April 2003 Shadow-Flicker Simulations

Project:
030326 Kittitas

Description:
For contour map
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
All turbines
.
.
.
.

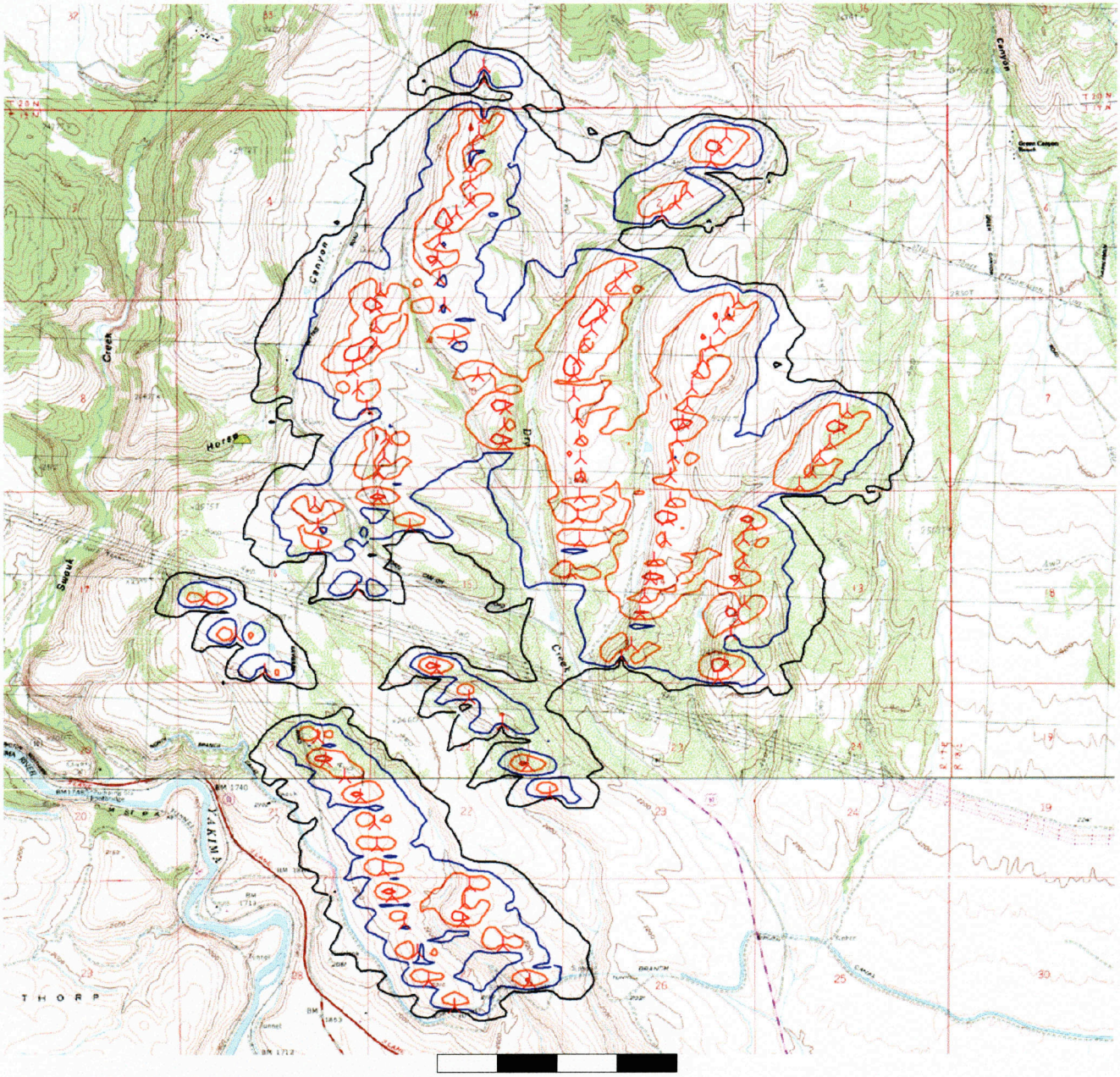
Printed/Page
04/22/2003 10:11 / 1

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/21/2003 19:30/2.3.1.127

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 0304209 Shadow-Flicker, all on one **File:** 030418 ZKV 24k,mt 001.bmi



0 500 1000 1500 2000 m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:50,000, Map center UTM NAD27 Zone: 10 East: 675,245 North: 5,223,395

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
For contour map
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
All turbines

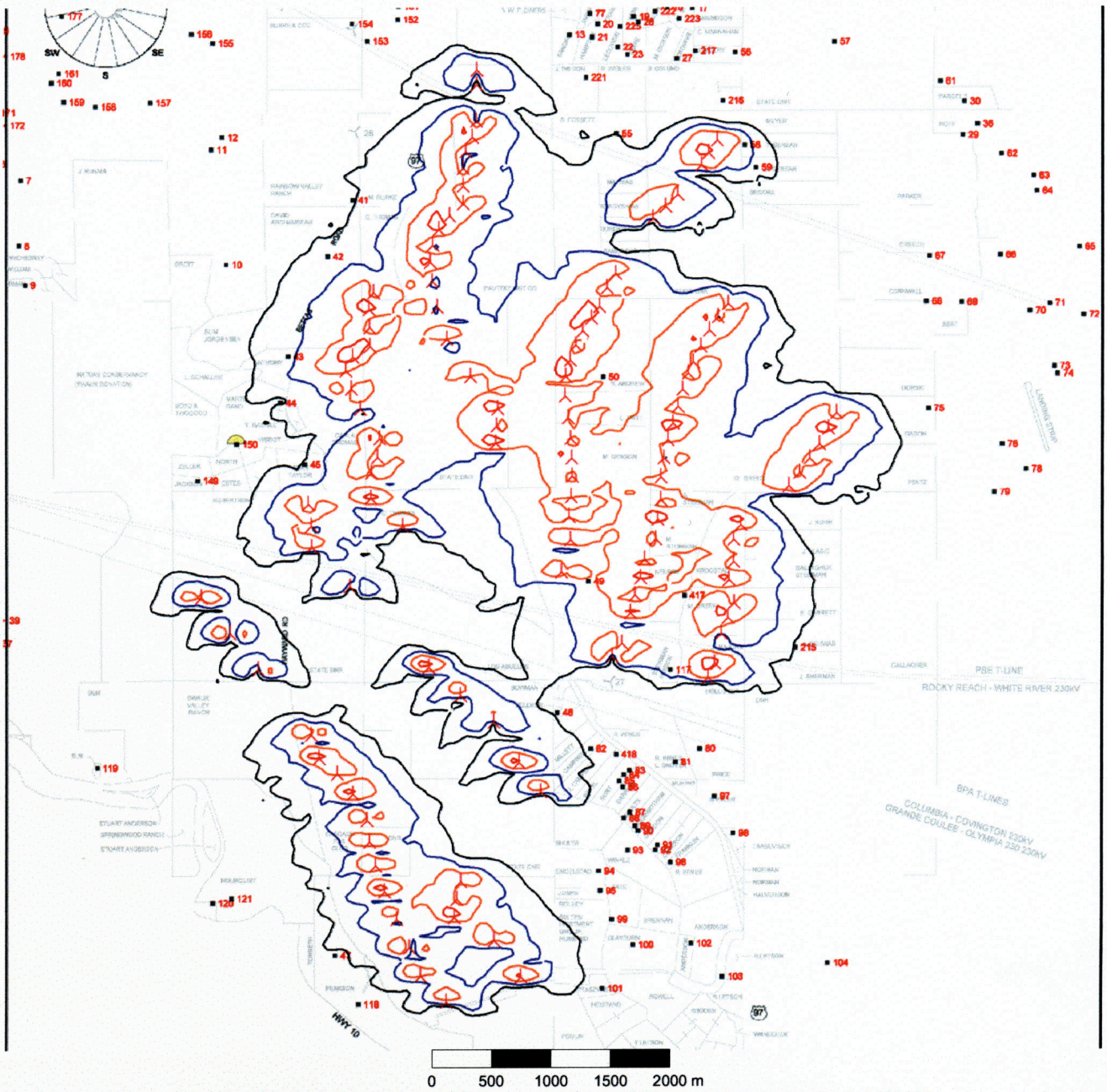
Printed/Page
04/22/2003 09:59 / 2

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/21/2003 19:30/2.3.1.127

SHADOW - z-fig101-houses2

Calculation: 0304209 Shadow-Flicker, all on one **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:50,000, Map center UTM NAD27 Zone: 10 East: 675,245 North: 5,223,395

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Nelson (417N and 417W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines I-14 through I-19 and J-08 through J-13
.
.
.
.

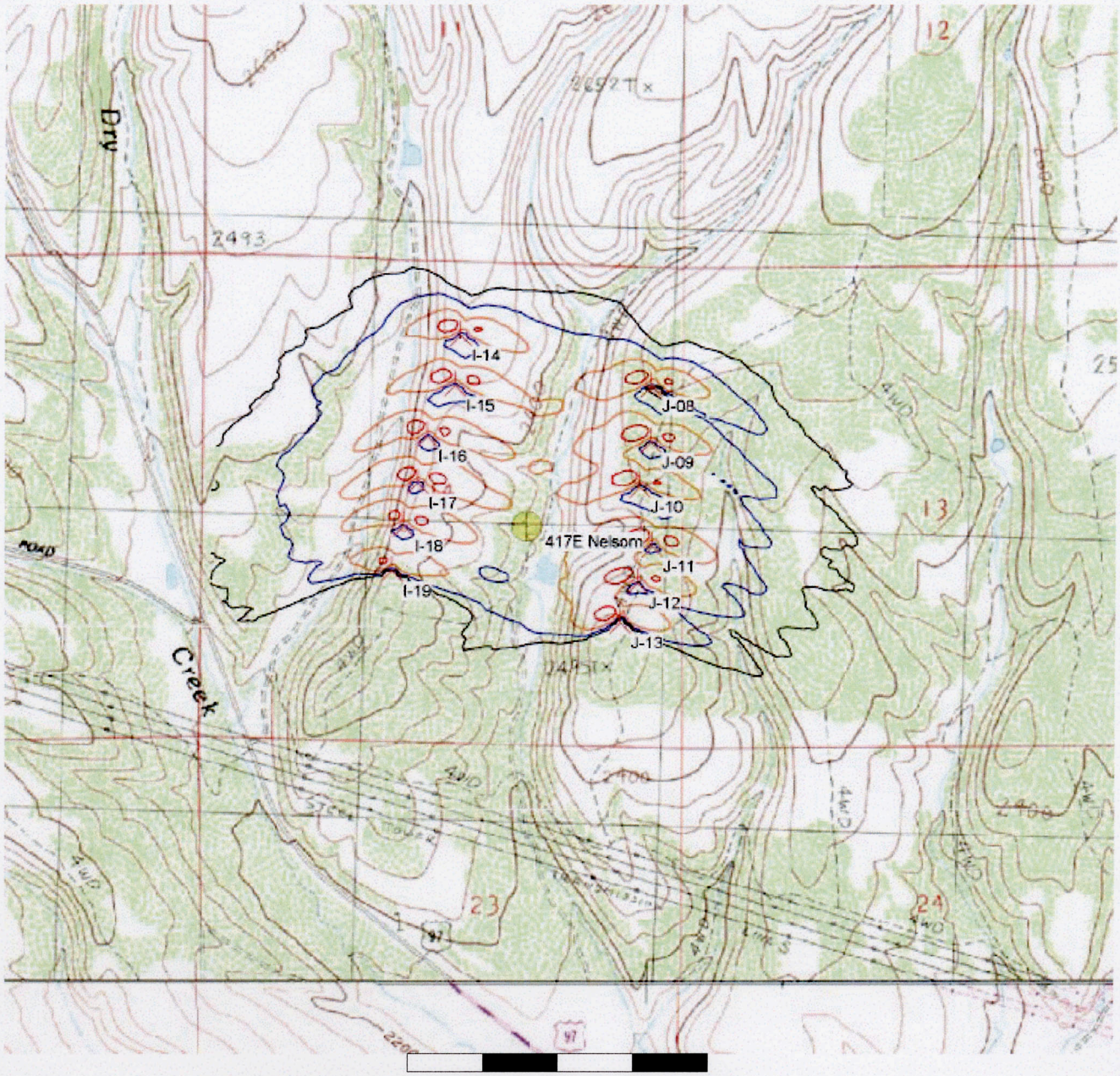
Printed/Page
04/22/2003 02:33 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/21/2003 00:42/2.3.1.127

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030418 Shadow-Flicker, I-14-19, J08-13, on 417E and 417W **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,585 North: 5,222,935

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Nelson (417N and 417W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines I-14 through I-19 and J-08 through J-13
.
.
.
.

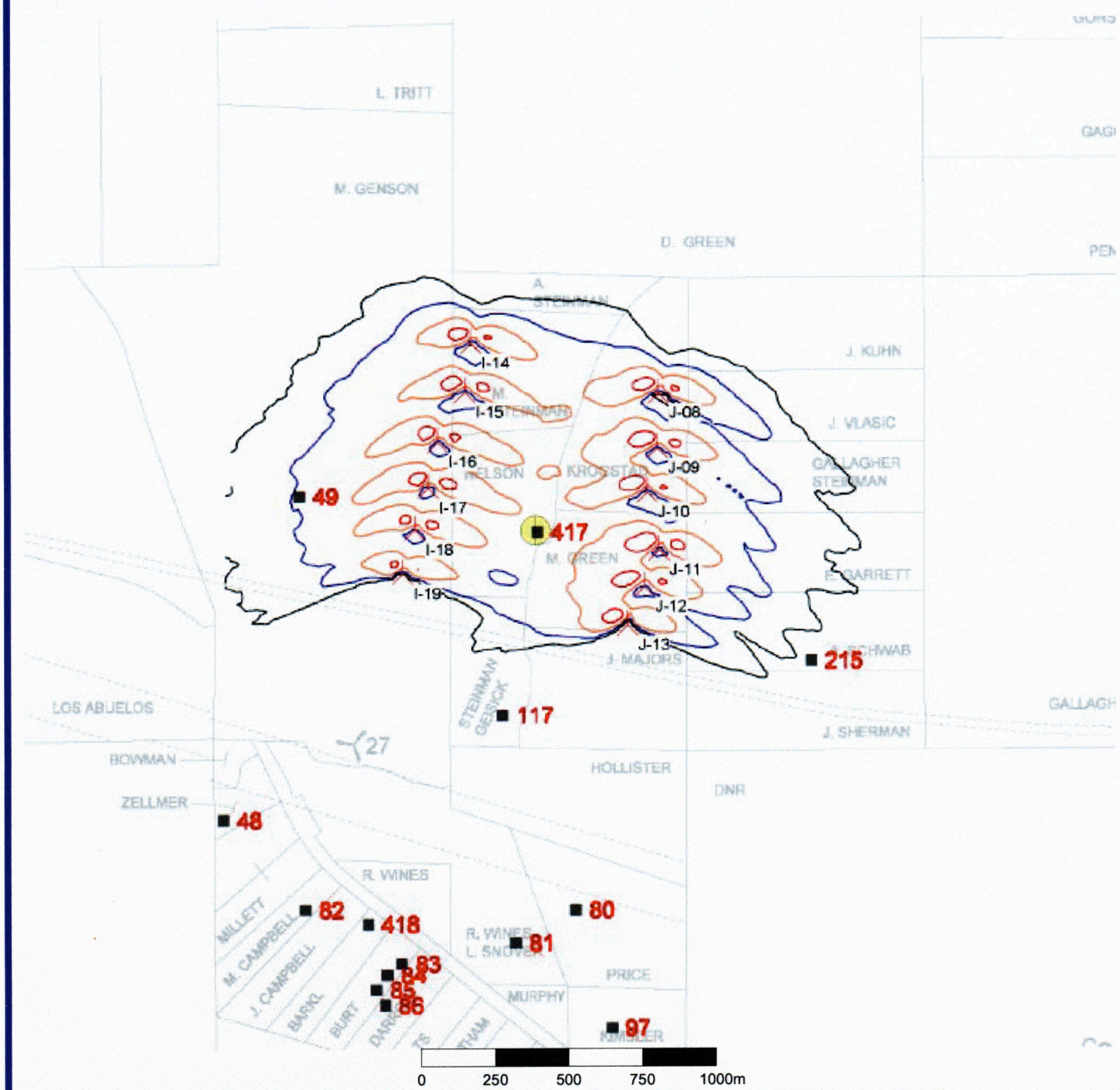
Printed/Page
04/22/2003 02:28 / 8

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/21/2003 00:42/2.3.1.127

SHADOW - z-fig101-houses2

Calculation: 030418 Shadow-Flicker, I-14-19, J08-13, on 417E and 417W **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,585 North: 5,222,935

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Taylor (045S and 045E)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines D-01 and D-02, F-09 through F-12
.
.
.
.

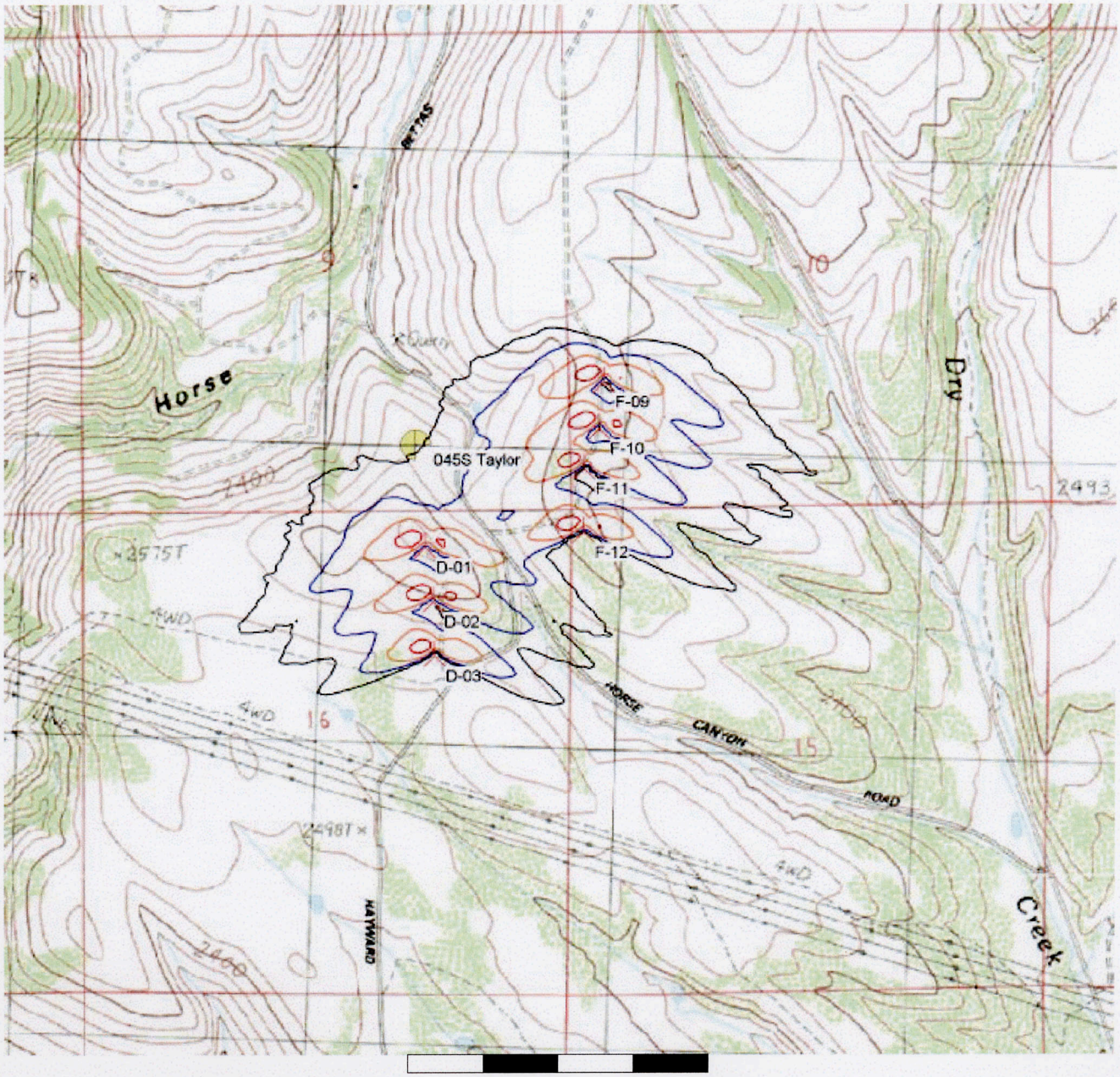
Printed/Page
04/22/2003 03:05 / 6

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 11:13/2.3.0.125

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030419 Shadow-Flicker, D-01-02 and F-09-12, on 045S and 045E **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 673,735 North: 5,223,685

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Taylor (045S and 045E)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines D-01 and D-02, F-09 through F-12
.
.
.
.

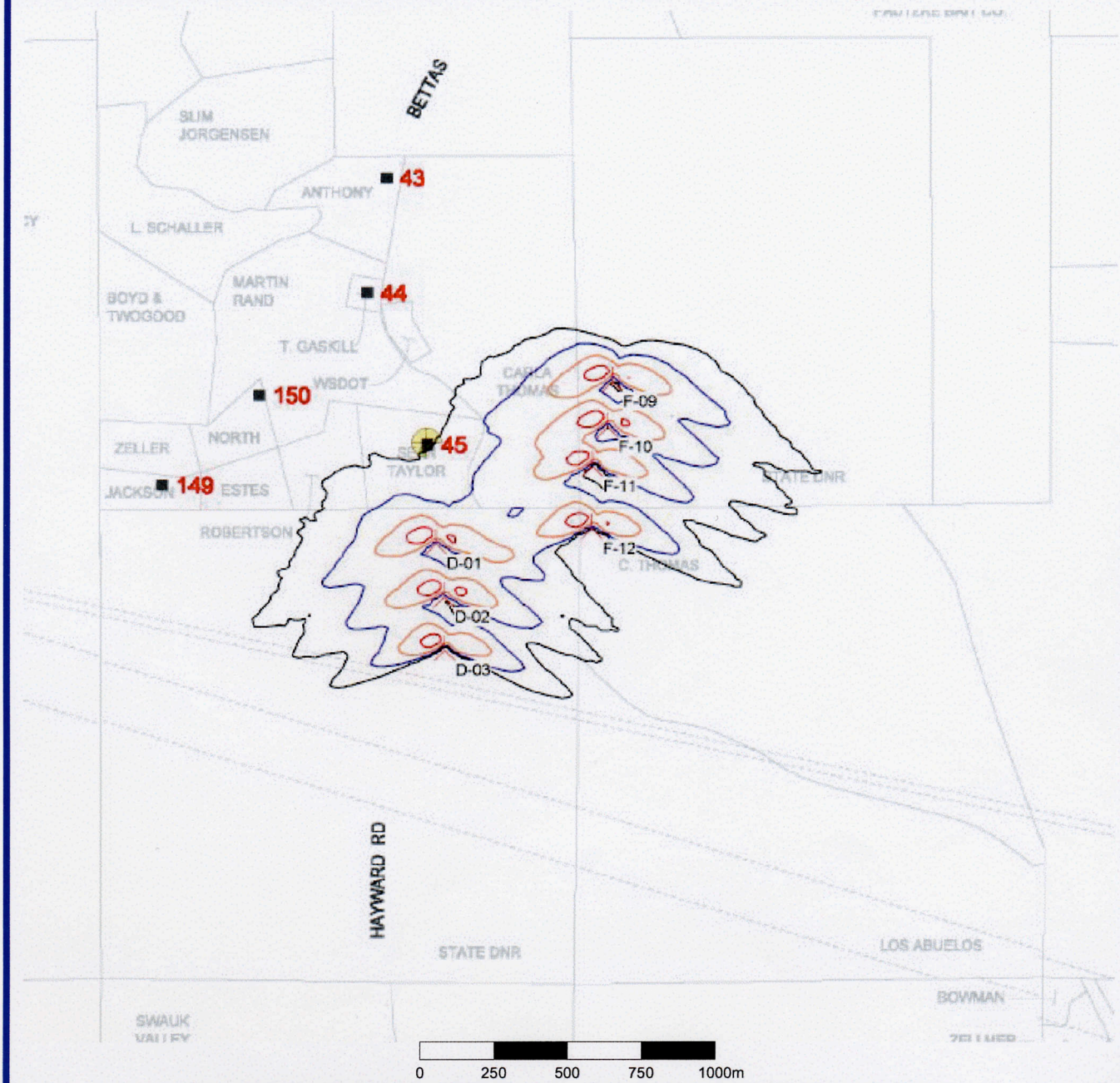
Printed/Page
04/22/2003 03:02 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 11:13/2.3.0.125

SHADOW - z-fig101-houses2

Calculation: 030419 Shadow-Flicker, D-01-02 and F-09-12, on 045S and 045E **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 673,735 North: 5,223,685

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Price and Schwab (080N and 215W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines J-10 through J-15
.
.
.
.

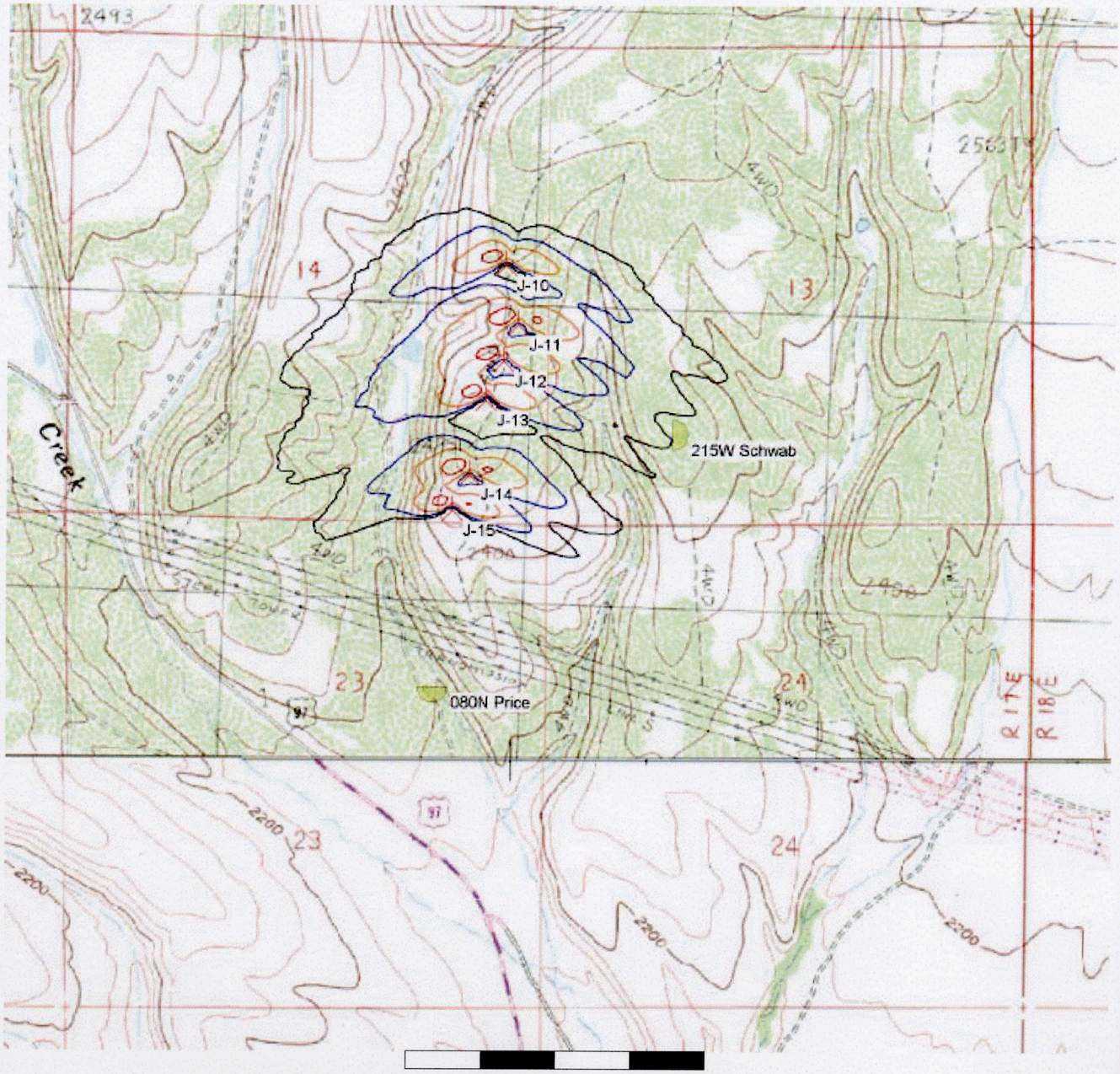
Printed/Page
04/22/2003 02:11 / 6

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/18/2003 12:56/2.3.0.125

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030418 Shadow-Flicker, J10-15, on 080N and 215W **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 677,060 North: 5,222,206

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Price and Schwab (080N and 215W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines J-10 through J-15

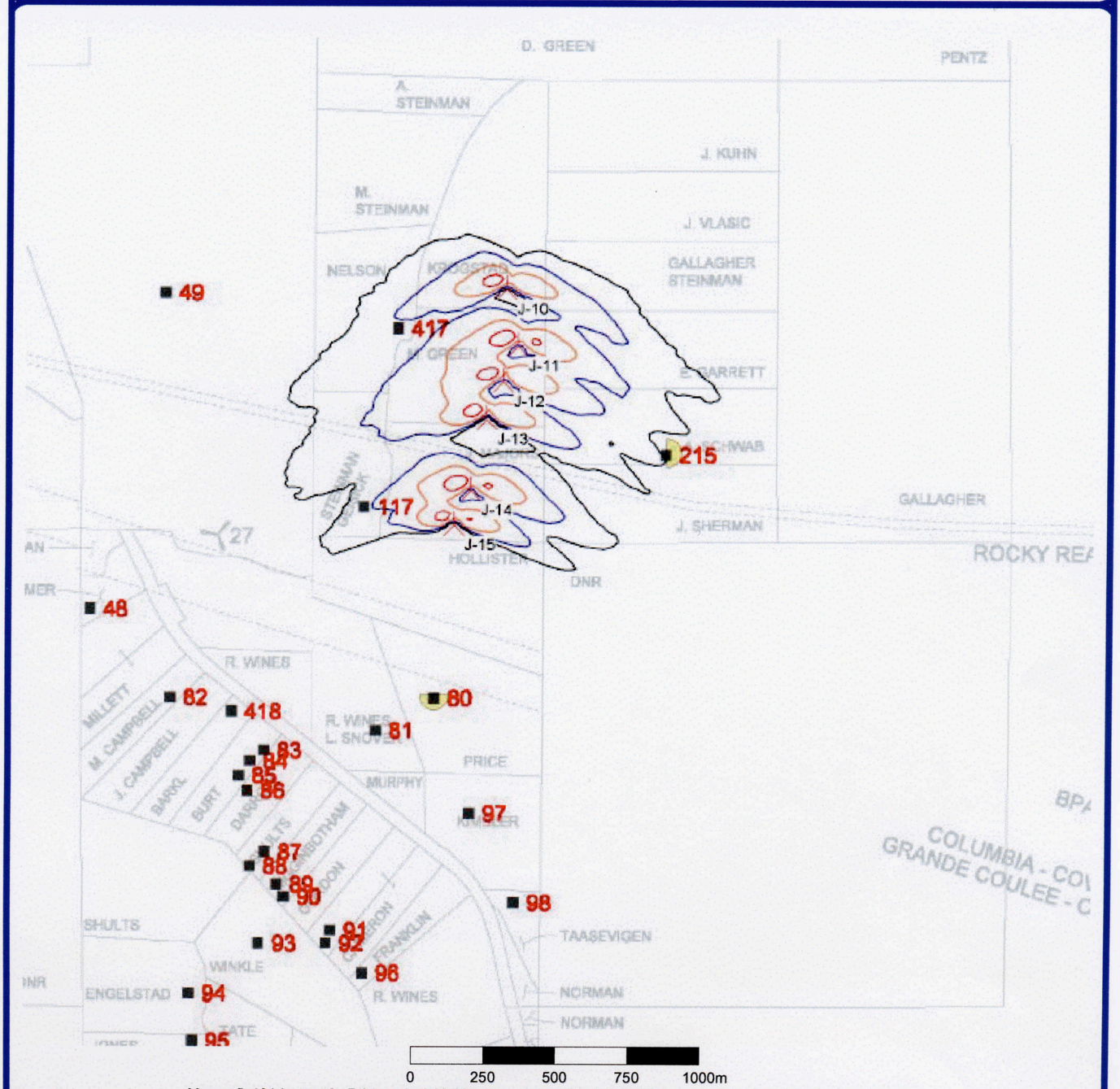
Printed/Page
04/22/2003 02:04 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/18/2003 12:56/2.3.0.125

SHADOW - z-fig101-houses2

Calculation: 030418 Shadow-Flicker, J10-15, on 080N and 215W **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 677,060 North: 5,222,206

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptors Pearson (047E, 118E)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines B-07 through B-12
.
.
.
.

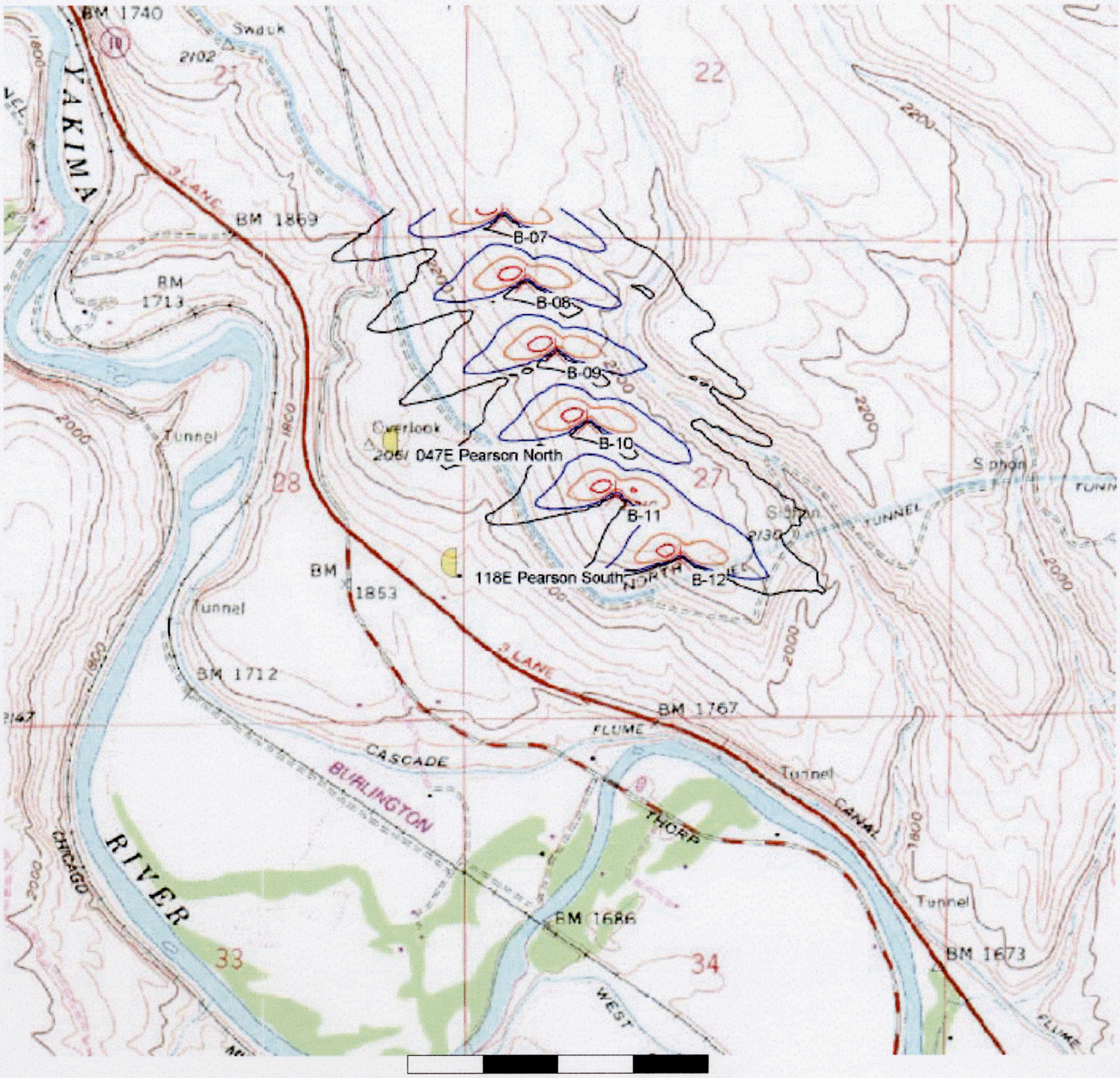
Printed/Page
04/22/2003 03:49 / 5

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/20/2003 04:26/2.3.0.125

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 0304209 Shadow-Flicker, B-07-12, on 047E and 118E **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 674,185 North: 5,219,535

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptors Pearson (047E, 118E)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines B-07 through B-12
.
.
.
.

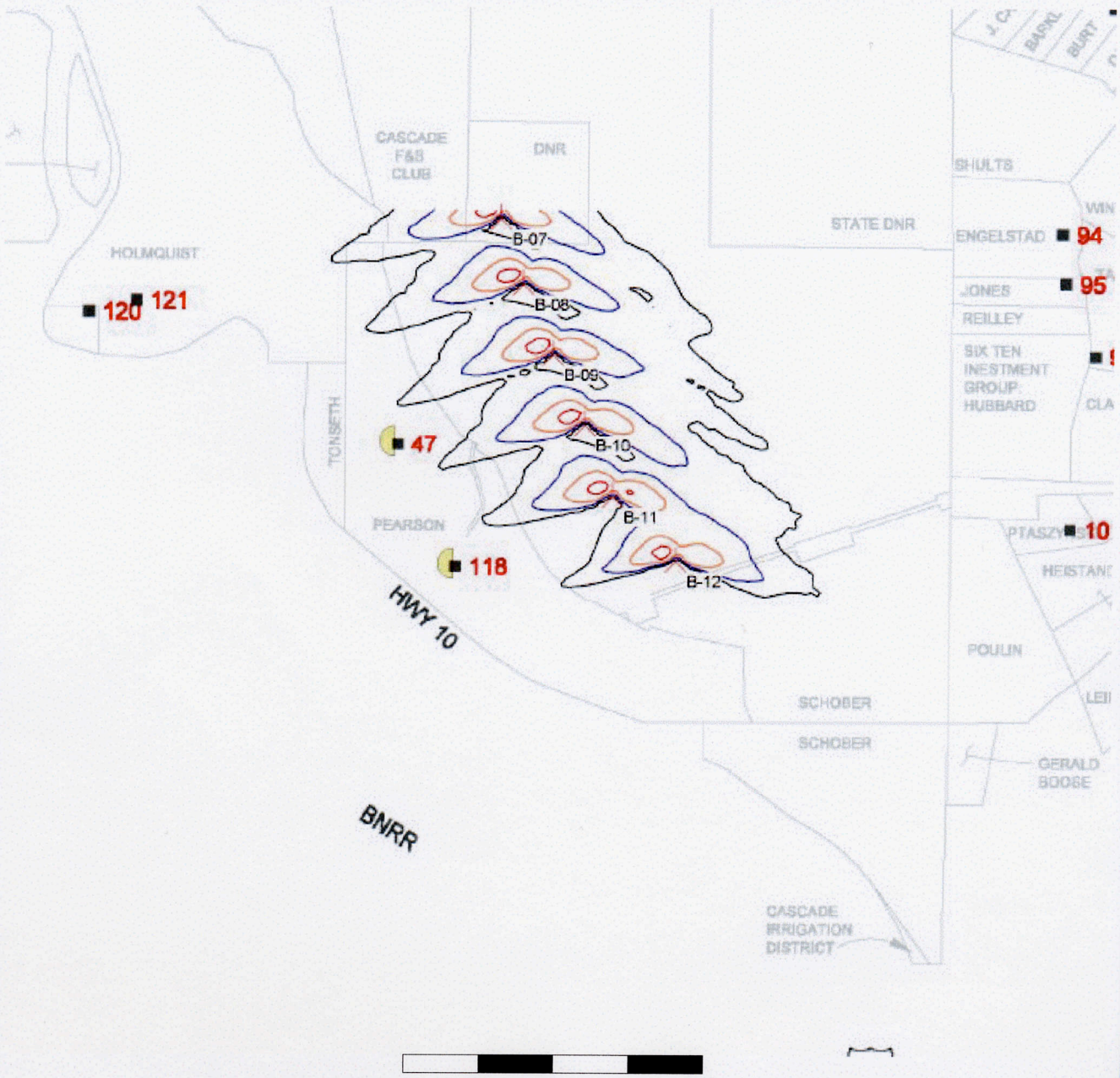
Printed/Page
04/22/2003 03:55 / 6

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/20/2003 04:26/2.3.0.125

SHADOW - z-fig101-houses2

Calculation: 0304209 Shadow-Flicker, B-07-12, on 047E and 118E **File:** z-fig101-houses2.bmi



0 250 500 750 1000m

Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 674,185 North: 5,219,535

New WTG
Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptors Zellmer, Campbell, Burt and Darrow (048SW, 082SW, 084SW and 086SW)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines E-01 through E-05
.
.
.
.

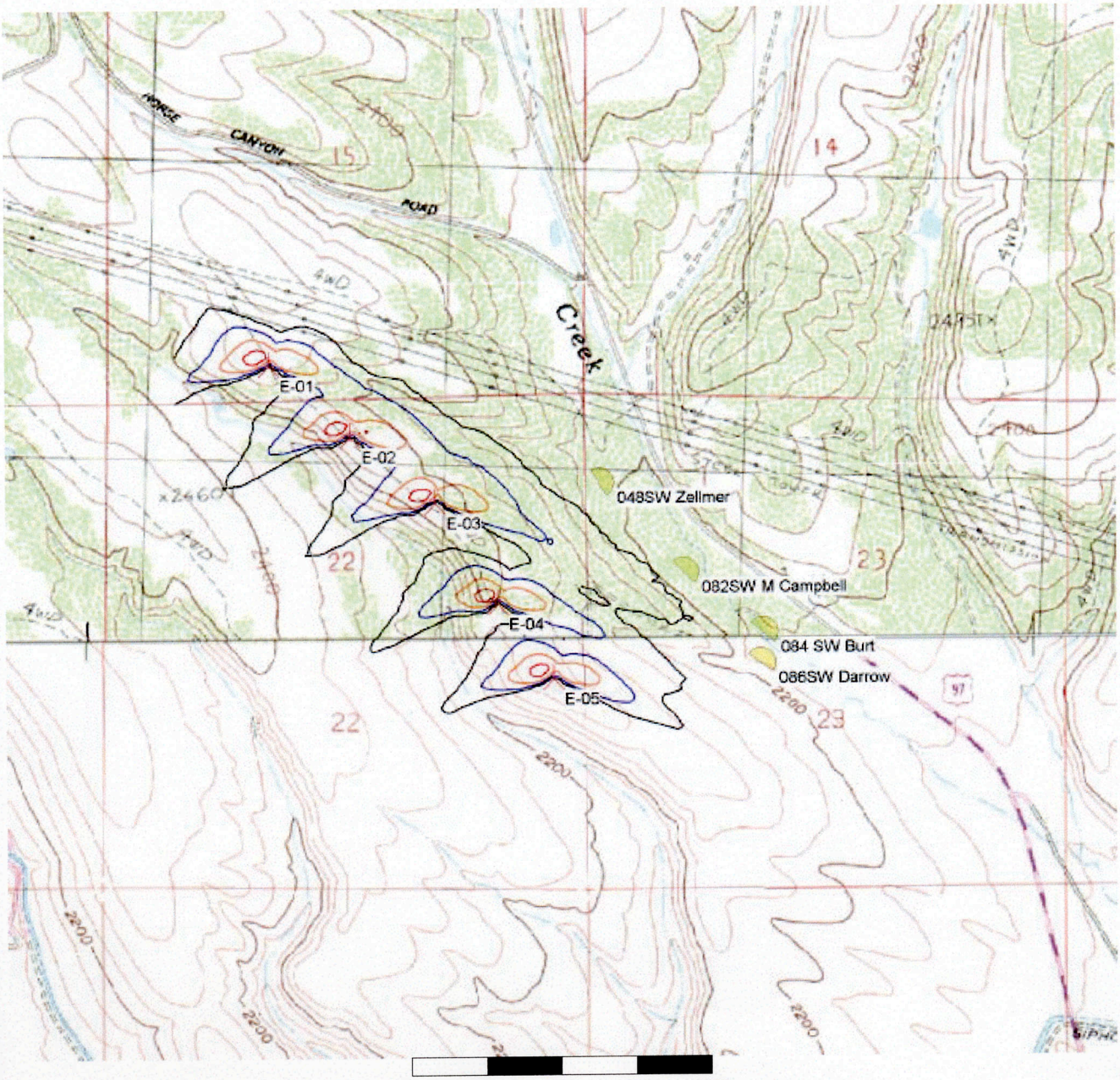
Printed/Page
04/22/2003 03:19 / 10

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 12:20/2.3.0.125

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030419 Shadow-Flicker, E-01-05, on 048SW, 082SW, 084SW and 086SW **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,335 North: 5,221,735

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptors Zellmer, Campbell, Burt and Darrow (048SW, 082SW, 084SW and 086SW)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines E-01 through E-05

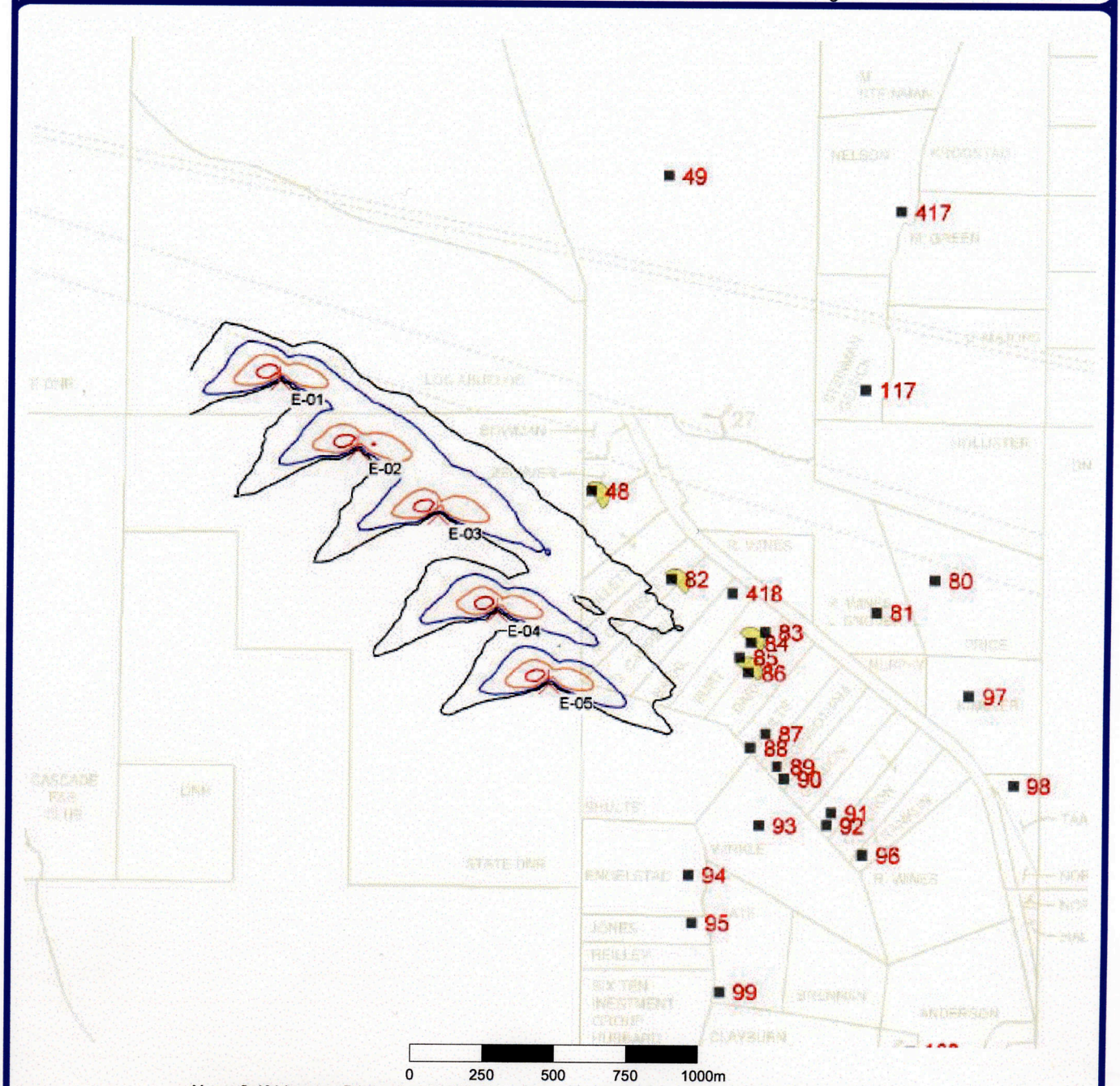
Printed/Page
04/22/2003 03:14 / 11

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 12:20/2.3.0.125

SHADOW - z-fig101-houses

Calculation: 030419 Shadow-Flicker, E-01-05, on 048SW, 082SW, 084SW and 086SW **File:** z-fig101-houses.bmi



Map: z-fig101-houses , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,335 North: 5,221,735

New WTG
Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptors Gaskill and Anthony (044E, 043E)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines F-01 through F-10
.
.
.
.

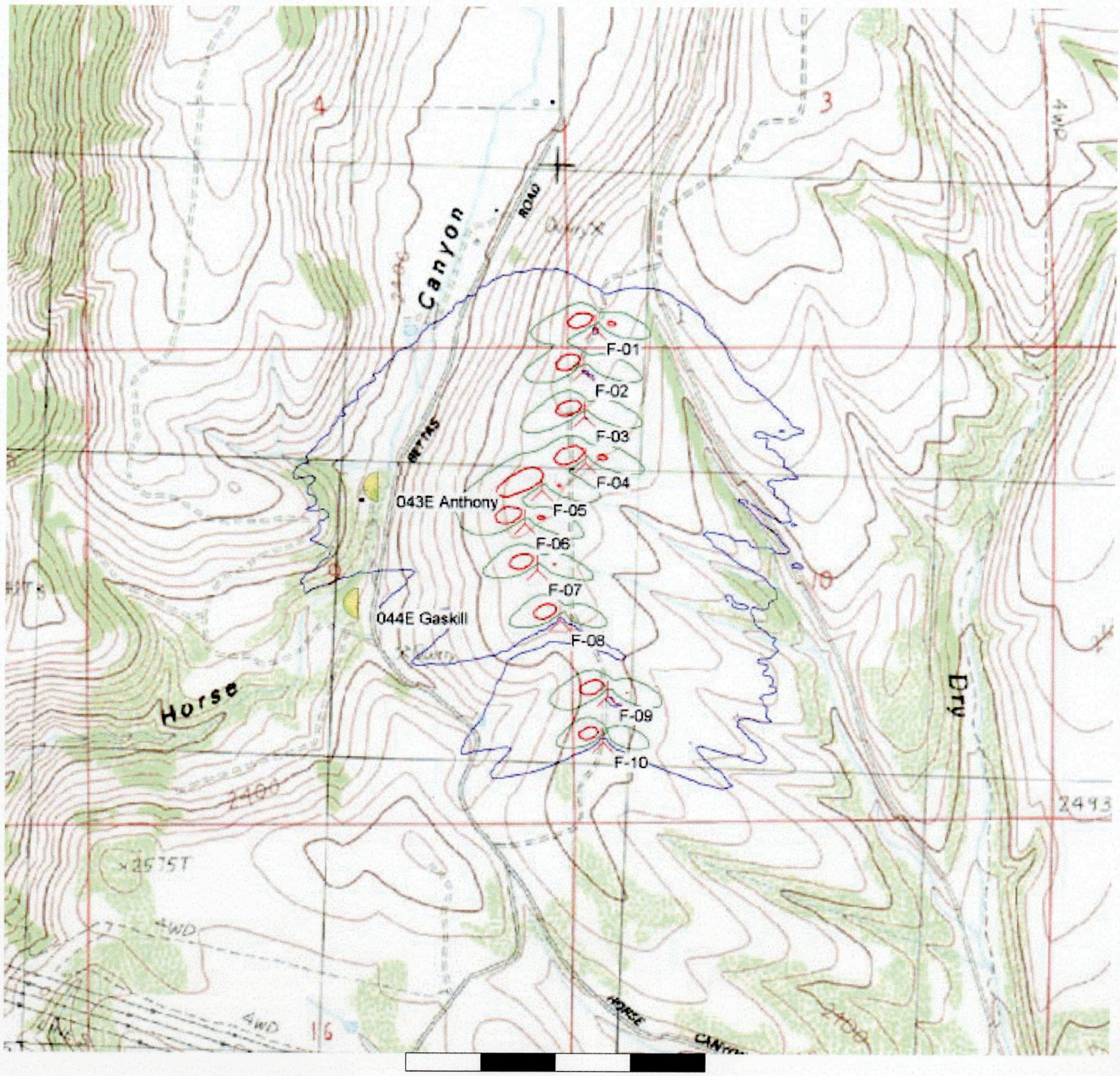
Printed/Page
04/22/2003 03:31 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 19:59/2.3.0.125

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030419 Shadow-Flicker, F-01-10, on 043E and 044E **File:** 030418 ZKV 24k,mt 001.bmi



Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 673,685 North: 5,224,735

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 100 200

Project:
030326 Kittitas

Description:
Shadow receptors Gaskill and Anthony (044E, 043E)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines F-01 through F-10
.
.
.
.

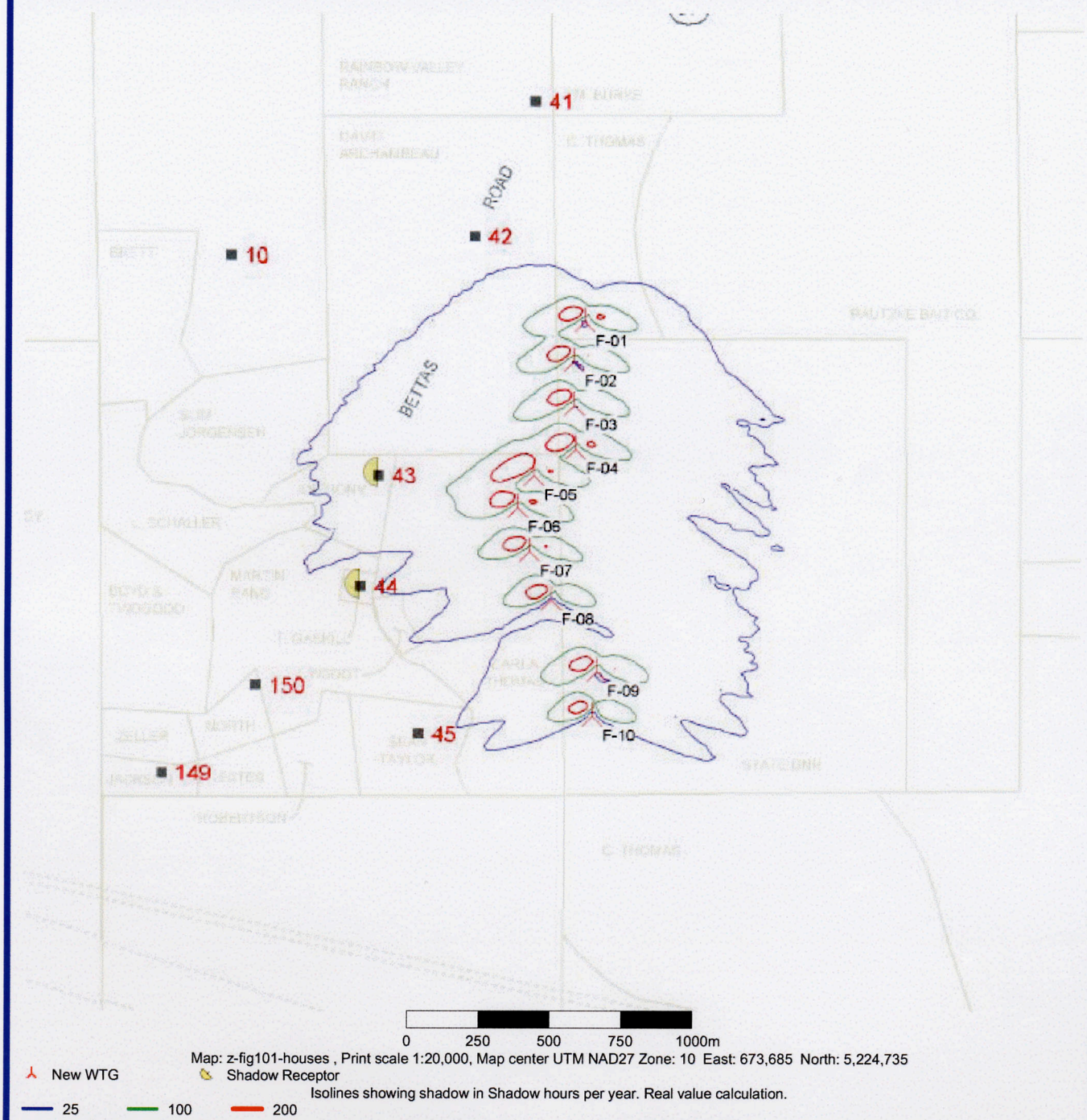
Printed/Page
04/22/2003 03:28 / 8

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 19:59/2.3.0.125

SHADOW - z-fig101-houses

Calculation: 030419 Shadow-Flicker, F-01-10, on 043E and 044E **File:** z-fig101-houses.bmi



Map: z-fig101-houses , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 673,685 North: 5,224,735

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 100 200

Project:
030326 Kittitas

Description:
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-01 through H-04
.
.
.
.

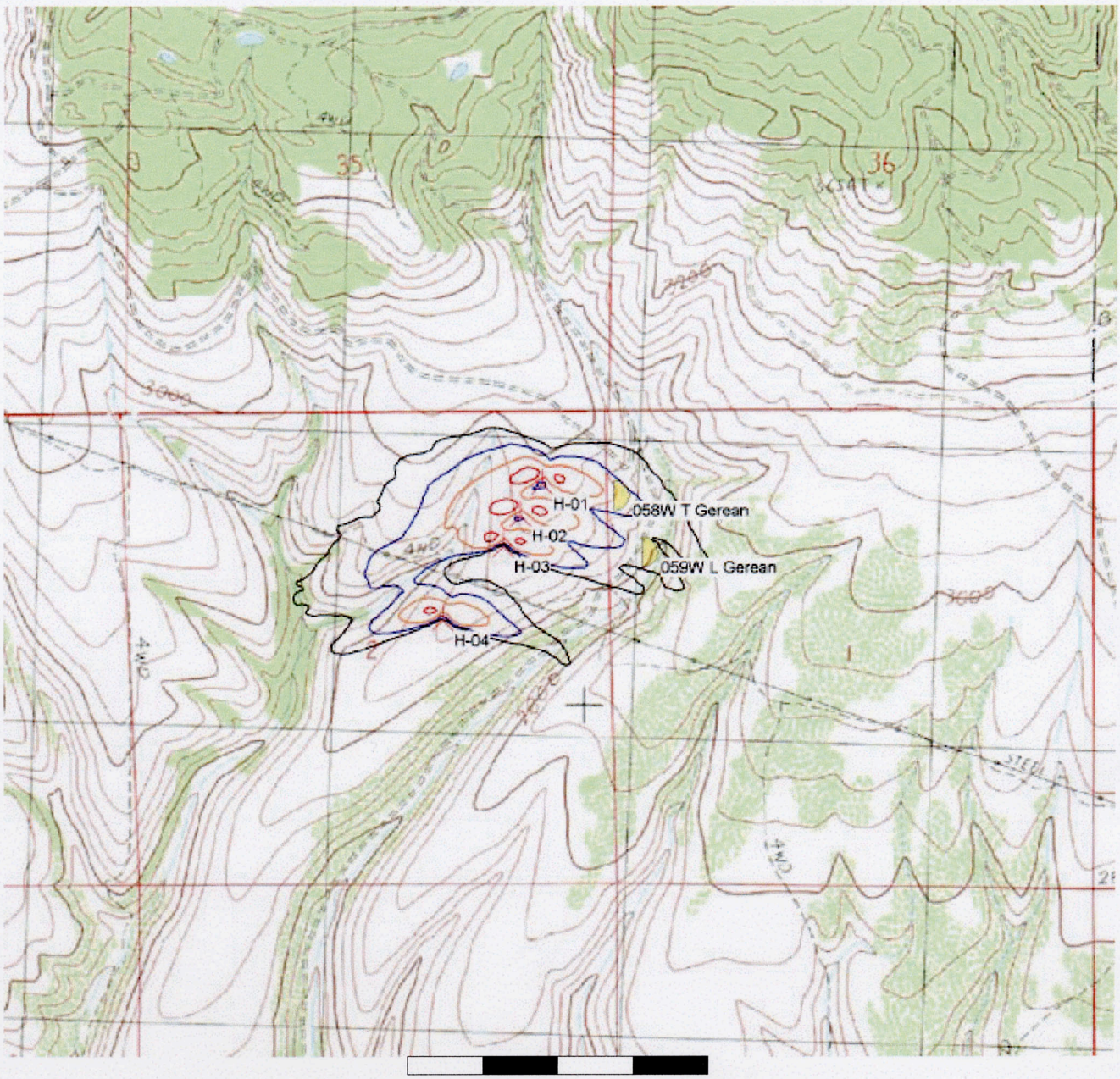
Printed/Page
04/22/2003 02:45 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 08:55/2.3.0.125

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030418 Shadow-Flicker, H-01-04, on 058W and 059W **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,685 North: 5,226,635

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-01 through H-04
.
.
.
.

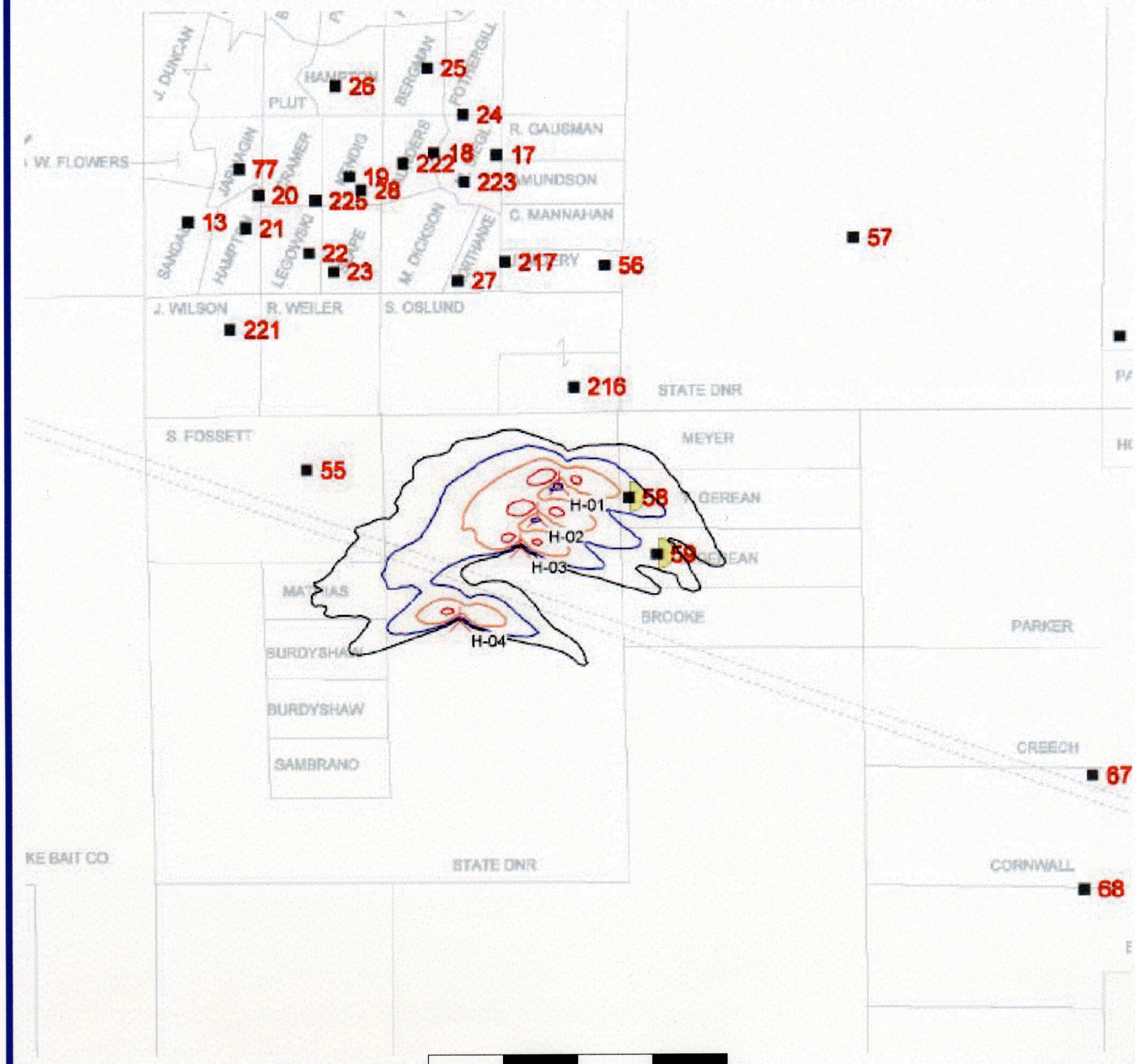
Printed/Page
04/22/2003 02:41 / 8

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/19/2003 08:55/2.3.0.125

SHADOW - z-fig101-houses2

Calculation: 030418 Shadow-Flicker, H-01-04, on 058W and 059W **File:** z-fig101-houses2.bmi



0 250 500 750 1000m

Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,685 North: 5,226,635

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Giesick (117E and 117W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines I-18 through I-21 and J-12 through J-15
.
.
.
.

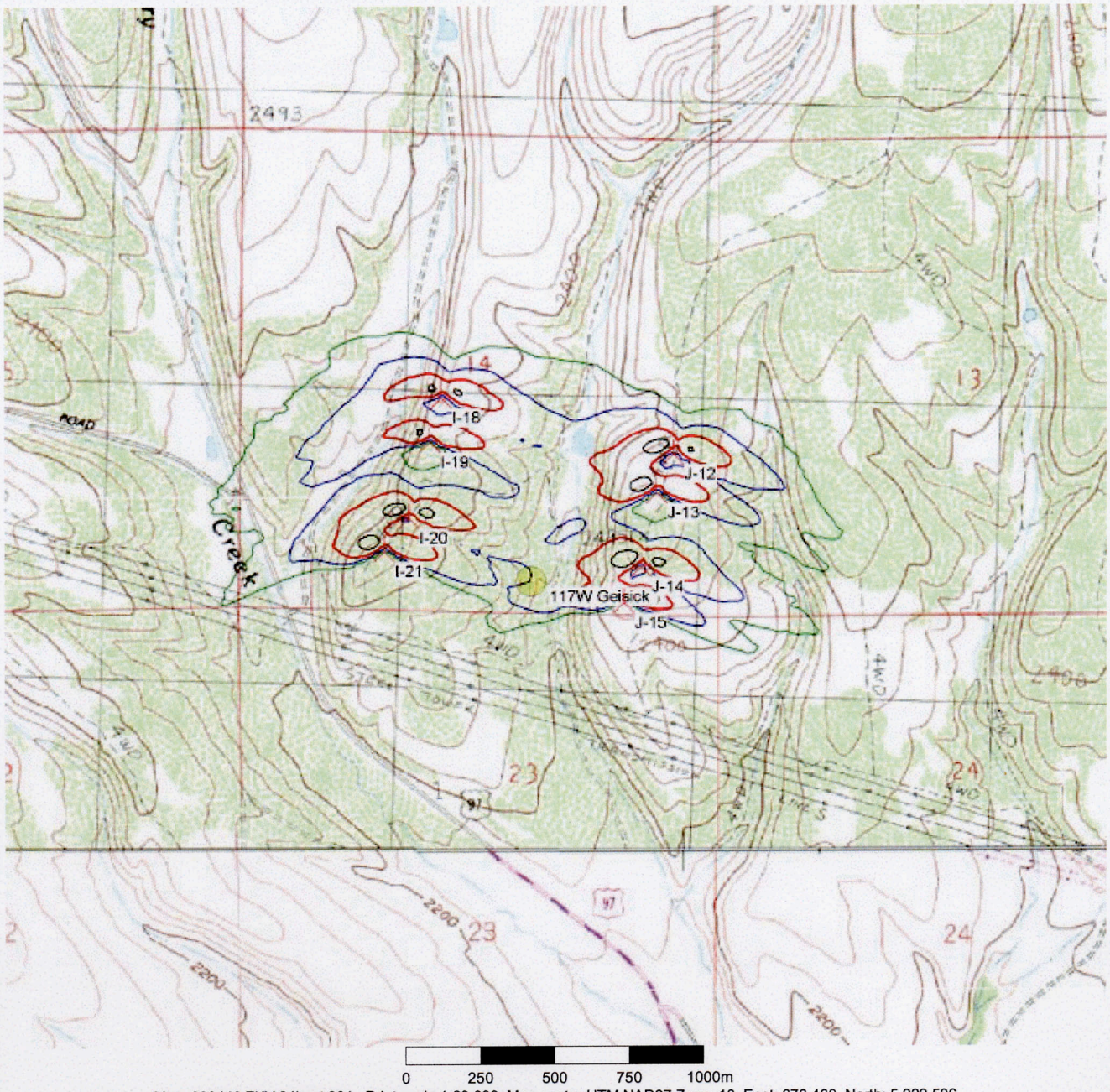
Printed/Page
04/22/2003 01:47 / 1

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/18/2003 11:47/2.3.0.125

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030416 Shadow-Flicker, I18-21 and J-12-15, on 117 **File:** 030418 ZKV 24k,mt 001.bmi



Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,460 North: 5,222,506

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Giesick (117E and 117W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines I-18 through I-21 and J-12 through J-15
.
.
.
.

Printed/Page
04/21/2003 22:31 / 1

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
04/18/2003 11:47/2.3.0.125

SHADOW - z-fig101-houses2

Calculation: 030416 Shadow-Flicker, I18-21 and J-12-15, on 117 **File:** z-fig101-houses2.bmi

Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,460 North: 5,222,506

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

June 2003 Shadow-Flicker Simulations

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19

Printed/Page
06/12/2003 09:17 / 1

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

SHADOW - Main Result

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE
160	73	35	231	871	390

S	SSW	WSW	W	WNW	NNW	Sum
113	73	59	881	3,189	973	7,048

Scale 1:100,000
New WTG
Shadow Receptor

WTGs

	UTM NAD27 Zone: 10				WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
H-22	675,563	5,223,427	750	H-22	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
H-23	675,494	5,223,153	732	H-23	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
I-16	676,191	5,223,281	740	I-16	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
I-17	676,164	5,223,123	740	I-17	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
I-18	676,122	5,222,978	740	I-18	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
I-19	676,087	5,222,827	740	I-19	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3

Shadow Receptor-Input

		UTM NAD27 Zone: 10							
No	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]
049E	049E Genson	675,725	5,223,087	719	1.0	1.0	1.0	-90.0	90.0
049W	049W Genson	675,725	5,223,087	719	1.0	1.0	1.0	90.0	90.0

Calculation Results

		Shadow, worst case			Shadow, expected values
No	Name	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
049E	049E Genson	126:40	255	0:40	47:31
049W	049W Genson	94:50	95	1:12	46:02

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19
.
.

Printed/Page
06/12/2003 09:14 / 2

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

SHADOW - Calendar

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W **Shadow Receptor:** 049E - 049E Genson

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
160	73	35	231	871	390	113	73	59	881	3,189	973	7,048

	January		February		March		April		May		June	
1	07:50		07:29		08:21 (6)	06:44		07:28 (5)	05:44		05:48		05:12		06:07 (3)
	16:23		17:03	36	08:57 (6)	17:46	14	07:42 (5)	18:31		20:12		20:50	32	06:39 (3)
2	07:50		07:28		08:19 (6)	06:43		07:26 (5)	05:42		05:47		05:11		06:06 (3)
	16:24		17:05	38	08:57 (6)	17:48	20	07:46 (5)	18:32		20:13		20:51	34	06:40 (3)
3	07:50		07:27		08:20 (6)	06:41		07:22 (5)	05:40		06:21 (4)	05:45		05:11		06:06 (3)
	16:25		17:06	38	08:58 (6)	17:49	26	07:48 (5)	18:33	10	06:31 (4)	20:15		20:52	34	06:40 (3)
4	07:50		07:25		08:19 (6)	06:39		07:21 (5)	05:38		06:17 (4)	05:44		05:10		06:07 (3)
	16:26		17:08	38	08:57 (6)	17:51	28	07:49 (5)	18:35	18	06:35 (4)	20:16		20:52	32	06:39 (3)
5	07:50		07:24		08:19 (6)	06:37		07:21 (5)	06:36		07:15 (4)	05:42		05:10		06:07 (3)
	16:27		17:10	38	08:57 (6)	17:52	30	07:51 (5)	19:36	22	07:37 (4)	20:17		20:53	32	06:39 (3)
6	07:49		07:23		08:20 (6)	06:35		07:19 (5)	06:34		07:13 (4)	05:41		05:09		06:09 (3)
	16:28		17:11	38	08:58 (6)	17:54	32	07:51 (5)	19:37	26	07:39 (4)	20:19		20:54	30	06:39 (3)
7	07:49		07:21		08:20 (6)	06:33		07:17 (5)	06:32		07:11 (4)	05:39		05:09		06:08 (3)
	16:29		17:13	38	08:58 (6)	17:55	36	07:53 (5)	19:39	28	07:39 (4)	20:20		20:55	32	06:40 (3)
8	07:49		07:20		08:21 (6)	06:31		07:17 (5)	06:30		07:09 (4)	05:38	06:16 (3)	05:08		06:08 (3)
	16:30		17:14	36	08:57 (6)	17:57	36	07:53 (5)	19:40	32	07:41 (4)	20:21	10	06:26 (3)	20:56	32	06:40 (3)
9	07:48		07:18		08:21 (6)	06:29		07:15 (5)	06:28		07:07 (4)	05:36		06:13 (3)	05:08		06:10 (3)
	16:31		17:16	36	08:57 (6)	17:58	38	07:53 (5)	19:42	34	07:41 (4)	20:23	16	06:29 (3)	20:56	30	06:40 (3)
10	07:48		07:17		08:22 (6)	06:27		07:15 (5)	06:26		07:07 (4)	05:35		06:12 (3)	05:08		06:09 (3)
	16:32		17:17	36	08:58 (6)	17:59	38	07:53 (5)	19:43	34	07:41 (4)	20:24	20	06:32 (3)	20:57	30	06:39 (3)
11	07:48		07:15		08:22 (6)	06:25		07:15 (5)	06:24		07:05 (4)	05:33		06:10 (3)	05:08		06:09 (3)
	16:34		17:19	34	08:56 (6)	18:01	38	07:53 (5)	19:44	36	07:41 (4)	20:25	22	06:32 (3)	20:58	30	06:39 (3)
12	07:47		07:14		08:22 (6)	06:23		07:13 (5)	06:22		07:05 (4)	05:32		06:09 (3)	05:07		06:11 (3)
	16:35		17:20	32	08:54 (6)	18:02	40	07:53 (5)	19:46	36	07:41 (4)	20:27	26	06:35 (3)	20:58	28	06:39 (3)
13	07:47		07:12		08:23 (6)	06:21		07:13 (5)	06:20		07:06 (4)	05:31		06:08 (3)	05:07		06:11 (3)
	16:36		17:22	32	08:55 (6)	18:04	40	07:53 (5)	19:47	36	07:42 (4)	20:28	28	06:36 (3)	20:59	28	06:39 (3)
14	07:46		07:11		08:23 (6)	06:19		07:13 (5)	06:18		07:04 (4)	05:29		06:07 (3)	05:07		06:11 (3)
	16:37		17:23	30	08:53 (6)	18:05	40	07:53 (5)	19:49	38	07:42 (4)	20:29	30	06:37 (3)	20:59	28	06:39 (3)
15	07:46		07:09		08:25 (6)	06:17		07:13 (5)	06:16		07:04 (4)	05:28		06:08 (3)	05:07		06:11 (3)
	16:39		17:25	26	08:51 (6)	18:07	38	07:51 (5)	19:50	38	07:42 (4)	20:31	28	06:36 (3)	21:00	28	06:39 (3)
16	07:45		07:07		08:28 (6)	06:16		07:13 (5)	06:15		07:04 (4)	05:27		06:06 (3)	05:07		06:11 (3)
	16:40		17:27	22	08:50 (6)	18:08	38	07:51 (5)	19:51	36	07:40 (4)	20:32	30	06:36 (3)	21:00	28	06:39 (3)
17	07:44		07:06		08:28 (6)	06:14		07:13 (5)	06:13		07:04 (4)	05:26		06:05 (3)	05:07		06:13 (3)
	16:41		17:28	20	08:48 (6)	18:10	38	07:51 (5)	19:53	36	07:40 (4)	20:33	32	06:37 (3)	21:01	26	06:39 (3)
18	07:44		07:04		08:32 (6)	06:12		07:13 (5)	06:11		07:04 (4)	05:25		06:06 (3)	05:07		06:13 (3)
	16:43		17:30	12	08:44 (6)	18:11	36	07:49 (5)	19:54	36	07:40 (4)	20:34	32	06:38 (3)	21:01	26	06:39 (3)
19	07:43		07:02			06:10		07:15 (5)	06:09		07:05 (4)	05:23		06:05 (3)	05:07		06:13 (3)
	16:44	8	08:39 (6)	17:31		18:12	32	07:47 (5)	19:55	34	07:39 (4)	20:35	34	06:39 (3)	21:02	26	06:39 (3)
20	07:42		08:28 (6)	07:01		06:08		07:15 (5)	06:07		07:05 (4)	05:22		06:04 (3)	05:07		06:13 (3)
	16:46	14	08:42 (6)	17:33		18:14	32	07:47 (5)	19:57	34	07:39 (4)	20:37	34	06:38 (3)	21:02	26	06:39 (3)
21	07:41		08:28 (6)	06:59		06:06		07:15 (5)	06:05		07:05 (4)	05:21		06:05 (3)	05:07		06:13 (3)
	16:47	18	08:46 (6)	17:34		18:15	30	07:45 (5)	19:58	32	07:37 (4)	20:38	34	06:39 (3)	21:02	26	06:39 (3)
22	07:40		08:27 (6)	06:57		06:04		07:17 (5)	06:04		07:05 (4)	05:20		06:04 (3)	05:08		06:14 (3)
	16:48	20	08:47 (6)	17:36		18:17	26	07:43 (5)	20:00	32	07:37 (4)	20:39	34	06:38 (3)	21:02	26	06:40 (3)
23	07:39		08:26 (6)	06:55		06:02		07:19 (5)	06:02		07:06 (4)	05:19		06:05 (3)	05:08		06:14 (3)
	16:50	22	08:48 (6)	17:37		18:18	22	07:41 (5)	20:01	30	07:36 (4)	20:40	34	06:39 (3)	21:03	26	06:40 (3)
24	07:38		08:24 (6)	06:54		06:00		07:21 (5)	06:00		07:06 (4)	05:18		06:05 (3)	05:08		06:14 (3)
	16:51	26	08:50 (6)	17:39		18:19	16	07:37 (5)	20:02	28	07:34 (4)	20:41	34	06:39 (3)	21:03	26	06:40 (3)
25	07:37		08:23 (6)	06:52		05:58		07:25 (5)	05:58		07:08 (4)	05:17		06:06 (3)	05:08		06:15 (3)
	16:53	28	08:51 (6)	17:40		18:21	8	07:33 (5)	20:04	24	07:32 (4)	20:42	34	06:40 (3)	21:03	26	06:41 (3)
26	07:36		08:22 (6)	06:50		05:56			05:57		07:09 (4)	05:16		06:05 (3)	05:09		06:13 (3)
	16:54	30	08:52 (6)	17:42		18:22			20:05	22	07:31 (4)	20:44	34	06:39 (3)	21:03	28	06:41 (3)
27	07:35		08:21 (6)	06:48		05:54			05:55		07:11 (4)	05:16		06:04 (3)	05:09		06:13 (3)
	16:56	32	08:53 (6)	17:43		18:24			20:07	16	07:27 (4)	20:45	36	06:40 (3)	21:03	28	06:41 (3)
28	07:34		08:22 (6)	06:46		05:52			05:53		07:13 (4)	05:15		06:05 (3)	05:10		06:14 (3)
	16:57	32	08:54 (6)	17:45		18:25			20:08	12	07:25 (4)	20:46	34	06:39 (3)	21:03	28	06:42 (3)
29	07:33		08:21 (6)			05:50			05:52			05:14		06:05 (3)	05:10		06:14 (3)
	16:59	34	08:55 (6)			18:26			20:09			20:47	34	06:39 (3)	21:03	28	06:42 (3)
30	07:32		08:19 (6)			05:48			05:50			05:13		06:06 (3)	05:11		06:15 (3)
	17:00	36	08:55 (6)			18:28			20:11			20:48	34	06:40 (3)	21:03	28	06:43 (3)
31	07:31		08:20 (6)			05:46						05:13		06:05 (3)			
	17:02	36	08:56 (6)			18:29						20:49	34	06:39 (3)			
Potential sun hours	278		287			368			407			467			475		
Total, worst case		336		580			772			760			718			862	
Sun reduction		0.25		0.46			0.56			0.56			0.56			0.65	
Oper. time red.		0.80		0.80			0.80			0.80			0.80			0.80	
Wind dir. red.		0.87		0.87			0.91			0.85			0.72			0.72	
Total reduction		0.18		0.32			0.41			0.38			0.32			0.38	
Total, real		61		187			316			291			232			329	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19
.
.

Printed/Page
06/12/2003 09:14 / 3

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

SHADOW - Calendar

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W **Shadow Receptor:** 049E - 049E Genson

Assumptions for shadow calculations

Maximum distance for influence	2,000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	2	minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
160	73	35	231	871	390	113	73	59	881	3,189	973	7,048

	July			August			September			October			November			December
1	05:11		06:13 (3)	05:41		06:20 (3)	06:22		07:04 (4)	07:01		07:53 (5)	06:45		07:51 (6)	07:28
	21:03	30	06:43 (3)	20:38	24	06:44 (3)	19:46	36	07:40 (4)	18:46	38	08:31 (5)	16:49	34	08:25 (6)	16:16
2	05:12		06:14 (3)	05:43		06:21 (3)	06:23		07:06 (4)	07:03		07:53 (5)	06:47		07:51 (6)	07:29
	21:03	30	06:44 (3)	20:37	22	06:43 (3)	19:44	34	07:40 (4)	18:44	40	08:33 (5)	16:48	36	08:27 (6)	16:16
3	05:12		06:14 (3)	05:44		06:22 (3)	06:24		07:05 (4)	07:04		07:52 (5)	06:48		07:51 (6)	07:30
	21:02	30	06:44 (3)	20:36	18	06:40 (3)	19:42	34	07:39 (4)	18:42	40	08:32 (5)	16:46	36	08:27 (6)	16:15
4	05:13		06:15 (3)	05:45		06:26 (3)	06:26		07:06 (4)	07:05		07:53 (5)	06:50		07:50 (6)	07:32
	21:02	30	06:45 (3)	20:34	14	06:40 (3)	19:40	32	07:38 (4)	18:40	38	08:31 (5)	16:45	38	08:28 (6)	16:15
5	05:14		06:14 (3)	05:46		06:29 (3)	06:27		07:07 (4)	07:07		07:53 (5)	06:51		07:50 (6)	07:33
	21:02	32	06:46 (3)	20:33	6	06:35 (3)	19:38	28	07:35 (4)	18:38	36	08:29 (5)	16:43	38	08:28 (6)	16:15
6	05:14		06:14 (3)	05:48			06:28		07:09 (4)	07:08		07:52 (5)	06:53		07:49 (6)	07:34
	21:01	30	06:44 (3)	20:31			19:36	26	07:35 (4)	18:36	36	08:28 (5)	16:42	38	08:27 (6)	16:14
7	05:15		06:13 (3)	05:49			06:29		07:10 (4)	07:09		07:54 (5)	06:54		07:49 (6)	07:35
	21:01	32	06:45 (3)	20:30			19:34	22	07:32 (4)	18:34	34	08:28 (5)	16:40	38	08:27 (6)	16:14
8	05:16		06:14 (3)	05:50			06:31		07:11 (4)	07:11		07:55 (5)	06:56		07:51 (6)	07:36
	21:01	32	06:46 (3)	20:28			19:32	18	07:29 (4)	18:32	32	08:27 (5)	16:39	38	08:29 (6)	16:14
9	05:17		06:15 (3)	05:51			06:32		07:14 (4)	07:12		07:54 (5)	06:57		07:50 (6)	07:37
	21:00	32	06:47 (3)	20:27			19:31	12	07:26 (4)	18:30	30	08:24 (5)	16:38	38	08:28 (6)	16:14
10	05:18		06:14 (3)	05:53			06:33			07:14		07:56 (5)	06:59		07:50 (6)	07:38
	21:00	34	06:48 (3)	20:25			19:29			18:28	28	08:24 (5)	16:36	38	08:28 (6)	16:14
11	05:18		06:14 (3)	05:54			06:35			07:15		07:57 (5)	07:00		07:51 (6)	07:39
	20:59	32	06:46 (3)	20:24			19:27			18:26	24	08:21 (5)	16:35	36	08:27 (6)	16:14
12	05:19		06:13 (3)	05:55			06:36			07:16		08:01 (5)	07:02		07:51 (6)	07:40
	20:58	34	06:47 (3)	20:22			19:24			18:25	18	08:19 (5)	16:34	36	08:27 (6)	16:13
13	05:20		06:14 (3)	05:57			06:37			07:18		08:04 (5)	07:03		07:53 (6)	07:41
	20:58	34	06:48 (3)	20:20			19:22			18:23	10	08:14 (5)	16:32	34	08:27 (6)	16:14
14	05:21		06:15 (3)	05:58			06:39			07:19			07:05		07:54 (6)	07:42
	20:57	34	06:49 (3)	20:19			19:20			18:21			16:31	32	08:26 (6)	16:14
15	05:22		06:14 (3)	05:59		07:21 (4)	06:40			07:21			07:06		07:54 (6)	07:42
	20:56	34	06:48 (3)	20:17	12	07:33 (4)	19:18			18:19			16:30	32	08:26 (6)	16:14
16	05:23		06:15 (3)	06:01		07:18 (4)	06:41			07:22			07:08		07:55 (6)	07:43
	20:56	34	06:49 (3)	20:15	18	07:36 (4)	19:16			18:17			16:29	30	08:25 (6)	16:14
17	05:24		06:14 (3)	06:02		07:16 (4)	06:43			07:23			07:09		07:57 (6)	07:44
	20:55	34	06:48 (3)	20:14	22	07:38 (4)	19:14			18:15			16:28	28	08:25 (6)	16:14
18	05:25		06:15 (3)	06:03		07:13 (4)	06:44			07:25			07:11		07:58 (6)	07:45
	20:54	34	06:49 (3)	20:12	26	07:39 (4)	19:12			18:13			16:27	26	08:24 (6)	16:14
19	05:26		06:14 (3)	06:04		07:12 (4)	06:45		08:07 (5)	07:26			07:12		08:00 (6)	07:45
	20:53	36	06:50 (3)	20:10	28	07:40 (4)	19:10	16	08:23 (5)	18:11			16:26	22	08:22 (6)	16:15
20	05:27		06:15 (3)	06:06		07:11 (4)	06:47		08:05 (5)	07:28			07:13		08:02 (6)	07:46
	20:52	34	06:49 (3)	20:09	30	07:41 (4)	19:08	22	08:27 (5)	18:10			16:25	20	08:22 (6)	16:15
21	05:28		06:14 (3)	06:07		07:11 (4)	06:48		08:02 (5)	07:29			07:15		08:03 (6)	07:46
	20:51	36	06:50 (3)	20:07	30	07:41 (4)	19:06	26	08:28 (5)	18:08			16:24	18	08:21 (6)	16:15
22	05:30		06:15 (3)	06:08		07:08 (4)	06:49		08:01 (5)	07:31			07:16		08:05 (6)	07:47
	20:50	34	06:49 (3)	20:05	34	07:42 (4)	19:04	28	08:29 (5)	18:06			16:23	14	08:19 (6)	16:16
23	05:31		06:16 (3)	06:10		07:07 (4)	06:50		07:58 (5)	07:32		09:05 (6)	07:18		08:08 (6)	07:47
	20:49	34	06:50 (3)	20:03	36	07:43 (4)	19:02	32	08:30 (5)	18:04	6	09:11 (6)	16:22	8	08:16 (6)	16:16
24	05:32		06:15 (3)	06:11		07:06 (4)	06:52		07:58 (5)	07:34		09:01 (6)	07:19			07:48
	20:48	34	06:49 (3)	20:01	36	07:42 (4)	19:00	34	08:32 (5)	18:03	16	09:17 (6)	16:21			16:17
25	05:33		06:16 (3)	06:12		07:06 (4)	06:53		07:57 (5)	06:35		07:58 (6)	07:20			07:48
	20:47	32	06:48 (3)	19:59	38	07:44 (4)	18:58	34	08:31 (5)	18:01	20	08:18 (6)	16:20			16:17
26	05:34		06:15 (3)	06:14		07:07 (4)	06:54		07:56 (5)	06:36		07:56 (6)	07:22			07:49
	20:46	34	06:49 (3)	19:58	36	07:43 (4)	18:56	36	08:32 (5)	16:59	24	08:20 (6)	16:20			16:18
27	05:35		06:16 (3)	06:15		07:06 (4)	06:56		07:54 (5)	06:38		07:55 (6)	07:23			07:49
	20:45	32	06:48 (3)	19:56	36	07:42 (4)	18:54	38	08:32 (5)	16:57	26	08:21 (6)	16:19			16:19
28	05:36		06:17 (3)	06:16		07:05 (4)	06:57		07:53 (5)	06:39		07:53 (6)	07:24			07:49
	20:43	30	06:47 (3)	19:54	38	07:43 (4)	18:52	40	08:33 (5)	16:56	30	08:23 (6)	16:18			16:19
29	05:38		06:19 (3)	06:18		07:05 (4)	06:59		07:52 (5)	06:41		07:53 (6)	07:26			07:49
	20:42	28	06:47 (3)	19:52	38	07:43 (4)	18:50	40	08:32 (5)	16:54	32	08:25 (6)	16:18			16:20
30	05:39		06:18 (3)	06:19		07:06 (4)	07:00		07:54 (5)	06:42		07:52 (6)	07:27			07:50
	20:41	28	06:46 (3)	19:50	36	07:42 (4)	18:48	38	08:32 (5)	16:52	32	08:24 (6)	16:17			16:21
31	05:40		06:19 (3)	06:20		07:05 (4)				06:44		07:52 (6)				07:50
	20:40	26	06:45 (3)	19:48	36	07:41 (4)				16:51	34	08:26 (6)				16:22
Potential sun hours	480			441			378			339			282			266
Total, worst case		1000			614			626			624			708		
Sun reduction		0.75			0.65			0.65			0.56			0.35		
Oper. time red.		0.80			0.80			0.80			0.80			0.80		
Wind dir. red.		0.72			0.83			0.88			0.89			0.87		
Total reduction		0.44			0.44			0.47			0.40			0.25		
Total, real		440			271			295			252			178		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19
.
.

Printed/Page
06/12/2003 09:14 / 4

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

SHADOW - Calendar

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W **Shadow Receptor:** 049W - 049W Genson

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
160	73	35	231	871	390	113	73	59	881	3,189	973	7,048

	January	February	March	April	May		June		July		August		September	October	November	December
1	07:50	07:29	06:44	05:44	05:48		05:12		18:29 (2) 05:11		18:33 (2) 05:41		18:48 (2) 06:22	07:01	06:45	07:28
	16:23	17:03	17:46	18:31	20:12		20:50	68	19:37 (2) 21:03	70	19:43 (2) 20:38	44	19:32 (2) 19:46	18:46	16:49	16:16
2	07:50	07:28	06:43	05:42	05:47		05:11		18:28 (2) 05:12		18:34 (2) 05:43		18:49 (2) 06:23	07:03	06:47	07:29
	16:24	17:05	17:48	18:32	20:13		20:51	68	19:36 (2) 21:03	70	19:44 (2) 20:37	42	19:31 (2) 19:44	18:44	16:48	16:16
3	07:50	07:27	06:41	05:40	05:45		05:11		18:28 (2) 05:12		18:34 (2) 05:44		18:52 (2) 06:24	07:04	06:48	07:30
	16:25	17:06	17:49	18:33	20:15		20:52	70	19:38 (2) 21:02	70	19:44 (2) 20:36	38	19:30 (2) 19:42	18:42	16:46	16:15
4	07:50	07:25	06:39	05:38	05:44		05:10		18:29 (2) 05:13		18:35 (2) 05:45		18:54 (2) 06:26	07:05	06:50	07:32
	16:26	17:08	17:51	18:35	20:16		20:52	68	19:37 (2) 21:02	70	19:45 (2) 20:34	34	19:28 (2) 19:40	18:40	16:45	16:15
5	07:50	07:24	06:37	06:36	05:42		18:59 (2) 05:10		18:29 (2) 05:14		18:34 (2) 05:46		18:55 (2) 06:27	07:07	06:51	07:33
	16:27	17:10	17:52	19:36	20:17	4	19:03 (2) 20:53	68	19:37 (2) 21:02	70	19:44 (2) 20:33	30	19:25 (2) 19:38	18:38	16:43	16:15
6	07:49	07:23	06:35	06:34	05:41		18:51 (2) 05:09		18:29 (2) 05:14		18:34 (2) 05:48		18:58 (2) 06:28	07:08	06:53	07:34
	16:28	17:11	17:54	19:37	20:19	18	19:09 (2) 20:54	70	19:39 (2) 21:01	70	19:44 (2) 20:31	24	19:22 (2) 19:36	18:36	16:42	16:14
7	07:49	07:21	06:33	06:32	05:39		18:48 (2) 05:09		18:28 (2) 05:15		18:35 (2) 05:49		19:03 (2) 06:29	07:09	06:54	07:35
	16:29	17:13	17:55	19:39	20:20	26	19:14 (2) 20:55	70	19:38 (2) 21:01	70	19:45 (2) 20:30	14	19:17 (2) 19:34	18:34	16:40	16:14
8	07:49	07:20	06:31	06:30	05:38		18:44 (2) 05:08		18:28 (2) 05:16		18:36 (2) 05:50		06:31	07:11	06:56	07:36
	16:30	17:14	17:57	19:40	20:21	32	19:16 (2) 20:56	70	19:38 (2) 21:01	68	19:44 (2) 20:28		19:32	18:32	16:39	16:14
9	07:48	07:18	06:29	06:28	05:36		18:43 (2) 05:08		18:30 (2) 05:17		18:35 (2) 05:51		06:32	07:12	06:57	07:37
	16:31	17:16	17:58	19:42	20:23	36	19:19 (2) 20:56	70	19:40 (2) 21:00	70	19:45 (2) 20:27		19:31	18:30	16:38	16:14
10	07:48	07:17	06:27	06:26	05:35		18:40 (2) 05:08		18:29 (2) 05:18		18:36 (2) 05:53		06:33	07:14	06:59	07:38
	16:32	17:17	17:59	19:43	20:24	40	19:20 (2) 20:57	70	19:39 (2) 21:00	68	19:44 (2) 20:25		19:29	18:28	16:36	16:14
11	07:48	07:15	06:25	06:24	05:33		18:38 (2) 05:08		18:29 (2) 05:18		18:36 (2) 05:54		06:35	07:15	07:00	07:39
	16:34	17:19	18:01	19:44	20:25	44	19:22 (2) 20:58	70	19:39 (2) 20:59	68	19:44 (2) 20:24		19:27	18:26	16:35	16:14
12	07:47	07:14	06:23	06:22	05:32		18:37 (2) 05:07		18:29 (2) 05:19		18:37 (2) 05:55		06:36	07:16	07:02	07:40
	16:35	17:20	18:02	19:46	20:27	46	19:23 (2) 20:58	70	19:39 (2) 20:58	68	19:45 (2) 20:22		19:24	18:25	16:34	16:13
13	07:47	07:12	06:21	06:20	05:31		18:36 (2) 05:07		18:29 (2) 05:20		18:36 (2) 05:57		06:37	07:18	07:03	07:41
	16:36	17:22	18:04	19:47	20:28	48	19:24 (2) 20:59	72	19:41 (2) 20:58	68	19:44 (2) 20:20		19:22	18:23	16:32	16:14
14	07:46	07:11	06:19	06:18	05:29		18:35 (2) 05:07		18:29 (2) 05:21		18:37 (2) 05:58		06:39	07:19	07:05	07:42
	16:37	17:23	18:05	19:49	20:29	50	19:25 (2) 20:59	72	19:41 (2) 20:57	68	19:45 (2) 20:19		19:20	18:21	16:31	16:14
15	07:46	07:09	06:17	06:16	05:28		18:34 (2) 05:07		18:31 (2) 05:22		18:38 (2) 05:59		06:40	07:21	07:06	07:42
	16:39	17:25	18:07	19:50	20:31	52	19:26 (2) 21:00	70	19:41 (2) 20:56	66	19:44 (2) 20:17		19:18	18:19	16:30	16:14
16	07:45	07:07	06:16	06:15	05:27		18:32 (2) 05:07		18:31 (2) 05:23		18:37 (2) 06:01		06:41	07:22	07:08	07:43
	16:40	17:27	18:08	19:51	20:32	54	19:26 (2) 21:00	70	19:41 (2) 20:56	66	19:43 (2) 20:15		19:16	18:17	16:29	16:14
17	07:44	07:06	06:14	06:13	05:26		18:33 (2) 05:07		18:31 (2) 05:24		18:38 (2) 06:02		06:43	07:23	07:09	07:44
	16:41	17:28	18:10	19:53	20:33	54	19:27 (2) 21:01	70	19:41 (2) 20:55	66	19:44 (2) 20:14		19:14	18:15	16:28	16:14
18	07:44	07:04	06:12	06:11	05:25		18:32 (2) 05:07		18:31 (2) 05:25		18:39 (2) 06:03		06:44	07:25	07:11	07:45
	16:43	17:30	18:11	19:54	20:34	56	19:28 (2) 21:01	70	19:41 (2) 20:54	64	19:43 (2) 20:12		19:12	18:13	16:27	16:14
19	07:43	07:02	06:10	06:09	05:23		18:31 (2) 05:07		18:31 (2) 05:26		18:40 (2) 06:04		06:45	07:26	07:12	07:45
	16:44	17:31	18:12	19:55	20:35	58	19:29 (2) 21:02	70	19:41 (2) 20:53	64	19:44 (2) 20:10		19:10	18:11	16:26	16:15
20	07:42	07:01	06:08	06:07	05:22		18:30 (2) 05:07		18:31 (2) 05:27		18:39 (2) 06:06		06:47	07:28	07:13	07:46
	16:46	17:33	18:14	19:57	20:37	60	19:30 (2) 21:02	70	19:41 (2) 20:52	64	19:43 (2) 20:09		19:08	18:10	16:25	16:15
21	07:41	06:59	06:06	06:05	05:21		18:31 (2) 05:07		18:31 (2) 05:28		18:40 (2) 06:07		06:48	07:29	07:15	07:46
	16:47	17:34	18:15	19:58	20:38	60	19:31 (2) 21:02	70	19:41 (2) 20:51	62	19:42 (2) 20:07		19:06	18:08	16:24	16:15
22	07:40	06:57	06:04	06:04	05:20		18:30 (2) 05:08		18:32 (2) 05:30		18:41 (2) 06:08		06:49	07:31	07:16	07:47
	16:48	17:36	18:17	20:00	20:39	62	19:32 (2) 21:02	70	19:42 (2) 20:50	60	19:41 (2) 20:05		19:04	18:06	16:23	16:16
23	07:39	06:55	06:02	06:02	05:19		18:29 (2) 05:08		18:32 (2) 05:31		18:40 (2) 06:10		06:50	07:32	07:18	07:47
	16:50	17:37	18:18	20:01	20:40	64	19:33 (2) 21:03	70	19:42 (2) 20:49	62	19:42 (2) 20:03		19:02	18:04	16:22	16:16
24	07:38	06:54	06:00	06:00	05:18		18:29 (2) 05:08		18:32 (2) 05:32		18:41 (2) 06:11		06:52	07:34	07:19	07:48
	16:51	17:39	18:19	20:02	20:41	64	19:33 (2) 21:03	70	19:42 (2) 20:48	60	19:41 (2) 20:01		19:00	18:03	16:21	16:17
25	07:37	06:52	05:58	05:58	05:17		18:30 (2) 05:08		18:33 (2) 05:33		18:42 (2) 06:12		06:53	06:35	07:20	07:48
	16:53	17:40	18:21	20:04	20:42	64	19:34 (2) 21:03	70	19:43 (2) 20:47	58	19:40 (2) 19:59		18:58	18:01	16:20	16:17
26	07:36	06:50	05:56	05:57	05:16		18:29 (2) 05:09		18:33 (2) 05:34		18:43 (2) 06:14		06:54	06:36	07:22	07:49
	16:54	17:42	18:22	20:05	20:44	66	19:35 (2) 21:03	70	19:43 (2) 20:46	56	19:39 (2) 19:58		18:56	16:59	16:20	16:18
27	07:35	06:48	05:54	05:55	05:16		18:28 (2) 05:09		18:33 (2) 05:35		18:44 (2) 06:15		06:56	06:38	07:23	07:49
	16:56	17:43	18:24	20:07	20:45	66	19:34 (2) 21:03	70	19:43 (2) 20:45	54	19:38 (2) 19:56		18:54	16:57	16:19	16:19
28	07:34	06:46	05:52	05:53	05:15		18:29 (2) 05:10		18:34 (2) 05:36		18:43 (2) 06:16		06:57	06:39	07:24	07:49
	16:57	17:45	18:25	20:08	20:46	66	19:35 (2) 21:03	70	19:44 (2) 20:43	54	19:37 (2) 19:54		18:52	16:56	16:18	16:19
29	07:33		05:50	05:52	05:14		18:29 (2) 05:10		18:32 (2) 05:38		18:45 (2) 06:18		06:59	06:41	07:26	07:49
	16:59		18:26	20:09	20:47	66	19:35 (2) 21:03	72	19:44 (2) 20:42	52	19:37 (2) 19:52		18:50	16:54	16:18	16:20
30	07:32		05:48	05:50	05:13		18:28 (2) 05:11		18:33 (2) 05:39		18:46 (2) 06:19		07:00	06:42	07:27	07:50
	17:00		18:28	20:11	20:48	68	19:36 (2) 21:03	70	19:43 (2) 20:41	50	19:36 (2) 19:50		18:48	16:52	16:17	16:21
31	07:31		05:46		05:13		18:27 (2)		05:40		18:47 (2) 06:20			06:44		07:50
	17:02		18:29		20:49	68	19:35 (2)		20:40	48	19:35 (2) 19:48			16:51		16:22
Potential sun hours	278	287	368	407	467		475		480		441		378	339	282	266
Total, worst case						1392		2098		1974		226				
Sun reduction						0.56		0.65		0.75		0.65				
Oper. time red.						0.80		0.80		0.80		0.80				
Wind dir. red.						0.91		0.91		0.91		0.91				
Total reduction						0.41		0.48		0.55		0.48				
Total, real						564		1003		1088		108				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19
.
.

Printed/Page
06/12/2003 09:14 / 5

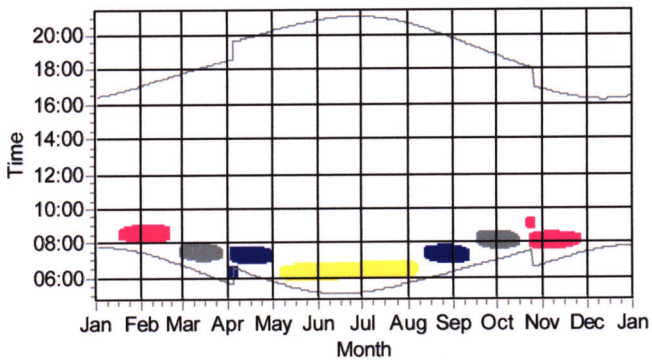
Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

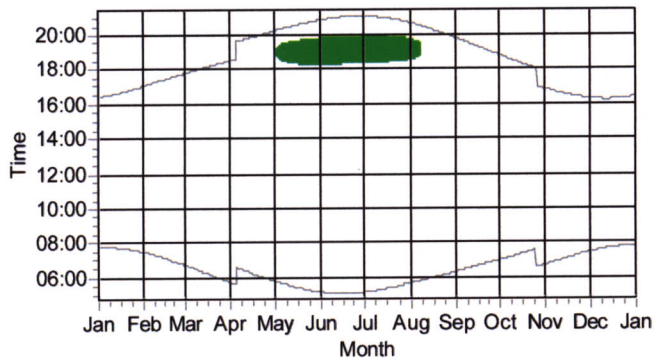
SHADOW - Calendar, graphical

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W

049E Genson



049W Genson



WTGs

H-23 I-16 I-17 I-18 I-19

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19
.
.

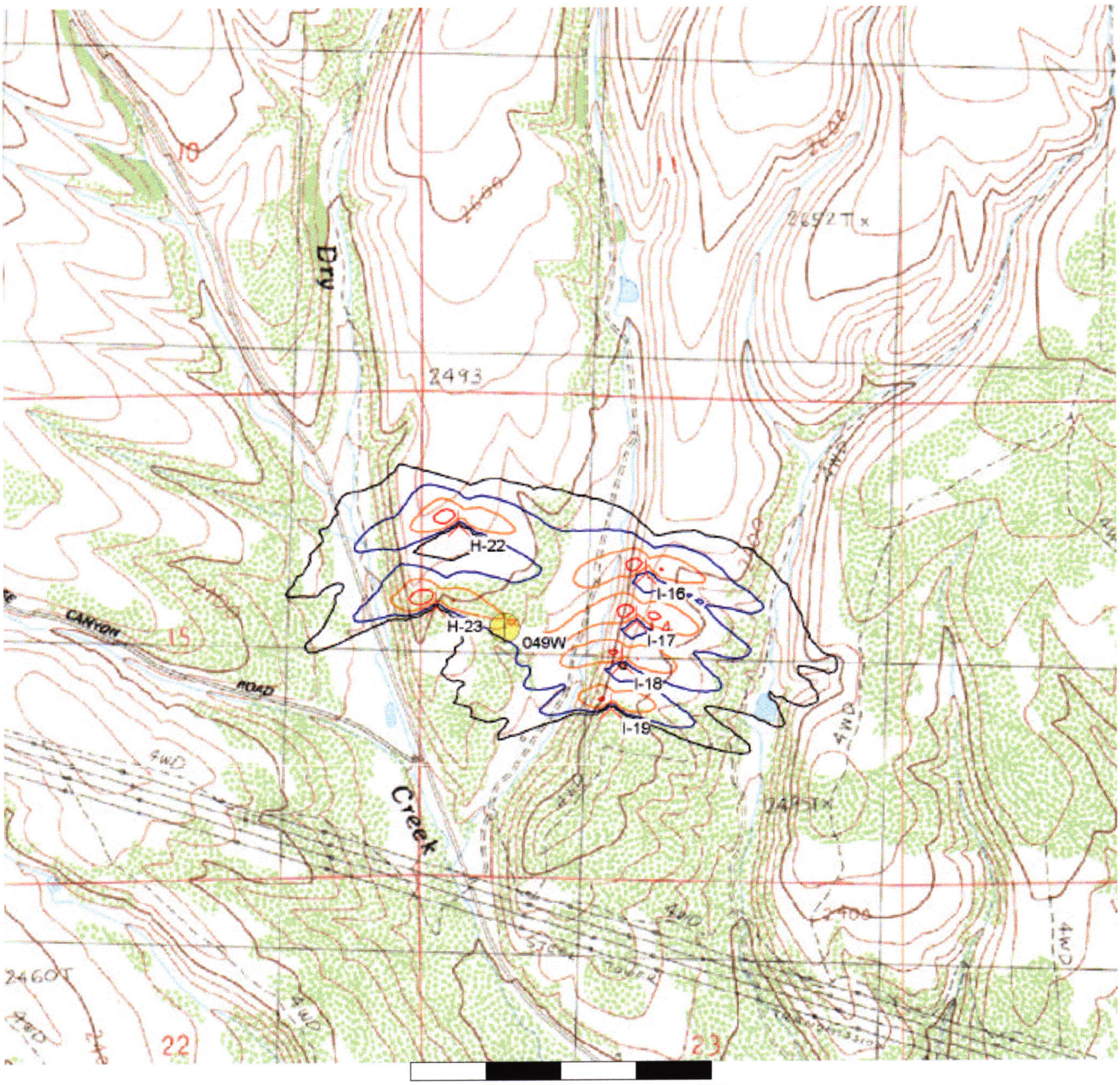
Printed/Page
06/12/2003 09:30 / 6

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W **File:** 030418 ZKV 24k,mt 001.bmi



Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,842 North: 5,223,356

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19
.
.

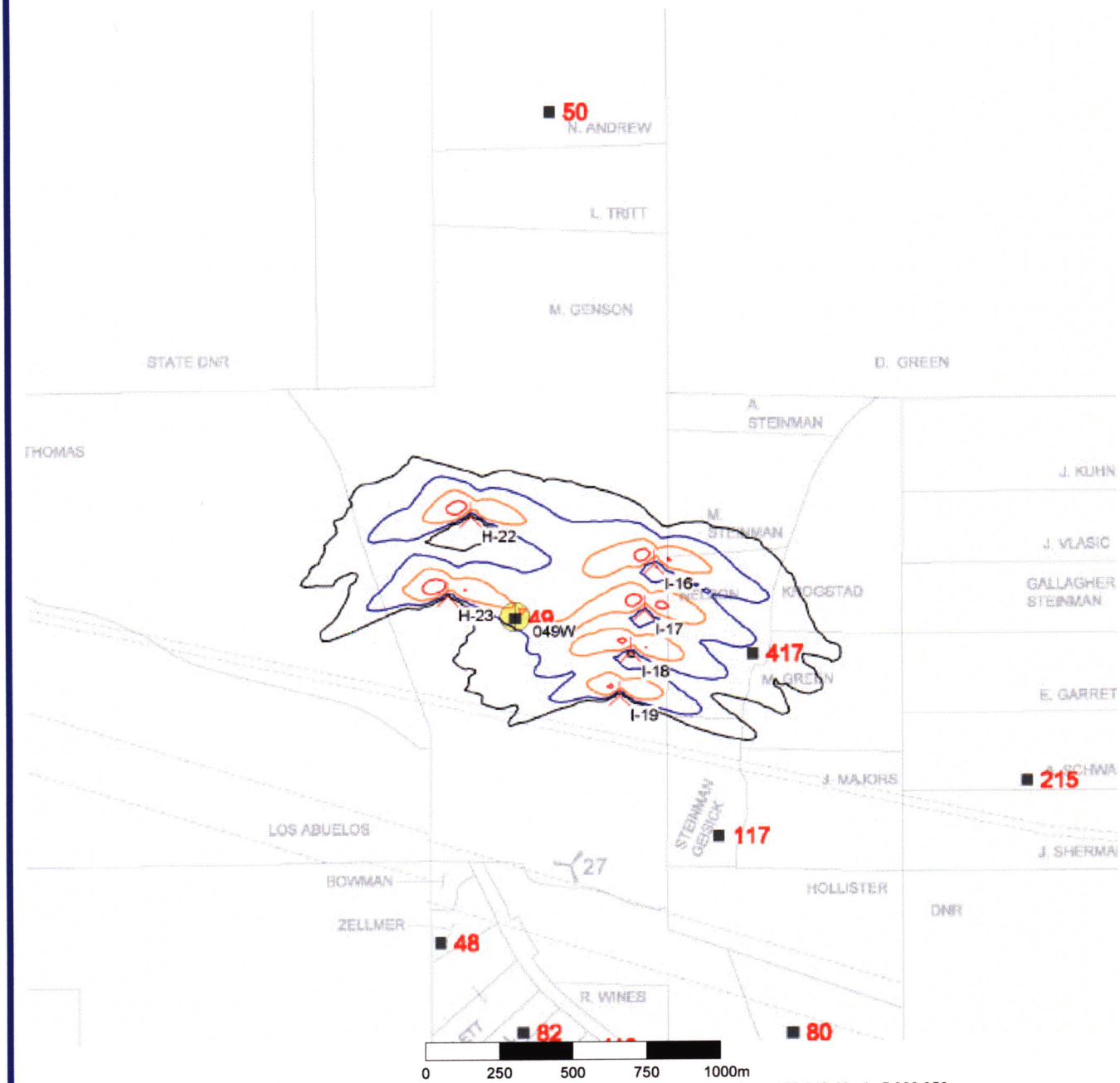
Printed/Page
06/12/2003 09:24 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

SHADOW - Bitmap map: z-fig101-houses2.bmi

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,842 North: 5,223,356

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor N. Andrew (050E and 050 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-11 through H-16
.
.

Printed/Page
06/12/2003 12:37 / 1

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 10:33/2.3.1.127

SHADOW - Main Result

Calculation: 030612 Shadow-Flicker, H-11-16 on 050E and 050 W

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

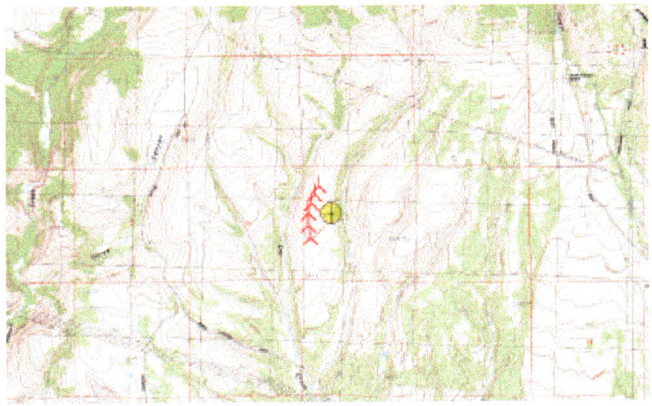
Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE
160	73	35	231	871	390

S	SSW	WSW	W	WNW	NNW	Sum
113	73	59	881	3,189	973	7,048



Scale 1:100,000
New WTG
Shadow Receptor

WTGs

	UTM NAD27 Zone: 10				WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
H-11	675,605	5,225,194	820	H-11	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
H-12	675,549	5,225,076	817	H-12	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
H-13	675,508	5,224,946	810	H-13	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
H-14	675,471	5,224,809	809	H-14	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
H-15	675,475	5,224,641	801	H-15	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3
H-16	675,507	5,224,460	790	H-16	Yes	NEG MICON	NM 72-1500C US	1,500	72.0	62.0	17.3

Shadow Receptor-Input

		UTM NAD27 Zone: 10							
No	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]
050E	050E N. Andrew	675,793	5,224,816	792	1.0	1.0	1.0	-90.0	90.0
050W	050W N. Andrew	675,793	5,224,816	792	1.0	1.0	1.0	90.0	90.0

Calculation Results

		Shadow, worst case			Shadow, expected values
No	Name	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
050E	050E N. Andrew	0:00	0	0:00	0:00
050W	050W N. Andrew	138:02	236	0:52	42:08

Project:
030326 Kittitas

Description:
Shadow receptor N. Andrew (050E and 050 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-11 through H-16
.
.

Printed/Page
06/12/2003 12:37 / 2

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 10:33/2.3.1.127

SHADOW - Calendar

Calculation: 030612 Shadow-Flicker, H-11-16 on 050E and 050 W **Shadow Receptor:** 050E - 050E N. Andrew

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
160	73	35	231	871	390	113	73	59	881	3,189	973	7,048

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:29	06:45	05:44	05:48	05:12	05:11	05:41	06:22	07:01	06:45	07:28
	16:23	17:03	17:46	18:31	20:12	20:50	21:03	20:38	19:46	18:46	16:49	16:16
2	07:50	07:28	06:43	05:42	05:47	05:11	05:12	05:43	06:23	07:03	06:47	07:29
	16:24	17:05	17:48	18:32	20:13	20:51	21:03	20:37	19:44	18:44	16:48	16:16
3	07:50	07:27	06:41	05:40	05:45	05:11	05:12	05:44	06:24	07:04	06:48	07:31
	16:25	17:06	17:49	18:33	20:15	20:52	21:02	20:36	19:42	18:42	16:46	16:15
4	07:50	07:26	06:39	05:38	05:44	05:10	05:13	05:45	06:25	07:05	06:50	07:32
	16:26	17:08	17:51	18:35	20:16	20:52	21:02	20:34	19:40	18:40	16:45	16:15
5	07:50	07:24	06:37	06:36	05:42	05:10	05:14	05:46	06:27	07:07	06:51	07:33
	16:27	17:09	17:52	19:36	20:17	20:53	21:02	20:33	19:38	18:38	16:43	16:15
6	07:49	07:23	06:35	06:34	05:41	05:09	05:14	05:48	06:28	07:08	06:53	07:34
	16:28	17:11	17:54	19:37	20:19	20:54	21:01	20:31	19:36	18:36	16:42	16:14
7	07:49	07:21	06:33	06:32	05:39	05:09	05:15	05:49	06:29	07:09	06:54	07:35
	16:29	17:13	17:55	19:39	20:20	20:55	21:01	20:30	19:34	18:34	16:40	16:14
8	07:49	07:20	06:31	06:30	05:38	05:08	05:16	05:50	06:31	07:11	06:56	07:36
	16:30	17:14	17:57	19:40	20:21	20:56	21:01	20:28	19:33	18:32	16:39	16:14
9	07:49	07:18	06:29	06:28	05:36	05:08	05:17	05:51	06:32	07:12	06:57	07:37
	16:31	17:16	17:58	19:42	20:23	20:56	21:00	20:27	19:31	18:30	16:38	16:14
10	07:48	07:17	06:27	06:26	05:35	05:08	05:18	05:53	06:33	07:14	06:59	07:38
	16:32	17:17	17:59	19:43	20:24	20:57	21:00	20:25	19:29	18:28	16:36	16:14
11	07:48	07:15	06:25	06:24	05:33	05:07	05:18	05:54	06:35	07:15	07:00	07:39
	16:34	17:19	18:01	19:44	20:25	20:58	20:59	20:24	19:27	18:26	16:35	16:13
12	07:47	07:14	06:23	06:22	05:32	05:07	05:19	05:55	06:36	07:16	07:02	07:40
	16:35	17:20	18:02	19:46	20:27	20:58	20:58	20:22	19:25	18:24	16:34	16:13
13	07:47	07:12	06:21	06:20	05:31	05:07	05:20	05:57	06:37	07:18	07:03	07:41
	16:36	17:22	18:04	19:47	20:28	20:59	20:58	20:20	19:22	18:23	16:32	16:13
14	07:46	07:11	06:19	06:18	05:29	05:07	05:21	05:58	06:39	07:19	07:05	07:42
	16:37	17:23	18:05	19:49	20:29	21:00	20:57	20:19	19:20	18:21	16:31	16:14
15	07:46	07:09	06:17	06:16	05:28	05:07	05:22	05:59	06:40	07:21	07:06	07:43
	16:39	17:25	18:07	19:50	20:31	21:00	20:56	20:17	19:18	18:19	16:30	16:14
16	07:45	07:07	06:16	06:15	05:27	05:07	05:23	06:01	06:41	07:22	07:08	07:43
	16:40	17:27	18:08	19:51	20:32	21:01	20:56	20:15	19:16	18:17	16:29	16:14
17	07:44	07:06	06:14	06:13	05:26	05:07	05:24	06:02	06:43	07:23	07:09	07:44
	16:41	17:28	18:10	19:53	20:33	21:01	20:55	20:14	19:14	18:15	16:28	16:14
18	07:44	07:04	06:12	06:11	05:25	05:07	05:25	06:03	06:44	07:25	07:11	07:45
	16:43	17:30	18:11	19:54	20:34	21:01	20:54	20:12	19:12	18:13	16:27	16:14
19	07:43	07:02	06:10	06:09	05:23	05:07	05:26	06:04	06:45	07:26	07:12	07:45
	16:44	17:31	18:12	19:56	20:36	21:02	20:53	20:10	19:10	18:11	16:26	16:15
20	07:42	07:01	06:08	06:07	05:22	05:07	05:27	06:06	06:47	07:28	07:13	07:46
	16:45	17:33	18:14	19:57	20:37	21:02	20:52	20:09	19:08	18:10	16:25	16:15
21	07:41	06:59	06:06	06:05	05:21	05:07	05:28	06:07	06:48	07:29	07:15	07:47
	16:47	17:34	18:15	19:58	20:38	21:02	20:51	20:07	19:06	18:08	16:24	16:15
22	07:40	06:57	06:04	06:04	05:20	05:07	05:29	06:08	06:49	07:31	07:16	07:47
	16:48	17:36	18:17	20:00	20:39	21:03	20:50	20:05	19:04	18:06	16:23	16:16
23	07:39	06:55	06:02	06:02	05:19	05:08	05:31	06:10	06:50	07:32	07:18	07:48
	16:50	17:37	18:18	20:01	20:40	21:03	20:49	20:03	19:02	18:04	16:22	16:16
24	07:38	06:54	06:00	06:00	05:18	05:08	05:32	06:11	06:52	07:34	07:19	07:48
	16:51	17:39	18:19	20:02	20:41	21:03	20:48	20:01	19:00	18:02	16:21	16:17
25	07:37	06:52	05:58	05:58	05:17	05:08	05:33	06:12	06:53	06:35	07:20	07:48
	16:53	17:40	18:21	20:04	20:42	21:03	20:47	19:59	18:58	18:01	16:20	16:17
26	07:36	06:50	05:56	05:57	05:16	05:09	05:34	06:14	06:54	06:37	07:22	07:49
	16:54	17:42	18:22	20:05	20:44	21:03	20:46	19:58	18:56	16:59	16:19	16:18
27	07:35	06:48	05:54	05:55	05:16	05:09	05:35	06:15	06:56	06:38	07:23	07:49
	16:56	17:43	18:24	20:07	20:45	21:03	20:45	19:56	18:54	16:57	16:19	16:19
28	07:34	06:46	05:52	05:53	05:15	05:10	05:36	06:16	06:57	06:39	07:24	07:49
	16:57	17:45	18:25	20:08	20:46	21:03	20:44	19:54	18:52	16:56	16:18	16:19
29	07:33		05:50	05:52	05:14	05:10	05:38	06:18	06:59	06:41	07:26	07:49
	16:59		18:26	20:09	20:47	21:03	20:42	19:52	18:50	16:54	16:17	16:20
30	07:32		05:48	05:50	05:13	05:11	05:39	06:19	07:00	06:42	07:27	07:50
	17:00		18:28	20:11	20:48	21:03	20:41	19:50	18:48	16:52	16:17	16:21
31	07:31		05:46		05:12		05:40	06:20		06:44		07:50
	17:02		18:29		20:49		20:40	19:48		16:51		16:22
Potential sun hours	278	287	368	407	467	475	481	441	378	339	282	266
Total, worst case												
Sun reduction												
Oper. time red.												
Wind dir. red.												
Total reduction												
Total, real												

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
Shadow receptor N. Andrew (050E and 050 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-11 through H-16
.
.

Printed/Page
06/12/2003 12:37 / 3

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 10:33/2.3.1.127

SHADOW - Calendar

Calculation: 030612 Shadow-Flicker, H-11-16 on 050E and 050 W **Shadow Receptor:** 050W - 050W N. Andrew

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
160	73	35	231	871	390	113	73	59	881	3,189	973	7,048

	January			February			March			April			May			June		
1	07:50		14:48 (6)	07:29			06:45		16:04 (5)	05:44		17:19 (4)	05:48		18:11 (4)	05:12		19:27 (3)
	16:23	36	15:24 (6)	17:03			17:46	42	16:46 (5)	18:31	22	17:41 (4)	20:12	30	18:41 (4)	20:50	22	19:49 (3)
2	07:50		14:48 (6)	07:28			06:43		16:04 (5)	05:42		17:17 (4)	05:47		18:11 (4)	05:11		19:26 (3)
	16:24	36	15:24 (6)	17:05			17:48	40	16:44 (5)	18:32	26	17:43 (4)	20:13	26	18:37 (4)	20:51	24	19:50 (3)
3	07:50		14:50 (6)	07:27			06:41		16:04 (5)	05:40		17:15 (4)	05:45		18:14 (4)	05:11		19:26 (3)
	16:25	34	15:24 (6)	17:06			17:49	40	16:44 (5)	18:33	30	17:45 (4)	20:15	22	18:36 (4)	20:52	26	19:52 (3)
4	07:50		14:50 (6)	07:26			06:39		16:07 (5)	05:38		17:13 (4)	05:44		18:16 (4)	05:10		19:25 (3)
	16:26	34	15:24 (6)	17:08			17:51	36	16:43 (5)	18:35	34	17:47 (4)	20:16	18	18:34 (4)	20:52	28	19:53 (3)
5	07:50		14:52 (6)	07:24			06:37		16:07 (5)	06:36		17:11 (4)	05:42		18:21 (4)	05:10		19:23 (3)
	16:27	34	15:26 (6)	17:09			17:52	36	16:43 (5)	19:36	38	17:49 (4)	20:17	8	18:29 (4)	20:53	30	19:53 (3)
6	07:49		14:51 (6)	07:23			06:35		16:09 (5)	06:34		18:09 (4)	05:41			05:09		19:22 (3)
	16:28	34	15:25 (6)	17:11			17:54	32	16:41 (5)	19:37	40	18:49 (4)	20:19			20:54	32	19:54 (3)
7	07:49		14:53 (6)	07:21			06:33		16:11 (5)	06:32		18:07 (4)	05:39			05:09		19:22 (3)
	16:29	32	15:25 (6)	17:13			17:55	28	16:39 (5)	19:39	44	18:51 (4)	20:20			20:55	34	19:56 (3)
8	07:49		14:53 (6)	07:20		16:21 (5)	06:31		16:13 (5)	06:30		18:07 (4)	05:38			05:08		19:22 (3)
	16:30	32	15:25 (6)	17:14	10	16:31 (5)	17:57	24	16:37 (5)	19:40	44	18:51 (4)	20:21			20:56	34	19:56 (3)
9	07:49		14:54 (6)	07:18		16:17 (5)	06:29		16:15 (5)	06:28		18:05 (4)	05:36			05:08		19:22 (3)
	16:31	30	15:24 (6)	17:16	18	16:35 (5)	17:58	18	16:33 (5)	19:42	46	18:51 (4)	20:23			20:56	36	19:58 (3)
10	07:48		14:56 (6)	07:17		16:14 (5)	06:27		16:21 (5)	06:26		18:03 (4)	05:35			05:08		19:21 (3)
	16:32	30	15:26 (6)	17:17	24	16:38 (5)	17:59	8	16:29 (5)	19:43	48	18:51 (4)	20:24			20:57	36	19:57 (3)
11	07:48		14:55 (6)	07:15		16:12 (5)	06:25			06:24		18:03 (4)	05:33			05:07		19:21 (3)
	16:34	30	15:25 (6)	17:19	28	16:40 (5)	18:01			19:44	48	18:51 (4)	20:25			20:58	36	19:57 (3)
12	07:47		14:57 (6)	07:14		16:10 (5)	06:23			06:22		18:03 (4)	05:32			05:07		19:21 (3)
	16:35	28	15:25 (6)	17:20	30	16:40 (5)	18:02			19:46	48	18:51 (4)	20:27			20:58	38	19:59 (3)
13	07:47		14:58 (6)	07:12		16:09 (5)	06:21			06:20		18:02 (4)	05:31			05:07		19:21 (3)
	16:36	26	15:24 (6)	17:22	34	16:43 (5)	18:04			19:47	50	18:52 (4)	20:28			20:59	38	19:59 (3)
14	07:46		14:59 (6)	07:11		16:07 (5)	06:19			06:18		18:02 (4)	05:29			05:07		19:21 (3)
	16:37	24	15:23 (6)	17:23	36	16:43 (5)	18:05			19:49	50	18:52 (4)	20:29			21:00	38	19:59 (3)
15	07:46		15:01 (6)	07:09		16:08 (5)	06:17			06:16		18:02 (4)	05:28			05:07		19:21 (3)
	16:39	22	15:23 (6)	17:25	38	16:46 (5)	18:07			19:50	50	18:52 (4)	20:31			21:00	40	20:01 (3)
16	07:45		15:04 (6)	07:07		16:06 (5)	06:16			06:15		18:02 (4)	05:27			05:07		19:21 (3)
	16:40	18	15:22 (6)	17:27	40	16:46 (5)	18:08			19:51	50	18:52 (4)	20:32			21:01	40	20:01 (3)
17	07:44		15:05 (6)	07:06		16:06 (5)	06:14			06:13		18:00 (4)	05:26			05:07		19:21 (3)
	16:41	16	15:21 (6)	17:28	40	16:46 (5)	18:10			19:53	52	18:52 (4)	20:33			21:01	40	20:01 (3)
18	07:44		15:08 (6)	07:04		16:04 (5)	06:12			06:11		18:00 (4)	05:25			05:07		19:21 (3)
	16:43	10	15:18 (6)	17:30	42	16:46 (5)	18:11			19:54	50	18:50 (4)	20:34			21:01	40	20:01 (3)
19	07:43			07:02		16:05 (5)	06:10			06:09		18:01 (4)	05:23			05:07		19:21 (3)
	16:44			17:31	42	16:47 (5)	18:12			19:56	50	18:51 (4)	20:36			21:02	40	20:01 (3)
20	07:42			07:01		16:03 (5)	06:08			06:07		18:01 (4)	05:22			05:07		19:21 (3)
	16:45			17:33	46	16:49 (5)	18:14			19:57	50	18:51 (4)	20:37			21:02	40	20:01 (3)
21	07:41			06:59		16:03 (5)	06:06			06:05		18:01 (4)	05:21			05:07		19:21 (3)
	16:47			17:34	46	16:49 (5)	18:15			19:58	48	18:49 (4)	20:38			21:02	40	20:01 (3)
22	07:40			06:57		16:03 (5)	06:04			06:04		18:01 (4)	05:20			05:07		19:22 (3)
	16:48			17:36	46	16:49 (5)	18:17			20:00	48	18:49 (4)	20:39			21:03	40	20:02 (3)
23	07:39			06:55		16:03 (5)	06:02			06:02		18:02 (4)	05:19			05:08		19:22 (3)
	16:50			17:37	44	16:47 (5)	18:18			20:01	46	18:48 (4)	20:40			21:03	40	20:02 (3)
24	07:38			06:54		16:04 (5)	06:00			06:00		18:02 (4)	05:18			05:08		19:22 (3)
	16:51			17:39	44	16:48 (5)	18:19			20:02	46	18:48 (4)	20:41			21:03	40	20:02 (3)
25	07:37			06:52		16:04 (5)	05:58			05:58		18:04 (4)	05:17			05:08		19:22 (3)
	16:53			17:40	44	16:48 (5)	18:21			20:04	42	18:46 (4)	20:42			21:03	40	20:02 (3)
26	07:36			06:50		16:04 (5)	05:56			05:57		18:05 (4)	05:16			05:09		19:23 (3)
	16:54			17:42	44	16:48 (5)	18:22			20:05	42	18:47 (4)	20:44			21:03	40	20:03 (3)
27	07:35			06:48		16:04 (5)	05:54			05:55		18:05 (4)	05:16			05:09		19:23 (3)
	16:56			17:43	44	16:48 (5)	18:24			20:07	40	18:45 (4)	20:45			21:03	40	20:03 (3)
28	07:34			06:46		16:04 (5)	05:52			05:53		18:05 (4)	05:15			05:10		19:24 (3)
	16:57			17:45	42	16:46 (5)	18:25			20:08	38	18:43 (4)	20:46			21:03	38	20:02 (3)
29	07:33						05:50			05:52		18:08 (4)	05:14			05:10		19:24 (3)
	16:59						18:26			20:09	34	18:42 (4)	20:47			21:03	38	20:02 (3)
30	07:32						05:48			05:50		18:08 (4)	05:13		19:32 (3)	05:11		19:25 (3)
	17:00						18:28			20:11	34	18:42 (4)	20:48	12	19:44 (3)	21:03	38	20:03 (3)
31	07:31						05:46		17:25 (4)				05:12		19:29 (3)			
	17:02						18:29	12	17:37 (4)				20:49	16	19:45 (3)			
Potential sun hours	278			287			368			407			467			475		
Total, worst case		506			782			316			1288			132			1086	
Sun reduction		0.25			0.46			0.56			0.56			0.56			0.65	
Oper. time red.		0.80			0.80			0.80			0.80			0.80			0.80	
Wind dir. red.		0.44			0.66			0.67			0.86			0.87			0.90	
Total reduction		0.08			0.23			0.28			0.36			0.37			0.45	
Total, real		42			177			88			467			48			485	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
Shadow receptor N. Andrew (050E and 050 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-11 through H-16
.
.

Printed/Page
06/12/2003 12:37 / 4

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 10:33/2.3.1.127

SHADOW - Calendar

Calculation: 030612 Shadow-Flicker, H-11-16 on 050E and 050 W **Shadow Receptor:** 050W - 050W N. Andrew

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
160	73	35	231	871	390	113	73	59	881	3,189	973	7,048

	July			August			September			October			November			December		
1	05:11		19:25 (3)	05:41			06:22		18:02 (4)	07:01			06:45		15:43 (5)	07:28		14:39 (6)
	21:03	38	20:03 (3)	20:38			19:46	48	18:50 (4)	18:46			16:49	24	16:07 (5)	16:16	28	15:07 (6)
2	05:12		19:26 (3)	05:43			06:23		18:02 (4)	07:03			06:47		15:47 (5)	07:29		14:39 (6)
	21:03	36	20:02 (3)	20:37			19:44	48	18:50 (4)	18:44			16:48	16	16:03 (5)	16:16	30	15:09 (6)
3	05:12		19:26 (3)	05:44			06:24		18:03 (4)	07:04			06:48		15:51 (5)	07:31		14:38 (6)
	21:02	36	20:02 (3)	20:36			19:42	46	18:49 (4)	18:42			16:46	10	16:01 (5)	16:15	30	15:08 (6)
4	05:13		19:27 (3)	05:45			06:25		18:04 (4)	07:05		16:53 (5)	06:50			07:32		14:37 (6)
	21:02	34	20:01 (3)	20:34			19:40	44	18:48 (4)	18:40	16	17:09 (5)	16:45			16:15	32	15:09 (6)
5	05:14		19:28 (3)	05:46			06:27		18:03 (4)	07:07		16:51 (5)	06:51			07:33		14:38 (6)
	21:02	34	20:02 (3)	20:33			19:38	44	18:47 (4)	18:38	22	17:13 (5)	16:43			16:15	32	15:10 (6)
6	05:14		19:28 (3)	05:48			06:28		18:05 (4)	07:08		16:48 (5)	06:53			07:34		14:37 (6)
	21:01	32	20:00 (3)	20:31			19:36	40	18:45 (4)	18:36	26	17:14 (5)	16:42			16:14	34	15:11 (6)
7	05:15		19:29 (3)	05:49			06:29		18:06 (4)	07:09		16:46 (5)	06:54			07:35		14:38 (6)
	21:01	32	20:01 (3)	20:30			19:34	38	18:44 (4)	18:34	30	17:16 (5)	16:40			16:14	34	15:12 (6)
8	05:16		19:32 (3)	05:50		18:28 (4)	06:31		18:07 (4)	07:11		16:43 (5)	06:56			07:36		14:38 (6)
	21:01	28	20:00 (3)	20:28	12	18:40 (4)	19:33	34	18:41 (4)	18:32	34	17:17 (5)	16:39			16:14	34	15:12 (6)
9	05:17		19:33 (3)	05:51		18:24 (4)	06:32		18:08 (4)	07:12		16:42 (5)	06:57			07:37		14:39 (6)
	21:00	26	19:59 (3)	20:27	20	18:44 (4)	19:31	32	18:40 (4)	18:30	36	17:18 (5)	16:38			16:14	34	15:13 (6)
10	05:18		19:33 (3)	05:53		18:21 (4)	06:33		18:10 (4)	07:14		16:40 (5)	06:59			07:38		14:38 (6)
	21:00	24	19:57 (3)	20:25	24	18:45 (4)	19:29	28	18:38 (4)	18:28	38	17:18 (5)	16:36			16:14	36	15:14 (6)
11	05:18		19:34 (3)	05:54		18:20 (4)	06:35		18:11 (4)	07:15		16:39 (5)	07:00			07:39		14:39 (6)
	20:59	22	19:56 (3)	20:24	28	18:48 (4)	19:27	24	18:35 (4)	18:26	40	17:19 (5)	16:35			16:13	36	15:15 (6)
12	05:19		19:37 (3)	05:55		18:17 (4)	06:36		18:14 (4)	07:16		16:39 (5)	07:02			07:40		14:40 (6)
	20:58	18	19:55 (3)	20:22	32	18:49 (4)	19:25	16	18:30 (4)	18:24	40	17:19 (5)	16:34			16:13	36	15:16 (6)
13	05:20		19:38 (3)	05:57		18:17 (4)	06:37			07:18		16:36 (5)	07:03			07:41		14:38 (6)
	20:58	16	19:54 (3)	20:20	34	18:51 (4)	19:22			18:23	44	17:20 (5)	16:32			16:13	38	15:16 (6)
14	05:21		19:41 (3)	05:58		18:14 (4)	06:39			07:19		16:36 (5)	07:05			07:42		14:39 (6)
	20:57	10	19:51 (3)	20:19	36	18:50 (4)	19:20			18:21	44	17:20 (5)	16:31			16:14	36	15:15 (6)
15	05:22			05:59		18:13 (4)	06:40			07:21		16:35 (5)	07:06			07:43		14:40 (6)
	20:56			20:17	38	18:51 (4)	19:18			18:19	44	17:19 (5)	16:30			16:14	36	15:16 (6)
16	05:23			06:01		18:12 (4)	06:41			07:22		16:35 (5)	07:08			07:43		14:41 (6)
	20:56			20:15	40	18:52 (4)	19:16			18:17	46	17:21 (5)	16:29			16:14	36	15:17 (6)
17	05:24			06:02		18:12 (4)	06:43			07:23		16:34 (5)	07:09			07:44		14:40 (6)
	20:55			20:14	42	18:54 (4)	19:14			18:15	46	17:20 (5)	16:28			16:14	38	15:18 (6)
18	05:25			06:03		18:09 (4)	06:44			07:25		16:34 (5)	07:11			07:45		14:40 (6)
	20:54			20:12	44	18:53 (4)	19:12			18:13	46	17:20 (5)	16:27			16:14	38	15:18 (6)
19	05:26			06:04		18:08 (4)	06:45			07:26		16:33 (5)	07:12			07:45		14:41 (6)
	20:53			20:10	46	18:54 (4)	19:10			18:11	46	17:19 (5)	16:26			16:15	38	15:19 (6)
20	05:27			06:06		18:07 (4)	06:47			07:28		16:35 (5)	07:13			07:46		14:41 (6)
	20:52			20:09	46	18:53 (4)	19:08			18:10	44	17:19 (5)	16:25			16:15	38	15:19 (6)
21	05:28			06:07		18:07 (4)	06:48			07:29		16:34 (5)	07:15			07:47		14:42 (6)
	20:51			20:07	48	18:55 (4)	19:06			18:08	44	17:18 (5)	16:24			16:15	38	15:20 (6)
22	05:29			06:08		18:06 (4)	06:49			07:31		16:34 (5)	07:16			07:47		14:42 (6)
	20:50			20:05	48	18:54 (4)	19:04			18:06	44	17:18 (5)	16:23			16:16	38	15:20 (6)
23	05:31			06:10		18:05 (4)	06:50			07:32		16:35 (5)	07:18			07:48		14:43 (6)
	20:49			20:03	50	18:55 (4)	19:02			18:04	42	17:17 (5)	16:22			16:16	38	15:21 (6)
24	05:32			06:11		18:04 (4)	06:52			07:34		16:35 (5)	07:19		14:46 (6)	07:48		14:43 (6)
	20:48			20:01	50	18:54 (4)	19:00			18:02	42	17:17 (5)	16:21	10	14:56 (6)	16:17	38	15:21 (6)
25	05:33			06:12		18:04 (4)	06:53			06:35		15:34 (5)	07:20		14:43 (6)	07:48		14:43 (6)
	20:47			19:59	50	18:54 (4)	18:58			18:01	42	17:16 (5)	16:20	16	14:59 (6)	16:17	38	15:21 (6)
26	05:34			06:14		18:03 (4)	06:54			06:37		15:36 (5)	07:22		14:42 (6)	07:49		14:44 (6)
	20:46			19:58	52	18:55 (4)	18:56			16:59	40	16:16 (5)	16:19	18	15:00 (6)	16:18	38	15:22 (6)
27	05:35			06:15		18:04 (4)	06:56			06:38		15:37 (5)	07:23		14:40 (6)	07:49		14:46 (6)
	20:45			19:56	50	18:54 (4)	18:54			16:57	36	16:13 (5)	16:19	22	15:02 (6)	16:19	36	15:22 (6)
28	05:36			06:16		18:03 (4)	06:57			06:39		15:37 (5)	07:24		14:39 (6)	07:49		14:46 (6)
	20:44			19:54	50	18:53 (4)	18:52			16:56	36	16:13 (5)	16:18	24	15:03 (6)	16:19	36	15:22 (6)
29	05:38			06:18		18:03 (4)	06:59			06:41		15:39 (5)	07:26		14:39 (6)	07:49		14:46 (6)
	20:42			19:52	50	18:53 (4)	18:50			16:54	34	16:13 (5)	16:17	26	15:05 (6)	16:20	36	15:22 (6)
30	05:39			06:19		18:02 (4)	07:00			06:42		15:40 (5)	07:27		14:38 (6)	07:50		14:46 (6)
	20:41			19:50	50	18:52 (4)	18:48			16:52	30	16:10 (5)	16:17	28	15:06 (6)	16:21	38	15:24 (6)
31	05:40			06:20		18:03 (4)				06:44		15:42 (5)				07:50		14:48 (6)
	20:40			19:48	48	18:51 (4)				16:51	26	16:08 (5)				16:22	36	15:24 (6)
Potential sun hours	481			441			378			339			282			266		
Total, worst case		386			988			442			1058			194			1104	
Sun reduction		0.75			0.65			0.65			0.56			0.35			0.25	
Oper. time red.		0.80			0.80			0.80			0.80			0.80			0.80	
Wind dir. red.		0.90			0.86			0.86			0.66			0.49			0.44	
Total reduction		0.51			0.43			0.43			0.28			0.13			0.08	
Total, real		199			422			189			292			26			93	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
Shadow receptor N. Andrew (050E and 050 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-11 through H-16
.
.

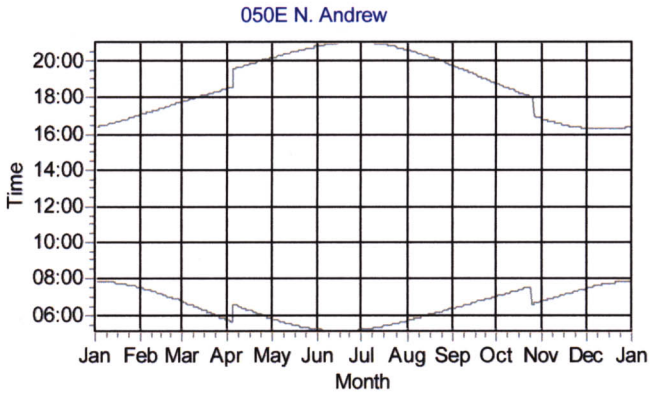
Printed/Page
06/12/2003 12:37 / 5

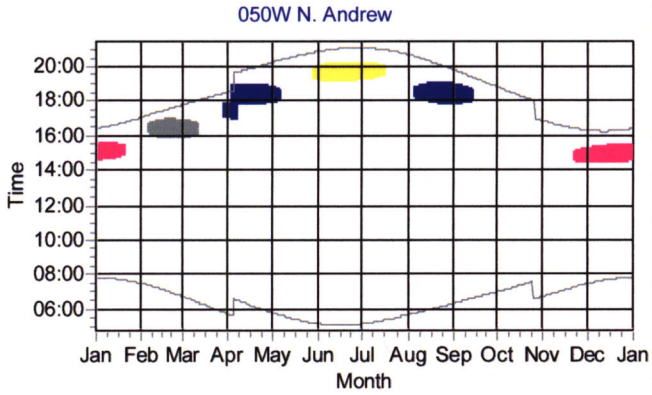
Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 10:33/2.3.1.127

SHADOW - Calendar, graphical

Calculation: 030612 Shadow-Flicker, H-11-16 on 050E and 050 W





WTGs

H-13 H-14 H-15 H-16

Project:
030326 Kittitas

Description:
Shadow receptor N. Andrew (050E and 050 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-11 through H-16
.
.

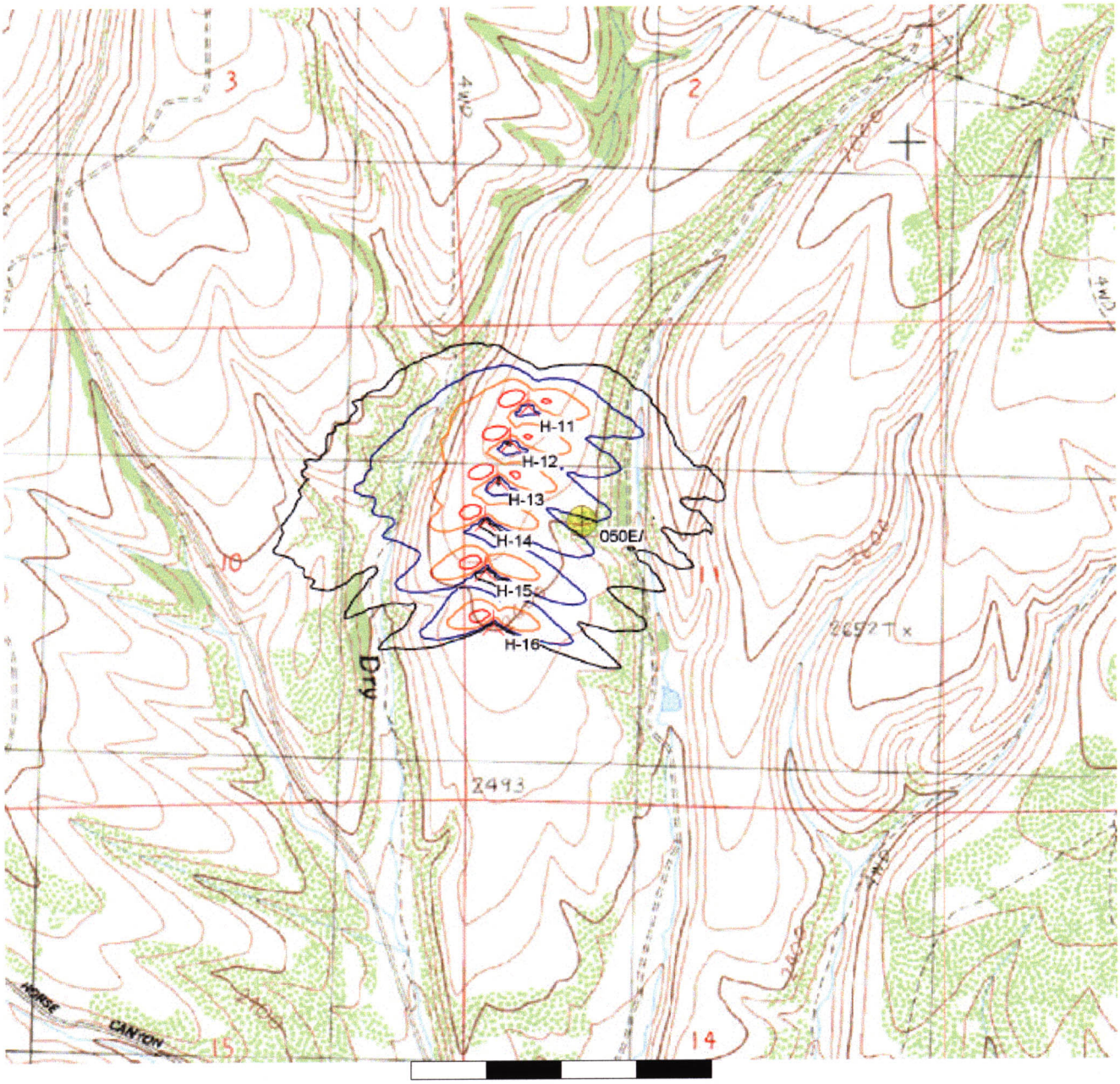
Printed/Page
06/12/2003 12:14 / 6

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 10:33/2.3.1.127

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030612 Shadow-Flicker, H-11-16 on 050E and 050 W **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,663 North: 5,224,722

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor N. Andrew (050E and 050 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-11 through H-16
.
.

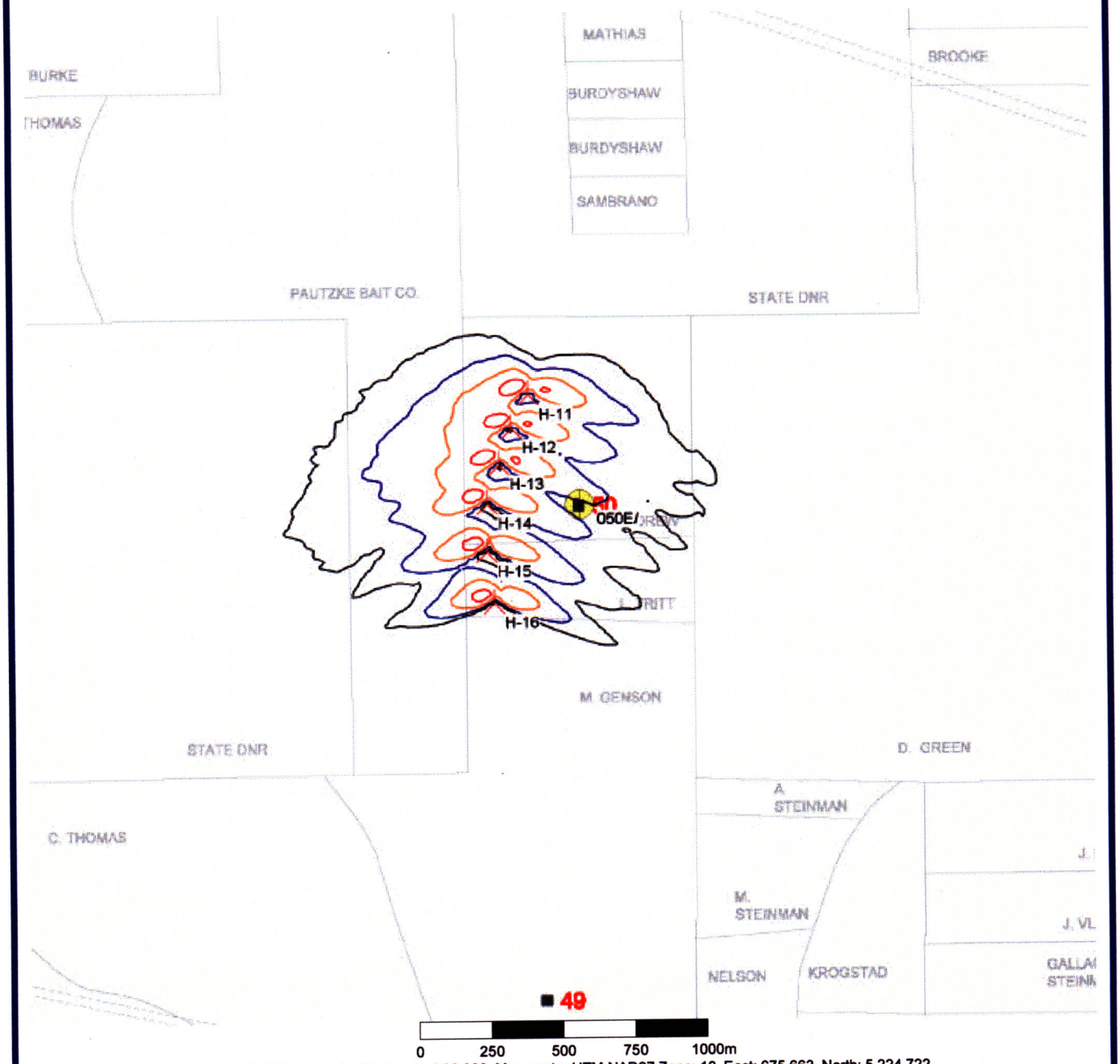
Printed/Page
06/12/2003 12:19 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 10:33/2.3.1.127

SHADOW - Bitmap map: z-fig101-houses2.bmi

Calculation: 030612 Shadow-Flicker, H-11-16 on 050E and 050 W **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,663 North: 5,224,722

New WTG
Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbine H-46

Printed/Page
06/13/2003 14:58 / 1

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/13/2003 14:46/2.3.1.127

SHADOW - Main Result

Calculation: 030613 Shadow-Flicker, H-45, on 058W and 059W

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

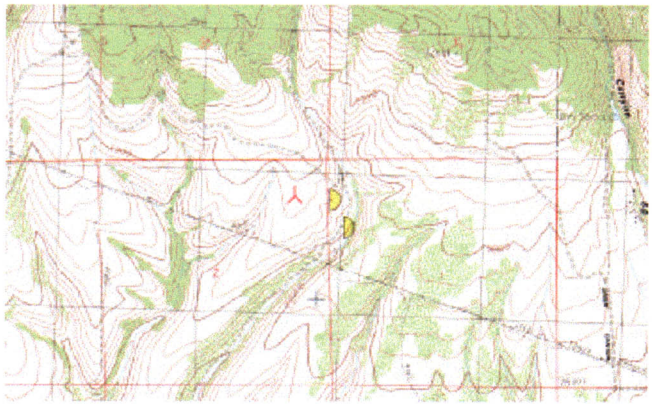
Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE
162	74	35	234	883	395

S	SSW	WSW	W	WNW	NNW	Sum
115	74	60	893	3,232	986	7,142



Scale 1:50,000
New WTG
Shadow Receptor

WTGs

	UTM NAD27 Zone: 10				WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
H-45	676,669	5,226,829	907	H-45	Yes	NORDEX	N-90	2,300	90.0	80.0	16.9

Shadow Receptor-Input

No	Name	UTM NAD27 Zone: 10 East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]
058W	058W T Gerean	676,922	5,226,808	890	1.0	1.0	1.0	90.0	90.0
059W	059W L Gerean	677,023	5,226,620	857	1.0	1.0	1.0	90.0	90.0

Calculation Results

No	Name	Shadow, worst case: Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
058W	058W T Gerean	154:22	134	1:20	72:15
059W	059W L Gerean	0:00	0	0:00	0:00

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbine H-46
.
.
.
.

Printed/Page
06/13/2003 14:58 / 2

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/13/2003 14:46/2.3.1.127

SHADOW - Calendar

Calculation: 030613 Shadow-Flicker, H-45, on 058W and 059W **Shadow Receptor:** 058W - 058W T Gerean

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
162	74	35	234	883	395	115	74	60	893	3,232	986	7,142

	January	February	March	April			May			June			July			August			September	October	November	December
1	07:50	07:29	06:44	05:43			05:48		17:44 (1)	05:12		17:45 (1)	05:11		17:53 (1)	05:41		17:50 (1)	06:21	07:01	06:45	07:28
	16:23	17:03	17:46	18:30			20:12	70	18:54 (1)	20:50	74	18:59 (1)	21:03	70	19:03 (1)	20:38	78	19:08 (1)	19:46	18:46	16:49	16:16
2	07:50	07:28	06:43	05:41			05:47		17:43 (1)	05:11		17:46 (1)	05:12		17:54 (1)	05:42		17:51 (1)	06:23	07:03	06:47	07:29
	16:24	17:05	17:48	18:32			20:13	72	18:55 (1)	20:51	72	18:58 (1)	21:03	70	19:04 (1)	20:37	78	19:09 (1)	19:44	18:44	16:48	16:16
3	07:50	07:27	06:41	05:40			05:45		17:43 (1)	05:10		17:46 (1)	05:12		17:54 (1)	05:44		17:50 (1)	06:24	07:04	06:48	07:31
	16:25	17:06	17:49	18:33			20:15	72	18:55 (1)	20:52	74	19:00 (1)	21:02	70	19:04 (1)	20:36	78	19:08 (1)	19:42	18:42	16:46	16:15
4	07:50	07:26	06:39	05:38			05:43		17:42 (1)	05:10		17:47 (1)	05:13		17:53 (1)	05:45		17:52 (1)	06:25	07:05	06:50	07:32
	16:26	17:08	17:51	18:35			20:16	74	18:56 (1)	20:52	72	18:59 (1)	21:02	72	19:05 (1)	20:34	76	19:08 (1)	19:40	18:40	16:45	16:15
5	07:50	07:24	06:37	06:36			05:42		17:43 (1)	05:09		17:47 (1)	05:14		17:54 (1)	05:46		17:51 (1)	06:27	07:07	06:51	07:33
	16:27	17:09	17:52	19:36			20:17	74	18:57 (1)	20:53	72	18:59 (1)	21:02	72	19:06 (1)	20:33	76	19:07 (1)	19:38	18:38	16:43	16:15
6	07:49	07:23	06:35	06:34			05:40		17:41 (1)	05:09		17:48 (1)	05:14		17:54 (1)	05:47		17:50 (1)	06:28	07:08	06:53	07:34
	16:28	17:11	17:54	19:37			20:19	76	18:57 (1)	20:54	70	18:58 (1)	21:01	72	19:06 (1)	20:31	76	19:06 (1)	19:36	18:36	16:42	16:14
7	07:49	07:21	06:33	06:32			05:39		17:42 (1)	05:09		17:48 (1)	05:15		17:53 (1)	05:49		17:51 (1)	06:29	07:09	06:54	07:35
	16:29	17:12	17:55	19:39			20:20	76	18:58 (1)	20:55	72	19:00 (1)	21:01	72	19:05 (1)	20:30	76	19:07 (1)	19:34	18:34	16:40	16:14
8	07:49	07:20	06:31	06:30			05:37		17:40 (1)	05:08		17:48 (1)	05:16		17:54 (1)	05:50		17:50 (1)	06:31	07:11	06:56	07:36
	16:30	17:14	17:56	19:40			20:21	78	18:58 (1)	20:56	72	19:00 (1)	21:01	72	19:06 (1)	20:28	76	19:06 (1)	19:32	18:32	16:39	16:14
9	07:49	07:18	06:29	06:28			05:36		17:41 (1)	05:08		17:49 (1)	05:17		17:53 (1)	05:51		17:52 (1)	06:32	07:12	06:57	07:37
	16:31	17:16	17:58	19:42			20:23	76	18:57 (1)	20:56	70	18:59 (1)	21:00	74	19:07 (1)	20:27	74	19:06 (1)	19:30	18:30	16:37	16:14
10	07:48	07:17	06:27	06:26			05:35		17:40 (1)	05:08		17:49 (1)	05:17		17:53 (1)	05:53		17:51 (1)	06:33	07:14	06:59	07:38
	16:32	17:17	17:59	19:43			20:24	78	18:58 (1)	20:57	70	18:59 (1)	21:00	74	19:07 (1)	20:25	74	19:05 (1)	19:28	18:28	16:36	16:13
11	07:48	07:15	06:25	06:24			05:33		17:40 (1)	05:07		17:49 (1)	05:18		17:54 (1)	05:54		17:52 (1)	06:35	07:15	07:00	07:39
	16:33	17:19	18:01	19:44			20:25	78	18:58 (1)	20:58	70	18:59 (1)	20:59	72	19:06 (1)	20:24	72	19:04 (1)	19:26	18:26	16:35	16:13
12	07:47	07:14	06:23	06:22			05:32		17:41 (1)	05:07		17:49 (1)	05:19		17:53 (1)	05:55		17:51 (1)	06:36	07:16	07:02	07:40
	16:35	17:20	18:02	19:46			20:27	78	18:59 (1)	20:58	70	18:59 (1)	20:58	74	19:07 (1)	20:22	72	19:03 (1)	19:24	18:24	16:34	16:13
13	07:47	07:12	06:21	06:20			05:31		17:40 (1)	05:07		17:51 (1)	05:20		17:54 (1)	05:56		17:53 (1)	06:37	07:18	07:03	07:41
	16:36	17:22	18:04	19:47			20:28	78	18:58 (1)	20:59	68	18:59 (1)	20:58	74	19:08 (1)	20:20	70	19:03 (1)	19:22	18:22	16:32	16:13
14	07:46	07:11	06:19	06:18			05:29		17:41 (1)	05:07		17:51 (1)	05:21		17:53 (1)	05:58		17:54 (1)	06:39	07:19	07:05	07:42
	16:37	17:23	18:05	19:49			20:29	78	18:59 (1)	21:00	70	19:01 (1)	20:57	74	19:07 (1)	20:19	68	19:02 (1)	19:20	18:21	16:31	16:13
15	07:46	07:09	06:17	06:16			05:28		17:39 (1)	05:07		17:51 (1)	05:22		17:52 (1)	05:59		17:53 (1)	06:40	07:21	07:06	07:43
	16:39	17:25	18:07	19:50			20:31	80	18:59 (1)	21:00	70	19:01 (1)	20:56	76	19:08 (1)	20:17	68	19:01 (1)	19:18	18:19	16:30	16:13
16	07:45	07:07	06:15	06:14		18:12 (1)	05:27		17:40 (1)	05:07		17:51 (1)	05:23		17:53 (1)	06:00		17:54 (1)	06:41	07:22	07:08	07:43
	16:40	17:26	18:08	19:51	20	18:32 (1)	20:32	78	18:58 (1)	21:01	70	19:01 (1)	20:56	76	19:09 (1)	20:15	64	18:58 (1)	19:16	18:17	16:29	16:14
17	07:44	07:06	06:13	06:13		18:06 (1)	05:26		17:41 (1)	05:07		17:51 (1)	05:24		17:52 (1)	06:02		17:56 (1)	06:42	07:23	07:09	07:44
	16:41	17:28	18:09	19:53	30	18:36 (1)	20:33	78	18:59 (1)	21:01	70	19:01 (1)	20:55	76	19:08 (1)	20:14	62	18:58 (1)	19:14	18:15	16:28	16:14
18	07:44	07:04	06:11	06:11		18:04 (1)	05:24		17:40 (1)	05:07		17:51 (1)	05:25		17:53 (1)	06:03		17:57 (1)	06:44	07:25	07:11	07:45
	16:43	17:30	18:11	19:54	34	18:38 (1)	20:34	78	18:58 (1)	21:01	70	19:01 (1)	20:54	76	19:09 (1)	20:12	60	18:57 (1)	19:12	18:13	16:27	16:14
19	07:43	07:02	06:09	06:09		18:00 (1)	05:23		17:41 (1)	05:07		17:53 (1)	05:26		17:52 (1)	06:04		17:56 (1)	06:45	07:26	07:12	07:45
	16:44	17:31	18:12	19:55	40	18:40 (1)	20:36	78	18:59 (1)	21:02	68	19:01 (1)	20:53	78	19:10 (1)	20:10	58	18:54 (1)	19:10	18:11	16:26	16:14
20	07:42	07:01	06:07	06:07		17:59 (1)	05:22		17:40 (1)	05:07		17:53 (1)	05:27		17:53 (1)	06:06		17:57 (1)	06:46	07:28	07:13	07:46
	16:45	17:33	18:14	19:57	44	18:43 (1)	20:37	78	18:58 (1)	21:02	68	19:01 (1)	20:52	76	19:09 (1)	20:09	56	18:53 (1)	19:08	18:09	16:25	16:15
21	07:41	06:59	06:05	06:05		17:55 (1)	05:21		17:41 (1)	05:07		17:53 (1)	05:28		17:52 (1)	06:07		17:58 (1)	06:48	07:29	07:15	07:47
	16:47	17:34	18:15	19:58	50	18:45 (1)	20:38	78	18:59 (1)	21:02	68	19:01 (1)	20:51	78	19:10 (1)	20:07	52	18:50 (1)	19:06	18:08	16:24	16:15
22	07:40	06:57	06:03	06:04		17:53 (1)	05:20		17:42 (1)	05:07		17:53 (1)	05:29		17:51 (1)	06:08		18:00 (1)	06:49	07:31	07:16	07:47
	16:48	17:36	18:17	20:00	54	18:47 (1)	20:39	76	18:58 (1)	21:03	68	19:01 (1)	20:50	78	19:09 (1)	20:05	50	18:50 (1)	19:04	18:06	16:23	16:16
23	07:39	06:55	06:01	06:02		17:52 (1)	05:19		17:41 (1)	05:08		17:54 (1)	05:30		17:52 (1)	06:10		18:03 (1)	06:50	07:32	07:18	07:48
	16:50	17:37	18:18	20:01	56	18:48 (1)	20:40	78	18:59 (1)	21:03	68	19:02 (1)	20:49	78	19:10 (1)	20:03	44	18:47 (1)	19:02	18:04	16:22	16:16
24	07:38	06:54	05:59	06:00		17:50 (1)	05:18		17:42 (1)	05:08		17:54 (1)	05:32		17:51 (1)	06:11		18:04 (1)	06:52	07:34	07:19	07:48
	16:51	17:39	18:19	20:02	60	18:50 (1)	20:41	76	18:58 (1)	21:03	68	19:02 (1)	20:48	78	19:09 (1)	20:01	40	18:44 (1)	19:00	18:02	16:21	16:17
25	07:37	06:52	05:57	05:58		17:50 (1)	05:17		17:42 (1)	05:08		17:52 (1)	05:33		17:52 (1)	06:12		18:08 (1)	06:53	06:35	07:20	07:48
	16:53	17:40	18:21	20:04	60	18:50 (1)	20:42	78	19:00 (1)	21:03	70	19:02 (1)	20:47	78	19:10 (1)	19:59	34	18:42 (1)	18:58	18:01	16:20	16:17
26	07:36	06:50	05:55	05:57		17:48 (1)	05:16		17:43 (1)	05:09		17:53 (1)	05:34		17:51 (1)	06:14		18:11 (1)	06:54	06:36	07:22	07:49
	16:54	17:42	18:22	20:05	62	18:50 (1)	20:44	76	18:59 (1)	21:03	70	19:03 (1)	20:46	78	19:09 (1)	19:58	28	18:39 (1)	18:56	16:59	16:19	16:18
27	07:35	06:48	05:53	05:55		17:47 (1)	05:15		17:44 (1)	05:09		17:53 (1)	05:35		17:50 (1)	06:15		18:14 (1)	06:56	06:38	07:23	07:49
	16:56	17:43	18:24	20:07	66	18:53 (1)	20:45	76	19:00 (1)	21:03	70	19:03 (1)	20:45	80	19:10 (1)	19:56	20	18:34 (1)	18:54	16:57	16:19	16:19
28	07:34	06:46	05:51	05:53		17:45 (1)	05:15		17:43 (1)	05:09		17:54 (1)	05:36		17:51 (1)	06:16			06:57	06:39	07:24	07:49
	16:57	17:45	18:25	20:08	68	18:53 (1)	20:46	76	18:59 (1)	21:03	70	19:04 (1)	20:44	78	19:09 (1)	19:54			18:52	16:56	16:18	16:19
29	07:33		05:49	05:51		17:46 (1)	05:14		17:45 (1)	05:10		17:54 (1)	05:37		17:50 (1)	06:17			06:58	06:41	07:26	07:49
	16:59		18:26	20:09	68	18:54 (1)	20:47	74	18:59 (1)	21:03	70	19:04 (1)	20:42	78	19:08 (1)	19:52			18:50	16:54	16:17	16:20
30	07:32		05:47	05:50		17:44 (1)	05:13		17:44 (1)	05:10		17:55 (1)	05:39		17:50 (1)	06:19			07:00	06:42	07:27	07:50
	17:00		18:28	20:11	70	18:54 (1)	20:48	76	19:00 (1)	21:03	68	19:03 (1)	20:41	80	19:10 (1)	19:50			18:48	16:52	16:17	16:21
31	07:31		05:45				05:12		17:45 (1)				05:40		17:51 (1)	06:20				06:44		07:50
	17:02		18:29				20:49	74	18:59 (1)				20:40	78	19:09 (1)	19:48				16:51		16:22
Potential sun hours	278	287	368	407			467			475			481			441			378	339	282	265
Total, worst case					782			2366			2102			2332			1680					
Sun reduction					0.56			0.56			0.65			0.75			0.65					
Oper. time red.					0.82			0.82			0.82			0.82			0.82					
Wind dir. red.					0.89			0.89			0.89			0.89			0.89					
Total reduction					0.40			0.40			0.47			0.55			0.47					
Total, real					314			951			997			1275			797					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbine H-46

Printed/Page
06/13/2003 14:58 / 3

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/13/2003 14:46/2.3.1.127

SHADOW - Calendar

Calculation: 030613 Shadow-Flicker, H-45, on 058W and 059W **Shadow Receptor:** 059W - 059W L Gerean

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	2 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.46	0.56	0.56	0.56	0.65	0.75	0.65	0.65	0.56	0.35	0.25

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
162	74	35	234	883	395	115	74	60	893	3,232	986	7,142

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:29	06:44	05:43	05:48	05:12	05:11	05:41	06:21	07:01	06:45	07:28
	16:23	17:03	17:46	18:30	20:12	20:50	21:03	20:38	19:46	18:46	16:49	16:16
2	07:50	07:28	06:43	05:41	05:47	05:11	05:12	05:42	06:23	07:03	06:47	07:29
	16:24	17:05	17:48	18:32	20:13	20:51	21:03	20:37	19:44	18:44	16:48	16:16
3	07:50	07:27	06:41	05:40	05:45	05:10	05:12	05:44	06:24	07:04	06:48	07:31
	16:25	17:06	17:49	18:33	20:15	20:52	21:02	20:36	19:42	18:42	16:46	16:15
4	07:50	07:26	06:39	05:38	05:43	05:10	05:13	05:45	06:25	07:05	06:50	07:32
	16:26	17:08	17:51	18:35	20:16	20:52	21:02	20:34	19:40	18:40	16:45	16:15
5	07:50	07:24	06:37	06:36	05:42	05:09	05:14	05:46	06:27	07:07	06:51	07:33
	16:27	17:09	17:52	19:36	20:17	20:53	21:02	20:33	19:38	18:38	16:43	16:15
6	07:49	07:23	06:35	06:34	05:40	05:09	05:14	05:47	06:28	07:08	06:53	07:34
	16:28	17:11	17:54	19:37	20:19	20:54	21:01	20:31	19:36	18:36	16:42	16:14
7	07:49	07:21	06:33	06:32	05:39	05:09	05:15	05:49	06:29	07:09	06:54	07:35
	16:29	17:12	17:55	19:39	20:20	20:55	21:01	20:30	19:34	18:34	16:40	16:14
8	07:49	07:20	06:31	06:30	05:37	05:08	05:16	05:50	06:31	07:11	06:56	07:36
	16:30	17:14	17:56	19:40	20:21	20:56	21:01	20:28	19:32	18:32	16:39	16:14
9	07:49	07:18	06:29	06:28	05:36	05:08	05:17	05:51	06:32	07:12	06:57	07:37
	16:31	17:16	17:58	19:42	20:23	20:56	21:00	20:27	19:30	18:30	16:37	16:14
10	07:48	07:17	06:27	06:26	05:35	05:08	05:17	05:53	06:33	07:14	06:59	07:38
	16:32	17:17	17:59	19:43	20:24	20:57	21:00	20:25	19:28	18:28	16:36	16:13
11	07:48	07:15	06:25	06:24	05:33	05:07	05:18	05:54	06:35	07:15	07:00	07:39
	16:33	17:19	18:01	19:44	20:25	20:58	20:59	20:24	19:26	18:26	16:35	16:13
12	07:47	07:14	06:23	06:22	05:32	05:07	05:19	05:55	06:36	07:16	07:02	07:40
	16:35	17:20	18:02	19:46	20:27	20:58	20:58	20:22	19:24	18:24	16:34	16:13
13	07:47	07:12	06:21	06:20	05:31	05:07	05:20	05:56	06:37	07:18	07:03	07:41
	16:36	17:22	18:04	19:47	20:28	20:59	20:58	20:20	19:22	18:22	16:32	16:13
14	07:46	07:11	06:19	06:18	05:29	05:07	05:21	05:58	06:39	07:19	07:05	07:42
	16:37	17:23	18:05	19:49	20:29	21:00	20:57	20:19	19:20	18:21	16:31	16:13
15	07:46	07:09	06:17	06:16	05:28	05:07	05:22	05:59	06:40	07:21	07:06	07:42
	16:39	17:25	18:07	19:50	20:31	21:00	20:56	20:17	19:18	18:19	16:30	16:13
16	07:45	07:07	06:15	06:14	05:27	05:07	05:23	06:00	06:41	07:22	07:08	07:43
	16:40	17:26	18:08	19:51	20:32	21:01	20:56	20:15	19:16	18:17	16:29	16:14
17	07:44	07:06	06:13	06:13	05:26	05:07	05:24	06:02	06:42	07:23	07:09	07:44
	16:41	17:28	18:09	19:53	20:33	21:01	20:55	20:14	19:14	18:15	16:28	16:14
18	07:44	07:04	06:11	06:11	05:24	05:07	05:25	06:03	06:44	07:25	07:11	07:45
	16:43	17:30	18:11	19:54	20:34	21:01	20:54	20:12	19:12	18:13	16:27	16:14
19	07:43	07:02	06:09	06:09	05:23	05:07	05:26	06:04	06:45	07:26	07:12	07:45
	16:44	17:31	18:12	19:55	20:35	21:02	20:53	20:10	19:10	18:11	16:26	16:14
20	07:42	07:01	06:07	06:07	05:22	05:07	05:27	06:06	06:46	07:28	07:13	07:46
	16:45	17:33	18:14	19:57	20:37	21:02	20:52	20:09	19:08	18:09	16:25	16:15
21	07:41	06:59	06:05	06:05	05:21	05:07	05:28	06:07	06:48	07:29	07:15	07:47
	16:47	17:34	18:15	19:58	20:38	21:02	20:51	20:07	19:06	18:08	16:24	16:15
22	07:40	06:57	06:03	06:04	05:20	05:07	05:29	06:08	06:49	07:31	07:16	07:47
	16:48	17:36	18:16	20:00	20:39	21:03	20:50	20:05	19:04	18:06	16:23	16:16
23	07:39	06:55	06:01	06:02	05:19	05:08	05:30	06:10	06:50	07:32	07:18	07:48
	16:50	17:37	18:18	20:01	20:40	21:03	20:49	20:03	19:02	18:04	16:22	16:16
24	07:38	06:54	05:59	06:00	05:18	05:08	05:32	06:11	06:52	07:34	07:19	07:48
	16:51	17:39	18:19	20:02	20:41	21:03	20:48	20:01	19:00	18:02	16:21	16:17
25	07:37	06:52	05:57	05:58	05:17	05:08	05:33	06:12	06:53	06:35	07:20	07:48
	16:53	17:40	18:21	20:04	20:42	21:03	20:47	19:59	18:58	18:01	16:20	16:17
26	07:36	06:50	05:55	05:57	05:16	05:09	05:34	06:14	06:54	06:36	07:22	07:49
	16:54	17:42	18:22	20:05	20:44	21:03	20:46	19:58	18:56	16:59	16:19	16:18
27	07:35	06:48	05:53	05:55	05:15	05:09	05:35	06:15	06:56	06:38	07:23	07:49
	16:56	17:43	18:24	20:07	20:45	21:03	20:45	19:56	18:54	16:57	16:19	16:19
28	07:34	06:46	05:51	05:53	05:15	05:09	05:36	06:16	06:57	06:39	07:24	07:49
	16:57	17:45	18:25	20:08	20:46	21:03	20:44	19:54	18:52	16:56	16:18	16:19
29	07:33		05:49	05:51	05:14	05:10	05:37	06:17	06:58	06:41	07:26	07:49
	16:59		18:26	20:09	20:47	21:03	20:42	19:52	18:50	16:54	16:17	16:20
30	07:32		05:47	05:50	05:13	05:10	05:39	06:19	07:00	06:42	07:27	07:50
	17:00		18:28	20:11	20:48	21:03	20:41	19:50	18:48	16:52	16:17	16:21
31	07:31		05:45		05:12		05:40	06:20		06:44		07:50
	17:02		18:29		20:49		20:40	19:48		16:51		16:22
Potential sun hours	278	287	368	407	467	475	481	441	378	339	282	265
Total, worst case												
Sun reduction												
Oper. time red.												
Wind dir. red.												
Total reduction												
Total, real												

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbine H-46

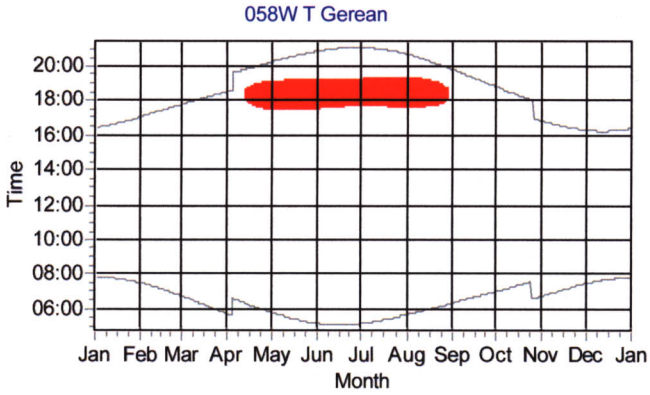
Printed/Page
06/13/2003 14:58 / 4

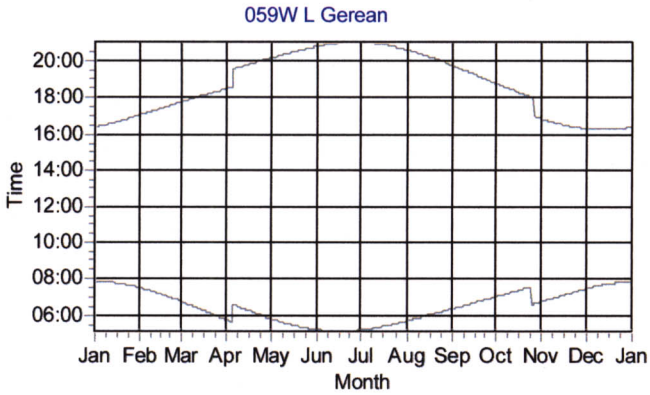
Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/13/2003 14:46/2.3.1.127

SHADOW - Calendar, graphical

Calculation: 030613 Shadow-Flicker, H-45, on 058W and 059W





WTGs

H-45

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbine H-46

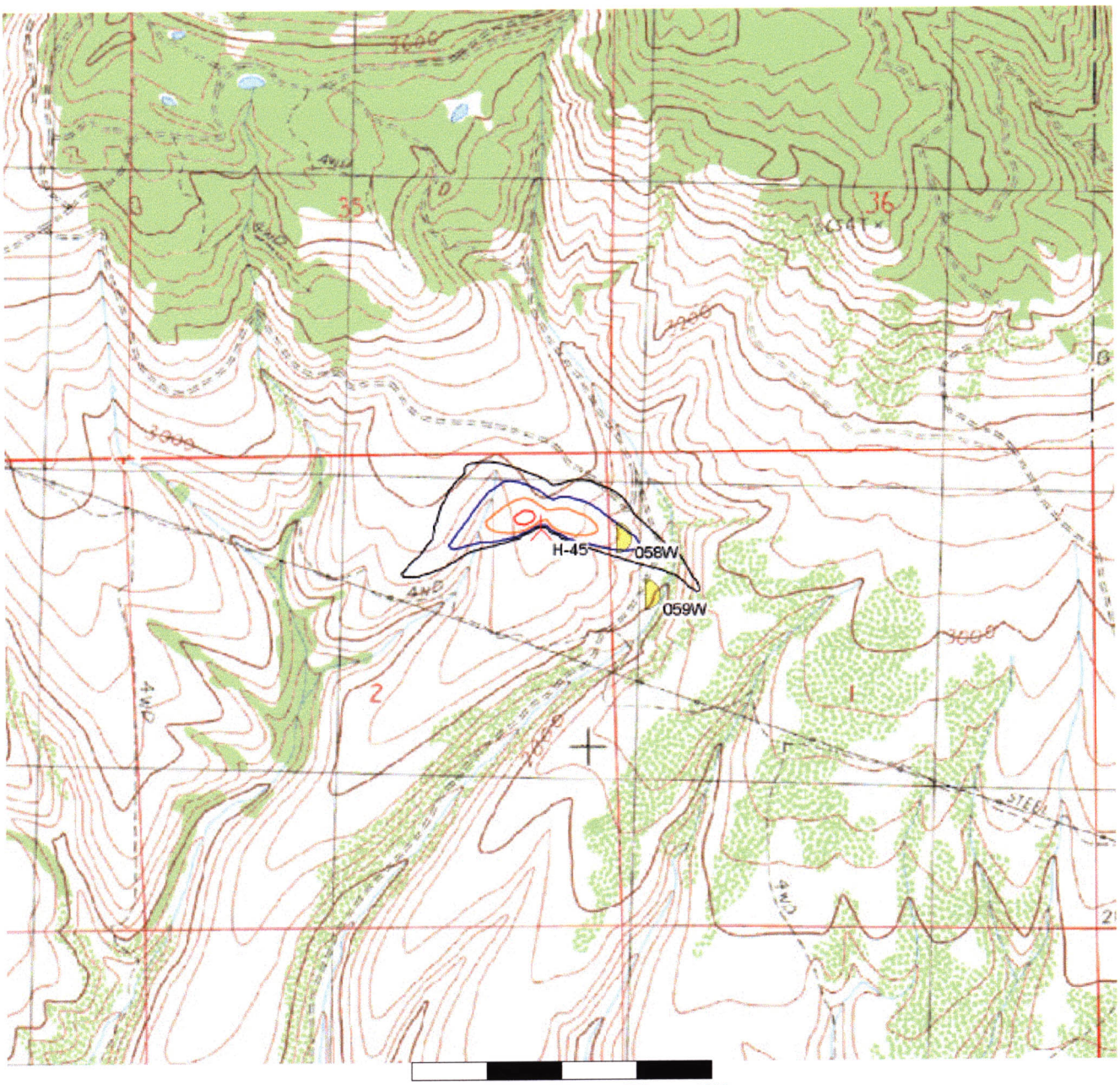
Printed/Page
06/13/2003 15:07 / 5

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/13/2003 14:46/2.3.1.127

SHADOW - Bitmap map: 030418 ZKV 24k,mt 001.bmi

Calculation: 030613 Shadow-Flicker, H-45, on 058W and 059W **File:** 030418 ZKV 24k,mt 001.bmi



0 250 500 750 1000m

Map: 030418 ZKV 24k,mt 001 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,673 North: 5,226,762

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor T Gerean and L Gerean (058W and 059W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbine H-46

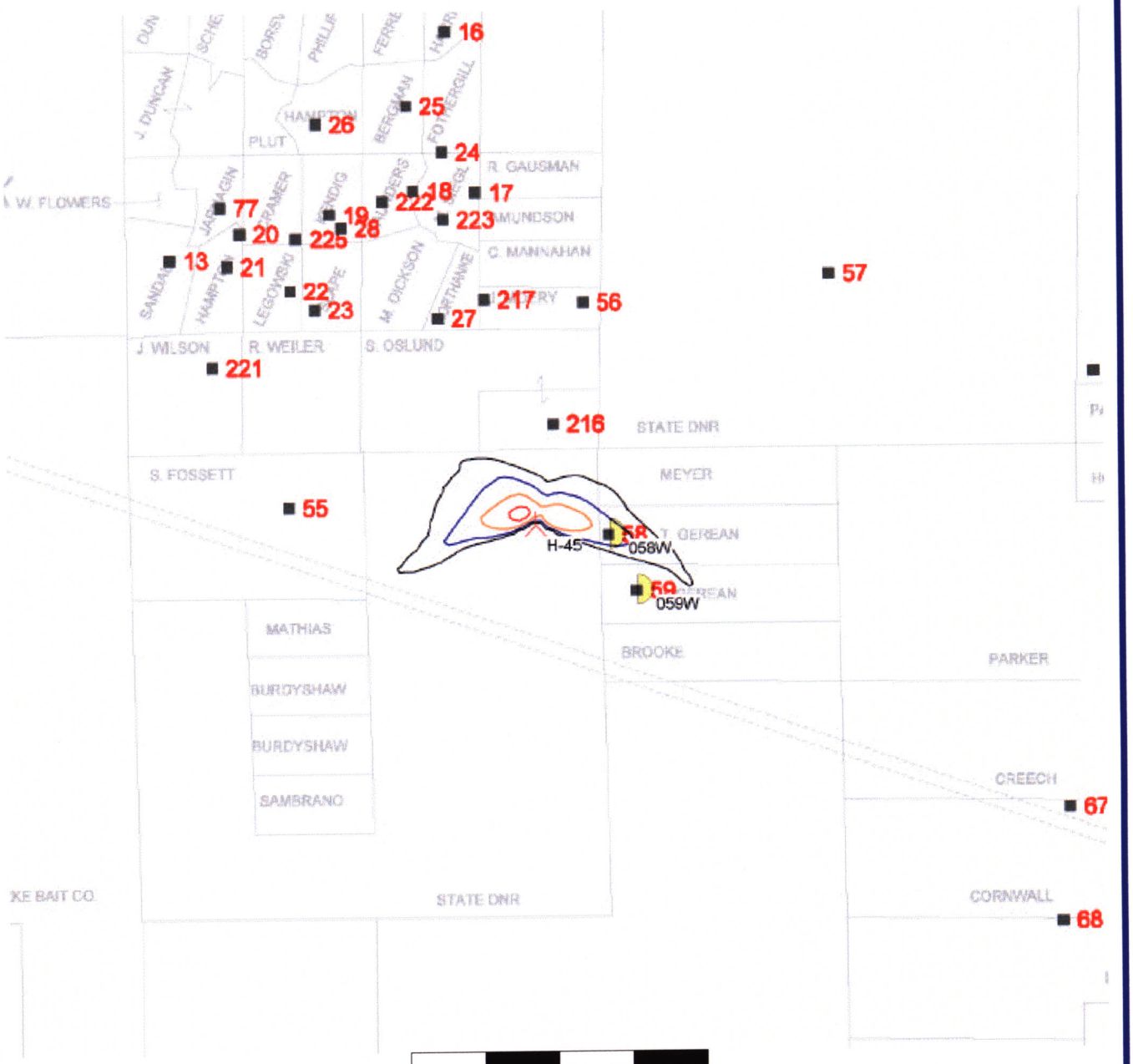
Printed/Page
06/13/2003 15:00 / 6

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/13/2003 14:46/2.3.1.127

SHADOW - Bitmap map: z-fig101-houses2.bmi

Calculation: 030613 Shadow-Flicker, H-45, on 058W and 059W **File:** z-fig101-houses2.bmi



0 250 500 750 1000m

Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,673 North: 5,226,762

New WTG
Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

July 2003 Shadow-Flicker Simulations

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor Genson (049E and 049W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbine H-46

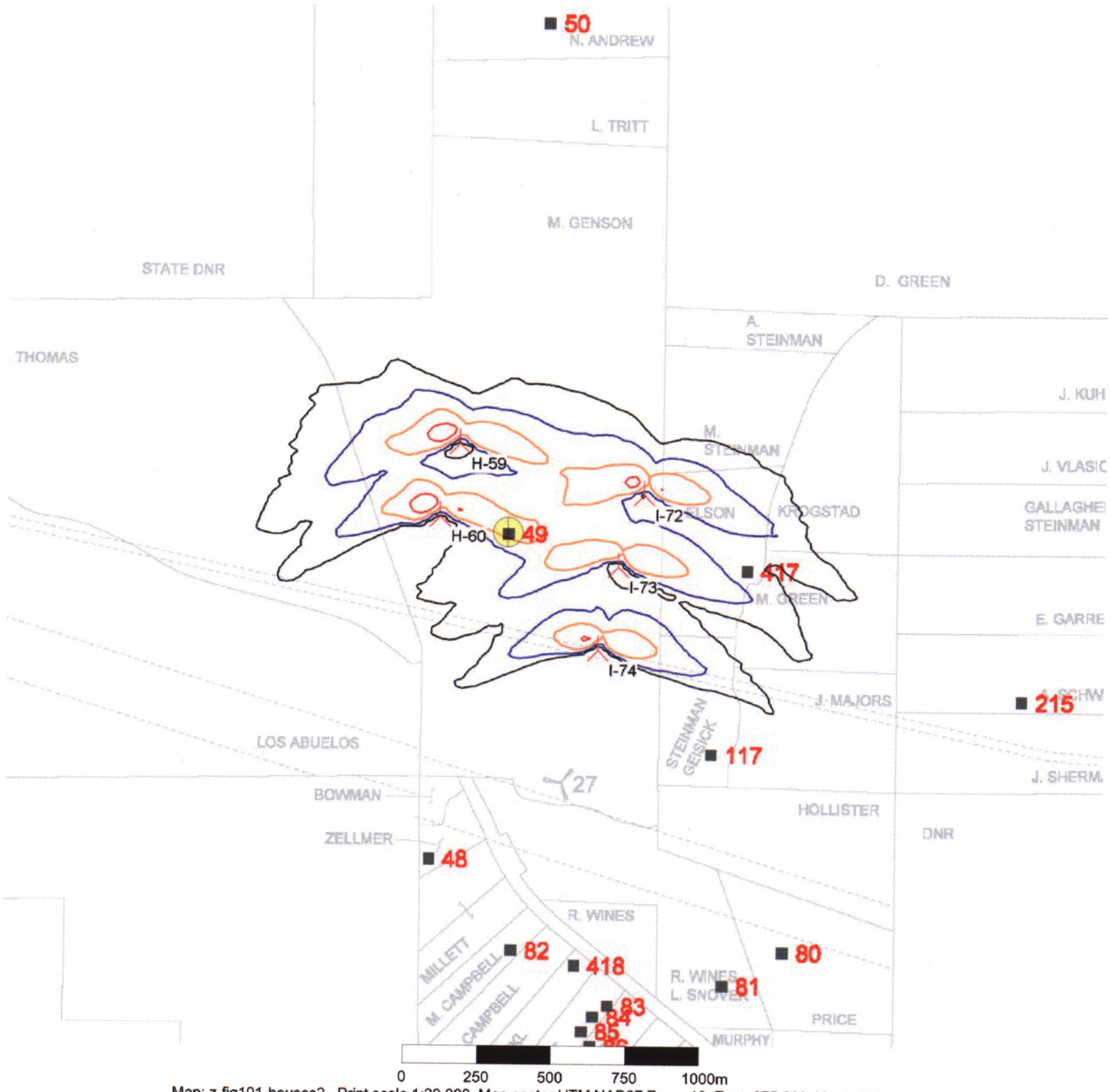
Printed/Page
07/18/2003 10:19 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
07/17/2003 23:56/2.3.1.127

SHADOW - Bitmap map: z-fig101-houses2.bmi

Calculation: 030717 Shadow-Flicker, H-59-60 and I-72-74, on 049E and 049W **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,823 North: 5,223,062

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Genson (049E and 049 W - east and west windows)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-22 through H-23 and I-16 through I-19
.
.

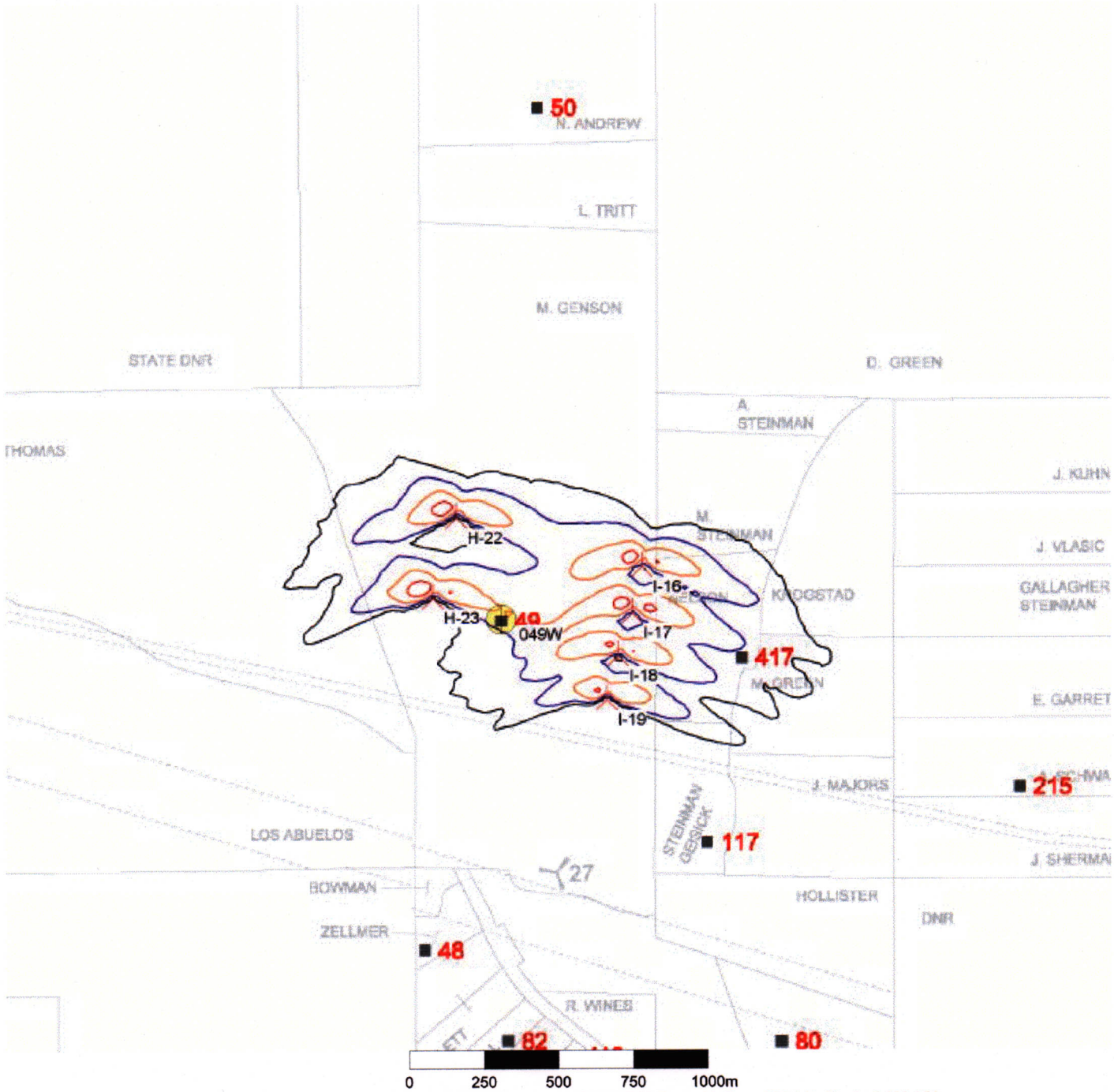
Printed/Page
06/12/2003 09:24 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
06/12/2003 09:12/2.3.1.127

SHADOW - Bitmap map: z-fig101-houses2.bmi

Calculation: 030612 Shadow-Flicker, H-22-23, I-16-19, on 049E and 049 W **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,842 North: 5,223,356

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
90 Meter diameter turbine
Shadow receptor Nelson (417N and 417W) and Geisick (117E and 117W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines I-61, I-70 through I-74 and J-75, J81 through J-84

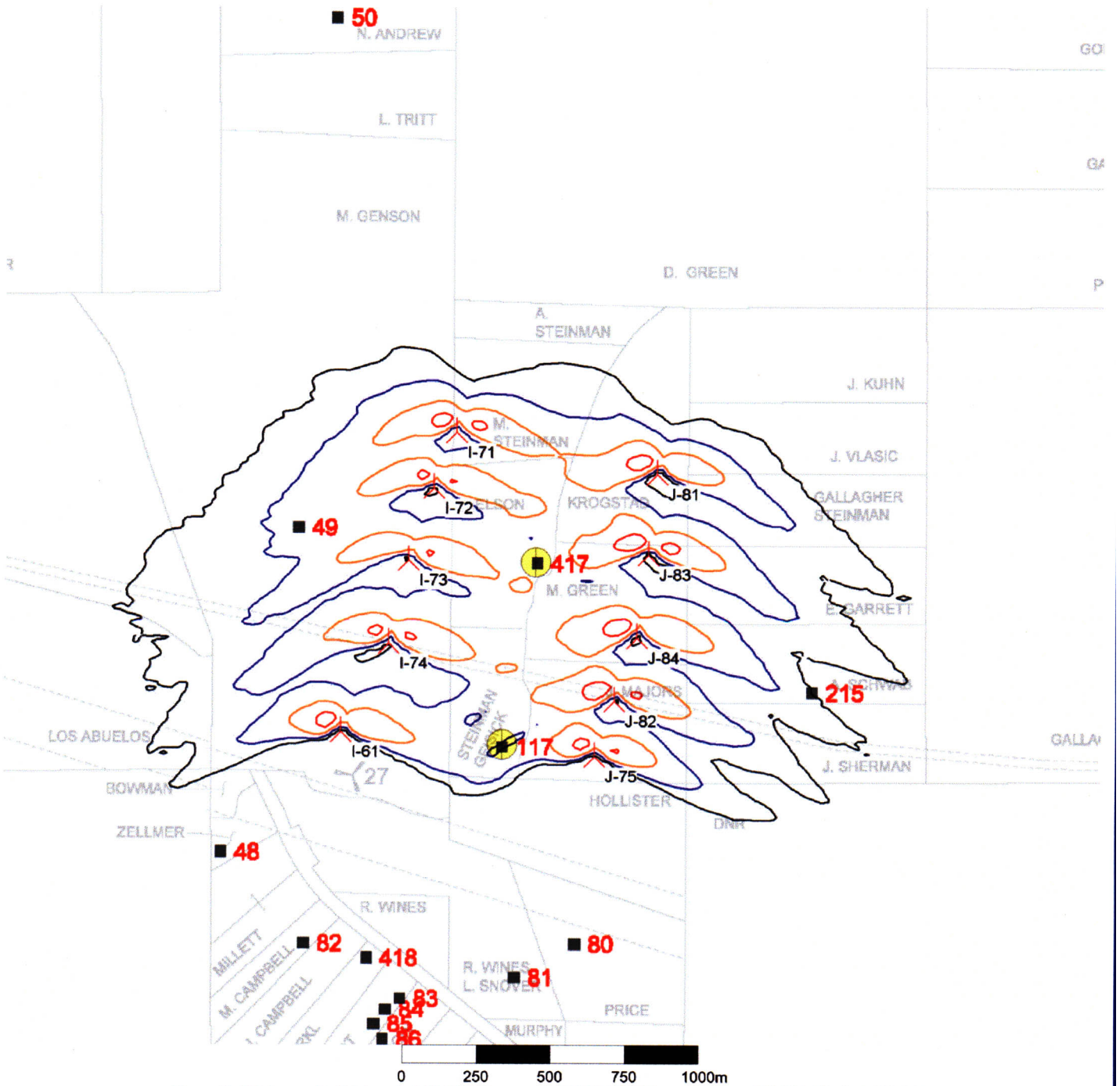
Printed/Page
7/29/2003 16:36 / 10

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
7/29/2003 15:31/2.3.1.127

SHADOW - Bitmap map: z-fig101-houses2.bmi

Calculation: 030729 Shadow-Flicker, I-61, I-7074 and J-75, J81-84, on 417E, 417W, 117E and 117W, 90m **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,523 North: 5,223,062

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Nelson (417N and 417W) and Geisick (117E and 117W)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines I-14 through I-21 and J-07 through J-15

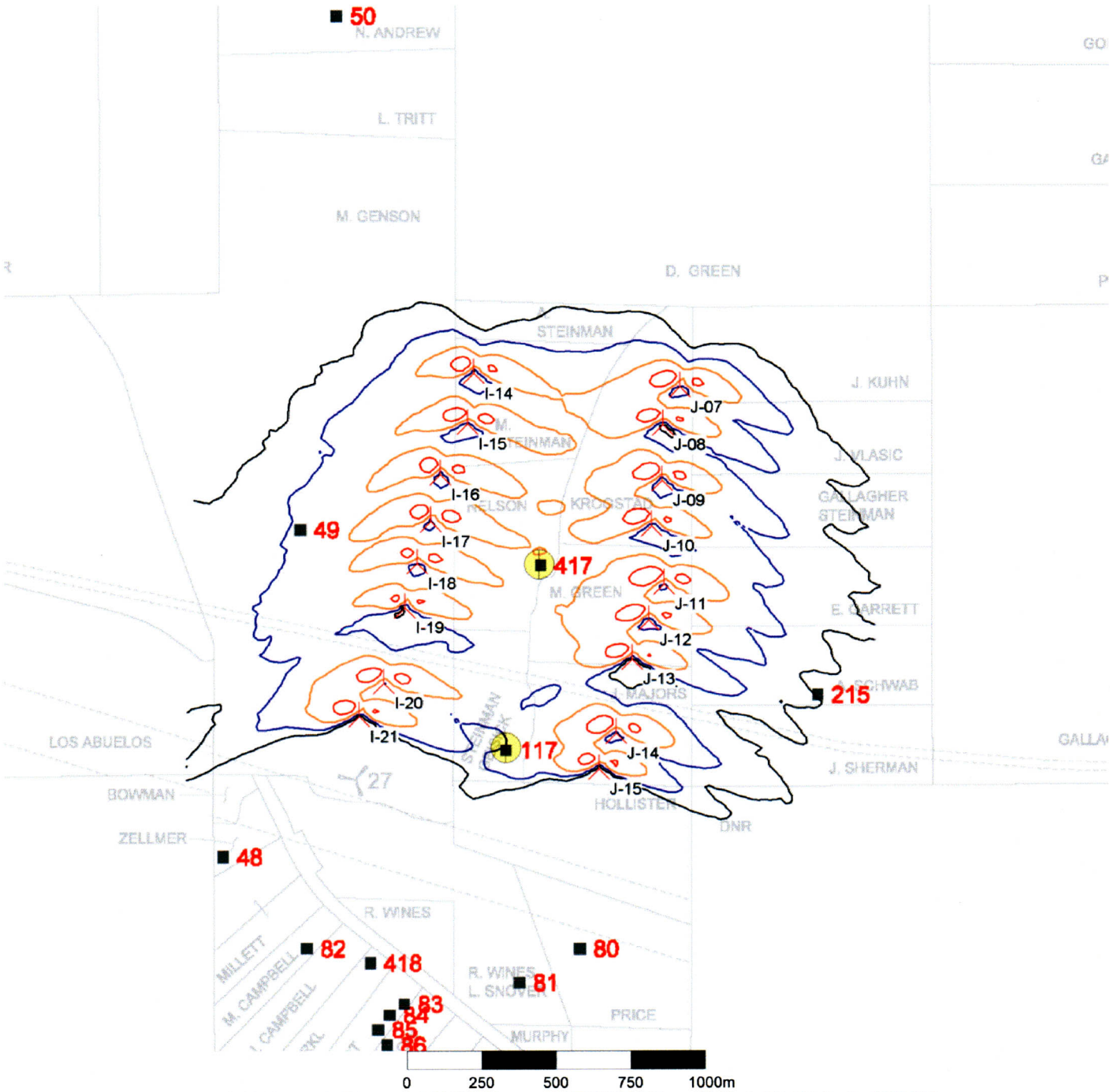
Printed/Page
07/17/2003 17:09 / 1

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
07/17/2003 16:05/2.3.1.127

SHADOW - Bitmap map: z-fig101-houses2.bmi

Calculation: 030717 Shadow-Flicker, I-14-21, J07-15, on 417E, 417W, 117E and 117W **File:** z-fig101-houses2.bmi



Map: z-fig101-houses2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,523 North: 5,223,062

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
90 meter diameter turbine
Shadow receptor Taylor (045S and 045E) and Robertson (555E, moved)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines D-15, F-30 and F-31

Printed/Page
08/20/2003 23:05 / 9

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
08/20/2003 22:50/2.3.1.127

SHADOW - zp-flicker01 copy

Calculation: 030820 Shadow-Flicker, D-15 and F-30-31, on 044S, 045E and 555E, 90m **File:** zp-flicker01 copy.bmi

Map: zp-flicker01 copy , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 673,623 North: 5,223,812

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
Shadow receptor Taylor (045S and 045E) and Robertson (555E, moved)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines D-01 and D-02, F-09 through F-12
.
.
.
.

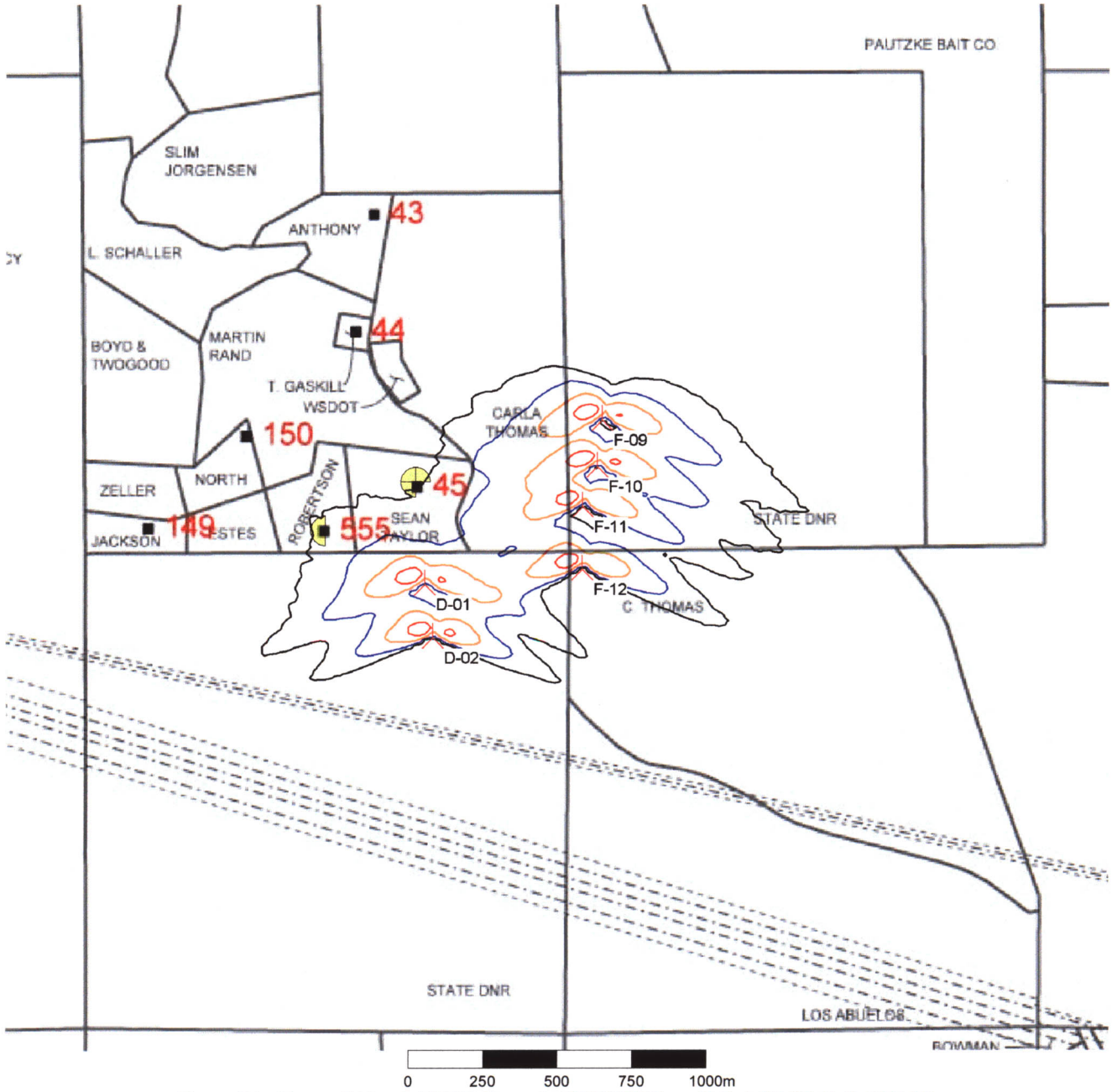
Printed/Page
08/21/2003 00:21 / 9

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
CA-92506 Riverside, USA

Calculated:
08/20/2003 23:58/2.3.1.127

SHADOW - zp-flicker01 copy

Calculation: 030820 Shadow-Flicker, D-01-02 and F-09-12, on 045S, 045E and 555E **File:** zp-flicker01 copy.bmi



Map: zp-flicker01 copy , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 673,723 North: 5,223,812

New WTG Shadow Receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200