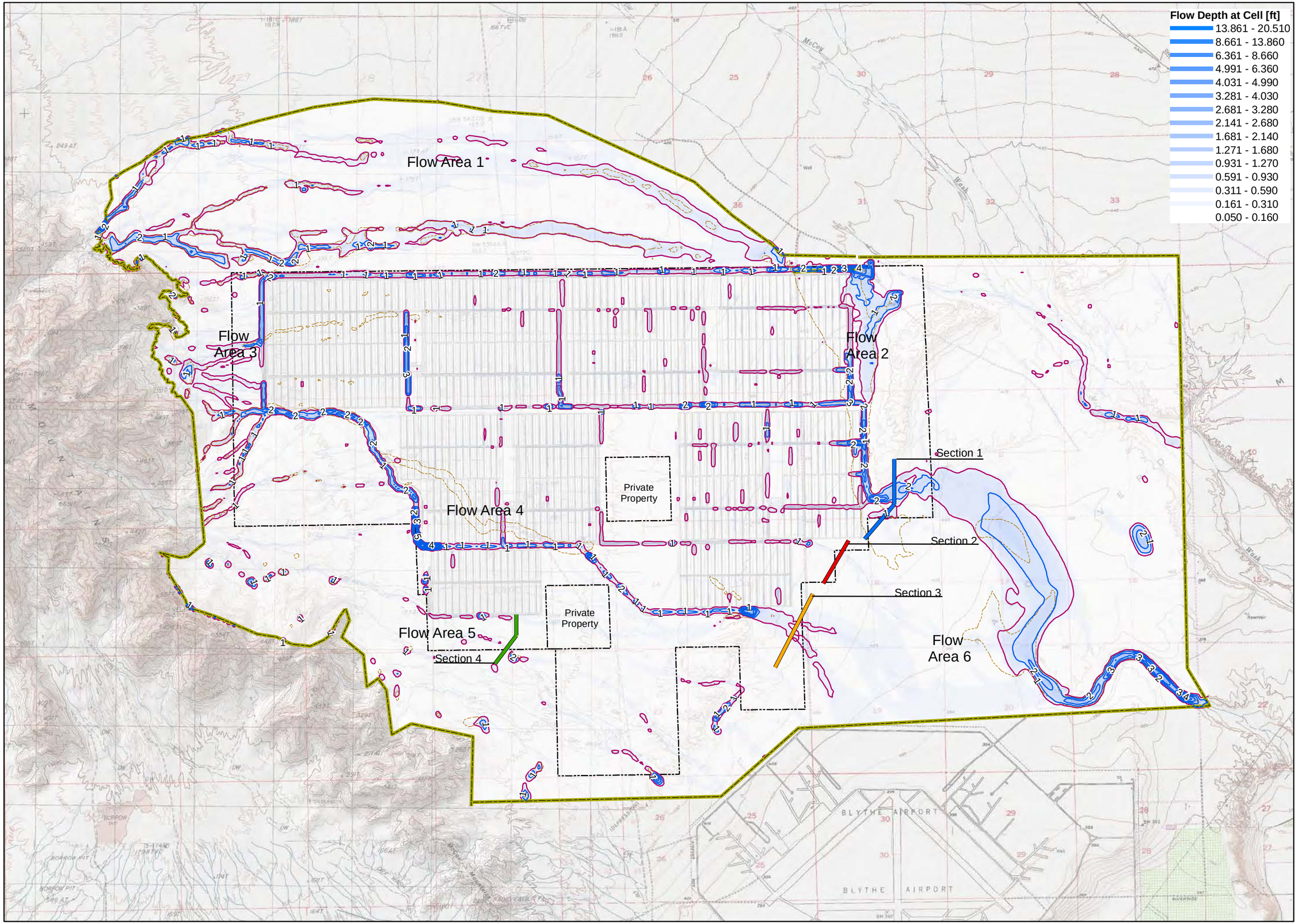
    2. The August 2009 analysis included HEC-HMS modeling based on 20-foot contour-interval topography; the current report analysis includes FLO-2D modeling based on 1-foot contour-interval topography. Contour interval resolution affects watershed slope and boundary delineation, flow routing dynamics, flow concentration and flow diffusion.

    3. The August 2009 analysis included HEC-HMS modeling based on Muskingum routing; the current report analysis includes FLO-2D modeling based on dynamic wave approximation. Each of these methods is appropriate for their respective modeling

(channel flow versus overland flow) but they are difficult to compare because they analyze different types of flow.

4. The August 2009 Drainage Report utilized HEC-HMS modeling, a software package for sizing the post development drainage channels. It does not have the modeling capability for predicting watershed storage. The current report analysis utilizes FLO-2D modeling, a software package that includes an on-site "Watershed Storage" factor that will hold water in on-site storage when simulated hydraulic head is beneath a specific threshold. This "storage factor" results in different flow rates at the site boundary.

**APPENDIX A:**
**100-year Existing Hydrology Flow Depth, Velocity, and Water Surface Maps**

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Prepared for:

Solar Millennium LLC

LEGEND:

Flow Analysis Section
1
2
3
4
Flow Depth at Cell (Contour)
Model Boundary
Pre-Area of Concentrated Flow*
Area of Concentrated Flow*
Site Boundary

* Area of maximum concentrated flow with water depth exceeding 0.3 feet

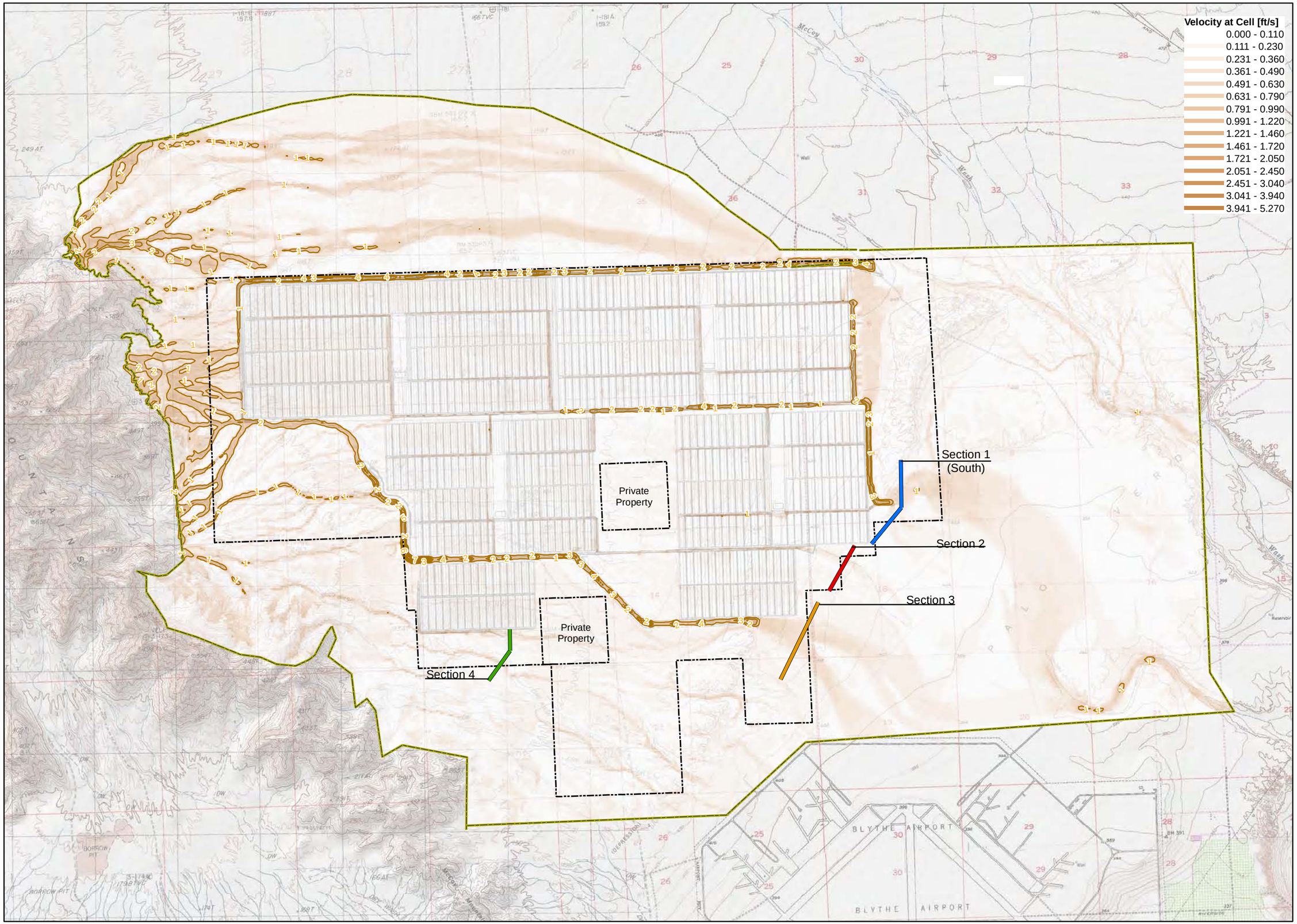
0 1,150 2,300 4,600 Feet

# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 100-Yr Storm Max. Flow Depth

Date: 01/28/10
Sheet: 1 of 3

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Prepared for:

Solar Millennium LLC

LEGEND:

Flow Analysis Section
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Model Boundary
Site Boundary
Velocity at Cell (Contour)

0 1,350 2,700 5,400 Feet

# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 100-Yr Storm Maximum Velocity

Date: 01/28/10
Sheet: 2 of 3

Q = 1654.4 cfs
V = 106.7 AF
N3a

Q = 242.4 cfs
V = 14.4 AF
N2a

Q = 280.8 cfs
V = 16.7 AF
NW3

Q = 151.2 cfs
V = 9.0 AF
NW1

Q = 1217.9 cfs
V = 77.4 AF
W1

Q = 1282.7 cfs
V = 95.3 AF
SW5

N4b Q = 1052.6 cfs
V = 223.6 AF

N5b Q = 425 cfs
V = 98.2 AF

1 Q = 1501.6 cfs
V = 1876.3 AF

Private Property

Private Property

Section 1

Section 2

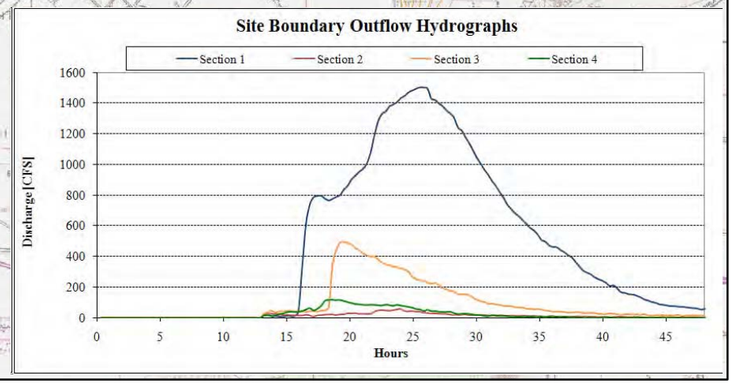
Section 3

Section 4

Q = 116.5 cfs
V = 92.4 AF
4

3 Q = 493.8 cfs
V = 375.3 AF

2 Q = 57.5 cfs
V = 51.9 AF

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Solar Millennium LLC

LEGEND:

Q = Peak Flow
V = Total 24-hour Volume

**Flow Analysis Section**
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2
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4

**Model Boundary**
Site Boundary
**Area of Concentrated Flow***
Blythe_SitePlan_CAD_2
**Surface Contours**

*** Area of maximum concentrated flow with water depth exceeding 0.3 feet**

N

0 1,300 2,600 5,200
Feet

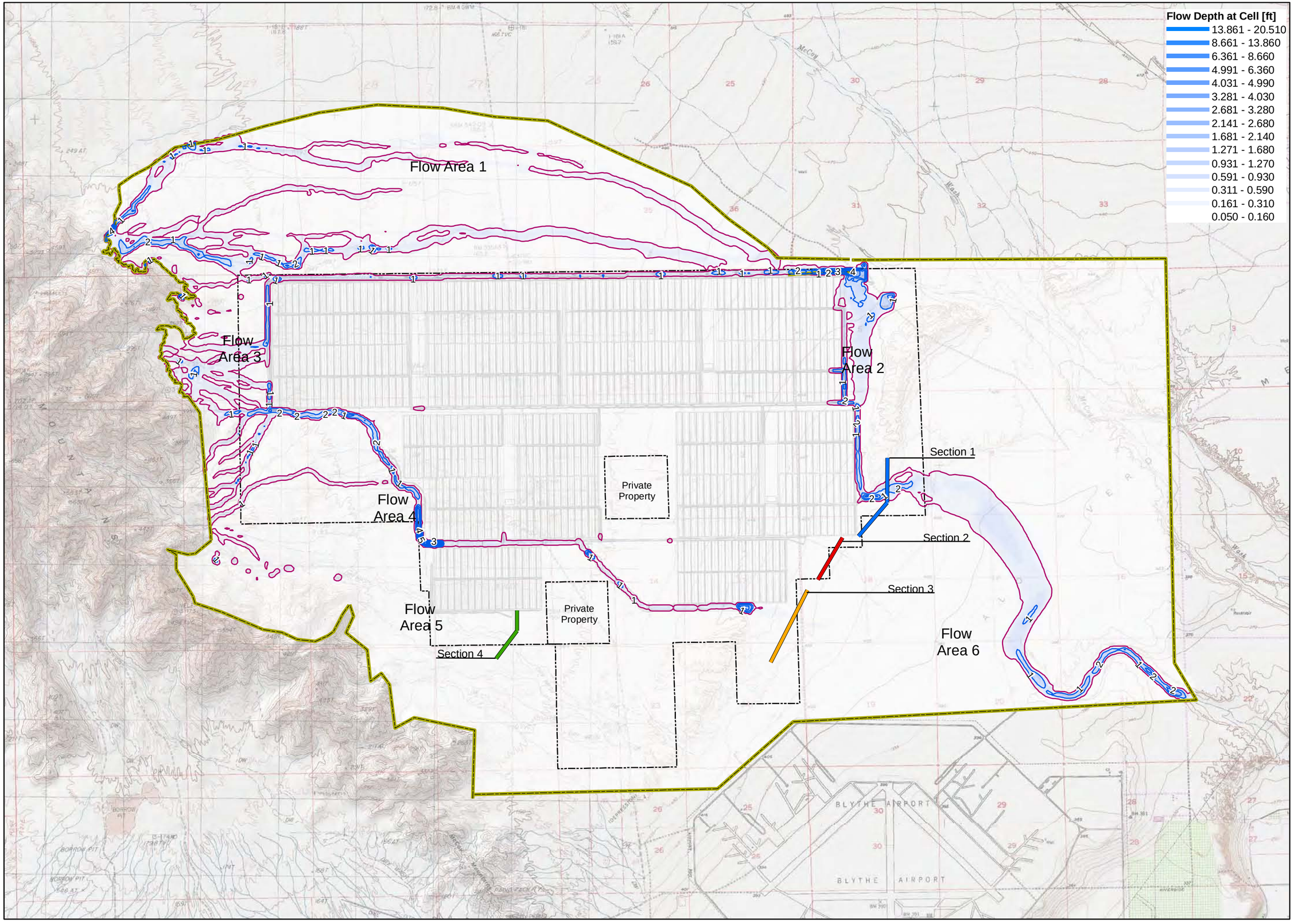
# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 100-Yr Storm Max. Water Surface

Date: 01/28/10
Sheet: 3 of 3

**APPENDIX B**
**25-year Existing Hydrology Flow Depth, Velocity, and Water Surface Maps**

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Prepared for:

Solar Millennium LLC

LEGEND:

Flow Analysis Section
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Flow Depth at Cell (Contour)
Model Boundary
Area of Concentrated Flow*
Site Boundary

* Area of maximum concentrated flow with water depth exceeding 0.3 feet

0 1,400 2,800 5,600 Feet

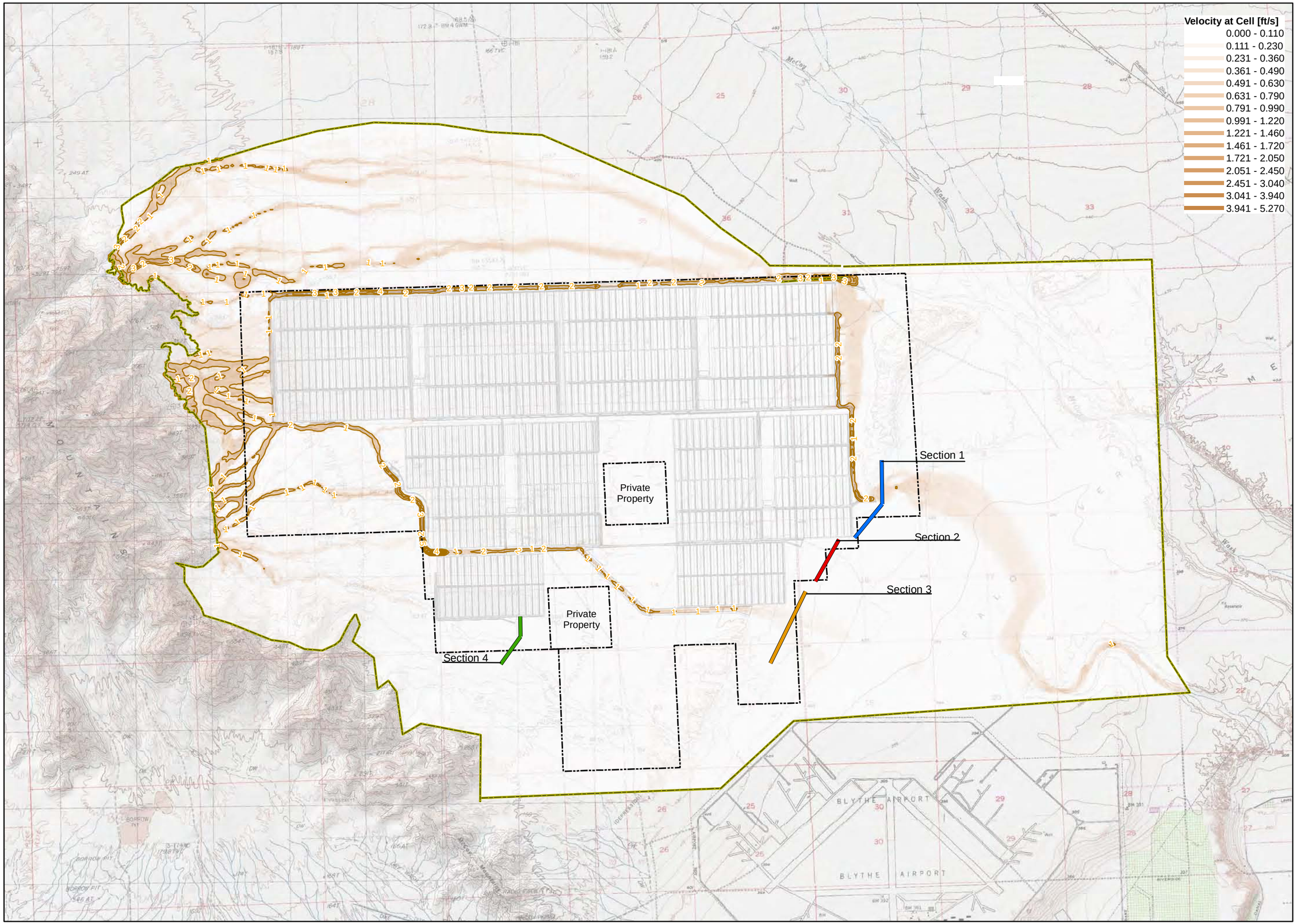
# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 25-Yr Storm Max. Flow Depth

Date: 01/28/10

Sheet: 1 of 3

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Solar Millennium LLC

LEGEND:

**Flow Analysis Section**
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3
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Model Boundary
Site Boundary
Velocity at Cell (Contour)

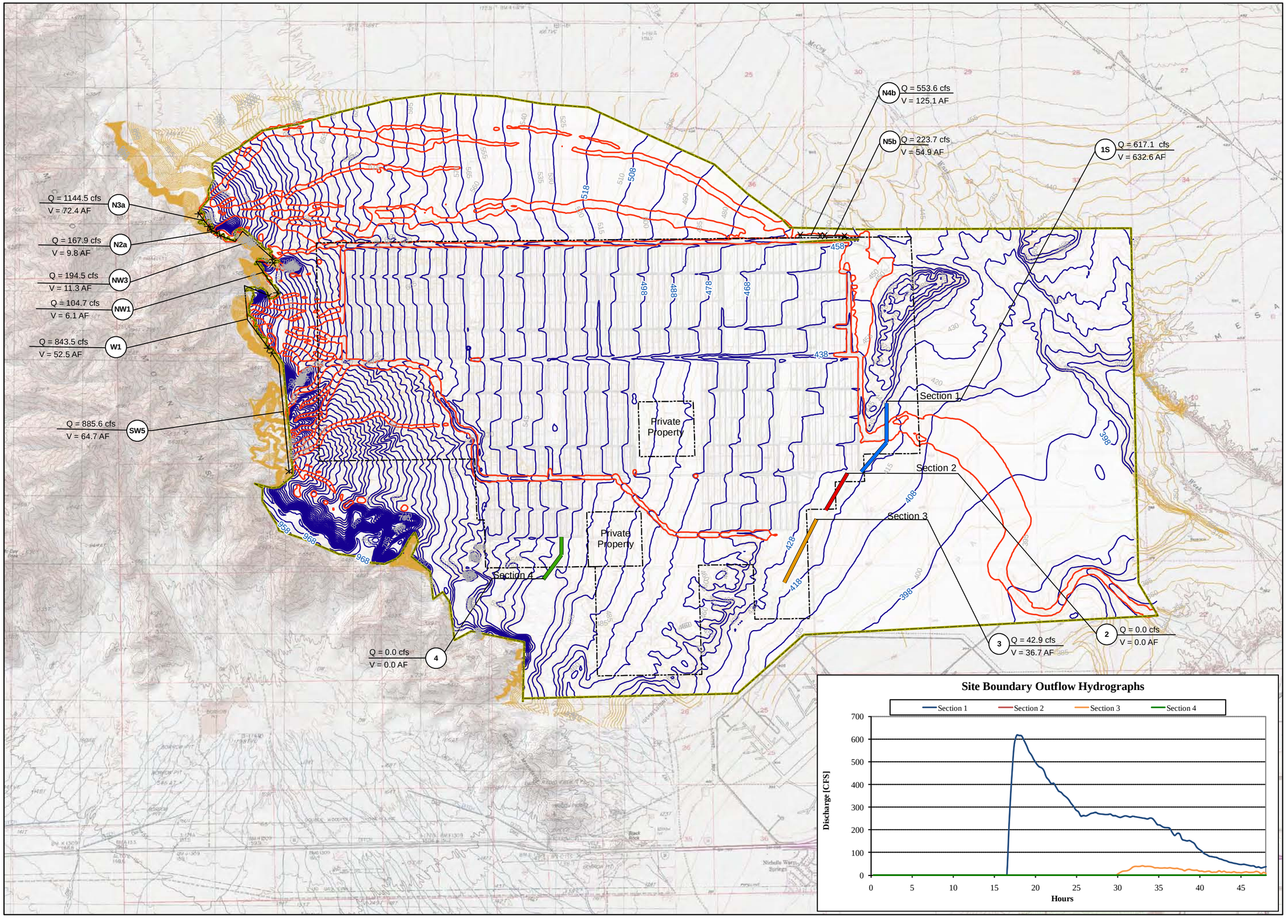
0 1,150 2,300 4,600 Feet

# Blythe Solar Power Plant

Riverside County, California

**Proposed Conditions 25-Yr Storm Maximum Velocity**

Date: 01/28/10
Sheet: 2 of 3







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Prepared for:

Solar Millennium LLC

LEGEND:

Q = Peak Flow
V = Total 24 hour Volume
Flow Analysis Section

1
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3
4

Model Boundary
Site Boundary
Area of Concentrated Flow*
Max Water Elevation
Blythe_SitePlan_CAD_2
Surface Contours

* Area of maximum concentrated flow with water depth exceeding 0.3 feet

0 1,300 2,600 5,200
Feet

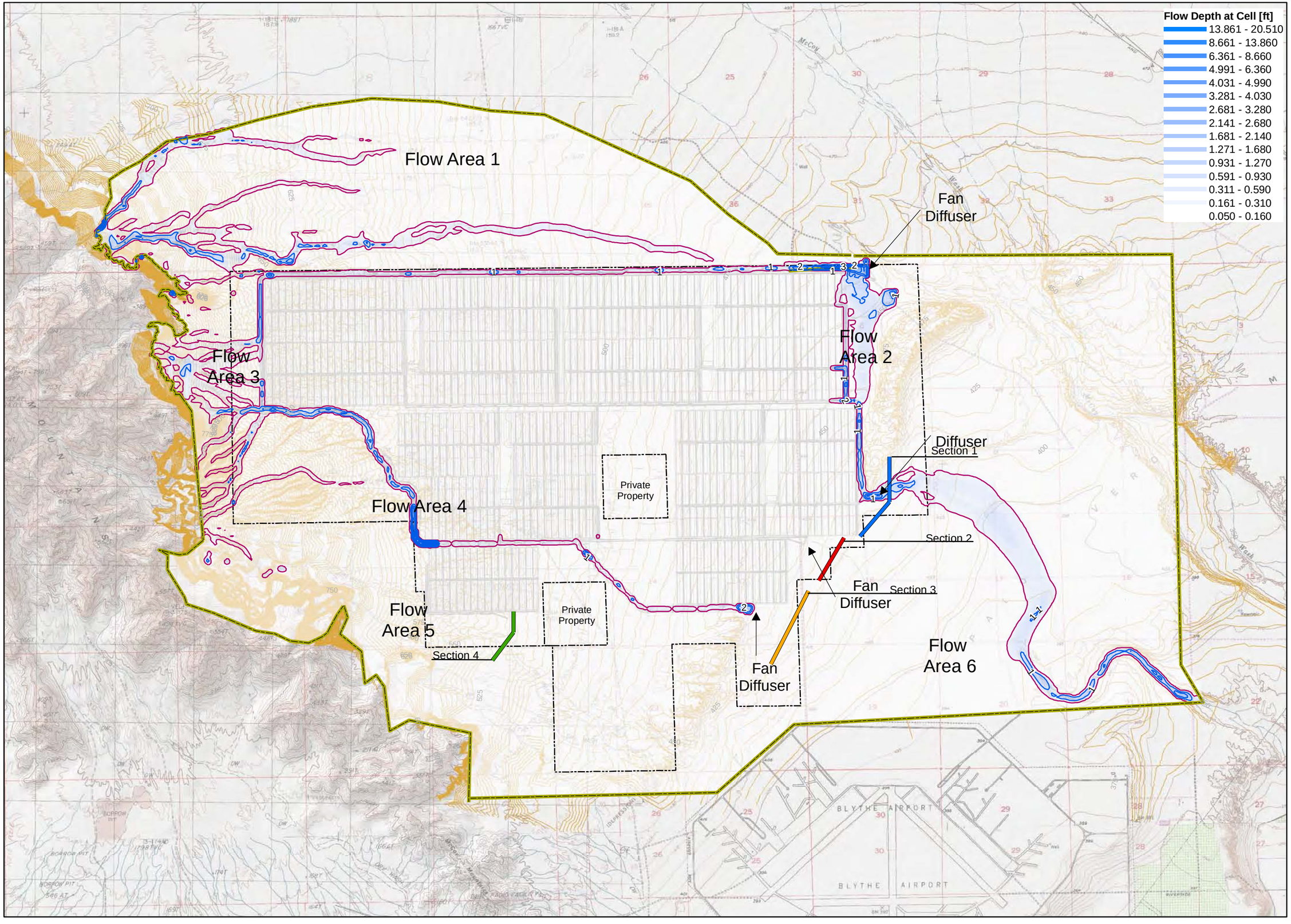
# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 25-Yr Storm Max. Water Surface

Date: 01/28/10
Sheet: 3 of 3

**APPENDIX C**
**10-year Existing Hydrology Flow Depth, Velocity, and Water Surface Maps**

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Solar Millennium LLC

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Flow Analysis Section
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Flow Depth at Cell (Contour)
Model Boundary
Area of Concentrated Flow*
Site Boundary

* Area of maximum concentrated flow with water depth exceeding 0.3 feet

0 1,200 2,400 4,800 Feet

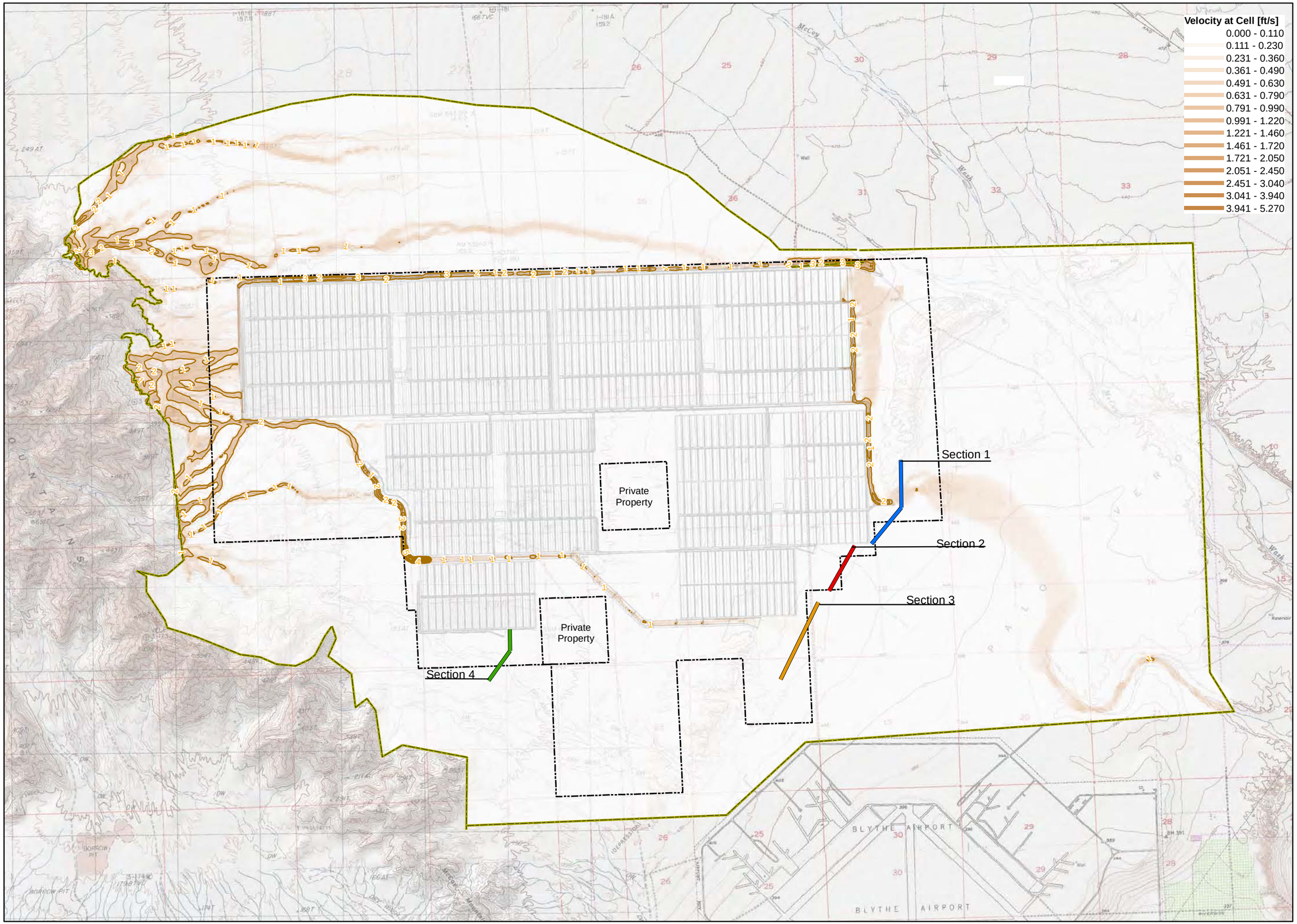
# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 10-Yr Storm Max. Flow Depth

Date: 01/28//10

Sheet: 1 of 3

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Solar Millennium LLC

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**Flow Analysis Section**
1
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3
4
Model Boundary
Site Boundary
Velocity at Cell (Contour)

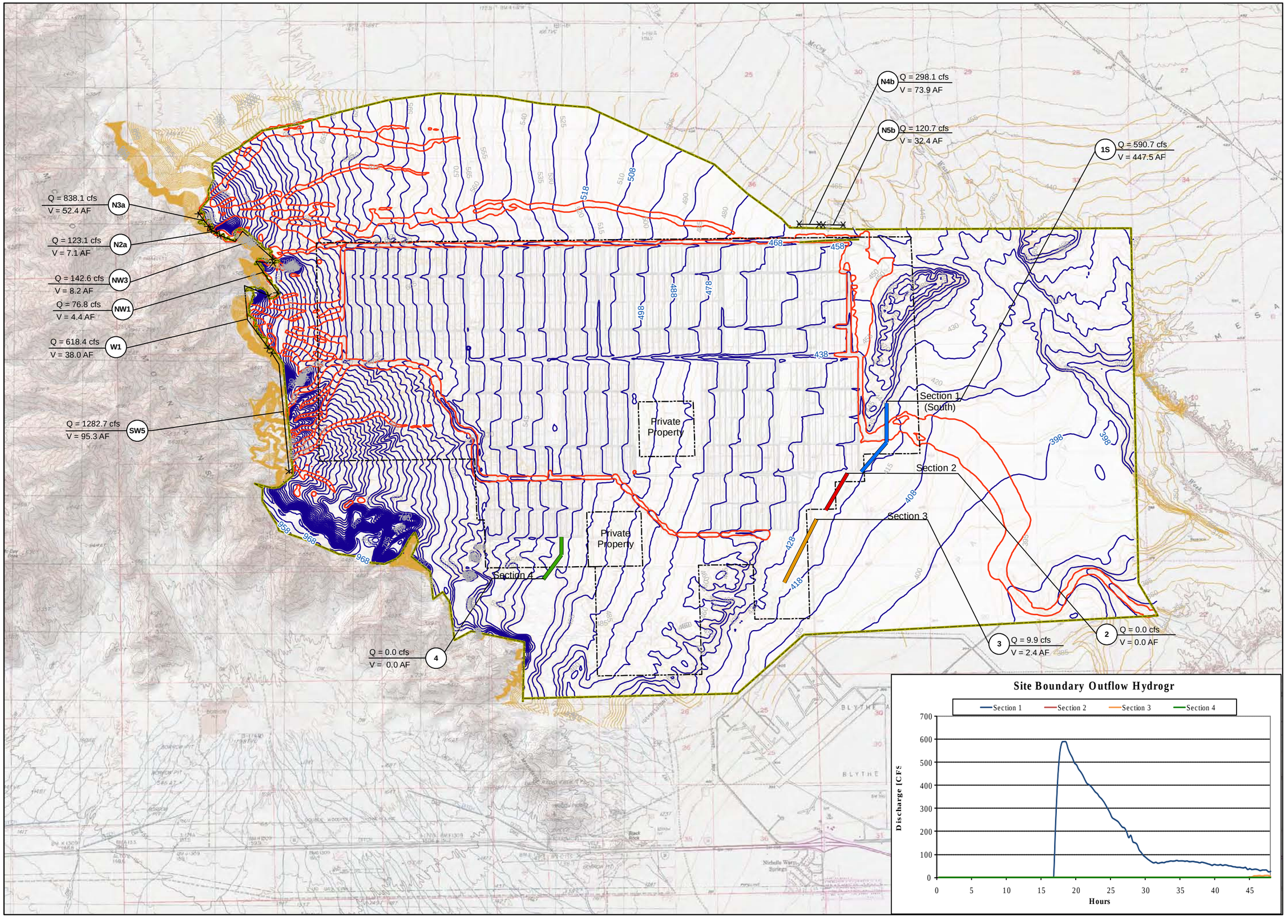
0 1,200 2,400 4,800 Feet

# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 10-Yr Storm Maximum Velocity

Date: 01/28/10
Sheet: 2 of 3







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Prepared for:

Solar Millennium LLC

LEGEND:

Q = Peak Flow
V = Total 24-hour Volume

Flow Analysis Section
1
2
3
4

Model Boundary
Site Boundary
Max Water Elevation
Surface Contours
Area of Concentrated Flow*
* Area of maximum concentrated flow with water depth exceeding 0.3 feet

0 1,350 2,700 5,400 Feet

# Blythe Solar Power Plant

Riverside County, California

## Proposed Conditions 10-Yr Storm Max. Water Surface

Date: 01/28/10
Sheet: 3 of 3

**STATE OF CALIFORNIA**
**ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION**

***In the Matter of:***
**APPLICATION FOR CERTIFICATION**
**for the *BLYTHE SOLAR POWER PROJECT***

**Docket No. 09-AFC-6**
**PROOF OF SERVICE**
***(Revised 1/26/2010)***

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## DECLARATION OF SERVICE

I, Carl Lindner, declare that on, January 29, 2010, I served and filed copies of the attached Blythe Solar Power Project Data Request #58: Blythe Solar Power Project Post Development Drainage Conditions report. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at:

**[http://www.energy.ca.gov/sitingcases/solar_millennium_blythe].**

The document has been sent to the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

**(*Check all that Apply*)**

**For service to all other parties:**

_____ sent electronically to all email addresses on the Proof of Service list;

__X__ by personal delivery or by overnight delivery service or depositing in the United States mail at Camarillo, California with postage or fees thereon fully prepaid and addressed as provided on the Proof of Service list above to those addresses **NOT** marked "email preferred."

***AND***

**For filing with the Energy Commission:**

__X__ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (preferred method);

***OR***

_____ depositing in the mail an original and 12 paper copies, along with 13 CDs, as follows:

**CALIFORNIA ENERGY COMMISSION**
Attn: Docket No. 09-AFC-6
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512

docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct.

Carl E. Lindner